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SPECIFICATION

Project No. R.076331
Building 111, Brandon Research Centre
Brandon, Manitoba
Issued for Construction – 08 June 2016
Solicitation No.

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Part 1 General

1.1 Work Covered By Contract Documents

- .1 Work of this Contract comprises general construction of a new pre-engineered building, including site work and infrastructure work, located at the Brandon Research Centre, Brandon Manitoba; and further identified as Building 111.

1.2 Contract Method

- .1 Construct Work under single stipulated price contract.

1.3 Work By Others

- .1 Co-operate with other Contractors in carrying out their respective works and carry out instructions from Consultant.
- .2 Co-ordinate work with that of other Contractors. If any part of work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Departmental Representative, in writing, any defects which may interfere with proper execution of Work.
- .3 Work of Project which will be executed after completion of Work of this Contract, and which is specifically excluded from this Contract:
 - .1 Supply and Installation of Furniture.
- .4 Work of this Project must include provisions for co-ordinating related work, identified in Contract Documents, for following principal items.
 - .1 Owner Supplied equipment.

1.4 Work Sequence

- .1 Construct Work in stages to accommodate Owner's continued use of adjacent premises during construction.
- .2 Maintain fire access/control.

1.5 Contractor Use Of Premises

- .1 Unrestricted use of site until Substantial Performance.
- .2 Co-ordinate use of premises under direction of Departmental Representative.
- .3 Obtain and pay for use of additional storage or work areas needed for operations under this Contract.
- .4 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .5 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.

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

1.6 Partial Owner Occupancy

- .1 Schedule and substantially complete designated portions of Work for Owner's occupancy prior to Substantial Performance of entire Work.
- .2 Owner will occupy designated areas for purpose of installation of equipment.
- .3 Execute Certificate of Substantial Performance for each designated portion of Work prior to Owner occupancy. Contractor shall allow:
 - .1 Access for Owner personnel.
 - .2 Use of parking facilities.
 - .3 Operation of HVAC and electrical systems.
- .4 On occupancy, Owner will provide for occupied areas:
 - .1 Operation of HVAC and electrical systems.
 - .2 Maintenance.
 - .3 Security.
- .5 Execute Partial Interim Certificate of Completion for each designated portion of Work prior to Owner occupancy. Contractor shall allow:
 - .1 Access for Owner personnel.
 - .2 Use of parking facilities.
 - .3 Operation of HVAC and electrical systems.

1.7 Owner Furnished Items

- .1 Owner 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 his control.
- .3 Schedule of Owner furnished items:
 - .1 Refer to Schedule on Drawing.

1.8 Existing Services

- .1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours' 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 pedestrian and vehicular traffic.
- .3 Provide alternative routes for personnel and vehicular traffic.
- .4 Establish location and extent of service lines in area of work before starting Work. Notify Departmental Representative of findings.
- .5 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .6 Provide temporary services when directed by Departmental Representative to maintain critical building and tenant systems.
- .7 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .8 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .9 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .10 Record locations of maintained, re-routed and abandoned service lines.
- .11 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.9 Documents Required

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

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

Part 2 Products

2.1 Not Used

- .1 Not used.

Part 3 Execution

3.1 Not Used

- .1 Not used.

END OF SECTION

Part 1 General

1.1 Access And Egress

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

1.2 Use Of Site And Facilities

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

1.3 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, provide Departmental Representative 48 hours' notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions to a minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends.
- .3 Provide for personnel and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.4 Special Requirements

- .1 Submit schedule in accordance with Section 01 32 16 - Construction Progress Schedule - Bar (GANTT) Chart.
- .2 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .3 Keep within limits of work and avenues of ingress and egress.
- .4 Ingress and egress of Contractor vehicles at site is limited to the location as designated by the Departmental Representative.

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

1.5 Building Smoking Environment

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 Administrative

- .1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting four days in advance of meeting date to Departmental Representative.
- .4 Provide physical space and make arrangements for meetings.
- .5 Preside at meetings.
- .6 Record the meeting minutes. Include significant proceedings and decisions. Identify actions by parties.
- .7 Reproduce and distribute copies of minutes within three days after meetings and transmit to meeting participants and, affected parties not in attendance.
- .8 Representative of Contractor, Subcontractor and suppliers attending meetings will be qualified and authorized to act on behalf of party each represents.

1.2 Preconstruction Meeting

- .1 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Senior representatives of Departmental Representative, Consultant, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.
- .4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
- .5 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work: in accordance with Section 01 32 16 - Construction Progress Schedules - Bar (GANTT) Chart.
 - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
 - .5 Site security in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.
 - .6 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

- .7 Owner provided products.
- .8 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .9 Maintenance manuals in accordance with Section 01 78 00 - Closeout Submittals.
- .10 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.
- .11 Monthly progress claims, administrative procedures, photographs, hold backs.
- .12 Appointment of inspection and testing agencies or firms.
- .13 Insurances, transcript of policies.

1.3 Progress Meetings

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

Part 2 Products

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 Definitions

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

1.2 Requirements

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

1.3 Submittals

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

1.4 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 Excavation.
 - .6 Backfill.
 - .7 Building footings.
 - .8 Slab on grade.
 - .9 Structural Steel.
 - .10 Siding and Roofing.
 - .11 Interior Architecture (Walls, Floors and Ceiling).
 - .12 Plumbing.
 - .13 Lighting.
 - .14 Electrical.
 - .15 Piping.
 - .16 Controls.
 - .17 Heating, Ventilating, and Air Conditioning.
 - .18 Millwork.
 - .19 Fire Systems.

- .20 Testing and Commissioning.
- .21 Supplied equipment long delivery items.
- .22 Engineer supplied equipment required dates.

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.

Part 2 Products
Not used.

Part 3 Execution
Not used.

END OF SECTION

Part 1 General

1.1 Administrative

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

1.2 Shop Drawings And Product Data

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in The Province of 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 7 business 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 copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
- .11 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental

- Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .12 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
 - .13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
 - .14 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and 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 Works and Government Services Canada (PWGSC) is for sole purpose of ascertaining conformance with general concept.

- .1 This review shall not mean that PWGSC approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.
- .2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 Samples

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Deliver samples prepaid to Departmental Representative's business addresses.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
- .6 Make changes in samples which Departmental Representative may require, consistent with Contract Documents.
- .7 Reviewed and accepted samples will become standard of workmanship and material against which installed Work will be verified.

1.4 Mock-Ups

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

1.5 Photographic Documentation

- .1 Submit electronic copy of colour digital photography in jpg format, fine resolution monthly with progress statement 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 as directed by Departmental Representative.
 - .1 Upon completion of: excavation, foundation, framing and services before concealment of Work, as directed by Departmental Representative.

1.6 Certificates And Transcripts

- .1 Immediately after award of Contract, submit Workers' Compensation Board status.
- .2 Submit transcription of insurance immediately after award of Contract.

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 References

.1 Definitions:

- .1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humans; or degrade environment aesthetically, culturally and/or historically.
- .2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction.

.2 Reference Standards:

- .1 U.S. Environmental Protection Agency (EPA)/Office of Water
 - .1 EPA 832/R-92-005-92, Storm Water Management for Construction Activities, Chapter 3.
 - .2 EPA General Construction Permit (GCP) 2012.

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 equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Submit 2 copies of WHMIS MSDS.

.3 Before commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative.

.4 Environmental Protection Plan must include comprehensive overview of known or potential environmental issues to be addressed during construction.

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

.6 Include in Environmental Protection Plan:

- .1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
- .2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
- .3 Names and qualifications of persons responsible for training site personnel.
- .4 Descriptions of environmental protection personnel training program.

- .5 Erosion and sediment control plan identifying type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations and EPA 832/R-92-005, Chapter 3.
- .6 Drawings indicating locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.
- .7 Traffic Control Plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather.
 - .1 Plans to include measures to minimize amount of material transported onto paved public roads by vehicles or runoff.
- .8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use.
 - .1 Plan to include measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.
- .9 Spill Control Plan to include procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
- .10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.
- .11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, are contained on project site.
- .12 Contaminant Prevention Plan identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
- .13 Waste Water Management Plan identifying methods and procedures for management discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.
- .14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.
- .15 Pesticide treatment plan to be included and updated, as required.

1.3 Fires

- .1 Fires and burning of rubbish on site is not permitted.
- .2 Where fires or burning is permitted, prevent staining or smoke damage to structures, materials or vegetation which is to be preserved.
 - .1 Restore, clean and return to new condition stained or damaged work.

- .3 Provide supervision, attendance and fire protection measures as directed.

1.4 Drainage

- .1 Develop and submit erosion and Sediment Control Plan (ESC) identifying type and location of erosion and sediment controls provided. Plan to include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations, EPA 832/R-92-005, Chapter 3.
- .2 Storm Water Pollution Prevention Plan (SWPPP) to be substituted for erosion and sediment control plan.
- .3 Provide temporary drainage and pumping required to keep excavations and site free from water.
- .4 Ensure pumped water into waterways, sewer or drainage systems is free of suspended materials.
- .5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.5 Site Clearing And Plant Protection

- .1 Protect trees and plants on site and adjacent properties as indicated.
- .2 Protect trees and shrubs adjacent to construction work, storage areas and trucking lanes, and encase with protective wood framework from grade level to height of 2 m minimum.
- .3 Protect roots of designated trees to dripline during excavation and site grading to prevent disturbance or damage.
 - .1 Avoid unnecessary traffic, dumping and storage of materials over root zones.
- .4 Minimize stripping of topsoil and vegetation.
- .5 Restrict tree removal to areas designated by Departmental Representative.

1.6 Pollution Control

- .1 Maintain temporary erosion and pollution control features installed under this Contract.
- .2 Control emissions from equipment and plant in accordance with local authorities' emission requirements.
- .3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area.
 - .1 Provide temporary enclosures where directed by Departmental Representative.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.7 Historical/Archaeological Control

- .1 Provide historical, archaeological, cultural resources, biological resources, and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on project site: and identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in area are discovered during construction.
- .2 Plan: include methods to assure protection of known or discovered resources and identify lines of communication between Contractor personnel and Departmental Representative.

1.8 Notification

- .1 Departmental Representative will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.
- .2 Contractor: after receipt of such notice, inform Departmental Representative of proposed corrective action and take such action for approval by Departmental Representative.
 - .1 Take action only after receipt of written approval by Departmental Representative.
- .3 Departmental Representative will issue stop order of work until satisfactory corrective action has been taken.
- .4 No time extensions granted or equitable adjustments allowed to Contractor for such suspensions.

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Cleaning

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Bury rubbish and waste materials on site where directed after receipt of written approval from Departmental Representative.
- .3 Ensure public waterways, storm and sanitary sewers remain free of waste and volatile materials disposal.
- .4 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

- .5 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.

END OF SECTION

Part 1 General

1.1 References And Codes

- .1 Perform Work in accordance with National Building Code of Canada (NBC) including amendments up to tender closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply.
- .2 Meet or exceed requirements of:
 - .1 Contract documents.
 - .2 Specified standards, codes and referenced documents.

1.2 Hazardous Material Discovery

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

1.3 Building Smoking Environment

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 Inspection

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

1.2 Independent Inspection Agencies

- .1 Engage certified material and testing agencies for purpose of inspecting and testing portions of Work. Include cost of testing in bid.
- .2 Departmental Representative may engage independent testing agencies to conduct random quality assurance testing. Costs for such testing will be borne by Departmental Representative.
- .3 Provide equipment required for executing inspection and testing by appointed agencies.
- .4 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .5 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 reinspection.

1.3 Access To Work

- .1 Allow inspection and 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 4 copies of inspection and test reports to Departmental Representative.
- .2 Provide copies to subcontractor of work 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 as specified in specific acceptable to Departmental Representative.
- .3 Prepare mock-ups for Departmental Representative 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 by reason of such default will be allowed.
- .5 If requested, Departmental Representative will assist in preparing schedule fixing dates for preparation.
- .6 Mock-ups may remain as part of Work.

1.9 Mill Tests

- .1 Submit mill test certificates as requested.

1.10 Equipment And Systems

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 References

- .1 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 Action And Informational Submittals

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

1.3 Installation And Removal

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

1.4 Dewatering

- .1 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.

1.5 Water Supply

- .1 Arrange for connection with appropriate utility company and pay costs for installation, maintenance and removal.
- .2 Contractor will pay for utility charges at prevailing rates.

1.6 Temporary Heating And Ventilation

- .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
- .2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.
- .3 Provide temporary heat and ventilation in enclosed areas as required to:
 - .1 Facilitate progress of Work.
 - .2 Protect Work and products against dampness and cold.
 - .3 Prevent moisture condensation on surfaces.
 - .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
 - .5 Provide adequate ventilation to meet health regulations for safe working environment.
- .4 Maintain temperatures of minimum 10 degrees C in areas where construction is in progress.
- .5 Ventilating:

- .1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
- .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
- .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
- .4 Ventilate storage spaces containing hazardous or volatile materials.
- .5 Ventilate temporary sanitary facilities.
- .6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.
- .6 Permanent heating system of building to be used when available. Be responsible for damage to heating system if use is permitted.
- .7 On completion of Work for which permanent heating system is used, replace filters, replace bearing, and clean ducts.
- .8 Ensure Date of Substantial Performance and Warranties for heating system do not commence until entire system is in as near original condition as possible and is certified by Departmental Representative.
- .9 Pay costs for maintaining temporary heat.
- .10 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
 - .1 Conform to applicable codes and standards.
 - .2 Enforce safe practices.
 - .3 Prevent abuse of services.
 - .4 Prevent damage to finishes.
 - .5 Vent direct-fired combustion units to outside.
- .11 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.7 Temporary Power And Light

- .1 Provide and pay for temporary power during construction for temporary lighting and operating of power tools, to a maximum supply of 208 volts 30 amps.
- .2 Arrange for connection with appropriate utility company. Pay costs for installation, maintenance and removal.
- .3 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx.
- .4 Contact Utility to determine requirements for temporary power during construction. Connect to existing power supply in accordance with Canadian Electrical Code and provide meters and switching.
- .5 Electrical power and lighting systems installed under this Contract may be used for construction requirements only with prior approval of Departmental Representative provided that guarantees are not affected. Make good damage to

electrical system caused by use under this Contract. Replace lamps which have been used for more than 3 months.

1.8 Temporary Communication Facilities

- .1 Provide and pay for temporary telephone and data hook up, lines and equipment necessary for own use.

1.9 Fire Protection

- .1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction governing codes, regulations and bylaws.
- .2 Burning rubbish and construction waste materials is not permitted on site.

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Temporary Erosion And Sedimentation Control

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

Part 1 General

1.1 References

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.189-00, Exterior Alkyd Primer for Wood.
 - .2 CGSB 1.59-97, Alkyd Exterior Gloss Enamel.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-0121-M1978(R2003), Douglas Fir Plywood.
 - .3 CAN/CSA-S269.2-M1987(R2003), Access Scaffolding for Construction Purposes.
 - .4 CAN/CSA-Z321-96(R2001), Signs and Symbols for the Occupational Environment.
- .3 Public Works Government Services Canada (PWGSC) Standard Acquisition Clauses and Conditions (SACC)-ID: R0202D, Title: General Conditions 'C', In Effect as of: May 14, 2004.
- .4 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.2 Action And Informational Submittals

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

1.3 Installation And Removal

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

1.4 Scaffolding

- .1 Scaffolding in accordance with CAN/CSA-S269.2.
- .2 Provide and maintain scaffolding, ladders, platforms and temporary stairs.

1.5 Hoisting

- .1 Provide, operate and maintain hoists cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for their use of hoists.
- .2 Hoists cranes to be operated by qualified operator.

1.6 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 be permitted on site provided it does not disrupt performance of Work.
- .2 Provide and maintain adequate access to project site.
- .3 Clean runways and taxi areas where used by Contractor's equipment.

1.8 Security

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

1.9 Offices

- .1 Provide office heated to 22 degrees C, lighted 750 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.
- .2 Provide marked and fully stocked first-aid case in a readily available location.
- .3 Subcontractors to provide their own offices as necessary. Direct location of these offices.

1.10 Equipment, Tool And Materials Storage

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

1.11 Sanitary Facilities

- .1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

- .3 When permanent water and drain connections are completed, provide temporary water closets and urinals complete with temporary enclosures, inside building. Permanent facilities may be used on approval of Departmental Representative.

1.12 Construction Signage

- .1 Provide and erect project sign, within three weeks of signing Contract, in a location designated by Departmental Representative.
- .2 Construction sign 2 x 4 m, of wood frame and plywood construction painted with exhibit lettering produced by a professional sign painter.
- .3 Indicate on sign, name of Owner, Consultants, Contractor and Subcontractor, of design style established by Departmental Representative.
- .4 No other signs or advertisements, other than warning signs, are permitted on site.
- .5 Provide project identification site sign comprising foundation, framing, and one 1200 x 2400 mm signboard as detailed and as described below.
 - .1 Foundations: 15 MPa concrete to CSA-A23.1 minimum 200 mm x 900 mm deep.
 - .2 Framework and battens: SPF, pressure treated minimum 89 x 89 mm.
 - .3 Signboard: 19 mm Medium Density Overlaid Douglas Fir Plywood to CSA O121.
 - .4 Paint: alkyd enamel to CAN/CGSB-1.59 over exterior alkyd primer to CAN/CGSB 1.189.
 - .5 Fasteners: hot-dip galvanized steel nails and carriage bolts.
 - .6 Vinyl sign face: printed project identification, self adhesive, vinyl film overlay, supplied by Departmental Representative.
- .6 Locate project identification sign as directed by Departmental Representative and construct as follows:
 - .1 Build concrete foundation, erect framework, and attach signboard to framing.
 - .2 Paint surfaces of signboard and framing with one coat primer and two coats enamel. Colour white on signboard face, black on other surfaces.
 - .3 Apply vinyl sign face overlay to painted signboard face in accordance with installation instruction supplied.
- .7 Direct requests for approval to erect Consultant/Contractor signboard to Departmental Representative. For consideration general appearance of Consultant/Contractor signboard must conform to project identification site sign. Wording in both official languages.
- .8 Signs and notices for safety and instruction in both official languages Graphic symbols to CAN/CSA-Z321.
- .9 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.

1.13 Protection And Maintenance Of Traffic

- .1 Provide access and temporary relocated roads as necessary to maintain traffic.
- .2 Maintain and protect traffic on affected roads during construction period except as otherwise specifically directed by Departmental Representative.
- .3 Provide measures for protection and diversion of traffic, including provision of watch-persons and flag-persons, erection of barricades, placing of lights around and in front of equipment and work, and erection and maintenance of adequate warning, danger, and direction signs
- .4 Protect travelling public from damage to person and property.
- .5 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.
- .6 Verify adequacy of existing roads and allowable load limit on these roads.
Contractor: responsible for repair of damage to roads caused by construction operations.
- .7 Construct access and haul roads as necessary.
- .8 Haul roads: constructed with suitable grades and widths; avoid sharp curves, blind corners, and dangerous cross traffic.
- .9 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.
- .10 Dust control: adequate to ensure safe operation at all times.
- .11 Location, grade, width, and alignment of construction and hauling roads: subject to approval by Departmental Representative.
- .12 Lighting: to assure full and clear visibility for full width of haul road and work areas during night work operations.
- .13 Provide snow removal during period of Work.
- .14 Remove, upon completion of work, haul roads designated by Departmental Representative.

1.14 Clean-Up

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Temporary Erosion And Sedimentation Control

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

Part 1 General

1.1 References

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

1.2 Installation And Removal

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

1.3 Hoarding

- .1 Erect temporary site enclosures using 38 x 89 mm construction grade lumber framing at 600 mm centres and 1200 x 2400 x 13 mm exterior grade fir plywood to CSA O121.
- .2 Apply plywood panels vertically flush and butt jointed.
- .3 Provide two lockable truck entrance gates and at least one pedestrian door as directed and conforming to applicable traffic restrictions on adjacent streets. Equip gates with locks and keys.
- .4 Paint public side of site enclosure in selected colours with one coat primer to CAN/CGSB 1.189 and one coat exterior paint to CGSB 1.59. Maintain public side of enclosure in clean condition.
- .5 Erect temporary site enclosure using new 1.2 m high snow fence wired to rolled steel "T" bar fence posts spaced at 2.4 m on centre. Provide one lockable truck gate. Maintain fence in good repair.
- .6 Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.

1.4 Guard Rails And Barricades

- .1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs.
- .2 Provide as required by governing authorities.

1.5 Weather Enclosures

- .1 Provide weather tight closures to unfinished door and window openings, tops of shafts and other openings in floors and roofs.
- .2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.
- .3 Design enclosures to withstand wind pressure and snow loading.

1.6 Access To Site

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

1.7 Public Traffic Flow

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

1.8 Fire Routes

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

1.9 Protection For Off-Site And Public Property

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

1.10 Protection Of Building Finishes

- .1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.
- .2 Provide necessary screens, covers, and hoardings.
- .3 Confirm with Departmental Representative locations and installation schedule three days prior to installation.
- .4 Be responsible for damage incurred due to lack of or improper protection.

1.11 Waste Management And Disposal

- .1 Separate waste materials for recycling 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 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 References

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

1.3 Availability

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that

substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.

- .2 In event of failure to notify 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 name plates.

1.5 Transportation

- .1 Pay costs of transportation of products required in performance of Work.
- .2 Transportation cost of products supplied by Owner will be paid for by 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 Refer to Section 01 73 00 - Execution Requirements.
- .2 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .3 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.11 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.

1.15 Existing Utilities

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 References

- .1 Owner's identification of existing survey control points and property limits.

1.2 Qualifications Of Surveyor

- .1 Qualified registered land surveyor, licensed to practice in Place of Work, acceptable to Departmental Representative.

1.3 Survey Reference Points

- .1 Locate, confirm and protect control points prior to starting site work. Preserve permanent reference points during construction.
- .2 Make no changes or relocations without prior written notice to Departmental Representative.
- .3 Report to Departmental Representative when reference point is lost or destroyed, or requires relocation because of necessary changes in grades or locations.
- .4 Require surveyor to replace control points in accordance with original survey control.

1.4 Survey Requirements

- .1 Establish two permanent bench marks on site, referenced to established bench marks by survey control points. Record locations, with horizontal and vertical data in Project Record Documents.
- .2 Provide as-built survey drawings and data.
- .3 Establish lines and levels, locate and lay out, by instrumentation.
- .4 Stake for grading, fill and topsoil placement and landscaping features.
- .5 Stake slopes and berms.
- .6 Establish pipe invert elevations.
- .7 Stake batter boards for foundations.
- .8 Establish foundation column locations and floor elevations.
- .9 Establish lines and levels for mechanical and electrical work.

1.5 Existing Services

- .1 Before commencing work, establish location and extent of service lines in area of Work and notify Departmental Representative of findings.
- .2 Remove abandoned service lines within 2 metres of structures. Cap or otherwise seal lines at cut-off points as directed by Departmental Representative.

1.6 Location Of Equipment And Fixtures

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

1.7 Records

- .1 Maintain a complete, accurate log of control and survey work as it progresses.
- .2 On completion of foundations and major site improvements, prepare a certified survey showing dimensions, locations, angles and elevations of Work.
- .3 Record locations of maintained, re-routed and abandoned service lines.

1.8 Action And Informational Submittals

- .1 Submit name and address of Surveyor to Departmental Representative.
- .2 On request of Departmental Representative, submit documentation to verify accuracy of field engineering work.
- .3 Submit certificate signed by surveyor certifying and noting those elevations and locations of completed Work that conform and do not conform with Contract Documents.

1.9 Subsurface Conditions

- .1 Promptly notify Consultant in writing if subsurface conditions at Place of Work differ materially from those indicated in Contract Documents, or a reasonable assumption of probable conditions based thereon.
- .2 After prompt investigation, should Departmental Representative determine that conditions do differ materially, instructions will be issued for changes in Work as provided in Changes and Change Orders.

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 Action And Informational Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit written request in advance of cutting or alteration which affects:
 - .1 Structural integrity of elements of project.
 - .2 Integrity of weather-exposed or moisture-resistant elements.
 - .3 Efficiency, maintenance, or safety of operational elements.
 - .4 Visual qualities of sight-exposed elements.
 - .5 Work of Owner or separate contractor.
- .3 Include in request:
 - .1 Identification of project.
 - .2 Location and description of affected Work.
 - .3 Statement on necessity for cutting or alteration.
 - .4 Description of proposed Work, and products to be used.
 - .5 Alternatives to cutting and patching.
 - .6 Effect on Work of Owner or separate contractor.
 - .7 Written permission of affected separate contractor.
 - .8 Date and time work will be executed.

1.2 Materials

- .1 As required for original installation.
- .2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00 - Submittal Procedures.

1.3 Preparation

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of Work.
- .3 Beginning of cutting or patching means acceptance of existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of project from damage.
- .5 Provide protection from elements for areas which are to be exposed by uncovering work; maintain excavations free of water.

1.4 Execution

- .1 Execute cutting, fitting, and patching including excavation and fill, to complete Work.

- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Remove samples of installed Work for testing.
- .6 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .7 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .8 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .9 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .10 Restore work with new products in accordance with requirements of Contract Documents.
- .11 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .12 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with firestopping material in accordance with Section 07 84 00 - Firestopping, full thickness of the construction element.
- .13 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .14 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas except where indicated otherwise.

1.5 Waste Management And Disposal

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 Project Cleanliness

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

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

1.3 Waste Management And Disposal

- .1 Separate waste materials 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 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 Waste Management Goals

- .1 Prior to start of Work conduct meeting with Departmental Representative to review and discuss PWGSC's waste management goal and Contractor's proposed Waste Reduction Workplan for Construction, Renovation and /or Demolition (CRD) waste to be project generated.
- .2 PWGSC's waste management goal: to divert a minimum 75 percent of total Project Waste from landfill sites. Prior to project completion provide Departmental Representative documentation certifying that waste management, recycling, reuse of recyclable and reusable materials have been extensively practiced. The overall waste diversion goal for this project is 50%.
- .3 Target percentage goals are achievable for waste diversion. Contractor to review and confirm Departmental Representative's Waste Audit acceptable values.
- .4 Minimize amount of non-hazardous solid waste generated by project and accomplish maximum source reduction, reuse and recycling of solid waste produced by CRD activities.
- .5 Protect environment and prevent environmental pollution damage.

1.2 References

- .1 Definitions:
 - .1 Approved/Authorized recycling facility: waste recycler approved by applicable provincial authority or other users of material for recycling approved by the Departmental Representative.
 - .2 Class III: non-hazardous waste - construction renovation and demolition waste.
 - .3 Construction, Renovation and/or Demolition (CRD) Waste: Class III solid, non-hazardous waste materials generated during construction, demolition, and/or renovation activities
 - .4 Cost/Revenue Analysis Workplan (CRAW): based on information from Waste Reduction Workplan, and intended as financial tracking tool for determining economic status of waste management practices (Schedule E).
 - .5 Inert Fill: inert waste - exclusively asphalt and concrete.
 - .6 Waste Source Separation Program (WSSP): implementation and co-ordination of ongoing activities to ensure designated waste materials will be sorted into pre-defined categories and sent for recycling and reuse, maximizing diversion and potential to reduce disposal costs.
 - .7 Recyclable: ability of product or material to be recovered at end of its life cycle and re-manufactured into new product for reuse.
 - .8 Recycle: process by which waste and recyclable materials are transformed or collected for purpose of being transferred into new products.

- .9 Recycling: process of sorting, cleaning, treating and reconstituting solid waste and other discarded materials for purpose of using in altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- .10 Reuse: repeated use of product in same form but not necessarily for same purpose. Reuse includes:
 - .1 Salvaging reusable materials from re-modelling projects, before demolition stage, for resale, reuse on current project or for storage for use on future projects.
 - .2 Returning reusable items including pallets or unused products to vendors.
- .11 Salvage: removal of structural and non-structural materials from deconstruction/disassembly projects for purpose of reuse or recycling.
- .12 Separate Condition: refers to waste sorted into individual types.
- .13 Source Separation: act of keeping different types of waste materials separate beginning from the point they became waste.
- .14 Waste Audit (WA): detailed inventory of estimated quantities of waste materials that will be generated during construction, demolition, deconstruction and/or renovation. Involves quantifying by volume/weight amounts of materials and wastes that will be reused, recycled or landfilled. Refer to Schedule A.
- .15 Waste Diversion Report: detailed report of final results, quantifying cumulative weights and percentages of waste materials reused, recycled and landfilled over course of project. Measures success against Waste Reduction Workplan (WRW) goals and identifies lessons learned.
- .16 Waste Management Co-ordinator (WMC): contractor representative responsible for supervising waste management activities as well as co-ordinating required submittal and reporting requirements.
- .17 Waste Reduction Workplan (WRW): written report which addresses opportunities for reduction, reuse, or recycling of materials generated by project. Specifies diversion goals, implementation and reporting procedures, anticipated results and responsibilities. Waste Reduction Workplan (Schedule B) information acquired from Waste Audit.
- .2 Reference Standards:
 - .1 Ontario Ministry of Environment
 - .1 Ontario 3 R's Regulations (regulation 102/94) for waste management programs applicable to construction and demolition projects greater than 2,000 m2.
 - .2 Ontario Environmental Protection Act (EPA)
 - .1 Regulation 102/94, Waste Audits and Waste Reduction Workplans.
 - .2 Regulation 103/94, Source Separation Programs.
 - .3 Canadian Construction Association (CCA)
 - .1 CCA 81-2001: A Best Practices Guide to Solid Waste Reduction.

- .4 Public Works and Government Services Canada (PWGSC)
 - .1 2002 National Construction, Renovation and Demolition Non-Hazardous Solid Waste Management Protocol.
 - .2 CRD Waste Management Market Research Report (available from PWGSC's Environmental Services).
 - .3 Sustainable Development Strategy 2007-2009: Target 2.1 Environmentally Sustainable Use of Natural Resources.
 - .1 Real Property projects over \$1 million and in communities where industrial recycling is supported, implementation of CRD waste management practices will be completed, with waste materials being reused or recycled.
 - .2 Contractually ensure resources used in construction or maintenance are consumed and recovered in a sustainable manner.

1.3 Documents

- .1 Post and maintain in visible and accessible area at job site, one copy of following documents:
 - .1 Waste Audit (Schedule A).
 - .2 Waste Reduction Workplan (Schedule B).
 - .3 Waste Source Separation Program.
 - .4 Schedules A and B completed for project.

1.4 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare and submit following prior to project start-up:
 - .1 1 electronic copy of completed Waste Audit (WA): Schedule A.
 - .2 1 electronic copy of completed Waste Reduction Workplan (WRW): Schedule B.
 - .3 1 electronic copy of Cost/Revenue Analysis Workplan (CRAW): Schedule E.
 - .4 1 electronic copy of Waste Source Separation Program (WSSP).
- .3 Prepare and submit on monthly basis, throughout project or at intervals agreed to by Departmental Representative the following:
 - .1 Receipts, scale tickets, waybills, and/or waste disposal receipts that show quantities and types of materials reused, recycled, or disposed of.
 - .2 Updated Waste Materials Tracking form (Schedule D).
 - .3 Written monthly summary report detailing cumulative amounts of waste materials reused, recycled and landfilled, and brief status of ongoing waste management activities.
- .4 Submit prior to final payment the following:

- .1 Waste Diversion Report, indicating final quantities [in tones] by material types salvaged for reuse, recycling or disposal in landfill and recycling centres, re-use depots, landfills and other waste processors that received waste materials (See Schedule C).
- .2 Provide receipts, scale tickets, waybills, waste disposal receipts that confirm quantities and types of materials reused, recycled or disposed of and destination.

1.5 Waste Audit (Wa)

- .1 Departmental Representative will prepare WA prior to project start-up. WA will be provided with bid documentation (see Schedule A).
- .2 WA provides detailed inventory, estimated quantities and types of waste materials that will be generated as well as their potential to be reused and/or recycled and project's waste diversion goals and objectives.
- .3 After award of contract, contractor to review WA and confirm that anticipated quantities of waste generated are accurate and goals achievable.
- .4 If after review, contractor determines that indicated quantities or opportunities in WA are not accurate or achievable, contractor to provide written details of discrepancies and revised quantities for areas of concern. Contractor to meet with Departmental Representative to review and justify revisions.
- .5 Post on-site WA where contractor and sub-contractors are able to review content.

1.6 Waste Reduction Workplan (Wrw)

- .1 Prepare and submit WRW (Schedule B) at least 10 days prior to project start-up.
- .2 WRW identifies strategies to optimize diversion through reduction, reuse, and recycling of materials and comply with applicable regulations, based on information acquired from WA.
- .3 WRW should include but not limited to:
 - .1 Applicable regulations.
 - .2 Specific goals for waste reduction, identify existing barriers and develop strategies to overcome them.
 - .3 Destination of materials identified.
 - .4 Deconstruction/disassembly techniques and schedules.
 - .5 Methods to collect, separate, and reduce generated wastes.
 - .6 Location of waste bins on-site.
 - .7 Security of on-site stock piles and waste bins.
 - .8 Protection of personnel, sub-contractors.
 - .9 Clear labelling of storage areas.
 - .10 Training plan for contractor and sub-contractors.
 - .11 Methods to track and report results reliably (Schedule D).
 - .12 Details on materials handling and removal procedures.

- .13 Recycler and reclaimer requirements.
- .14 Quantities of materials to be salvaged for reuse or recycled and materials sent to landfill.
- .15 Requirements for monitoring on-site wastes management activities.
- .4 Structure WRW to prioritize actions and follow 3R's hierarchy, with Reduction as first priority, followed by Reuse, then Recycle.
- .5 Post WRW or summary where workers at site are able to review content.
- .6 Monitor and report on waste reduction by documenting total volume (in tonnes) and cost of actual waste removed from project (Schedule D).

1.7 Cost/Revenue Analysis Workplan (Craw)

- .1 Prepare CRAW (see Schedule E) and include the following:
 - .1 Cost of current waste management practices.
 - .2 Implementation cost of waste diversion program.
 - .3 Savings and benefits resulting from waste diversion program.

1.8 Waste Source Separation Program (Wssp)

- .1 As part of Waste Reduction Workplan, prepare WSSP prior to project start-up.
- .2 WSSP will detail methodology and planned on-site activities for separation of reusable and recyclable materials from waste intended for landfill.
- .3 Provide list and drawings of locations that will be made available for sorting, collection, handling and storage of anticipated quantities of reusable and recyclable materials.
- .4 Provide sufficient on-site facilities and containers for collection, handling, and storage of anticipated quantities of reusable and recyclable materials.
- .5 Locate containers to facilitate deposit of materials without hindering daily operations.
- .6 Provide training for contractor in handling and separation of materials for reuse and/or recycling.
- .7 Locate separated materials in areas which minimizes material damage.
- .8 Clearly and securely label containers to identify types/conditions of materials accepted and assist workers in separating materials accordingly.
- .9 Monitor on-site waste management activities by conducting periodic site inspections to verify: state of signage, contamination levels, bin locations and condition, personnel participation, use of waste tracking forms and collection of waybills, receipts and invoices.
- .10 On-site sale of salvaged materials is not permitted unless authorized in writing by Departmental Representative and provided that site safety regulations and security requirements are adhered to.

1.9 Use Of Site And Facilities

- .1 Execute Work with minimal interference and disturbance to normal use of premises.
- .2 Maintain security measures established by facility provide temporary security measures approved by Departmental Representative.

1.10 Waste Processing Sites

- .1 Contractor is responsible to research and locate waste diversion resources and service providers. Salvaged materials are to be transported off site to approved and/or authorized recycling facilities or to users of material for recycling.

1.11 Quality Assurance

- .1 After award of Contract, a mandatory site examination will be held for this Project for Contractor responsible for construction, renovation demolition/deconstruction waste management.
- .2 Waste Management Meeting: Waste Management Co-ordinator is to provide an update on status of waste diversion and management activities at each meeting. Written monthly Waste Diversion Report summary to be provided by Waste Management Coordinator (refer to the Waste Diversion Report form in Schedule C and Waste Materials Tracking form in Schedule D).

1.12 Storage, Handling And Protection

- .1 Store, materials to be reused, recycled and salvaged in locations as directed by Departmental Representative.
- .2 Unless specified otherwise, materials for removal do not become Contractor's property.
- .3 Protect, stockpile, store and catalogue salvaged items.
- .4 Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to licensed disposal facility.
- .5 Protect structural components not removed and salvaged materials from movement or damage.
- .6 Support affected structures. If safety of building is endangered, cease operations and immediately notify Departmental Representative.
- .7 Protect surface drainage, mechanical and electrical from damage and blockage.
- .8 Provide on-site facilities and containers for collection and storage of reusable and recyclable materials.
- .9 Separate and store materials produced during project in designated areas.
- .10 Prevent contamination of materials to be salvaged and recycled and handle materials in accordance with requirements for acceptance by designated processing facilities.
 - .1 On-site source separation is recommended.
 - .2 Remove co-mingled materials to off site processing facility for separation.

- .3 Obtain waybills, receipts and/or scale tickets for separated materials removed from site.
- .4 Materials reused on-site are considered to be diverted from landfill and as such are to be included in all reporting.

1.13 Disposal Of Wastes

- .1 Do not bury rubbish or waste materials.
- .2 Do not dispose of waste into waterways, storm, or sanitary sewers.
- .3 Keep records of construction waste including:
 - .1 Number and size of bins.
 - .2 Waste type of each bin.
 - .3 Total tonnage generated.
 - .4 Tonnage reused or recycled.
 - .5 Reused or recycled waste destination.
- .4 Remove materials on-site as Work progresses.
- .5 Prepare project summary to verify destination and quantities on a material-by-material basis as identified in the waste audit.

1.14 Scheduling

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Application

- .1 Perform Work in compliance with WRW and WSSP.
- .2 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

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 recycling.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
- .2 Source separate materials to be reused/recycled into specified sort areas.

3.3 Diversion Of Materials

- .1 From following list, separate materials from general waste stream and stockpile in separate piles or containers, as reviewed by Departmental Representative, and consistent with applicable fire regulations.
 - .1 Mark containers or stockpile areas.
 - .2 Provide instruction on disposal practices.
- .2 On-site sale of recyclable materials is not permitted.

3.4 Waste Diversion Report

- .1 At completion of Project, prepare written Waste Diversion Report indicating quantities of materials reused, recycled or disposed of as well as the following:
 - .1 Identify final diversion results and measure success against goals from Waste Reduction Workplan.
 - .2 Compare final quantities/percentages diverted with initial projections in Waste Audit and Waste Reduction Workplan, and explain variances.
 - .1 Supporting documentation.
 - .2 Waybills and tracking forms.
 - .3 Description of issues, resolutions and lessons learned.

3.5 Waste Audit (Wa)

- .1 Schedule A - Waste Audit (WA)

(1) Material Category	(2) Material Quantity Unit	(3) Estimated Waste %	(4) Total Quantity of Waste (unit)	(5) Generation Point	(6) % Recycled	(7) % Reused
Wood and Plastics Material Description						
Off-cuts						
Warped Pallet Forms						
Plastic Packaging						
Cardboard Packaging						
Other						
Doors and						

Windows						
Material						
Description						
Painted						
Frames						
Glass						
Wood						
Metal						
Other						

3.6 Waste Reduction Workplan (Wrw)

.1 Schedule B

(1) Material Category	(2) Person(s) Respon- sible	(3) Total Quantity of Waste (unit)	(4) Reused Amount (units) Projected	Actual	(5) Recycled Amount (unit) Projected	Actual	(6) Material(s) Destina- tion
Wood and Plastics Material Description							
Chutes							
Warped Pallet Forms							
Plastic Packag ing							
Card- board Packag ing							
Other							
Doors and Windows Material Description							
Painted Frames							
Glass							
Wood							
Metal							
Other							

3.7 Cost/Revenue Analysis Workplan (Craw)

.1 Schedule E - Cost/Revenue Analysis Workplan (CRAW)

(1) Material	(2) Total	(3) Volume	(4) Weight	(5) Disposal	(6) Category
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Description	Quantity (unit)	(cum)	(cum)	Cost/Credit \$(+/-)	Sub-Total \$(+/-)
Wood					
Wood Stud					
Plywood					
Baseboard - Wood					
Door Trim - Wood					
Cabinet					\$
Doors and Windows					
Panel Regular					
Slab Regular					
Wood Laminate					
Byfold - Closet					
Glazing					\$
		(7) Cost (-) / Revenue (+)			\$

3.8 Canadian Governmental Departments Chief Responsibility For The Environment

.1 Schedule G - Government Chief Responsibility for the Environment:

Province	Address	General Inquires	Fax
Manitoba	Manitoba Environment Building 2, 139 Tuxedo Avenue, Winnipeg, MB R3N 0H6	204-945-7100	
	The Clean Environment Commission 284 Reimer Avenue, Box 21420 Steinbach MB R0A 2T3	204-326-2395	204-326-2472

3.9 Schedules

.1 Following Schedules are attached to this Specification:

- .1 Waste Audit - Schedule A.
- .2 Waste Reduction Workplan Form - Schedule B.
- .3 Waste Diversion Report Form - Schedule C.
- .4 Waste Materials Tracking Form - Schedule D.

- .5 Cost/Revenue Analysis Workplan - Schedule E.
- .6 Market Research Report - Schedule F (When Available).

END OF SECTION

Part 1 General

1.1 Administrative Requirements

- .1 Acceptance of Work Procedures:
 - .1 Contractor's Inspection: Contractor: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .1 Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
 - .2 Request Departmental Representative's inspection.
 - .2 Departmental Representative 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 and 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; 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.
 - .5 Declaration of Substantial Performance: when Departmental Representative considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

- .6 Commencement of Lien and Warranty Periods: date of Departmental Representative's acceptance of submitted declaration of Substantial Performance to be date for commencement for warranty period and commencement of lien period unless required otherwise by lien statute of Place of Work.
- .7 Final Payment:
 - .1 When Departmental Representative considers final deficiencies and defects corrected and requirements of Contract met, make application for final payment.

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: separate waste materials for recycling 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 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 References

1.2 Administrative Requirements

.1 Pre-warranty Meeting:

- .1 Convene meeting one week prior to contract completion with Departmental Representative, in accordance with Section 01 31 19 - Project Meetings to:
 - .1 Verify Project requirements.
 - .2 Review warranty requirements and Manufacturer's installation instructions.
- .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.

1.3 Action And Informational Submittals

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

1.4 Format

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

- .5 Arrange content by systems, process flow, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab.
 - .1 Bind in with text; fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format on CD or DVD.

1.5 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 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.

1.6 As -Built Documents And Samples

- .1 Maintain, in addition to requirements in General Conditions, at site for Departmental Representative, one as-built 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 "PROJECT AS-BUILT" 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.

1.7 Recording Information On Project As-Built Documents

- .1 Record information on set of blue line opaque drawings, and in copy of Project Manual, provided by Departmental Representative.
- .2 Use felt tip marking pens, maintaining separate colours for each major system, for recording information.
- .3 Record information concurrently with construction progress.
 - .1 Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.
 - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
 - .4 Field changes of dimension and detail.
 - .5 Changes made by change orders.
 - .6 Details not on original Contract Drawings.
 - .7 References to related shop drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.
- .7 Provide digital photos, if requested, for site records.

1.8 Final Survey

- .1 Submit final site survey certificate in accordance with Section 01 71 00 - Examination and Preparation, certifying that elevations and locations of completed Work are in conformance, or non-conformance with Contract Documents.

1.9 Equipment And Systems

- .1 For each item of equipment and each system include description of unit or system, and component parts.
 - .1 Give function, normal operation characteristics and limiting conditions.
 - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .3 Include installed colour coded wiring diagrams.
- .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences.
 - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
 - .2 Include summer, winter, and any special operating instructions.
- .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .6 Provide servicing and lubrication schedule, and list of lubricants required.
- .7 Include manufacturer's printed operation and maintenance instructions.
- .8 Include sequence of operation by controls manufacturer.
- .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .10 Provide installed control diagrams by controls manufacturer.
- .11 Provide Contractor's co-ordination drawings, with installed colour coded piping diagrams.
- .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and 01 91 13 - General Commissioning (Cx) Requirements.
- .15 Additional requirements: as specified in individual specification sections.

1.10 Materials And Finishes

- .1 Building products, applied materials, and finishes: include product data, with catalogue number, size, composition, and colour and texture designations.
 - .1 Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-protection and weather-exposed products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional requirements: as specified in individual specifications sections.

1.11 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.

1.12 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.

1.13 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 4 month and 9 month warranty inspection, measured from time of acceptance, by Departmental Representative.
- .9 Include information contained in warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with warranty process, including points of contact and telephone numbers within the

- organizations of Contractors, subcontractors, manufacturers or suppliers involved.
- .2 Listing and status of delivery of Certificates of Warranty for extended warranty items, to include roofs, HVAC balancing, pumps, motors, transformers, commissioned systems, and alarm systems.
- .3 Provide list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of manufacturers or suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one-year overall warranty of construction. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent Operation and Maintenance manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
- .4 Contractor's plans for attendance at 4 and 9 month post-construction warranty inspections.
- .5 Procedure and status of tagging of equipment covered by extended warranties.
- .6 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .10 Respond in timely manner to oral or written notification of required construction warranty repair work.
- .11 Written verification to follow oral instructions.
 - .1 Failure to respond will be cause for the Departmental Representative to proceed with action against Contractor.

1.14 Warranty Tags

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water resistant tag approved by Departmental Representative.
- .2 Attach tags with copper wire and spray with waterproof silicone coating.
- .3 Leave date of acceptance until project is accepted for occupancy.

- .4 Indicate following information on tag:
 - .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 Administrative Requirements

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to designated personnel two weeks prior to date of substantial performance.
- .2 Departmental Representative: 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 testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and equipment and systems are fully operational.
- .4 Demonstration and Instructions:
 - .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed-upon times, at the equipment installation 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: Provide adequate time for full orientation and instruction of designated personnel on each system and item of equipment.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to agreed-upon dates, for Departmental Representative's approval.
- .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4 Give time and date of each demonstration, with list of persons present.
- .5 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.3 Quality Assurance

- .1 When specified in individual Sections requiring manufacturer to provide authorized representative to demonstrate operation of equipment and systems:
 - .1 Instruct personnel designated by Departmental Representative.
 - .2 Provide written report that demonstration and instructions have been completed. A sample form is included after this Section.

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 Summary

- .1 Section Includes:
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to FPT of components, equipment, sub-systems, systems, and integrated systems.
 - .2 Include Commissioning IAW CSA-Z320
- .2 Acronyms:
 - .1 SOM - System Operation Manual
 - .2 Cx - Commissioning.
 - .3 EMCS - Energy Management Control System
 - .4 M&D – Maintenance and Data Manual
 - .5 PTRTD - Product Test Report and Technical Documents
 - .6 FPT - Functional Performance Testing
 - .7 OPT – Optimization
 - .8 CWS – Cold Water System
 - .9 HWS – Hot Water System
 - .10 CO2 – Carbon Dioxide

1.2 General

- .1 Consultant Cx “Plan” and related project specific forms to be reviewed and accepted by Departmental Representative prior to commencement of construction.
- .2 Commissioning will include, but not necessarily limited to, the following:
 - .1 Cx Structural and Architectural Systems;
 - .1 Door hardware
 - .2 Commissioning Mechanical systems and associated equipment;
 - .3 Plumbing
 - .1 Domestic CWS and HWS.
 - .2 Regular sanitary waste systems.
 - .3 Sanitary lift pump.
 - .4 Condensate pumps.
 - .5 Plumbing fixtures
 - .4 HVAC and exhaust systems:
 - .1 General exhaust systems, including transfer fans.
 - .2 Split air conditioning systems.
 - .3 Test all existing fan coil and perimeter heating units.
 - .4 Test all new and existing variable air volume boxes.

- .5 Test existing demand control ventilation systems including existing CO2 sensor and ventilation supply fan.
- .5 Fire and life safety systems:
 - .1 Wet pipe sprinkler systems.
- .6 EMCS:
 - .1 Test all existing controls in the renovated area and controls are functioning as intended.
 - .2 Test all new controls in the renovated area and verify successful integration of all new equipment with the existing EMCS.
- .7 Commissioning Electrical Systems;
 - .1 Lighting
- .8 Commissioning Communications systems
 - .1 Access Control System
- .3 CX is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx shall be based on CSA Z320-11 Building Commissioning standards. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
 - .1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the BMM.
 - .3 Effectively train M&D staff.
- .4 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .5 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 Commissioning Overview

- .1 Section 01 91 31 - Commissioning (Cx) Plan.
- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.
- .3 Cx is conducted in concert with activities performed during stage of project delivery. Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under weather, environmental

and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.

- .4 Departmental Representative will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
 - .2 Equipment, components and systems have been commissioned.
 - .3 M&D training has been completed.

1.4 Non-Conformance To Performance Verification Requirements

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the un-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. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 Pre-Cx Review

- .1 Before Construction:
 - .1 Review contract documents, confirm by writing to Departmental Representative.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems, 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 OPT procedures on systems, submit OPT reports to Departmental Representative for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.6 Conflicts

- .1 Report conflicts between requirements of this section and other sections to Departmental Representative before start-up and obtain clarification.
- .2 Failure to report conflict and obtain clarification will result in application of most stringent requirement.

1.7 Commissioning Documentation

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Test Report and Technical Documents (PTRTD)
- .2 (PI) / Functional Performance Testing (FPT) Forms for requirements and instructions for use.
- .3 Departmental Representative to review and approve Cx documentation.
- .4 Provide completed and approved Cx documentation to Departmental Representative.

1.8 Commissioning Schedule

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16 – Construction Progress Schedule – Bar (GANTT) Chart.
 - .1 Cx schedule to utilize critical path methods, identify interdependencies between contractor verifications and commissioning and be fully integrated with the construction master schedule.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.
 - .4 Training.

1.9 Commissioning Meetings

- .1 Convene Cx meetings following project meetings: 01 32 16 – Construction Progress Schedule – Bar (GANTT) Chart and as specified herein.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .3 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage, Section 01 32 16 – Construction Progress Schedule – Bar (GANTT) Chart. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.

- .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .6 Meeting will be chaired by Departmental Representative, who will record and distribute minutes.
- .7 Ensure subcontractors and relevant manufacturer representatives are present at 60% and subsequent Cx meetings and as required.

1.10 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.

1.11 Witnessing Of Starting And Testing

- .1 Provide 14 days notice prior to commencement.
- .2 Departmental Representative to witness of start-up and testing.

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

- .3 To report results in clear, concise, logical manner.

1.13 Procedures

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System FPT: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved FPT 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.
 - .1 Field quality test result.
 - .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.14 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.

1.15 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 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.

1.16 Test Results

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

1.17 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 performance verification of systems have been completed.

1.18 Instruments / Equipment

- .1 Submit to Departmental Representative for review and approval:
 - .1 Complete list of instruments proposed to be used.
 - .2 Listed data including, serial number, current calibration certificate, calibration date, and 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.

1.19 Commissioning Performance Verification

- .1 Carry out Cx:
 - .1 Under actual operating conditions, and in all operating and programmed failure modes.
 - .2 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.

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

1.20 Witnessing Commissioning

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

1.21 Authorities Having Jurisdiction

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

1.22 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.

1.23 Extent Of Verification

- .1 Provide manpower and instrumentation to test and verify all new and modified mechanical equipment including, but not limited to, new fans, VAV boxes, split air conditioners, existing fan coils and all associated controls.
- .2 Provide manpower and instrumentation to test and verify all new and modified systems including but not limited to distribution equipment, life-safety systems, electrical power systems, including circuit testing, verifications, etc. Written certifications will be required. Commissioning will be performed by the Electrical Contractor in concert with the Commissioning Agent (Cx).
- .3 Provide manpower and instrumentation to verify upto 30% of reported results, unless specified otherwise in other sections.
- .4 Number and location to be at discretion of Departmental Representative.
- .5 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .6 Review and repeat commissioning of systems if inconsistencies found in more than 20 of reported results.
- .7 Perform additional commissioning until results are acceptable to Departmental Representative.

1.24 Repeat Verifications

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

1.25 Sundry Checks And Adjustments

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

1.26 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.

1.27 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.

1.28 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.

1.29 Training

- .1 In accordance with Section 01 91 41 – Commissioning Training

1.30 Maintenance Materials, Spare Parts, Special Tools

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

1.31 Occupancy

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

1.32 Installed Instrumentation

- .1 Use instruments installed under Contract for OPT and FPT 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.

1.33 Performance Verification Tolerances

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

1.34 Departmental Representative'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**2.1 Not Used**

- .1 Not Used.

Part 3 Execution**3.1 Not Used**

- .1 Not Used.

END OF SECTION

Part 1 General

1.1 Summary

.1 Section Includes:

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

1.2 References

- .1 American Water Works Association (AWWA)
- .2 National Fire Protection Association (NFPA)
 - .1 NFPA-13-02, Installation of Sprinkler Systems Handbook.
 - .2 NFPA-14-02, Automatic Sprinkler Systems Handbook.
 - .3 NFPA-20-03, Standard for the Installation of Stationary Fire Pumps for Fire Protection.
- .3 Canadian Standards Association
 - .1 CSA Z320-11 Building Commissioning.
- .4 Underwriters' Laboratories of Canada (ULC)

1.3 General

- .1 Provide a fully functional facility:
 - .1 Systems, equipment and components meet user's functional requirements before date of acceptance, and operate consistently at peak efficiencies and within specified energy budgets under normal loads.
 - .2 Facility user and M&D personnel have been fully trained in aspects of installed systems.
 - .3 Optimized life cycle costs.
 - .4 Complete documentation relating to installed equipment and systems.
 - .5 Commissioning in accordance with CSA-Z320-11 Building Commissioning
- .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 M&D, process and administration of Cx.
 - .4 Describes process of verification of how built works meet the Departmental Representative 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 M&D – Maintenance and Data Manual
 - .3 SOM - System Operation Manual.
 - .4 EMCS - Energy Management and Control System.
 - .5 MSDS - Material Safety Data Sheets.
 - .6 PI - Product Information.
 - .7 FPT - Functional Performance Testing.
 - .8 OPT - Optimization.
 - .9 HVAC – Heating, Ventilation and Air Conditioning
 - .10 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.
- .6 Cx Plan to be 95% completed before added into Project Specifications.
- .7 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.
- .8 Submit completed Cx Plan to Departmental Representative and obtain written approval.

1.4 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 6 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.

1.5 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 PWGSC Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
 - .2 PWGSC Quality Assurance Commissioning Manager: ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and M&D personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
 - .3 Departmental Representative is responsible for:
 - .1 Organizing Cx.
 - .2 Monitoring operations Cx activities.
 - .3 Witnessing, certifying accuracy of reported results.
 - .4 Witnessing and certifying OPT and other tests.
 - .5 Developing SOM.
 - .6 Ensuring implementation of final Cx Plan.
 - .7 Performing verification of performance of installed systems and equipment.
 - .8 Implementation of Training Plan.
 - .4 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
 - .1 Testing.
 - .2 OPT.
 - .3 Performance of Cx activities.
 - .4 Delivery of training and Cx documentation.

- .5 Assigning one person as point of contact with Consultant and PWGSC Cx Manager for administrative and coordination purposes.
- .5 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
- .6 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.
 - .2 Day-To-Day operation and maintenance of facility.

1.6 Cx Participants

- .1 Installation contractor/subcontractor:
 - .1 Equipment and systems except as noted.
- .2 Equipment manufacturer: equipment specified to be installed and started by manufacturer.
 - .1 To include Functional Performance Testing.
- .3 Specialist subcontractor: equipment and systems supplied and installed by specialist subcontractor.
- .4 Specialist Cx agency:
 - .1 Possessing specialist qualifications and installations providing environments essential to client's program but are outside scope or expertise of Cx specialists on this project.
- .5 Client: responsible for intrusion and access security systems.
- .6 Ensure that Cx participant:
 - .1 Could complete work within scheduled time frame.
 - .2 Available for emergency and troubleshooting service during first year of occupancy by user for adjustments and modifications outside responsibility of M&D 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 M&D personnel.
 - .4 Redistribution of electrical services.
 - .5 Modifications of fire alarm systems.
 - .6 Modifications to voice communications systems.
- .7 Provide names of participants to Departmental Representative and details of instruments and procedures to be followed for Cx 3 months prior to starting date of Cx for review and approval.

1.7 Extent Of Cx

- .1 Cx Structural and Architectural Systems:
 - .1 Architectural and structural:
 - .1 Doors, windows, related hardware:
 - .2 Commission mechanical systems and associated equipment:
 - .1 Plumbing systems:
 - .1 Domestic CWS and HWS.
 - .2 Regular sanitary waste systems.
 - .3 Sump pumps
 - .2 HVAC and exhaust systems:
 - .1 HVAC systems.
 - .2 General exhaust systems
 - .3 Exhaust systems and related systems
 - .4 Heat recovery systems
 - .3 Fire and life safety systems:
 - .1 Fire extinguishers.
 - .4 IAQ environmental control systems:
 - .1 Indoor conditions in areas listed herein:
 - .1
 - .2 Indoor air quality (IAQ) in areas listed herein:
 - .1
 - .3 Environmental control systems in areas listed herein:
 - .1
 - .5 EMCS:
 - .1
 - .6 Energy metering systems for steam, hot water, chilled water, electricity.
- .3 Commission electrical systems and equipment:
 - .1 Low voltage below 750 V:
 - .1 Low voltage equipment.
 - .2 Low voltage distribution systems.
 - .3 Access Control systems.
 - .4 Electronic data and communications information systems.
 - .2 Lighting systems:
 - .1 Lighting equipment.
 - .2 Distribution systems.
 - .3 Emergency lighting systems, including battery packs.
 - .4 Fire exit emergency signage.
 - .3 Fire alarm systems, equipment:
 - .1 Annunciators.

- .2 Control panels.
- .3 Fire alarm battery banks.
- .1

1.8 Deliverables Relating To M&D 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.

1.9 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 tests.
- .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed Functional Performance Testing (FPT) report forms.
 - .6 Results of Functional Performance Testing Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Training Plans.
 - .10 Cx Reports.

- .11 Prescribed activities during warranty period.
- .4 Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative.
- .5 Departmental Representative to participate.

1.10 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 Departmental Representative will monitor some of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - ARCHITECTURAL AND STRUCTURAL:
 - .1 Doors, windows, related hardware:
 - .1 Overhead doors: Test for proper operation
 - .2 Door and window hardware: Test for proper operation
- .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 OPT on systems. OPT reports to be approved by Departmental Representative.
 - .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 Carry out point-by-point verification.
 - .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
 - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
 - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
- .4 Pre-Cx activities - LIFE SAFETY SYSTEMS
- .1 Include equipment and systems identified above.
 - .1
 - .2 Reports of test results to be witnessed and certified by Departmental Representative before verification.
- .5 Pre-Cx activities - ELECTRICAL:
- .1 High voltage distribution systems over 750 V:
 - .1
 - .2 Low voltage distribution systems under 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.
 - .2
 - .3 Emergency power generation systems
 - .1 Transfer switches: test by simulating loss of power. Verify availability of power at equipment requiring same.
 - .1
 - .2 Uninterruptible power systems: test under full and partial load conditions.
 - .1
 - .4 Lighting systems:
 - .1 Emergency lighting systems:
 - .1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.
 - .5 Fire alarm systems: test after other safety and security systems are completed. Testing to include a complete verification in accordance with ULC requirements Departmental Representative has witnessed and certified report, demonstrate devices and zones.
 - .6 Low voltage systems: these include:
 - .1 Communications, low voltage lighting control systems and data communications systems.

- .2 Special systems such as Simultaneous Translation systems, MPs Call systems, Messenger Call systems, Division Bell systems.
- .7 Security, surveillance and intrusion alarm systems: to include verification by Departmental Representative.
- .8 Lightning protection systems.
- .9 Watchman's tour systems.

1.11 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
- .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 (FPT):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Departmental Representative.
 - .2 Use procedures modified generic procedures to suit project requirements.
 - .3 Departmental Representative to witness and certify reported results using approved PI and FPT forms.
 - .4 Departmental Representative to approve completed FPT reports.
 - .5 Departmental Representative reserves right to verify up to 30% of reported results at random.
 - .6 Failure of randomly selected item shall result in rejection of FPT report or report of system startup and testing.

1.12 Cx Activities And Related Documentation

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

1.13 Cx Of Integrated Systems And Related Documentation

- .1 Cx to be performed by specified Cx specialist, using procedures developed by Departmental Representative.
- .2 Tests to be witnessed by Departmental Representative and documented on approved report forms.
- .3 Upon satisfactory completion, Cx specialist to prepare Cx Report, to be certified and reviewed by Departmental Representative.
- .4 Departmental Representative reserves right to verify percentage of reported results.
- .5 Integrated systems to include:
 - .1 HVAC and associated systems forming part of integrated HVAC systems:
 - .2 Smoke control systems:
 - .3 Stair shaft pressurization systems:
 - .4 Indoor air quality:
 - .5 Environmental space conditions:
 - .6 Fire alarm systems:
 - .7 Fire pumps and controllers:
 - .8 Voice communications systems:
 - .9 Emergency power generator:
 - .10 Transfer switch and controllers:
 - .11 Emergency lighting systems:
- .6 Identification:
 - .1 In later stages of Cx, before hand-over and acceptance Departmental Representative, 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.

1.14 Installation Check Lists (Icl)

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Functional Performance Testing (FPT) Forms.

1.15 Product Information (Pi) Report Forms

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Functional Performance Testing (FPT) Forms.

1.16 Functional Performance Testing (Fpt) Report

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Functional Performance Testing (FPT) 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, including:
 - .1 Design criteria, design intents.
 - .2 Pre-OPT review: 28 days after contract award, and before construction starts.
 - .3 Cx agents' credentials: 60 days before start of Cx.
 - .4 Cx procedures: 3 months after award of contract.
 - .5 Cx Report format: 3 months after contract award.
 - .6 Discussion of heating/cooling loads for Cx: 3 months before start-up.
 - .7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
 - .8 Notification of intention to start OPT: 21 days before start of OPT.
 - .9 OPT: after successful start-up, correction of deficiencies and verification of normal and safe operation.
 - .10 Notification of intention to start Cx: 14 days before start of Cx.
 - .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
 - .12 Identification of deferred Cx.
 - .13 Implementation of training plans.
 - .14 Cx of smoke management/control systems: after Cx of related systems is completed and 7 days before proposed date of Cx these systems.
 - .15 Cx stair shaft pressurization systems: before issuance of occupancy certificate.
 - .16 Cx reports: immediately upon successful completion of Cx.
 - .17 Emergency evacuation exercises: after 80% occupancy and at same time as Cx of stair shaft pressurization systems.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Property Manager.

- .3 6 months in Cx schedule for verification of performance in all seasons and wear conditions.
 - .2 After approval, incorporate Cx Schedule into Construction Schedule.
 - .3 Consultant, Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.
- 1.19 Cx Reports**
- .1 Submit reports of tests, witnessed and certified by Departmental Representative who will verify reported results.
 - .2 Include completed and certified FPT reports in properly formatted Cx Reports.
 - .3 Before reports are accepted, reported results to be subject to verification by Departmental Representative.
- 1.20 Preliminary And Final Cx**
- .1
- 1.21 Activities During Warranty Period**
- .1 Cx activities must be completed before issuance of Interim Certificate, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
 - .1 Fine tuning of HVAC systems.
 - .2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.
 - .3 Full-scale emergency evacuation exercises.
- 1.22 Tests To Be Performed By Owner/User**
- .1 [None is anticipated on this project].
- 1.23 Training Plans**
- .1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.
- 1.24 Final Settings**
- .1 Upon completion of Cx to satisfaction of Departmental Representative lock control devices in their final positions, indelibly mark settings marked and include in Cx Reports.
- Part 2 Products
- 2.1 Not Used**
- .1 Not Used.

Part 3 Execution

3.1 Not Used

.1 Not Used.

END OF SECTION

Part 1 General

1.1 Summary

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.
 - .2 Use Commissioning Forms as provided in CSA-Z320, examples have been provided for modification

1.2 Installation/Start-Up Check Lists

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

1.3 Product Test Report and Technical Documents (PTRTD) Forms

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

1.4 Functional Performance Testing (Fpt) Forms

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and

function independently and interactively with other systems as intended with project requirements.

- .2 FPT report forms include those developed by Contractor records measured data and readings taken during functional testing and Performance Verification procedures.
- .3 Prior to FPT of integrated system, complete FPT forms of related systems and obtain Departmental Representative's approval.

1.5 Samples Of Commissioning Forms

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

1.6 Changes And Development Of New Report Forms

- .1 When additional forms are required, but are not available from Consultant 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 Consultant

1.7 Commissioning Forms

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Consultant provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on these forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record analytical and substantiating data.
 - .7 Verify reported results.
 - .8 Form to bear signatures of recording technician and reviewed and signed off by Consultant.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Departmental Representative with originals of completed forms.

- .12 Maintain copy on site during start-up, testing and commissioning period.
- .13 Forms to be both hard copy and electronic format with typed written results in System Operation Manual in accordance with Section 01 91 51 - System Operation Manual (SOM).

1.8 Language

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

Part 2 Products

2.1 Not Used

- .1 Not Used.

Part 3 Execution

3.1 Not Used

- .1 Not Used.

END OF SECTION

Static Verification

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

NAMEPLATE			
SUBJECT	Common Interior	LOCATION	
ASSEMBLY	Finishes	DRAWING REFERENCE	

COMPONENTS	SPECIFIED	SHOP DRAWINGS	INSTALLED
OTHER ACCESSORIES			

OTHER ACCESSORIES					
Architectural Field Review & Compliance Activity	Performance Criteria	STATUS			COMMENTS
		YES	NO	N/A	
Construction checklists prepared					
Construction checklists completed					
Field review reports completed					
Compliance test reports completed					
Deficiency (Issues log) created					
Issues Log items addressed					
Verify training completed					
Review required maintenance and data, and systems operations manuals					
INTERIM ACCEPTANCE					
Seasonal Compliance test reports completed					
Issues Log Seasonal items addressed					
Outstanding Cx issues addressed or explained					
FINAL ACCEPTANCE					

POSITION/TITLE	SIGNATURE	DATE

Architectural Field Review and Compliance

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Architectural Field Review and Compliance
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

AIR HANDLING UNIT

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

SUPPLEMENTAL INFORMATION

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SYSTEM COMPONENTS

SYSTEM /EQUIPMENT DATA	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SERIAL NO.			

SUPPLY FAN INFO	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SERIAL NO.			
FAN CFM			
FAN RPM			
FAN ESP/TSP			
BELT SIZE/QUANTITY			

SUPPLY FAN MOTOR INFO	SPECIFIED	SHOP DRAWINGS	INSTALLED
MOTOR MANUFACTURER			
MODEL NO.			
SERIAL NO.			
HORSEPOWER/VOLTAGE/NO. OF PHASES/FULL LOAD AMPS			
INSULATION CLASS			
FRAME SIZE			
RPM			

RETURN FAN INFO	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SERIAL NO.			
FAN CFM			
FAN RPM			
FAN ESP/TSP			
BELT SIZE/QUANTITY			

AIR HANDLING UNIT

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

RETURN FAN MOTOR INFO	SPECIFIED	SHOP DRAWINGS	INSTALLED
MOTOR MANUFACTURER			
MODEL NO.			
SERIAL NO.			
HORSEPOWER/VOLTAGE/NO. OF PHASES/FULL LOAD AMPS			
INSULATION CLASS			
FRAME SIZE			
RPM			

EXHAUST FAN INFO	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SERIAL NO.			
FAN CFM			
FAN RPM			
FAN ESP/TSP			
BELT SIZE/QUANTITY			

EXHAUST FAN MOTOR INFO	SPECIFIED	SHOP DRAWINGS	INSTALLED
MOTOR MANUFACTURER			
MODEL NO.			
SERIAL NO.			
HORSEPOWER/VOLTAGE/NO. OF PHASES/FULL LOAD AMPS			
INSULATION CLASS			
FRAME SIZE			
RPM			

ENERGY RECOVERY DEVICE	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SERIAL NO.			
AIRFLOW			
PRESSURE DROP			
EAT/LAT			

VFD INFO	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			

AIR HANDLING UNIT

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

HP RATING			
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COILS	SPECIFIED	SHOP DRAWINGS	INSTALLED
MODEL NO.			
EAT/LAT			
EWT/LWT			
FINS PER INCH			
NUMBER OF ROWS			
GPM			

FILTER	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
AIR VOLUME			
STATIC PRESSURE DROP			
TYPE/EFFICIENCY			
SIZE/QTY			
FACE VELOCITY			

HUMIDIFIER SECTION	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
TYPE			
LBS/HOUR			
VOLTAGE/AMPS			

DAMPERS	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
BLADE TYPE			
BLADE INSULATION			

EVALUATION			
AIR HANDLING CABINET AND GENERAL INSTALLATION	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
PERMANENT AND DURABLE NAMEPLATE LABELS AFFIXED TO UNIT			
CASING CONDITION GOOD: NO DENTS, DOOR GASKETS INSTALLED			
NO HOLES IN THE UNIT, I.E., MISSING SCREWS OR CAPS			
ACCESS DOORS CLOSE TIGHTLY, AND OPEN EASILY			
ACCESS DOORS OPEN ACCORDING TO THE PRESSURE IN CORRESPONDING SECTION AS REQUIRED			

AIR HANDLING UNIT

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

VIEWING WINDOWS INSTALLED AS SPECIFIED			
MARINE VAPOR PROOF LIGHTS INSTALLED AS SPECIFIED			
SPECIFIED INSULATION PROPERLY ADHERED TO INTERIOR WALL			

MOTORIZED DAMPER	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
CORRECT BLADE ORIENTATION (PARALLEL/OPPOSED)			
DAMPER INSULATED AS REQUIRED			
CORRECT NON-ENERGIZED DAMPER POSITION			
DAMPERS CLOSE TIGHTLY			
DAMPER LINKAGES HAVE MINIMUM PLAY			
DAMPER STROKES 100% WITHOUT BINDING			
SPRING RETURN ACTION IS FUNCTIONAL			
DAMPER MODULATES CORRECTLY ACCORDING TO CONTROL SIGNAL			

EXHAUST BACKDRAFT DAMPER	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
DAMPER BLADES OPEN FREELY WITHOUT OBSTRUCTION			
BACKDRAFT DAMPER OPENS WHEN EXHAUST FAN IS OPERATIONAL			
THE BACKDRAFT DAMPER BLADES DO NOT RATTLE OR MAKE UNACCEPTABLE NOISE			

AIR FILTRATION	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
CORRECT FILTER TYPE(S) USED			
FILTERS INSTALLED IN CORRECT ORIENTATION			
CORRECT QUANTITY			
CORRECT SEALS INSTALLED BETWEEN DOOR AND FILTER TRACK			
NO GAPS BETWEEN FILTERS			
BLANK-OFF PLATES INSTALLED AS REQUIRED			

ENERGY RECOVERY DEVICE	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
NO BYPASS LEAKAGE PATH AROUND THE RECOVERY DEVICE			
VARIABLE SPEED DRIVE FOR ENERGY RECOVERY WHEEL			
PURGE INSTALLED IN CORRECT LOCATION			
FACE AND BYPASS DAMPERS FOR PLATE TYPE HEAT EXCHANGER OR HEAT PIPE AS SPECIFIED			
FACE AND BYPASS DAMPER IN NORMALLY OPEN ACROSS HEAT EXCHANGER AND CLOSE ON BYPASS			
THERMISTOR OR OTHER TYPE OF THERMAL OVERHEATING PROTECTION INTERLOCKED WITH MOTOR CONTROLS			

Static Verification

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

EASILY ACCESSIBLE AND REMOVABLE			
MEASURED VOLTAGE : PHASE 1			
MEASURED VOLTAGE : PHASE 2			
MEASURED VOLTAGE : PHASE 3			
MEASURED AMPS : PHASE 1			
MEASURED AMPS : PHASE 2			
MEASURED AMPS : PHASE 3			

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

AIR HANDLING UNIT

Start-Up

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

EVALUATION

AIR HANDLING CABINET AND GENERAL INSTALLATION	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
AIR HANDLING CABINET AND GENERAL INSTALLATION			
CONNECTION BETWEEN DUCTS AND UNIT TIGHT AIRTIGHT			
SHIPPING BLOCKS REMOVED (IN PARTICULAR FAN SECTION)			
ALL CONSTRUCTION AND INSTALLATION DEBRIS CLEANED UP INSIDE UNIT			
UNIT INSTALLED ON ELEVATED AND LEVEL BASE AS SPECIFIED			
INSPECTION OF UNIT CASING: MINIMAL AIR LEAKAGE THROUGH DOORS AND JOINTS			
SUPPLY AND RETURN DUCTS CORRECTLY INSTALLED			
FLEXIBLE CONNECTIONS INSTALLED AS REQUIRED			
FLEXIBLE CONNECTIONS CONTAIN ADEQUATE SLACK			
NO TEARS IN FLEXIBLE CONNECTIONS			

ROOF CURB	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
ROOF CURB INSTALLED CORRECTLY ACCORDING TO PLANS AND SPECIFICATIONS			
ROOF CURB IS INSULATED AS REQUIRED			
CORRECT ROOF CURB HEIGHT ACCORDING TO APPROVED SHOP DRAWINGS			
UNIT SITS FLUSH ON ROOF CURB			
PROPER FLASHING AROUND THE CURB, I.E., CURB IS ADEQUATELY SEALED AND INTEGRATED TO ROOF STRUCTURE			
NO AIR LEAKAGE FROM THROUGH CURB			

FAN	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
FANS ROTATES FREELY			
FLEX CONNECTIONS INSTALLED CORRECTLY ACCORDING TO BLOWER PRESSURE (SUCTION/DISCHARGE)			
CORRECT TYPE OF VIBRATION ISOLATORS INSTALLED UNDERNEATH FAN/MOTOR BASE			
SPRING ISOLATION LOAD DISTRIBUTED EQUALLY			
PROPER FAN BELT TENSION AND DRIVE ALIGNMENT			
FAN BEARINGS ADEQUATELY LUBRICATED			
DRAIN PLUG IN FAN REMOVED			
FAN GUARDS PROVIDED WHERE NECESSARY			
CORRECT FAN ROTATION			

AIR HANDLING UNIT

Start-Up

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NO UNUSUAL VIBRATION OR NOISE DURING SUPPLY FAN OPERATION			
ALIGNMENT IS CORRECT			
FAN CASING CLEANED			
INLET & OUTLET GUARDS INSTALLED			
DUCT AND FAN GEOMETRY CORRECT			
VIBRATION ISOLATORS INSTALLED AND ADJUSTED			
STARTERS & DISCONNECTS INSTALLED			
DISCONNECT LOCATION CORRECT			
INTERLOCKS INSTALLED			
THERMISTOR OR OTHER TYPE OF THERMAL OVERHEATING PROTECTION INTERLOCKED WITH MOTOR CONTROLS			
EASILY ACCESSIBLE AND REMOVABLE			
MEASURED VOLTAGE : PHASE 1			
MEASURED VOLTAGE : PHASE 2			
MEASURED VOLTAGE : PHASE 3			
MEASURED AMPS : PHASE 1			
MEASURED AMPS : PHASE 2			
MEASURED AMPS : PHASE 3			

COIL	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
CORRECT COUNTERFLOW SUPPLY/RETURN CONNECTIONS (SUPPLY ENTERING ON THE BOTTOM CIRCUIT LEAVING SIDE OF COIL AND RETURN LEAVING ON TOP CIRCUIT ON THE ENTERING SIDE OF COIL)			
CONTROL VALVE IS THE CORRECT TYPE, PROPERLY ORIENTED, AND IS ACCESSIBLE FOR MAINTENANCE			
ISOLATION AND BALANCING VALVES INSTALLED, CORRECT TYPE, PROPERLY ORIENTED, AND IS ACCESSIBLE FOR MAINTENANCE. DOES NOT OBSTRUCT COIL REMOVAL			
STEAM TRAPS ARE THE CORRECT TYPE, AND STRAINER IS INSTALLED. ISOLATION VALVES INSTALLED. UNIONS INSTALLED FOR SERVICE AND REPLACEMENT. STEAM TRAP MONITORS INSTALLED, IF APPLICABLE.			
AIR VENT LOCATED ON RETURN CONNECTION/DRAIN LOCATED ON THE SUPPLY CONNECTIONS			
VACUUM BREAKERS INSTALLED ON STEAM COILS			
CORRECT FIN TYPE AND SPACING			
FINS UNDAMAGED			
ACCESS ADEQUATE FOR COIL CLEANING AND INSPECTION			
ADEQUATE SPACE TO REMOVE COIL			
SUITABLE TRANSITIONS UPSTREAM AND DOWNSTREAM OF COIL			
COIL CORROSION RESISTANT COATING APPLIED AS REQUIRED			

AIR HANDLING UNIT

Start-Up

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

DX COIL	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
PROPER TRANSITION BETWEEN UPSTREAM AND DOWNSTREAM COMPONENTS			
THERMAL EXPANSION VALVE INSTALLED IN CORRECT LOCATION			
CORRECT SETTING FOR THERMAL EXPANSION VALVE INSTALLED IN CORRECT LOCATION			
CIRCUITING IS CORRECT			
EVAPORATOR COIL FINS UNDAMAGED			
CONDENSER COIL FINS UNDAMAGED			
COIL CORROSION RESISTANT COATING APPLIED AS REQUIRED			
CONDENSATE DRAIN PAN ADEQUATELY SLOPED			
ADEQUATE HEIGHT TO INSTALL DRAIN TRAP			
CONDENSATE PAN CLEAN & DRAINS PROPERLY			

HUMIDIFIER	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
PERMANENT AND DURABLE NAMEPLATE LABELS AFFIXED TO HUMIDIFIER			
CASING CONDITION GOOD			
CLEARANCE PROVIDED ACCORDING TO MANUFACTURER'S RECOMMENDATIONS			
HUMIDIFIER PROPER SECURED TO STAND, AND STAND BOLTED TO FLOOR OR WALL			
HUMIDIFIER INSTALLED LEVEL			
WATER SUPPLY MANUAL SHUT-OFF VALVE PROVIDED			
INTERNAL DRAIN WATER COOLER INSTALLED AS PER LOCAL CODES			
ALL CONDENSATE RETURN LINES ARE CORRECTLY TRAPPED ACCORDING TO MANUFACTURER'S RECOMMENDATION.			
ALL HOSE CLAMPS TIGHTLY INSTALLED			
HIGH HUMIDITY CUT OUT SENSOR CORRECTLY LOCATED			
HUMIDITY SENSOR PROPERLY LOCATED			

ENERGY RECOVERY DEVICE	VALUE	COMPLIES: Y / N	COMMENT REFERENCE NUMBER
THERMISTOR OR OTHER TYPE OF THERMAL OVERHEATING PROTECTION INTERLOCKED WITH MOTOR CONTROLS			
EASILY ACCESSIBLE AND REMOVABLE			
MEASURED VOLTAGE : PHASE 1			
MEASURED VOLTAGE : PHASE 2			
MEASURED VOLTAGE : PHASE 3			
MEASURED AMPS : PHASE 1			
MEASURED AMPS : PHASE 2			
MEASURED AMPS : PHASE 3			

AIR HANDLING UNIT

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

AIR HANDLING UNIT
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

AIR HANDLING UNITS - OUTSIDE AIR CHANGES, TEMP., HUMIDITY

Static Verification

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

POSITION/TITLE	SIGNATURE	DATE

AIR HANDLING UNITS - OUTSIDE AIR CHANGES, TEMP., HUMIDITY

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Functional Performance Testing

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

TESTING PROTOCOL TO BE USED:

[illegible]

AIR HANDLING UNITS - OUTSIDE AIR CHANGES, TEMPERATURE, HUMIDITY
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

Table with 8 empty columns.

Table with 9 columns: AIR HANDLING SYSTEM, Actual Temperature Deg. F (Return Air, Outside Air, Mixed Air), BAS Difference in Actual & BAS, Percentage of relative Humidity (Setpoint, Actual, Deviation), BAS Difference in Actual & BAS. Includes 20 empty rows for data entry.

COMMENTS:

Table with 3 columns: POSITION/TITLE, SIGNATURE, DATE.

AIR HANDLING UNITS - OUTSIDE AIR CHANGES, TEMPERATURE, HUMIDITY
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

BUILDING SYSTEM INTEGRATION

Static Verification

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

NAMEPLATE			
MANUFACTURER		EQUIPMENT NO.	
SERVICE	ALL RELATED EQUIPMENT AND SYSTEMS	LOCATION	

DESCRIPTION	RELATED SYSTEMS	POWER REQUIREMENTS	OPERATION TESTED & VERIFIED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

BUILDING SYSTEM INTEGRATION

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

BUILDING SYSTEM INTEGRATION

Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DDC FIELD CONTROL PANEL

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE			
MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SERIAL NO.			
TYPE			
I/O INTERFACE			
BATTERY BACKUP			

CONTROLLER INFORMATION	FIELD PANEL 1	FIELD PANEL 2	FIELD PANEL 3
MODEL NUMBER			
POINT CAPACITY			
POINTS USED			
SERIAL NUMBER			

STATIC VERIFICATION ACTIVITY	Y/N	COMMENTS	Y/N	COMMENTS	Y/N	COMMENTS
WIRING TERMINATED						
POWER CONNECTED						
EMERGENCY POWER						
WIRING IDENTIFICATION						
PANEL IDENTIFICATION						
PANEL DIRECTORY						
PANEL ACCESSIBLE						

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DDC FIELD CONTROL PANEL

Startup

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

STARTUP ACTIVITY	DDC PANEL 1		DDC PANEL 2		DDC PANEL 3	
	Y/N	COMMENTS	Y/N	COMMENTS	Y/N	COMMENTS
VERIFICATION COMPLETE						
POINTS LIST COMPLETE						
NETWORK CONNECTION COMPLETE						
CONTROL PROGRAM INSTALLED						
PANEL COMMUNICATING WITH OWS						
SENSORS CALIBRATED						
PANEL DRESSED						
DIRECTORY INSTALLED						
PANEL IDENTIFICATION INSTALLED						
PANEL CLEANED						

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DDC FIELD CONTROL PANEL
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DOMESTIC COLD WATER SYSTEM

Verification Program

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

VERIFICATION ACTIVITIES	EQUIPMENT NUMBER	STATUS			COMMENTS
		YES	NO	N/A	
CONTROL INTERFACE VERIFIED					
MUNICIPAL CONNECTION VERIFIED					
BACK FLOW PREVENTERS INSTALLED & CERTIFIED					
CONTRACTOR STARTUP COMPLETE					
DOMESTIC WATER PUMP VERIFIED					
PRESSURE REDUCING VALVES SET AND VERIFIED					
FLOW MEASURING DEVICES VERIFIED					
INITIAL CHEMICAL TREATMENT COMPLETE					
POTABLE WATER TESTING COMPLETE					
BALANCING COMPLETE					
DOMESTIC WATER SYSTEM READY FOR FUNCTIONAL PERFORMANCE TESTING					

GENERAL COMMENTS:

--

POSITION/TITLE	SIGNATURE	DATE

DOMESTIC COLD WATER SYSTEM

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DOMESTIC COLD WATER SYSTEM

Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Static Verification

NAME:

COMPANY:

ADDRESS:

CUSTOMER:

PROJECT:

FILE NUMBER:

DATE:

MANUFACTURER

EQUIPMENT NO.

SERVICE

LOCATION

GENERAL COMMENTS:[Static Verification] Page 1 of 3

DOMESTIC HOT WATER SYSTEM

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DOMESTIC HOT WATER SYSTEM

Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Static Verification

NAME:

COMPANY:

ADDRESS:

CUSTOMER:

PROJECT:

FILE NUMBER:

DATE:

MANUFACTURER

EQUIPMENT NO.

SERVICE

LOCATION

[illegible]

DRAINAGE SYSTEM
Static Verification

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

NAMEPLATE			
MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

EQUIPMENT NO.	FIXTURE LOCATION	SPECIFIED	SHOP DRAWINGS	INSTALLED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DRAINAGE SYSTEM

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DRAINAGE SYSTEM
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

DUCTWORK INSPECTION AND TESTS

Static Verification

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

VERIFICATION PRE-TEST INSPECTION	YES	NO	COMMENTS
TEST PLAN PREPARED			
ANY VISIBLE DAMAGE TO DUCT WORK?			
ALL ENDS AND SPIN-OFFS SEALED FOR TEST			
TEST EQUIPMENT CONNECTION VERIFIED			
TEST EQUIPMENT CALIBRATION CERTIFICATE VERIFIED			
DUCT GEOMETRY CORRECT			
SCHEMATIC DRAWING OF DUCT PROVIDED			
DUCT SIZE AND LENGTH IS AS PER: DRAWINGS			
TOTAL FLOW RATE (L/S)			

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Start-Up

NAME:

COMPANY:

ADDRESS:

CUSTOMER:

PROJECT:

FILE NUMBER:

DATE:

GENERAL COMMENTS:

[**Start-Up**] Page 2 of 4

DUCTWORK INSPECTION AND TESTS

Functional Performance Testing

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

FORMULA FOR LEAKAGE CALCULATION

Actual Leakage (L/S)		Allowable Leakage (L/S)	
Test Pressure (Pa)		Leakage Class	
Total Flow of Duct Run (L/S)		Allowable Leakage (L/S for given area)	
Total Surface Area (M ²)		Actual Leakage (L/S for given area)	
Maximum Allowable Leakage		TEST RESULT (PASS/FAIL)	

Orifice Identification		Orifice Size	
Test Differential Pressure		Flow Tube Size	
Test Equipment Used		Duration of Test	

Duct Branch	Width (mm) Diameter (mm)	Depth (mm) ("0" if round)	Length (M)	Area (M ²)

COMMENTS: Where no specified duct pressure class designations are provided by the designer the 1" water gage pressure class is the basis of compliance. (SMACNA)

POSITION/TITLE	SIGNATURE	DATE

DUCTWORK INSPECTION AND TESTS

Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

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EXHAUST FANS

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

EXHAUST FAN	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
TYPE/ SIZE			
MODEL NO.			
MOTOR CONTROL CENTRE NO.			
MOTOR HP			
VOLTAGE / PHASE / FREQUENCY			
STATIC PRESSURE AIR (PA)			
FAN RPM			
AIR VOLUME (L/S)			
VIBRATION ISOLATOR TYPE			

EXHAUST FAN	STATUS	COMMENTS
INSTALLED AS PER DRAWINGS & SPECIFICATIONS		
INSTALLED AS PER MANUFACTURER'S REQUIREMENTS		
FAN BEARINGS LUBRICATED		
GREASE EXTENSION LEADS REQUIRED		
FAN ROTATION CORRECT		
FAN CASING CLEANED		
BELT GUARDS INSTALLED		
ALIGNMENT REPORT ATTACHED		
INLET & OUTLET GUARDS INSTALLED		
DUCT GEOMETRY CORRECT		
FLEXIBLE CONNECTORS CORRECT		
VIBRATION ISOLATORS CORRECT		
STARTER & DISCONNECT COMPLETE		
DISCONNECT LOCATION CORRECT		
BELT TENSION		
FAN WHEEL CLEARANCE		
FAN INTERLOCKS CORRECT		
VARIABLE SPEED DRIVE/VOLUME CONTROLS		

EXHAUST FANS

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

AIR DISTRIBUTION SYSTEM

	STATUS	COMMENTS
QUALITY OF DUCT CONSTRUCTION		
SUITABILITY OF DUCT FITTINGS		
DUCTWORK INSULATION		
WALL PENETRATIONS SEALED		
ACCESS FOR INSPECTION & SERVICING		
DUCT MOUNTED ACCESS DOORS CLOSED		
FIRE DAMPERS OPEN		

START-UP

	STATUS	COMMENTS
ALL SYSTEM COMPONENTS STARTED AS DETAILED ON EQUIPMENT START-UP SHEETS.		
DUCTWORK PRESSURE TESTED		
NOISE & VIBRATION		
AIR BALANCING COMPLETE		
AIR BALANCE REPORT ATTACHED		

MOTORIZED DAMPER

	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
TYPE OR MODEL NO.			
SUPPLY DAMPER SIZE			
RETURN DAMPER SIZE			

MOTORIZED DAMPER	STATUS		
	NO. 1	NO. 2	NO. 3
DAMPERS			
DAMPER LOCATION			
AIR LEAKAGE AT SHUTOFF			
NO CRACKS AROUND DAMPER FRAME			
BLADES CLOSE FULLY, SEAL TIGHTLY			
MOTORIZED DAMPER STROKES FULLY OPEN TO FULLY CLOSED			
DAMPER ACCESSIBLE & IDENTIFIED			

EXHAUST FANS

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

MOTORIZED DAMPER	STATUS		
	NO. 1	NO. 2	NO. 3
LINKAGE CONNECTIONS INSTALLED			
FREE MOVEMENT & STROKE			
ACCESS TO DAMPER			
ACTUATOR NOT IN AIR STREAM			
NORMAL POSITIONS AS SPECIFIED			
DAMPER CONTROL SEQUENCES			
MIXING DAMPERS STROKE IN UNISON			
LINKAGE CONNECTIONS INSTALLED			
FREE MOVEMENT & STROKE			
ACCESS TO DAMPER			
ACTUATOR NOT IN AIR STREAM			
NORMAL POSITIONS AS SPECIFIED			
DAMPER CONTROL SEQUENCES			
MIXING DAMPERS STROKE IN UNISON			

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

EXHAUST FANS

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

EXHAUST FANS
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

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GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Static Verification

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

NAMEPLATE			
MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

FAN COILS	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SIZE			
SERIAL NO.			

FAN COILS	STATUS	COMMENTS
MOUNTING CORRECT		
SERVICE SPACE ADEQUATE		
PIPE SUPPORT & LAYOUT CORRECT		
ISOLATING VALVES INSTALLED		
BALANCING VALVES INSTALLED		
AIR VENTS INSTALLED		
DRAIN PAN & PIPING INSTALLED		
FILTERS INSTALLED		
CONTROL VALVE INSTALLED		
THERMOSTAT CORRECT		
SPEED SWITCH INSTALLED		
VIBRATION & NOISE CORRECT		
FRESH AIR DAMPER OPERATIONAL		

GENERAL COMMENTS:	

POSITION/TITLE	SIGNATURE	DATE

FAN COILS

Start-Up

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

FAN COILS
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

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GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Static Verification

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

[illegible]

Static Verification

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

START-UP	SPECIFIED	COMMENTS
INSTALLED AS PER DRAWINGS & SPECIFICATIONS		
INSTALLED AS PER MANUFACTURER'S RECOMMENDATIONS		
COLD WATER FEED CLEAN		
COLD WATER FEED PRESSURE		
HOT WATER FEED CLEAN		
HOT WATER FEED PRESSURE		
FIXTURE CLEAN		
PIPE ARRANGEMENT & SUPPORT		
NO LEAKAGE FROM SEALS		
FIXTURE WORKS CORRECTLY		

POSITION/TITLE	SIGNATURE	DATE

PLUMBING FIXTURE

Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

PLUMBING FIXTURE
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

PUMP

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

PUMP	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL			
SERIAL NO.			
PUMP CAPACITY (USGPM)			
PUMP HEAD (FT)			
PUMP RPM			
PUMP CURVE NO.			

PUMP	STATUS	COMMENTS
SPECIFICATIONS		
RECOMMENDATIONS		
PUMP IS LEVEL		
MOTOR & PUMP ALIGNED (ALIGNMENT REPORT ATTACHED)		
PUMP BASE GROUTED		
PUMP HAS ADEQUATE SERVICE SPACE		
RECOMMENDED		
PRESSURE GAUGES INSTALLED		
OF FLOW CORRECT		
VALVES & STRAINERS INSTALLED		
BEARINGS LUBRICATED		
NAMEPLATE IS VISIBLE		
VIBRATION ISOLATORS CORRECT		
PIPE ARRANGEMENT & SUPPORT		
CUNO FILTER FULL AND VALVES OPEN		
PIPING IDENTIFICATION INSTALLED		
STRAINERS / PARTICLE FILTERS		
CHEMICAL FEEDER		
COUPLING GUARD		
LIFTING HOOKS FOR MOTOR INSTALLED		
NAMEPLATE HEAD (FT)		
OPERATION TYPE (PARALLEL/SINGLE)		
OPERATION & MAINTENANCE		

MOTOR	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			

PUMP

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

MODEL			
SERIAL NO.			
MOTOR HORSEPOWER			
VOLTAGE / PHASE / FREQUENCY			
AMPERAGE			
HEADER SIZE AND RATE			
EFFICIENCY			
MOTOR RPM			

START-UP	STATUS	COMMENTS
IMPELLER & MOTOR ROTATION CORRECT		
OPERATION FROM ECMS VERIFIED		
OPERATED FOR 12 HOURS CONTINUOUSLY		
WORN PART & SEALS REPLACED IN PUMPS USED FOR CLEANING		
NO LEAKAGE FROM MECHANICAL SEALS.		
NET POSITIVE SUCTION HEAD CHECKED/CALCULATED		
AIR FLOW FOR MOTOR COOLING		

GENERAL COMMENTS:

--

POSITION/TITLE	SIGNATURE	DATE

PUMP

Start-Up

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

PUMP
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

RADIATION

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

RADIATION	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6
LOCATION						
THERMOSTAT LOCATED CORRECTLY						
SHUT-OFF VALVES INSTALLED						
AIR VENTS INSTALLED						
PIPING CORRECT						
FIN & ENCLOSURE CONDITION						
ACCESS AVAILABLE						
CONTROL VALVE OPERATION						
CONTROL VALVE NORMALLY OPEN/CLOSED						
CIRCUIT BALANCING VALVES						

START-UP	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6
GPM SPECIFIED						
GPM ACTUAL						
PRESSURE DROP						
SPECIFIED CAPACITY						
CALCULATED CAPACITY						

GENERAL COMMENTS:

--

POSITION/TITLE	SIGNATURE	DATE

RADIATION

Start-Up

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

RADIATION

Functional Performance Testing

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Static Verification

NAME:

COMPANY:

ADDRESS:

CUSTOMER:

PROJECT:

FILE NUMBER:

DATE:

MANUFACTURER

EQUIPMENT NO.

SERVICE

LOCATION

SPECIFIED

SHOP DRAWINGS

INSTALLED

MANUFACTURER

MODEL NO.

LOCATION

TYPE

SERIAL NO.

MOTOR MCA

VOLTAGE / PHASE / FREQUENCY

REFRIGERANT {TYPE} INSTALLED

LINE SET

SPLIT SYSTEM CONDENSER

STATUS

COMMENTS

INSTALLATION & MOUNTING

PIPING CONNECTIONS

ACCESS FOR SERVICING

PIPING INSULATION

ISOLATING/BALANCING VALVES

THERMOSTAT INSTALLED

VIBRATION & NOISE

GENERAL COMMENTS:**POSITION/TITLE**

SIGNATURE

DATE _____

SPLIT SYSTEM AIR CONDITIONING UNIT

Start-Up

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

SPLIT SYSTEM AIR CONDITIONING UNIT

Functional Performance Testing

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

SUMP PUMP

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE			
MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

SUMP PUMP	SPECIFIED	SHOP DRAWINGS	INSTALLED
MANUFACTURER			
MODEL NO.			
SERIAL NO.			
TYPE			
SIMPLEX OR DUPLEX			
CAPACITY (USGPM)			
HEAD (FT)			
MOTOR RPM			
MOTOR (HP)			
VOLTAGE / PHASE / FREQUENCY			

SUMP PUMP	STATUS	COMMENTS
INSTALLED AS PER DRAWINGS & SPECIFICATIONS		
INSTALLED AS PER MANUFACTURER'S RECOMMENDATIONS		
PUMP INSTALLED LEVEL ON FIRM BASE		
PUMP ACCESSIBLE FOR SERVING		
MOTOR AND PUMP ALIGNED		
BEARINGS LUBRICATED		
NAMEPLATE VISIBLE		
PUMP ON/OFF CONTROL FLOAT/MERCURY FLOAT SWITCHES AT CORRECT LEVEL		
HIGH LEVEL ALARM INSTALLED AT CORRECT LEVEL AND VERIFIED		
PIPING AS PER SPECIFICATION		
ISOLATION & CHECK VALVES		
INTAKE SCREEN/FILTER		
PRESSURE GAUGES INSTALLED		
ESSENTIAL POWER		

SUMP PUMP

Static Verification

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

START-UP

	STATUS	COMMENTS
CAPACITY (USGPM)		
SUMP CONTAINS WATER BEFORE PUMP STARTED		
IMPELLER AND MOTOR ROTATION CORRECT		
FLOW DIRECTION CORRECT		
PUMP CAN BE REMOVED FROM SUMP FOR SERVICE		
NO LEAKAGE FROM MECHANICAL SEALS		

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

SUMP PUMP
Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

SUMP PUMP

Functional Performance Testing

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

Static Verification

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

MANUFACTURER		EQUIPMENT NO.	
SERVICE		LOCATION	

MANUFACTURER, MODEL & TYPE	VAV-1	VAV-2	VAV-3	VAV-4	VAV-5	VAV-6
LOCATION						
SIZE						
FLOW (L/S) (DESIGN/ACTUAL)						
INLET DUCT LENGTH (MIN. 4 X DUCT I)						
SILENCER/ACOUSTIC DUCT INSTALLED						
VAV BOX UNDAMAGED						
VAV BOX SUPPORTED CORRECTLY						
IDENTIFICATION TAGS VISIBLE						
CONTROLS ACCESSIBLE						

PIPING CORRECT						
PIPING IDENTIFIED						
PIPING INSULATED						
DRAIN INSTALLED						
AIR VENT INSTALLED						
SHUT OFF VALVE INSTALLED						
ACCESS DOORS INSTALLED						

CONTROL VALVE OPERATION						
CONTROLS VERIFIED						
ENTERING AIR TEMPERATURE AT MAXIMUM AIR FLOW						
EXITING AIR TEMPERATURE AT MAXIMUM AIR FLOW						

VAV BOX
Static Verification

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

POSITION/TITLE	SIGNATURE	DATE

VAV BOX
Start-Up

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

VAV BOX
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

SHEET INTENTIONALLY LEFT BLANK FOR INDIVIDUAL TO POPULATE AS NEEDED

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

INSULATED MOLDED CASE CIRCUIT BREAKERS

Functional Performance Testing

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

NAMEPLATE DATA

MANUFACTURER		SERIAL NO.	
--------------	--	------------	--

EQUIP. TEMPERATURE

°C Indicates Temperature Corrected Reading to 20°C

CONTACT RESISTANCE

RESISTANCE TCF:

	PHASE A	PHASE B	PHASE C
INITIAL (MICRO-OHMS)			
INITIAL (MICRO-OHMS)			
CLEANED (MICRO-OHMS)			
CLEANED (MICRO-OHMS)			

ELECTRICAL OPERATIONS

CLOSE		OK	N/A
TRIP		OK	N/A
TRIP-FREE		OK	N/A
ANTIPUMP		OK	N/A

MINIMUM COIL PICKUPS

CLOSE COIL		V
TRIP COIL		V

BOLTED CONNECTION RESISTANCE

MICRO-OHMS

MILLI-OHMS

RESISTANCE TCF:

FROM	TO	PHASE A	PHASE B	PHASE C	NEUTRAL	GROUND

INSULATION TESTS

MEG-OHMS

MICRO-AMPS

INSULATION TCF:

	KV	TIME (min)	PHASE A	PHASE B	PHASE C	NEUTRAL
PHASE-TO-PHASE						
PHASE-TO-GROUND						
LINE-TO-LOAD						

INSULATED MOLDED CASE CIRCUIT BREAKERS

Functional Performance Testing

REVISION #: _____

NAME: _____

COMPANY: _____

ADDRESS: _____

CUSTOMER: _____

PROJECT: _____

FILE NUMBER: _____

DATE: _____

BREAKER NAMEPLATE										
MANUFACTURER				SERIAL NO.						
TYPE				CATALOG NO.						
FRAME SIZE (F)				MOUNTING			B.I.		D.O.	

TRIP UNIT NAMEPLATE										
MANUFACTURER				CT RATIO						
TYPE				RATING PLUG(R)						
THERMAL MEMORY				ON		OFF		SENSOR TAP		
ZONE INTLK		TARGETS								

SETTINGS AS FOUND				LONG TIME PU				DELAY							
RATING PLUG(R)				SHORT TIME PU				DELAY				i ² T	IN	OUT	N/A
SENSOR TAP				INST. PU				ON	OFF						
GRD. FLT.		3W 4W		GRD. FLT. PU				ON	OFF	DELAY		i ² T	IN	OUT	N/A

SETTINGS AS LEFT				LONG TIME PU				DELAY							
RATING PLUG(R)				SHORT TIME PU				DELAY				i ² T	IN	OUT	N/A
SENSOR TAP				INST. PU				ON	OFF						
GRD. FLT.		3W 4W		GRD. FLT. PU				ON	OFF	DELAY		i ² T	IN	OUT	N/A

PRIMARY INJECTION		SECONDARY INJECTION		MFG. TIME CURRENT CURVE NO.	
-------------------	--	---------------------	--	-----------------------------	--

PICKUP TESTS	MFG STANDARD		PHASE A		PHASE B		PHASE C	
	MIN	MAX	FOUND	LEFT	FOUND	LEFT	FOUND	LEFT
INSTANTANEOUS								
LONG TIME								
SHORT TIME								
GROUND FAULT								

TIME DELAY TESTS	MFG STANDARD		PHASE A				PHASE B				PHASE C			
			FOUND		LEFT		FOUND		LEFT		FOUND		LEFT	
	MIN	MAX	AMPS	DELAY	AMPS	DELAY	AMPS	DELAY	AMPS	DELAY	AMPS	DELAY	AMPS	DELAY
INSTANTANEOUS														
LONG TIME														
SHORT TIME														
GROUND FAULT														

INSULATED MOLDED CASE CIRCUIT BREAKERS
Functional Performance Testing

REVISION #: _____

NAME: _____
COMPANY: _____
ADDRESS: _____

CUSTOMER: _____
PROJECT: _____
FILE NUMBER: _____
DATE: _____

GENERAL COMMENTS:

POSITION/TITLE	SIGNATURE	DATE

ACCESS CONTROL SYSTEM

Refer to Section 28 13 23

REVISION #: _____

NAME:	PROJECT No.:
COMPANY:	FILE NUMBER:
ADDRESS:	DRAWING No.:
	BUILDING No.:
CLIENT:	TAG No.:
ADDRESS:	DATE (DDMMYYYY):

COMPONENTS	SPECIFIED	SHOP DRAWINGS	INSTALLED
Card Reader			
Request to Exir Motion Sensor			
Door Contact			
Power Supply			
Other Accessories			

FIELD REVIEW AND COMPLIANCE ACTIVITY	STATUS			COMMENTS
	YES	NO	N/A	
1. Equipment is installed as per the approved shop drawings.				
2. Access Control Unit is installed in location as designed.				
3. Record Date, revision, and version of firmware.				
4. Cabinet, Plug-in units and modules are securely fastened.				
5. Cabinets equiped with continious tamper detection.				
6. Cabinets are housed in locable cabinets.				
7. Controller Unit has a stand alone monitoring and scramble pad control.				
8. Stores a minimum of 3000 event transactions for later uploading to central monitoring station				
9. Access Control Unit is powered by a dedicated Electrical circuit and is clearly identified for Access Control.				
10. Tamper alarm is generated when controller cabinet is opened.				
11. Tamper/restored.				
12. Communications/fail with Central Monitoring Station.				
13. Communications/ restored with Central monitoring Station.				
14. Power fail alarm generated.				
15. Control Unit on Battery, Low Battery alarm.				
16. Minimum 24-battery back-up record number of hours.				
17. Power restore alarm.				
18. General Housekeeping Complete.				

NONCONFORMANCE DESCRIPTION:

POSITION/TITLE	NAME	SIGNATURE	DATE
Witnessed By:			
DCC Site Engineer:			
Design Authority:			

Part 1 General

1.1 Summary

- .1 Section Includes:
 - .1 This Section specifies roles and responsibilities of Commissioning Training.
- .2 Related Requirements;
Provide training for the following Sections;
 - .1 Section

1.2 Trainees

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

1.3 Instructors

- .1 Consultant will provide:
 - .1 Descriptions of systems.
 - .2 Instruction on design philosophy, design criteria, and design intent.
- .2 Contractor and certified factory-trained manufacturers' personnel: to provide instruction on the following:
 - .1 Start-Up, operation, shut-down of equipment, components and systems.
 - .2 Control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices.
 - .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.
- .3 Contractor and equipment manufacturer to provide instruction on:
 - .1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out FPT 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 Operating Manual.
 - .3 Maintenance Manual.
 - .4 Management Manual.
 - .5 TAB and PV Reports.
- .3 Project Manager, Commissioning Manager and Property 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 Transparencies for overhead projectors.
 - .2 Multimedia presentations.
 - .3 Manufacturer's training videos.
 - .4 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.

1.8 Training Content

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:

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

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 Acronyms:

- .1 SOM - System Operation Manual .
- .2 Cx - Commissioning.
- .3 HVAC - Heating, Ventilation and Air Conditioning.
- .4 M&D – Maintenance and Data Manual
- .5 PTRTD - Product Test Report and Technical Documents.
- .6 FPT - Functional Performance Testing
- .7 OPT – Optimization
- .8 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 Including 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 Product Test Report and Technical Documents (PTRTD) and Performance Verification (PV) report forms, approved and accepted by Departmental Representative.
- .13 Commissioning reports.

1.5 Contents Of Operating And Maintenance Manual

- .1 For detailed requirements refer to Section 01 78 00 - Closeout Submittals.
- .2 Departmental Representative to review and approve format and organization within 12 weeks of award of contract.
- .3 Include original manufactures brochures and written information on products and equipment installed on this project.
- .4 Record and organize for easy access and retrieval of information contained in SOM.
- .5 Include completed PI report forms, data and information from other sources as required.
- .6 Inventory directory relating to information on installed systems, equipment and components.
- .7 Approved project shop-drawings, product and maintenance data.
- .8 Manufacturer's data and recommendations relating: manufacturing process, installation, commissioning, start-up, M&D, shutdown and training materials.
- .9 Inventory and location of spare parts, special tools and maintenance materials.
- .10 Warranty information.
- .11 Inspection certificates with expiration dates, which require on-going re-certification inspections.
- .12 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, loose of water or pressure, chemical spills and refrigerant release.
 - .2 Failure of elevators and escalators.
 - .3 HVAC emergencies and fuel supply failures.
 - .4 Intrusion and security breach.
 - .5 Emergency provisions for natural disasters, bomb threats and other disruptive situations.
 - .6 Dedicated emergency generators for high security projects, medical facilities and computer systems.
 - .7 Emergency control procedures for fire, power and major equipment failure.
 - .8 Emergency contacts and numbers.
 - .9 Manual to be readily available and comprehensible to non- technical readers.

1.7 Supporting Documentation For Insertion Into Supporting Appendices

- .1 Provide Departmental Representative supporting documentation relating to installed equipment and system, including:
 - .1 General:
 - .1 Finalized commissioning plan.
 - .2 WHMIS information manual.
 - .3 Approved "as-built" drawings and specifications.
 - .4 Procedures used during commissioning.
 - .5 Cross-Reference to specification sections.
 - .2 Architectural and structural:
 - .1 Inspection certificates, construction permits.
 - .2 Roof anchor log books.
 - .3 PV reports.
 - .3 Fire prevention, suppression and protection:
 - .1 Test reports.
 - .2 Smoke test reports.
 - .3 PV reports.
 - .4 Mechanical:
 - .1 Installation permits, inspection certificates.
 - .2 Piping pressure test certificates.
 - .3 Ducting leakage test reports.
 - .4 TAB and PV reports.
 - .5 Charts of valves and steam traps.
 - .6 Copies of posted instructions.

- .5 Electrical:
 - .1 Installation permits, inspection certificates.
 - .2 TAB and PV reports.
 - .3 Electrical work log book.
 - .4 Charts and schedules.
 - .5 Locations of cables and components.
 - .6 Copies of posted instructions.
 - .7 Copper and Fibre Optic Cable Test Report
 - .8 Product cut-sheets, installation and maintenance manual, software
- .2 Assist Departmental Representative with preparation of SOM.
- 1.8 Language**
 - .1 English Language to be in separate binders.
- 1.9 Identification Of Facility**
 - .1 When submitting information to Departmental Representative for incorporation into SOM, use following system for identification of documentation:
 - .1 Brandon Crop Services Building, 2701 Grand Valley Road, Brandon
Manitoba Project No. R.076331
- 1.10 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
- 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 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-O86S1-05, Supplement No. 1 to CAN/CSA-O86-01, Engineering Design in Wood.
 - .3 CSA O121-M1978(R2003), Douglas Fir Plywood.
 - .4 CSA O153-M1980(R2003), Poplar Plywood.
 - .5 CSA O437 Series-93(R2006), Standards for OSB and Waferboard.
 - .6 CSA S269.1-1975(R2003), Falsework for Construction Purposes.
 - .7 CAN/CSA-S269.3-M92(R2003), Concrete Formwork, National Standard of Canada

1.2 Action And Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts.

1.3 Delivery, Storage And Handling

- .1 Waste Management and Disposal:
 - .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

Part 2 Products

- .1 Formwork materials:
 - .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA-O121, CAN/CSA-O86, CSA O437 Series and CSA-O153.
 - .2 For concrete with special architectural features, use formwork materials to CSA-A23.1/A23.2.
 - .3 Void forms: 150 mm deep, constructed from waxed corrugated cardboard wrapped in 0.152 mm polyethylene. Use plywood or similar product, to provide base to support reinforcing steel.
- .2 Tubular column forms: round, spirally wound laminated fibre forms, internally treated with release material.

- .1 Spiral pattern not to show in hardened concrete.
- .3 Form ties:
 - .1 For concrete not designated architectural, use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.
 - .2 For architectural concrete, use snap ties complete with plastic cones and light grey concrete plugs.
- .4 Form liner:
 - .1 Plywood: Douglas Fir to CSA O121, 19 mm thick.
- .5 Form release agent: non-toxic, biodegradable, maximum VOC content: 350 g/L (less water)
- .6 Concrete Sealant: to Section 07 92 00 – Joint Sealants.

Part 3 Execution

3.1 Fabrication And Erection

- .1 Verify lines, levels and centres before proceeding with formwork and ensure dimensions agree with drawings.
- .2 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
- .3 Fabricate and erect falsework in accordance with CSA S269.1.
- .4 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
- .5 Refer to landscape drawings for concrete retaining walls requiring exposed finishes.
- .6 Do not place shores and mud sills on frozen ground.
- .7 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .8 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA-A23.1/A23.2.
- .9 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
- .10 Use 20 mm chamfer strips on external corners and 20 mm fillets at interior corners, joints, unless specified otherwise.

- .11 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .12 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .13 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

3.2 Removal And Reshoring

- .1 Leave formwork in place for following minimum periods of time after placing concrete:
 - .1 Walls and piers: concrete curing temperatures of:
 - .1 21°C to 35°C = 2 days.
 - .2 16°C to 21°C = 3 days.
 - .3 10°C to 16°C = 4 days.
 - .2 Beam soffits, slabs, and other structural members: concrete curing temperatures of:
 - .1 21°C to 35°C = 14 days.
 - .2 16°C to 21°C = 17 days.
 - .3 10°C to 16°C = 21 days.
- .2 Remove formwork when concrete has reached 75% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .3 Provide all necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .4 Space reshoring in each principal direction at not more than 2 m. apart.
- .5 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

END OF SECTION

Part 1 General

1.1 References

- .1 National Building Code of Canada 2010.
- .2 American Concrete Institute (ACI)
 - .1 SP-66-04, ACI Detailing Manual 2004.
 - .1 ACI 315-99, Details and Detailing of Concrete Reinforcement.
 - .2 ACI 315R-04, Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.
- .3 ASTM International (ASTM)
 - .1 ASTM A1064/A1064M-13, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- .4 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-09/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-A23.3-04, Design of Concrete Structures.
 - .3 CSA W186-M1990 (R2002), Welding of Reinforcing Bars in Reinforced Concrete Construction.
 - .4 CAN/CSA-G164-M92 (R2003), Hot Dip Galvanizing of Irregularly Shaped Articles
- .5 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC-2004, Reinforcing Steel Manual of Standard Practice.

1.2 Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and ACI 315.
- .3 Submit shop drawings including placing of reinforcement and indicate:
 - .1 Bar bending details.
 - .2 Lists.
 - .3 Quantities of reinforcement.
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by the Consultant, with identifying code marks to permit correct placement without reference to structural drawings.
 - .5 Sizes of chairs, spacers and hangers
- .4 Detail lap lengths and bar development lengths to CSA-A23.3.

1.3 Quality Assurance

- .1 Submit in accordance with Section 01 45 00 - Quality Control
 - .1 Mill Test Report: upon request, provide The Consultant with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .2 Upon request submit in writing to The Consultant proposed source of reinforcement material to be supplied.

1.4 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 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 Materials

- .1 Substitute different size bars only if permitted in writing by The Consultant.
- .2 Reinforcing steel: billet steel, grade 400, deformed bars to CAN/CSA-G30.18.
- .3 Welded deformed steel wire fabric: to ASTM A1064/A1064M. Provide in flat sheets only.
- .4 Galvanizing of non-prestressed reinforcement: to CAN/CSA-G164, minimum zinc coating 610 g/m².
- .5 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.
- .6 Cold-drawn annealed steel wire ties to CSA G30.3
- .7 Mechanical splices: subject to approval of The Consultant.

2.2 Fabrication

- .1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2, ACI 315 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.

- .2 Obtain Consultant's approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of the Consultant, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

2.3 Source Quality Control

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

Part 3 Execution

3.1 Field Bending

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

3.2 Placing Reinforcement

- .1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA-A23.1/A23.2.
- .2 Do not displace reinforcing to accommodate sleeves, inserts, waterstops, & reglets except where indicated or authorized by the Consultant.
- .3 Prior to placing concrete, obtain the consultant's approval of reinforcing material and placement. Confirm schedule by giving the Consultant 48 hour notice of completion of reinforcing steel placing. Allow after completion of placing reinforcing steel 4 hours for site review of reinforcing steel and formwork.
- .4 Ensure cover to reinforcement is maintained during concrete pour.

END OF SECTION

Part 1 General

1.1 References

- .1 National Building Code of Canada 2010.
- .2 ASTM International (ASTM)
 - .1 ASTM C260-01, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .2 ASTM D1751-04(2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- .3 Canadian Standards Association (CSA)
 - .1 CSA-A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA-A3000-03, Cementitious Materials.

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide testing and inspection results and reports for review by the Consultant and do not proceed without written approval when deviations from mix design or parameters are found.
- .3 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.
- .4 Concrete hauling time: provide for review by The Consultant deviations exceeding maximum allowable time of 120 minutes for concrete to be delivered to site of Work and discharged after batching.

1.3 Waste Management And Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction Waste Management And Disposal and the Waste Reduction Workplan.
- .2 Use trigger operated spray nozzles for water hoses.
- .3 Designate cleaning area for tools to limit water use and runoff.
- .4 Carefully coordinate the specified concrete work with weather conditions.
- .5 Ensure emptied containers are sealed and stored safely for disposal away from children.

- .6 Prevent plasticizers, water-reducing agents and air-entraining agents from entering drinking water supplies or streams. Using appropriate safety precautions, collect liquid or solidify liquid with an inert, non-combustible material and remove for disposal. Dispose of waste in accordance with applicable local, provincial and national regulations.
- .7 Choose least harmful, appropriate cleaning method which will perform adequately.

1.4 Delivery, Storage And Handling

- .1 Delivery and Acceptance Requirements:
 - .1 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.
 - .1 Do not modify maximum time limit without receipt of prior written agreement from the Consultant and concrete producer as described in CSA A23.1/A23.2.
 - .2 Deviations to be submitted for review by the Consultant.
 - .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

Part 2 Products

2.1 Materials

- .1 Portland cement to CSA-A3001.
- .2 Supplementary cementing materials: to CSA A3001.
- .3 Cementitious hydraulic slag: to CAN/CSA A3000.
- .4 Water: to CAN/CSA-A23.1.
- .5 Aggregates: to CAN/CSA-A23.1. Coarse aggregates to be normal density, except as otherwise specified.
- .6 Air entraining admixture: to ASTM C260.
- .7 Chemical admixtures: to ASTM C494. Obtain the Consultant's approval before using accelerating or set retarding admixtures during cold and hot weather placing.
- .8 Superplasticizing admixtures: to ASTM C494. Obtain the Consultant's approval before using superplasticizing admixtures. Concrete retarders: to ASTM C494 water based, low VOC, solvent free. Do not allow moisture of any kind to come in contact with retarder film.
 - .1 Maximum VOC Content: 350g/L (less water)

- .9 Grout: Portland Cement based non-shrink, non-metallic composition, meeting following requirements:
 - .1 Not exhibit bleeding or segregation at pumpable consistency.
 - .2 Compressive Strength: 25 MPa at 1 day.
 - .3 Bond Strength (ASTM C882) 13 MPa @ 28 days.
 - .4 Positive expansion confirmed by ASTM C827.
 - .5 Not produce a vapour barrier.
- .10 Non-premixed dry pack grout: composition of non metallic aggregate Portland cement with sufficient water for the mixture to retain its shape when made into a ball by hand and capable of developing compressive strength of 35 MPa at 28 days.
- .11 Cure and sealing compound: to CSA-A23.1 and ASTM C309, Type 1.
 - .1 Maximum VOC Content: 200 g/L (less water)
- .12 Pre-moulded joint fillers:
 - .1 Bituminous impregnated fiber board: to ASTM D1751.
- .13 Polyethylene film: 0.254 mm thickness to CAN/CGSB-51.34 under slabs on grade.

2.2 Mixes

- .1 Refer to drawing S1.1 for concrete mix design requirements.

Part 3 Execution

3.1 Preparation

- .1 Obtain the Consultant's approval before placing concrete.
 - .1 Provide 72 hours minimum notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 During concreting operations:
 - .1 Development of cold joints not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Pumping of concrete is permitted only after approval of equipment and mix.
- .5 Do not disturb reinforcement and inserts during concrete placement.
- .6 Prior to placing of concrete obtain The Consultant's approval of proposed method for protection of concrete during placing and curing in adverse weather.

- .7 Protect previous Work from staining.
- .8 Clean and remove stains prior to application for concrete finishes.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .10 In locations where new concrete is dowelled to existing work, drill holes in existing concrete.
 - .1 Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.
- .11 Do not place load upon new concrete until authorized by The Consultant.

3.2 Installation/Application

- .1 Do cast-in-place concrete work in accordance with CSA-A23.1/A23.2
- .2 Sleeves and inserts.
 - .1 Set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere. Sleeves and openings greater than 100 x 100mm not indicated on structural drawings must be approved by the Consultant.
 - .2 No sleeves, ducts, pipes or other openings shall pass through beams, walls or slabs, except where expressly detailed on structural drawings or approved by The Consultant.
 - .3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications from The Consultant before placing of concrete.
 - .4 Check locations and sizes of sleeves and openings shown on structural drawings with architectural, mechanical and electrical drawings.
 - .5 Set special inserts for strength testing as indicated and as required by Non-Destructive Method of Testing Concrete.
 - .6 Place anchor bolts to templates under supervision of trade supplying anchors prior to placing concrete.
- .3 Anchor bolts.
 - .1 Set anchor bolts to templates under supervision of appropriate trade prior to placing concrete.
 - .2 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
- .4 Drainage holes and weep holes:
 - .1 Form weep holes and drainage holes in accordance with Section 03 10 00 - Concrete Forming and Accessories. If wood forms are used, remove them after concrete has set.
 - .2 Install weep hole tubes and drains as indicated.

- .5 Dovetail anchor slots:
 - .1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
 - .2 Install continuous vertical anchor slots at 800 mm oc where concrete walls are masonry faced.
- .6 Grout under base plates and machinery using procedures in accordance with manufacturer's recommendations which result in 100 % contact over grouted area.
- .7 Joint fillers.
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by The Consultant. When more than one piece is required for a joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
 - .2 Locate and form isolation expansion joints as indicated. Install joint filler.
- .8 Cold Weather Concrete
 - .1 The following are minimum requirements for protecting concrete during and after placement in freezing weather. Except as noted below, concrete curing and protection to be in accordance with CAN/CSA-A23.1.
 - .2 Before any concrete is placed, all ice, snow and frost shall be completely removed from all formwork, reinforcing and other surfaces shall be raised above 10°C for 24 hours minimum prior to concreting. Where concrete work is to come in contact with the earth, the surfaces of the earth shall be completely free of frost when the concrete is placed thereon.
 - .3 Concrete aggregates and water shall be heated to not over 80°C.
 - .4 Concrete shall not be less than nor more than 30°C in temperature when deposited.
 - .5 Concrete when placed during freezing weather (or if freezing is anticipated during curing period) shall be fully enclosed and the temperature of same maintained at 18°C for the first three days and 10°C for the next three days.
 - .6 Provide adequate heating to attain specified concrete strengths required prior to stripping, or provide concrete mix which will meet specified stripping strengths under reduced curing temperatures.
 - .7 Keep protecting covering clear of concrete and form surfaces to permit full circulation of air, and maintain intact for at least 24 hours after artificial heat is discontinued.
 - .8 Heating enclosures: strong and windproof, but well ventilated. Heating units located as to prevent local overheating, drying of concrete, and damage from combustion gases. Only Herman Nelson heat exchange, fuel oil type heaters will be acceptable for slabs and flat areas. Units must be vented outside the building. No direct fired units will be acceptable.
- .9 Hot Weather Concrete
 - .1 All concreting operations during hot weather in accordance with CAN/CSA-23.1.

- .2 Exercise particular care to prevent surface crazing of floor slabs due to combined high temperature and drying winds.
- .3 Use of water reducing-retarding chemical admixture in the concrete mix may be required at the The Consultant's discretion.

3.3 Finishing Horizontal Surfaces

- .1 Following consolidation and screeding, immediately bull-float surface to close and smooth the surface.
- .2 Under adverse conditions only, excess bleed water may be removed from surface using procedures acceptable to The Consultant and those noted in CSA-A23.1. Ensure surface is not damaged.
- .3 It is imperative that finishing be completed before surface of concrete dries, otherwise extensive cracking will result. Follow CPCA and CSA-A23.1 procedures and recommendations.
- .4 Ensure uniform, level surface is obtained.
- .5 Immediately after final finishing, apply additional coat of evaporation reducer to prevent drying shrinkage. Apply at manufacturer's recommended coverage. Do not apply evaporation reducer during any finishing operation nor should it be worked into surface.
- .6 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radius edges unless otherwise indicated.
- .7 Mechanical Rooms, and other surfaces not otherwise noted where concrete is to be exposed:
 - .1 Specified finish: Class A as defined by CSA-A23.1, and meeting following requirements:
 - .1 FF = 20
 - .2 FL = 15
 - .3 SWI = 4
 - .4 Surface texture: Steel trowel finish as per CSA-A23.1 Section 7.5.4.3.
 - .5 Surface free of all trowel marks and ridges.

3.4 Joints

- .1 Install control joints at locations shown on the structural drawings.
- .2 Where slabs on fill abut curbs, walls and other vertical surfaces use pre-moulded joint filler.
- .3 Round edges, including edges of joints with a 10 mm radius edging tool.
- .4 Location of control and construction joints as follows:

- .1 Curbs and upstand walls: matching joints in slabs.
- .5 In curbs and upstand walls, discontinue horizontal reinforcing steel at joints unless otherwise noted.
- .6 Control joints in flatwork and curbs shall be formed at locations specified on the drawings or alternatively sawcut via specialized dry-process cutting (e.g. Soff Cut) to depth indicated on the structural drawings.
 - .1 Dry-process saw cutting to occur immediately upon initial set of concrete. Timing of dry-process saw cutting will vary with weather conditions however are typically completed within 1 to 4 hours after final finishing.
 - .2 Timing of dry-process saw cutting will be responsibility of Contractor.
 - .3 Sawcutting 24 hours following placement will not be permitted.
 - .4 Upon minimum 28 day cure, re-cut joints to 12 mm wide by 10 mm deep. Prepare surface and infill with sealant in accordance with Section 07 92 00 – Joint Sealants.
- .7 Unless otherwise indicated, fill control and construction joints with pre-moulded joint filler.

3.5 Curing

- .1 Cure and protect concrete in accordance with requirements of Section 7.4 of CSA A23.1.
- .2 Concrete surfaces to be cured at a minimum temperature of 10°C for the entire curing period.
- .3 Curing regime shall conform to Table 20 of CSA A23.1 and shall depend upon class of exposure.
- .4 Upon final finishing of concrete, and once concrete has hardened sufficiently to prevent surface damage, curing shall commence. Curing of concrete surfaces for curing Types 1 and 2 in Table 20 of CSA A23.1 shall be achieved using one or more of following methods:
 - .1 Curing compound as per section 2.1.11. Apply curing compound per manufacturer's recommendations.
 - .2 Waterproofing paper or plastic film;
 - .3 Forms in contact with concrete surface;
- .5 Additional curing requirements are required for concrete containing a high volume of supplementary cementing materials, such as fly ash, per CSA A23.1 Section 8.8.
- .6 Workers shall not be allowed on concrete for 12 hours after placement. Ensure that curing method does not interfere with concrete placing operations, or damage surface of freshly placed concrete.

3.6 Field Quality Control

- .1 Inspection and testing of concrete and concrete materials will be carried out by inspection/testing agency in accordance with CAN/CSA-A23.2.
- .2 Inspection and testing of concrete and concrete materials by Testing Laboratory designated and paid for by The Consultant.
- .3 Take three test cylinders from each 75 cubic metres of each class of concrete placed or for each day of concrete placement if the latter is less than 75 cubic metres. Testing shall be as follows:
 - .1 One 7 day laboratory cured test.
 - .2 Two 28 day laboratory cured tests.
- .4 Take one additional test cylinder during cold weather concreting. Cure cylinder on job site under same conditions as concrete which it represents.
- .5 Make at least one slump test for each set of test cylinders taken.
- .6 Cure concrete test cylinders in location designated by testing agency for a minimum of 48 hours prior to transporting to laboratory.
- .7 Additional testing required due to low, inaccurate or otherwise questionable results shall be paid for by this Section.
- .8 Non-destructive Methods for Testing Concrete shall be in accordance with CAN/CSA-A23.2M.
- .9 Inspection or testing by The Consultant will not augment or replace Contractor quality control nor relieve him/her of contractual responsibility. Testing agency shall report all results of testing found to be outside specified amounts to the Contractor and the The Consultant.
- .10 Number of trial mixes employed shall be sufficient to satisfy The Consultant that specified air dry density will be met or exceeded.
- .11 Test each type aggregate for gradation, other properties to CAN/CSA-A23.2. Minimum 22.68 kg. samples.

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 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .3 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.

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 for products actually used on project.
- .3 Shop Drawings:
 - .1 If required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
 - .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, 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 MATERIALS

- .1 Steel Bollard: ASTM A500 structural grade, Schedule 80 steel pipe, dimensions as shown in drawings.
 - .1 Wall thickness: 11.0 mm.
 - .2 Finish: Paint to Section 09 91 00.
 - .3 Colour: Safety yellow.
 - .4 Finish: Galvanized.

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

3.2 ERECTION

- .1 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .2 Provide suitable means of anchorage acceptable to Departmental Representative.
- .3 Exposed fastening devices to match finish and be compatible with material through which they pass.
- .4 Supply components for work by other trades in accordance with shop drawings and schedule.
- .5 Deliver items over for casting into concrete together with setting templates to appropriate location and construction personnel.

3.3 SAFETY BOLLARDS

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

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-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) 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 O141-05 (R2014), Softwood Lumber.
 - .3 CSA O151-09 (R2014), Canadian Softwood Plywood.
- .4 National Lumber Grades Authority (NLGA)
 - .1 NLGA Standard Grading Rules for Canadian Lumber, 2007 edition.

1.2 SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Where required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.

1.3 QUALITY ASSURANCE

- .1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood in accordance with CSA and ANSI standards.

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 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, and sleepers:
 - .1 Use S2S or S4S materials.
 - .2 Board sizes: "Standard" or better grade.
 - .3 Dimension sizes: "Standard" light framing or better grade.
 - .4 Post and timbers sizes: "Standard" or better grade.
- .3 Plywood: CSA O325.
 - .1 Plywood installed as backboard in mechanical/electrical area: Before installation, paint all six sides with fire retardant paint as specified in Section 09 91 00 – Painting.
- .4 Canadian softwood plywood (CSP): CSA O151, standard construction.

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

3.2 PREPARATION

- .1 Paint all six surfaces of plywood in mechanical/electrical area with fire-retardant paint, before installation.

3.3 FURRING AND BLOCKING

- .1 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, washroom accessories, toilet partitions, electrical equipment mounting boards, and other work as required.
- .2 Install rough bucks, nailers, and linings to rough openings as required to provide backing for frames and other work.

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 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
 - .1 Architectural Woodwork Standards, 2nd Edition, 2014.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 71.20-M88, Adhesive, Contact, Brushable.
- .4 Canadian Standards Association (CSA)
 - .1 CSA B111-1974, Wire Nails, Spikes and Staples.
 - .2 CSA O141-05 (R2014), Softwood Lumber.
 - .3 CSA O151-09 (R2014), Canadian Softwood Plywood.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .6 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA LD3-2005, High-Pressure Decorative Laminates (HPDL).
- .7 National Hardwood Lumber Association (NHLA)
 - .1 Rules for the Measurement and Inspection of Hardwood and Cypress, 2011.
- .8 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber, 2007.
- .9 National Particleboard Association (NPA)
 - .1 NPA A208.1-09 – Particleboard.
 - .2 NPA A208.2-09 - Medium Density Fiberboard (MDF) for Interior Applications.

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 and 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 If required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
 - .2 Indicate details of construction, profiles, jointing, fastening and other related details.
 - .1 Scales: profiles full size, details half full size.
 - .3 Indicate materials, thicknesses, finishes and hardware.
 - .4 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 samples of laminated plastic for colour selection.
 - .2 Submit duplicate samples of laminated plastic joints, edging, cutouts and postformed profiles.
- .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 Sustainable Standards Certification:
- .3 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 and with manufacturer's written instructions.
- .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 15% 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 Hardwood lumber: Moisture content in accordance with following standards:
 - .1 National Hardwood Lumber Association (NHLA).
 - .2 AWMAC custom grade, moisture content as specified.
- .4 Interior mat-formed wood particleboard: To ANSI/NPA A208.1.
 - .1 Particleboard resin to contain no added urea-formaldehyde.
- .5 MDF (medium density fibreboard): To ANSI A208.2, Grade 130 or better.
 - .1 Modulus of rupture: Minimum 21.6 N/mm² (3130 psi).
 - .2 MDF resin to contain no added urea-formaldehyde.
- .6 Moisture resistant MDF: To ANSI A208.2, Grade 155 MR50.
- .7 Canadian softwood plywood (CSP): To CSA O151, standard construction.
 - .1 Plywood resin to contain no added urea-formaldehyde.
- .8 Laminated plastic for horizontal surfaces: To NEMA LD3, Horizontal Grade Standard (HGS), 1.2 ± 0.12 mm thick; suede or matte finish.
- .9 Laminated plastic for vertical surfaces: To NEMA LD3, Vertical Grade Standard (VGS), 0.7 mm ± 0.10 mm thick, microdot, wood grain, suede, or matte finish.
- .10 Laminated plastic liner sheet: Grade CLS, 0.5 ± 0.10 mm thick, white colour.
- .11 Laminated plastic backing sheet: Grade BKL, minimum 0.5 mm thickness.
- .12 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).
- .13 Edgebanding: Extruded impact resistant PVC, 3 mm thick, colour to match plastic laminate.
- .14 Nails and staples: To CSA B111.
- .15 Wood screws: Stainless steel, type and size to suit application.
- .16 Splines: Metal.
- .17 Sealant: In accordance with Section 07 92 00 - Joint Sealants.
- .18 Laminated plastic adhesive: Contact adhesive to CAN/CGSB 71.20.

2.2 MANUFACTURED UNITS

- .1 All work to AWMAC Custom grade.
- .2 Core: Particleboard or MDF.
- .3 Casework:
 - .1 Construction type: Frameless.
 - .2 Cabinet and door interface: Flush overlay.
 - .3 Core:
 - .1 Top, bottom, gables, doors, body, shelves, and valances: Particleboard, 19 mm thick.
 - .2 Backs: Particleboard, 13 mm thick.
 - .4 Surfaces:
 - .1 Exposed exterior surfaces: HPDL.
 - .2 Exposed interior surfaces: HPDL matching exposed surfaces.
 - .3 Semi-exposed surfaces: Cabinet liner vertical grade laminate, white.
 - .4 Concealed: Manufacturer's choice.
 - .5 Edgeband: Post-formed.
 - .6 Ladder base: Canadian softwood plywood, 19 mm thick.
 - .1 At wet locations: Mount 6 mm moisture resistant MDF to front face of ladder base.
- .4 Drawers:
 - .1 Fronts: Particleboard core, 19 mm thick, with HPDL.
 - .2 Sides and Backs:
 - .1 Particleboard, 16 mm, with white melamine surfaces.
 - .3 Bottoms:
 - .1 Tempered hardboard, 13 mm thick, with white melamine surfaces.
- .5 Laminated plastic countertops:
 - .1 Core material: Particleboard.
 - .2 Surface: HPDL.
 - .3 Front edges and exposed side edges: Post-formed.

2.3 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 laminated plastic 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 3000 mm. Keep joints 600 mm from sink cut-outs.
- .9 Form shaped profiles and bends as indicated, using postforming grade laminate to manufacturer's instructions.
- .10 Use straight self-edging laminate strip for flatwork to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20°. Do not mitre laminate edges.
- .11 Apply laminate backing sheet to reverse side of core of plastic laminate work.
- .12 Apply laminated plastic liner sheet where indicated.

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 plastic laminate counter back splash and adjacent wall finish, apply small bead of sealant in accordance with Section 07 92 00 - Joint Sealants.

- .7 Apply water resistant building paper or bituminous coating 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, 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 C356-10, Linear Shrinkage of Preformed High-Temperature Thermal Insulation Subjected to Soaking Heat.
 - .2 ASTM C423-09a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
 - .3 ASTM C518-10, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .4 ASTM C553-02, Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
 - .5 ASTM C612-04, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .6 ASTM C665-12, Mineral-Fibre Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - .7 ASTM C1104/C1104M-13a, Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
 - .8 ASTM C1338-14, Fungi Resistance of Insulation Materials and Facings.
 - .9 ASTM D1621-10, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - .10 ASTM E90-04, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
 - .11 ASTM E413-04, Classification for Rating Sound Insulation.
- .2 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC S102-03, 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 S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Coverings.
 - .4 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. Indicate VOC content of insulation products and adhesives.
- .3 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.
- .4 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

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.
- .4 Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.4 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 BOARD INSULATION

- .1 Extruded polystyrene (XPS): To CAN/ULC S701, closed cell rigid board.
 - .1 Type: 4.
 - .2 Compressive strength to ASTM D1621: Minimum 210 kPa.
 - .3 Thermal resistance to ASTM C518: RSI 0.88/25 mm.
 - .4 Thickness: As indicated on Drawings.
 - .5 Size: 610 x 2440 mm.
 - .6 Edges: Square.
- .2 Mineral fibre board: To ASTM C612.
 - .1 Thermal Resistance to ASTM C518: Minimum R4/25.4 mm.
 - .2 Fire resistance to CAN/ULC S102:
 - .1 Flame spread: Maximum 25.
 - .2 Smoke Developed: Maximum 50.
 - .3 Water vapour sorption to ASTM C1104: Maximum 5% by weight.

- .4 Corrosion resistance: To ASTM C665 – Non-corrosive to steel, pass.
- .5 Fungal resistance to ASTM C1338: Pass.

2.2 BATT INSULATION

- .1 Semi-rigid batt insulation: To ASTM C612, Type IVB.
 - .1 Fire performance:
 - .1 Noncombustible to CAN/ULC S114.
 - .2 Surface burning characteristics to CAN/ULC S102:
 - .1 Flame spread: 0.
 - .2 Smoke developed: 0.
 - .2 Thermal resistance: For thicknesses 65 mm and greater – minimum RSI 0.74/25.4 mm.
 - .3 Moisture sorption: Maximum 1.0% to ASTM C1104/C1104M.
 - .4 Corrosion resistance: To ASTM C665 – Non-corrosive to steel, pass.
- .2 Batt insulation: To CAN/ULC S702, Type 1, glass fibre inorganic, pre-formed, unfaced, designed for friction-fit in frame cavities.
 - .1 Surface burning characteristics to CAN/ULC S102:
 - .1 Flame spread: 0.
 - .2 Smoke developed: 0.
 - .2 Corrosive resistance: To ASTM C665 – Non-corrosive to steel, pass.
- .3 Acoustic fire batt (AFB) insulation: To CAN/ULC S702, Type 1; non-combustible to CAN/ULC S114, lightweight, 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 Rating sound insulation: To ASTM E413.
 - .4 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

2.3 ACCESSORIES

- .1 Tape and adhesives: 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 thermal protection to building elements and spaces.
- .3 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior 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 and approved by Departmental Representative.

3.3 EXAMINATION

- .1 Examine substrates and inform Departmental Representative of defects.
- .2 Verify substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.
- .3 Confirm mechanical and electrical service lines in walls and ceilings to be insulated have been inspected.

3.4 BOARD INSULATION INSTALLATION

- .1 Apply adhesive to polystyrene and mineral fibre insulation in accordance with manufacturer's recommendations.
- .2 Leave insulation board joints unbonded over line of expansion and control joints. Bond a continuous 150 mm wide 0.15 mm modified bituminous membrane over expansion and control joints using compatible adhesive and primer before application of insulation.

3.5 BATT INSULATION INSTALLATION

- .1 Install insulation to maintain continuity of thermal protection to building elements and spaces.
- .2 Place blankets between studs ensuring friction fit, free of sags, folds, voids, or open joints that may let sound pass through.
- .3 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.

- .4 Do not compress insulation excessively to fit voids.
- .5 Do not enclose insulation until it has been inspected and approved by Departmental Representative.

3.6 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM D412-06a (2013), Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
 - .2 ASTM E96/E96M-05, Water Vapor Transmission of Materials.
 - .3 ASTM E283-04 (2012), Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .4 ASTM E2357-11, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
- .2 Canadian General Standards Board (CGSB)
 - .1 CGSB 37-GP-56M-1985, Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.
- .3 Sealant and Waterproofer's Institute - Sealant and Caulking Guide Specification.

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 datasheet. Include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS Material Safety Data Sheets.
- .3 Quality Assurance Submittals:
 - .1 Existing Substrate Condition: Report deviations in writing to Departmental Representative.
 - .2 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, AND cleaning procedures.

1.3 QUALITY ASSURANCE

- .1 Mock-Up:
 - .1 Construct typical exterior wall panel, minimum 2500 mm long by 2500 mm wide, incorporating insulation, building corner condition, junction with roof system; and illustrating materials interface and seals.
 - .2 Locate where directed.

- .3 Mock-up may remain as part of finished work.
- .4 Allow for inspection of mock-up by Departmental Representative before proceeding with air/vapour barrier Work.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.
- .2 Clean spills and leave area as it was prior to spill.

1.5 WASTE MANAGEMENT AND DISPOSAL

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

1.6 AMBIENT CONDITIONS

- .1 Install solvent curing sealants and vapour release adhesive materials in open spaces with ventilation.
- .2 Maintain temperature and humidity recommended by materials manufacturers before, during, and after installation.

1.7 SEQUENCING

- .1 Sequence work to permit installation of materials in conjunction with related materials and seals.

Part 2 Products

2.1 GENERAL

- .1 Provide air/vapour barrier system components from one manufacturer.

2.2 SHEET MATERIALS

- .1 Self-adhering air/vapour barrier membrane, SBS modified bitumen complete with cross-laminated polyethylene film, to ASTM E2357.
 - .1 Physical properties:
 - .1 Thickness: 1.0 mm.
 - .2 Air leakage to ASTM E283: <0.005 L/s.m² at 75 Pa.
 - .3 Water vapour permeance to ASTM E96: 1.6 ng/Pa.s.m².
 - .4 Low temperature flexibility to CGSB 37-GP-56M: -30°C.
 - .5 Elongation to ASTM D412-modified: 200%.

2.3 SEALANTS

- .1 Sealants in accordance with Section 07 92 00 - Joint Sealants.
- .2 Primer: As recommended by sealant manufacturer and appropriate to application conditions.
- .3 Substrate Cleaner: Non-corrosive, type recommended by sealant manufacturer; compatible with adjacent materials.

2.4 ADHESIVES

- .1 Adhesive: Synthetic rubber-based adhesive for self-adhering membranes, quick setting, for application at temperatures above -12°C.
- .2 Primer: Water-based polymer emulsion-based adhesive, quick setting, for application at temperatures above -4°C.

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 surfaces and conditions are ready to accept work of this section.
- .2 Ensure surfaces are clean, dry, sound, smooth, continuous, and in compliance with air barrier manufacturer's requirements.
- .3 Report unsatisfactory conditions to Departmental Representative.
- .4 Do not start work until deficiencies have been corrected.
 - .1 Beginning of Work implies acceptance of conditions.

3.3 PREPARATION

- .1 Remove loose or foreign matter that might impair adhesion of materials.
- .2 Ensure substrates are clean of oil or excess dust; open joints filled; and concrete surfaces free of large voids, spalled areas, or sharp protrusions.
- .3 Ensure substrates are free of surface moisture prior to application of self-adhesive membrane and primer.
- .4 Ensure metal closures are free of sharp edges and burrs.
- .5 Prime substrate surfaces to receive adhesive in accordance with manufacturer's instructions.

3.4 INSTALLATION

- .1 Install materials in accordance with manufacturer's instructions.

- .1 Caulk to ensure complete air seal.
- .2 Position lap seal over firm bearing.
- .2 Apply sealant within recommended application temperature ranges.
 - .1 Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.5 CLEANING

- .1 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.

3.6 PROTECTION OF WORK

- .1 Do not permit adjacent work to damage work of this section.
- .2 Ensure finished work is protected from climatic conditions.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A653/A653M-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .3 ASTM D822/D822M-13, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 37.5-M89, Cutback Asphalt Plastic Cement.
 - .2 CAN/CGSB-37.29-M89, Rubber-Asphalt Sealing Compound.
- .3 Canadian Sheet Steel Building Institute (CSSBI)
 - .1 CSSBI 20M-15: Sheet Steel Cladding for Architectural, Industrial and Commercial Building Applications.
- .4 Canadian Standards Association (CSA)
 - .1 CSA S136-12, Design of Cold Formed Steel Structural Members.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 DESIGN REQUIREMENTS

- .1 Design cladding system in accordance with:
 - .1 CSA S136.
 - .2 CSSBI Standard 20M.
 - .3 National Building Code of Canada.
- .2 Design wall system to resist:
 - .1 Wind loads, positive and negative, expected in geographical region of project with 50 year probability.
- .3 Deflection of the wall system is not to exceed $1/180^{\text{th}}$ of the span for the wind load based on serviceability limit states.
- .4 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, overstressing of components, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.

- .5 Design expansion joints to accommodate movement in cladding and between cladding and structure to prevent permanent distortion or damage to the cladding.
- .6 Design wall system to maintain the following erection tolerances:
 - .1 Maximum variation from plane or location shown on shop drawings: 20 mm/10 m (3/4 inch/30 feet).
 - .2 Maximum offset from true alignment between two adjacent members abutting end to end in line: 1 mm (0.04 inches).

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 metal siding. Include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS for products actually used on the project.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
 - .2 Indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, metal furring, and related work.
- .4 Samples:
 - .1 Submit duplicate 300 x 300 mm samples of siding material, of colour and profile specified.

1.4 QUALITY ASSURANCE

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

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

Part 2 Products

2.1 STEEL CLADDING AND COMPONENTS

- .1 Steel Liner:
 - .1 Fabricated from ASTM A653M structural quality Grade 230 galvanized steel, with zinc coating of Z275 galvanized, as designated by ASTM A653M.
 - .2 Sub-girts: Minimum 1.21 mm (0.048 inch) thick formed galvanized steel, ASTM A653M Grade 230 with Z275 zinc coating. Full depth of wall system, factory notched and formed to match liner.
 - .3 Insulation: As indicated on drawings and specified in Section 07 21 00.
 - .4 Steel Cladding:
 - .1 Fabricated from Z275 galvanized sheet steel conforming to ASTM A653M Grade 230.
 - .5 Fasteners: Stainless steel, with exposed fasteners colour matched to cladding.

2.2 STEEL SHEET FINISH

- .1 Factory applied silicone modified polyester.
 - .1 Colour: As selected by Departmental Representative from manufacturer's standard range.
 - .2 Specular gloss: 30 units +/-5 to ASTM D523.
 - .3 Coating thickness: 25 micrometres minimum.
 - .4 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:
 - .1 Outdoor exposure period 1000 hours minimum.
 - .2 Humidity resistance exposure period 1000 hours minimum.

2.3 CAULKING

- .1 Sealants: In accordance with Section 07 92 00 - Joint Sealants.
 - .1 Butyl sealant – for metal panel joints.

2.4 ACCESSORIES

- .1 Exposed trim: Inside corners, outside corners, cap strip, drip cap, undersill trim, starter strip and window/door trim of same material, colour, and gloss as cladding, with fastener holes pre-punched.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate are acceptable 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 Liner Sheet:
 - .1 Fasten liner sheet, together with sub-girts, to steel framing. Ensure all fasteners are driven normal to the plane of the liner.
 - .2 Interlock liner side joints and seal with butyl caulking. Lap all ends at least 100 mm (4 inches) over support.
- .2 Sub-girt framing system:
 - .1 Install notched sub-girts through liner directly to steel structure. Frame all openings in the cladding.
- .3 Flashing:
 - .1 Install starter flashing, drip and other flashing, and corners, edgings, window and door flashing as shown on the drawings.
- .4 Insulation:
 - .1 Install insulation in accordance with manufacturer's recommendations. Ensure insulation is positively fixed to liner to prevent sagging.
- .5 Exterior Cladding:
 - .1 Install exterior cladding in accordance with manufacturer's standard installation procedures, providing proper laps and detailing to ensure a weathertight face.
 - .2 Install finishing flashing and cap flashing.
- .6 Sealants:
 - .1 Install sealants at junctions with adjoining work, and where shown on the drawings, in accordance with Section 07 92 00.

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 Clean exposed panel surfaces in accordance with manufacturer's instructions.
- .4 Repair and touch up with colour matching high-grade enamel minor surface damage.

- .5 Replace damaged panels and components that cannot be satisfactorily repaired.
- .6 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .7 Waste Management: Separate waste material 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 preformed metal siding installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A653/A653M-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .3 ASTM D822/D822M-13, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 37.5-M89, Cutback Asphalt Plastic Cement.
 - .2 CAN/CGSB-37.29-M89, Rubber-Asphalt Sealing Compound.
- .3 Canadian Sheet Steel Building Institute (CSSBI)
 - .1 CSSBI 10M-13: Steel Roof Deck.
 - .2 CSSBI 20M-15: Sheet Steel Cladding for Architectural, Industrial and Commercial Building Applications.
- .4 Canadian Standards Association (CSA)
 - .1 CSA S136-12, Design of Cold Formed Steel Structural Members.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 DESIGN REQUIREMENTS

- .1 Design cladding system in accordance with:
 - .1 CSA S136.
 - .2 CSSBI Standards 10M and 20M.
 - .3 National Building Code of Canada.
- .2 Design roof to resist:
 - .1 Show loads and snow build-up expected in geographical region of project with 50 year probability.
 - .2 Wind loads, positive and negative, expected in geographical region of project with 50 year probability.
 - .3 Dead load of roof.
 - .4 Water penetration.
 - .5 Corrosion.
 - .6 Loads imposed by the snow retention system.
- .3 Maximum deflection 1/240 of clean span under live loads of wind, snow and ice.

- .4 Calculate snow and ice loads for building area in accordance with National Building Code of Canada.
- .5 Allow for thermal movement.

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 sheet metal roofing. Include product characteristics, performance criteria, physical size, finishes, and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:
 - .1 If required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
- .4 Samples:
 - .1 Submit duplicate 250 x 250 mm samples of each sheet metal material.
- .5 Closeout submittals: To Section 01 78 00 – Closeout Submittals.
 - .1 Provide 30 extra clamps for snow guard attachment.

1.4 QUALITY ASSURANCE

- .1 Mock-ups:
 - .1 Submit mock-ups in accordance with Section 01 45 00 - Quality Control.
 - .2 Fabricate 2000 x 2000 mm sample roofing panel using identical project materials and methods, including typical seam.
 - .3 Mock-up will be used:
 - .1 To judge workmanship, substrate preparation, operation of equipment, and material application.
 - .4 Locate where directed.
 - .5 Allow for inspection of mock-up by Departmental Representative before proceeding with sheet metal flashing 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.

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

Part 2 Products

2.1 SHEET METAL MATERIALS FOR STANDING SEAM ROOFING

- .1 Zinc coated steel sheet: To ASTM A653/A653M, commercial quality, with Z275 galvanized coating, smooth surface, prefinished, metal thickness minimum 0.64 mm (24 gauge).

2.2 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory-applied silicone modified polyester.
 - .1 Colour: As selected by Departmental Representative from manufacturer's standard range.
 - .2 Specular gloss: 30 units +/-5 to ASTM D523.
 - .3 Coating thickness: 25 micrometres minimum.
 - .4 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:
 - .1 Outdoor exposure period 1000 hours minimum.
 - .2 Humidity resistance exposure period 1000 hours minimum.

2.3 ACCESSORIES

- .1 Subgirt system:
 - .1 Clips: Purpose made, sliding clip designed to accommodate expansion and contraction of roof sheet; galvanized material, thickness to suit design parameters.
 - .2 Continuous hat bar and Z-clips: Galvanized material, thickness to suit design parameters and accommodate depth of insulation.
- .2 Snow retention devices: As approved by sheet metal roofing manufacturer, double-pipe snow fence, with attachment clamps installed to standing seams.
 - .1 Tubing: 6061-T6 aluminum extrusions to ASTM B221, 25.4 mm (1 inch) outer diameter, 19 mm (3/4 inch) inner diameter; complete with nylon end caps.
 - .2 Tubing couplers: Extruded aluminum, 19 mm exterior diameter, with rubber seals, and nylon end caps.
 - .3 Clamps: 6061-T6 alloy aluminum extrusions to ASTM B221; or aluminum castings to ASTM B85; complete with collars for retention of tubing.

- .4 Set screws: 300 series stainless steel, 18-8 alloy, 9.5 mm diameter, with round nose point.
- .5 Attachment bolts: 300 series stainless steel, 18-8 alloy, 10 mm diameter, with flat washers.
- .3 Insulation: Semi-rigid, refer to Section 07 21 00 – Building Insulation.
- .4 Isolation coating: Alkali resistant bituminous paint.
- .5 Plastic cement: To CAN/CGSB-37.5.
- .6 Sealant: Butyl rubber, non-skinning, non-drying, compatible with systems materials, recommended by system manufacturer.
- .7 Rubber-asphalt sealing compound: To CAN/CGSB 37.29.
- .8 Flashing: In accordance with Section 07 62 00. Material to match cladding in exposed locations, galvanized material in concealed locations. Custom fabricated to suit architectural details, as required. Use preformed corner pieces only. Double back exposed edges.
- .9 Cleats: Of same material, and temper as sheet metal; minimum 50 mm wide.
- .10 Fasteners: Galvanized, compatible with sheet material, with exposed fasteners colour matched to pre-finished sheet materials.
- .11 Washers: Of same material as sheet metal, 1 mm thick with rubber packings.
- .12 Touch-up paint: As recommended by sheet metal roofing manufacturer.

2.4 FABRICATION

- .1 Fabricate roof components to comply with dimensions, profiles, gauges and details as shown on the shop drawings, including all companion flashing.
- .2 Provide metal liner, roofing, and all accessories in longest practicable length to minimize field lapping of joints.
- .3 Make allowances for expansion at joints.
- .4 Hem exposed edges on underside 12 mm, mitre and seal.
- .5 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .6 Apply minimum 0.2 mm dry film thickness coat of plastic cement to both faces of dissimilar metals in contact.
- .7 Protect metals against oxidization by backpainting with isolation coating where indicated.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrate are acceptable for sheet metal roofing 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 Conform to reviewed shop drawings.
- .2 Fix all materials in assembly in accordance with manufacturer's recommendations. Fix all building components to allow thermal expansion caused by thermal influences.
- .3 Erect metal roofs and accessories in accordance with manufacturer's written recommendations and as follows:
 - .1 Factory form panels in continuous one-piece lengths to maximum practical size to keep joints to minimum.
 - .2 Locate joints where indicated on shop drawings.
 - .3 Joints: Fully seal joints, including expansion joints within roof system, and between roof and adjacent materials for rain and snow-proof installation. Make penetrations in roofing watertight.
 - .4 Make minimum 250 mm (10 inch) overlap at cross seams.
 - .5 Roof panel support system Z-clip subgirt conforming to ASTM A653/A653M minimum 18 gauge thickness, zinc coating Z275 at centres, determined by roofing thickness. Designed to accommodate insulation depth and allow full thermal expansion and contraction of roof sheet.
- .4 Install semi-rigid insulation as shown in drawings. Tightly butt against support clips. Ensure insulation is continuous.
- .5 Interlock liner side joints and seal with butyl caulking. Lap all ends at least 100 mm (4 inches) over support.
- .6 Install sealants at junctions with adjoining work, and where shown on the drawings, in accordance with Section 07 92 00.
- .7 When cutting or drilling prefinished material, ensure that cuttings do not remain to rust on exposed prefinished surfaces. Where practicable, conduct cutting and drilling so that cuttings do not strike or accumulate on exposed cladding surfaces. Hand trim edges cut with an abrasive blade.
- .8 Install snow retention devices as recommended by sheet roofing manufacturer.

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 Clean exposed panel surfaces in accordance with manufacturer's instructions.
- .4 Repair and touch up minor surface damage with colour matching high grade enamel.

- .5 Replace damaged panels and components that cannot be satisfactorily repaired.
- .6 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .7 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 sheet metal roofing installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A653/A653M-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .3 ASTM D822/D822M-13, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .2 Canadian Roofing Contractors Association (CRCA)
 - .1 Roofing Specifications Manual, current edition.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 37.5-M89, Cutback Asphalt Plastic Cement.
- .4 Canadian Standards Association (CSA)
 - .1 CSA A123.3-05 (R2010), Asphalt Saturated Organic Roofing Felt.
 - .2 CSA B111-1974 (R2003), Wire Nails, Spikes and Staples.
- .5 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 for sheet metal flashing systems materials, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies WHMIS MSDS - Material Safety Data Sheets for products actually used on project.
- .3 Shop Drawings:
 - .1 Shop drawings: Where required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
- .4 Samples:
 - .1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes, and colours.
- .5 Quality assurance submittals: Submit following in accordance with Section 01 45 00 - Quality Control.

- .1 Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.3 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
 - .1 Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 SHEET METAL MATERIALS

- .1 Zinc coated steel sheet: Commercial quality to ASTM A653/A653M, with Z275 designation zinc coating.

2.2 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied silicone modified polyester.
 - .1 Colour: As selected by Departmental Representative from manufacturer's standard range.
 - .2 Specular gloss: 30 units +/- in accordance with ASTM D523.
 - .3 Coating thickness: Minimum 20 micrometres.
 - .4 Resistance to accelerated weathering for chalk rating of 8, colour fade 5 units or less and erosion rate less than 20% to ASTM D822 as follows:
 - .1 Outdoor exposure period 1000 hours.
 - .2 Humidity resistance exposure period 1000 hours.

2.3 ACCESSORIES

- .1 Isolation coating: Alkali resistant bituminous paint.
- .2 Plastic cement: to CAN/CGSB 37.5.
- .3 Underlay for metal flashing: No. 15 perforated asphalt felt to CSA A123.3.
- .4 Sealants: Butyl sealant as specified in Section 07 92 00.
- .5 Fasteners: Same material as sheet metal, to CSA B111, ring thread flat head roofing nails of length and thickness suitable for metal flashing application.
- .6 Washers: Same material as sheet metal, 1 mm thick with rubber packings.
- .7 Touch-up paint: as recommended by prefinished material manufacturer.

2.4 FABRICATION - METAL FLASHINGS

- .1 Fabricate metal flashings and other sheet metal work in accordance with applicable CRCA 'FL' series details.

- .2 Form flashings, copings, fascias, eavestroughs, and downpipes from prefinished steel.
- .3 Provide goosenecks, outlets, and necessary fastenings.
- .4 Form pieces in 2400 mm maximum lengths.
 - .1 Make allowance for expansion at joints.
- .5 Hem exposed edges on underside 12 mm.
 - .1 Mitre and seal corners with sealant.
- .6 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .7 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify existing conditions before starting work.
- .2 Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- .3 Verify roofing termination and base flashings are in place, sealed, and secure.

3.2 PREPARATION

- .1 Install starter and edge strips, and cleats before starting sheet metal installation.

3.3 INSTALLATION

- .1 Install sheet metal work in accordance with CRCA Roofing Specifications Manual.
- .2 Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
- .3 Fit flashings tightly in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- .4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.
 - .1 Flash joints using standing seams forming tight fit over hook strips.
- .5 Lock end joints and caulk with sealant.
- .6 Install pans, where shown around items projecting through roof membrane.

3.4 EAVESTROUGHES AND DOWNPIPES

- .1 Install eavestroughs and secure to building at 750 mm on centre.
 - .1 Slope eavestroughs to downpipes as indicated.
 - .2 Seal joints watertight.

- .2 Install downpipes and provide goosenecks back to wall.
- .1 Secure downpipes to wall with straps at 1800 mm on centre; minimum two straps per downpipe.
- .3 Install splash pans as indicated.

3.5 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 Leave work areas clean, free from grease, finger marks, and stains.

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, 2009 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 S101-07 – Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC S102-07 – Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC S115-05 - 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 Contractor: Company specializing in performing the work of this section, with minimum 3 years of documented experience, and with at least one of the following qualifications:
 - .1 Approved in accordance with FM Standard 4991.
 - .2 FCIA Member in good standing.
 - .3 UL Approved Contractor.
 - .4 Licensed by the local authority having jurisdiction.
- .2 Single Source Responsibility: Obtain firestop systems for each type of penetration and construction situation from a single primary firestop systems manufacturer.
- .3 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:
 - .1 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.

1.8 SEQUENCING AND SCHEDULING

- .1 Schedule installation of cast-in-place firestop devices after completion of floor formwork, metal form deck, or composite deck, but before placement of concrete.
- .2 Schedule installation of drop-in firestop devices after placement of concrete but before installation of pipe penetration.
- .3 Schedule installation of other firestopping materials after completion of penetrating item installation, but prior to covering or concealing of openings.

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 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 C834-05, Standard Specification for Latex Sealants.
 - .2 ASTM C919-12, Standard Practice for Use of Sealants in Acoustical Applications.
 - .3 ASTM C920-05, Standard Specification for Elastomeric Joint Sealants.
 - .4 ASTM C1184-05, Standard Specification for Structural Silicone Sealants.
 - .5 ASTM C1193-13, Standard Guide for Use of Sealants.
 - .6 ASTM C1311-02, Standard Specification for Solvent Release Sealants.
 - .7 ASTM C1401-14, Standard Guide for Structural Sealant Glazing.
 - .8 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 in accordance with Section 01 35 29 - Health and Safety Requirements.
- .3 Samples:
 - .1 Submit 2 samples of each type of material and colour.
 - .2 Cured samples of exposed sealants for each colour where required to match adjacent material.
- .4 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 Ventilate area of work as directed by Departmental Representative, by use of approved portable supply and exhaust fans.

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 Type 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, precast concrete panels, expansion joints, curtain walls, panel walls, perimeter windows.
- .2 Type 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, pre-cast concrete panel joints, perimeter caulking of windows and doors, curtain wall joints.

- .3 Type 3: Glazing sealant: To ASTM C920, Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing; compatible with glazing system components, recommended by aluminum framed system manufacturer.
- .4 Butyl: To CGSB 19-GP-14M and ASTM C1311, blend of butyl rubber and polyisobutylene.
 - .1 For metal panel joints.
- .5 Acoustic Sealant: To CAN/CGSB 19.21 and ASTM C919, acoustic grade, single component, non-hardening, non-skinning.
 - .1 Acoustic sealing of gypsum wall board partitions.
- .6 Latex Sealant: To CAN/CGSB 19.17; and ASTM C834; single component, acrylic latex or siliconized acrylic latex.
 - .1 General purpose, acoustic sealing, back bedding glazing compound, window frame perimeters.
- .7 Fire-Resistive Sealant: To ASTM E814, one part fire-stopping sealant.
 - .1 Penetrations in fire-rated floor and wall assemblies.
 - .2 Refer to Section 07 84 00 – Fire Stopping.
- .8 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 Around washroom fixtures, lavatories, and other wet areas.
- .9 Structural Silicone Sealant: To ASTM C1184, Type M Grade NS, Class 25, Use NT, G and A; multi-component, high modulus structural sealant.
 - .1 Typical uses: Structural glazing.
- .10 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.
- .11 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 sealants installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Architectural Manufacturers Association (AAMA)
 - .1 AAMA 812-04(2010), 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.
 - .2 ASTM E84-12, Surface Burning Characteristics of Building Materials.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
 - .2 CGSB 41-GP-19Ma-84, Rigid Vinyl Extrusions for Windows and Doors.
- .4 Canadian Standards Association (CSA)
 - .1 CSA G40.20-04/G40.21-04, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 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.
 - .3 CAN/ULC S702-09, Standard for Thermal Insulation, Mineral Fibre, for Buildings.
 - .4 CAN/ULC S704-03, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.
 - .5 CAN/ULC S710.1-05, Thermal Insulation – Bead Applied One-Component Polyurethane Air Sealant Foam.

1.2 SYSTEM DESCRIPTION

- .1 Design Requirements:
 - .1 Design exterior frame assembly to accommodate to expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.
 - .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.
 - .3 Provide fire labelled frames for openings requiring fire protection ratings. Test products in conformance with CAN4-S104 or NFPA 252 and listed by nationally recognized agency having factory inspection services.

1.3 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product data: Indicate door and frame configurations and finishes, location of cut-outs for hardware reinforcement.
- .3 Shop drawings:
 - .1 If required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
 - .2 Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, openings, glazing, arrangement of hardware, fire rating, and finishes.
 - .3 Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings [reinforcing] [fire rating] finishes.
 - .4 Include schedule identifying each unit, with door marks and numbers relating to numbering on drawings and door schedule.
- .4 Samples:
 - .1 Submit one 250 x 250 mm corner sample of each type of frame.
 - .2 Show butt cut-out, glazing stops.

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:
 - .1 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 Reinforcement: To CSA G40.20/G40.21, Type 44W, coating designation to ASTM A653M, ZF75.

2.2 DOOR CORE MATERIALS

- .1 Stiffened: Face sheets welded, core as indicated.
 - .1 Interior non-rated: To CAN/ULC S702, semi-rigid, density 24 kg/m³.
 - .2 Interior acoustic: Manufacturer's proprietary core, tested to STC indicated on schedule.
 - .3 Exterior: Polyurethane to CAN/ULC S704, faced boards.
- .2 Temperature rise rated (TRR): Core composition to limit temperature rise on unexposed side of door to 250°C at 60 minutes. Core to be tested as part of a complete door assembly, in accordance with CAN4-S104 or NFPA 252, covering Standard Method of Tests of Door Assemblies and listed by nationally recognized testing agency having factory inspection service.

2.3 ADHESIVES

- .1 Steel components: Heat resistant, spray grade, resin reinforced neoprene/rubber (polychloroprene) based, low viscosity, contact cement.
- .2 Polyurethane cores: Heat resistant, epoxy resin based, low viscosity, contact cement.
- .3 Lock-seam doors: Fire resistant, resin reinforced polychloroprene, high viscosity, sealant/adhesive.

2.4 PRIMER

- .1 Touch-up prime CAN/CGSB 1.181.

2.5 PAINT

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

2.6 ACCESSORIES

- .1 Door Hardware and Weatherstripping: Specified in Section 08 71 00.
- .2 Door silencers: Single stud rubber/neoprene type.
- .3 Thermal breaks for frames: Neoprene or PVC.
- .4 Exterior top caps: Rigid polyvinylchloride extrusion conforming to CGSB 41-GP-19Ma.

- .5 Metallic paste filler: To manufacturer's standard.
- .6 Fire labels: Metal riveted.
- .7 Exterior frame insulation: Expanding polyurethane foam to CAN/ULC S710.1, low pressure, non-frame warping.
 - .1 Fire resistance to ASTM E84:
 - .1 Flame spread: Maximum 15.
 - .2 Smoke developed: Maximum 20.
 - .2 To AAMA 812, pressure build 0.55 kPa (0.08 psi).
- .8 Sealant: Refer to Section 07 92 00 – Joint Sealing.
- .9 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.
- .10 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 Exterior frames: 1.6 mm welded construction, thermally broken.
- .4 Interior frames: 1.6 mm welded type construction.
- .5 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.
- .6 Protect mortised cut-outs with steel guard boxes.
- .7 Prepare frame for door silencers, 3 for single door, 2 at head for double door.
- .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 Shim and anchor new doors in accordance with CAN/CSA A440.4.
- .2 Provide appropriate anchorage to floor and wall construction.
- .3 Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb.
- .4 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.

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 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 Exterior doors: Hollow steel construction.
- .3 Interior doors: Hollow steel construction.
- .4 Fabricate doors with longitudinal edges lock seamed, adhesive assisted. Seams: grind welded joints to a flat plane, fill with metallic paste filler and sand to a uniform smooth finish.
- .5 Blank, reinforce, drill doors and tap for mortised, templated hardware electronic hardware.
- .6 Factory prepare holes 12.7 mm diameter and larger except mounting and through-bolt holes, on site, at time of hardware installation.
- .7 Reinforce doors where required, for surface mounted hardware. Provide flush PVC top caps to exterior doors. Provide inverted, recessed, spot welded channels to top and bottom of interior doors.
- .8 Provide factory-applied touch-up primer at areas where zinc coating has been removed during fabrication.
- .9 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.

2.11 HOLLOW STEEL CONSTRUCTION

- .1 Form face sheets for exterior doors from 1.6 mm sheet steel.
- .2 Form face sheets for interior doors from 1.6 mm sheet steel.
- .3 Reinforce doors with vertical stiffeners, securely welded or laminated to face sheets at 150 mm on centre maximum.
- .4 Fill voids between stiffeners of exterior doors with polyurethane core.
- .5 Fill voids between stiffeners of interior doors with fibreglass, acoustically absorbent core, or temperature rise rated core as required.

2.12 THERMALLY BROKEN DOORS AND FRAMES

- .1 Fabricate thermally broken doors by using insulated core and separating exterior parts from interior parts with continuous interlocking thermal break.
- .2 Thermal break: rigid polyvinyl chloride extrusion conforming to CGSB 41-GP-19Ma.
- .3 Fabricate thermally broken frames separating exterior parts from interior parts with continuous interlocking thermal break.
- .4 Apply insulation.

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 frames with purpose-made expanding polyurethane foam.
- .6 Caulk perimeter of frames between frame and adjacent material.
- .7 Maintain continuity of vapour retarder.

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, noncombustible sill 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 and surfaces with imperfections with metallic paste filler, and sand to a uniform smooth finish.

3.6 GLAZING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM A653/A653M-08 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 CSA C22.1-06 - Canadian Electrical Code, Part I (20th Edition), Safety Standard for Electrical Installations.
- .3 CAN/CSA-C22.2 No. 100-04 - Motors and Generators.
- .4 CAN/CSA-C22.2 No. 247-92 (R2008) - Operators and Systems of Doors, Gates, Draperies and Louvres.
- .5 UL 325-2010 - Door, Drapery, Gate, Louvre, and Window Operators and Systems.

1.2 PERFORMANCE REQUIREMENTS

- .1 Wind Loads: Design and size components to withstand loads caused by pressure and suction of wind acting normal to plane of wall as calculated in accordance with applicable code.

1.3 SUBMITTALS

- .1 Section 01 33 00: Submission procedures.
- .2 Product Data: Provide general construction, component connections and details, and electrical equipment.
- .3 Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details.
- .4 Samples: Submit duplicate 150 x 150 mm samples of sheet metal, illustrating shape, colour, and finish texture.
- .5 Installation Data: Manufacturer's special installation requirements, including installation sequence and procedures, adjustment and alignment procedures.

1.4 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: Indicate lubrication requirements and frequency, and periodic adjustments required.

1.5 REGULATORY REQUIREMENTS

- .1 Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

- .2 Provide certificate of compliance from authority having jurisdiction indicating approval of door and operating hardware assembly.

Part 2 Products

2.1 INSULATED SECTIONAL OVERHEAD DOOR

- .1 Door assembly: Metal/foam/metal sandwich panel construction with thermal break and ship-lap joints.
 - .1 Panel thickness: 51 mm.
 - .2 Exterior surface: Flush, textured.
 - .3 Exterior steel: 1.00 mm (20 gauge), hot dip galvanized.
 - .4 End stiles: 1.61 mm (16 gauge), with thermal break.
 - .5 Spring counterbalance: Sized to weight of door, with helically wound, oil tempered torsion spring mounted on steel shaft. Cable drum of die cast aluminum with high strength galvanized aircraft-grade cable. Size for minimum safety factor 7:1.
 - .1 Spring rated to 10,000 cycles minimum.
 - .6 Insulation: Polyurethane, fully encapsulated.
 - .7 Insulation value: Minimum R 17.4.
 - .8 Air infiltration: 0.08 cfm at 15 mph, 0.15 cfm at 25 mph.
 - .9 Finish: Two coat baked-on polyester:
 - .1 Interior: White.
 - .2 Exterior: As selected by Departmental Representative from manufacturer's standard range.
- .2 Design door assembly to withstand wind/suction load, without undue deflection or damage to door or assembly components.
- .3 Hardware:
 - .1 Galvanized steel hinges and fixtures.
 - .2 Ball bearing rollers with hardened steel races.
 - .3 Keyed lock with interlock switch for automatic operator.
 - .4 Weatherstripping:
 - .1 EPDM bulb-type strip at bottom.
 - .2 Flexible header and jamb seals.
- .4 Track: As recommended by manufacturer for load requirements and available clearances.
- .5 Electric operator:
 - .1 Provide UL listed electric operator, size and type as recommended by manufacturer with manual override in case of power failure.
 - .1 Entrapment protection: Electric sensing edge to UL 325.

- .2 Controls:
 - .1 Push-button operated control station with open, close and stop buttons.
 - .2 Surface mounted.
 - .3 Interior location.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify existing conditions before starting work.
- .2 Verify that opening sizes, tolerances, and conditions are acceptable.
- .3 Verify electric power is available and of correct characteristics.
- .4 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .5 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Install door assemblies in accordance with approved shop drawings and to manufacturer's printed instructions.
- .2 Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.
- .3 Anchor assemblies to wall construction and building framing without distortion or stress.
- .4 Securely brace door tracks suspended from structure. Secure tracks to structural members only.
- .5 Fit and align door assembly including hardware.
- .6 Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

3.3 ERECTION TOLERANCES

- .1 Maintain dimensional tolerances and alignment with adjacent work.
- .2 Maximum Variation From Plumb: 1.5 mm (1/16 inch).
- .3 Maximum Variation From Level: 1.5 mm (1/16 inch).
- .4 Longitudinal or Diagonal Warp: ± 3 mm per 3 m (1/8 inch per 10 ft) straight edge.

3.4 ADJUSTING

- .1 Adjust door, hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

- .1 Clean door and components.
- .2 Remove labels and visible markings.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM B221/B221M-14, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - .2 ASTM B456-11e1, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
 - .3 ASTM B633-15, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
- .2 Canadian Standards Association (CSA)
 - .1 AAMA/WDMA/CSA 101/I.S.2/A440-11, NAFS – North American Fenestration Standard/Specification for Windows, Doors, and Skylights.

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 windows; include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 If required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
 - .2 Indicate materials and details in full size scale, showing sections, details, attachments to other work, and installation details.
- .4 Samples:
 - .1 Submit duplicate samples of vertical-to-horizontal intersection of aluminum frame system, minimum size 200 x 200 mm, showing:
 - .1 Joinery, including concealed welds.
 - .2 Anchorage.
 - .3 Expansion provisions.
 - .4 Flashing and drainage.
- .5 Test and Evaluation Reports:
 - .1 Submit test reports from approved independent testing laboratories, certifying compliance with specifications, for:
 - .1 Anodized finish.
 - .2 Air tightness.
 - .3 Water tightness.
 - .4 Wind load resistance.

.5 Condensation resistance.

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 windows for incorporation into manual.

1.4 QUALITY ASSURANCE

- .1 Certifications: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .2 Single source supplier: All windows by same manufacturer.

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

Part 2 Products

2.1 MATERIALS

- .1 Materials: To CSA A440 supplemented as follows:
- .2 Main frame:
 - .1 Aluminum, thermally broken.
 - .2 Outside glazed.
- .3 Glass: Insulated glazing units in accordance with Section 08 80 50 - Glazing.
- .4 Aluminum Extrusions: Alloy and temper recommended by aluminum storefront manufacturer for strength, corrosion resistance, and application of required finish and minimum 1.8 mm wall thickness at any location for the main frame and complying with ASTM B 221: 6063-T6 alloy and temper.
- .5 Fasteners: Aluminum, nonmagnetic stainless steel, or other materials to be non-corrosive and compatible with aluminum members, trim hardware, anchors, and other components.
- .6 Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service

conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

- .7 Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.
- .8 Screens: To CAN/CGSB 79.1.
 - .1 Insect screening mesh: count 18 x 14.
 - .2 Screen frames: Aluminum, colour to match window frames.
 - .3 Mount screen frames for interior replacement.
- .9 Sealant: For sealants required within fabricated storefront system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.
- .10 Thermal Barrier: Minimum 6.4 mm separation between the interior and exterior aluminum created by intermittent polymer clips.
- .11 Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of storefront members are nominal and in compliance with AA Aluminum Standards and Data.
- .12 Isolation coating: Cold-applied, asphalt-mastic paint to SSPC Paint-12, asbestos free, 0.76 mm (30 mil) per coat.

2.2 GLAZING

- .1 Glaze windows in accordance with CSA A440 and Section 08 80 50 - Glazing.
- .2 Glazing gaskets: Manufacturer's standard compression type, extruded EPDM rubber, replaceable.
- .3 Spacers and setting blocks: Manufacturer's standard elastomeric type.
- .4 Bond-breaker tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.
- .5 Glazing sealants:
 - .1 Weatherseal: Type 3 glazing sealant as specified in Section 07 92 00 – Joint Sealing.

2.3 FABRICATION

- .1 Fabricate in accordance with CSA A440 supplemented as follows:
 - .1 Profiles sharp, straight, and free of defects or deformations.
 - .2 Accurately fit joints; make joints flush, hairline, and weatherproof.
 - .3 Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - .4 Physical and thermal isolation of glazing from framing members.

- .5 Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
- .6 Provisions for field replacement of glazing.
- .7 Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

2.4 ALUMINUM FINISHES

- .1 Finish exposed surfaces of aluminum components in accordance with Aluminum Association Designation System for Aluminum Finishes.
 - .1 Clear anodic finish.

2.5 ISOLATION COATING

- .1 Isolate aluminum from following components, by means of isolation coating:
 - .1 Dissimilar metals except stainless steel or zinc of small area.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates previously installed under other Sections or Contracts 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 INSTALLATION

- .1 Comply with Drawings, Shop Drawings, and manufacturer's written instructions for installing aluminum-framed storefront system, accessories, and other components.
- .2 Install aluminum frame system level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction.
- .3 Set sill members in bed of sealant or with gaskets, as indicated, for weather tight construction.
- .4 Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

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 Clean aluminum surfaces immediately after installing aluminum frames. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- .3 Clean glass immediately after installation. Comply with glass manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.
- .4 Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- .5 Final Cleaning: Upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .6 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 window installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American National Standards Institute (ANSI) / Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI A117.1-2009, Standard for Accessible and Usable Buildings.
 - .2 ANSI/BHMA A156.1-2000, American National Standard for Butts and Hinges.
 - .3 ANSI/BHMA A156.2-2003, Bored and Preassembled Locks and Latches.
 - .4 ANSI/BHMA A156.4-2000, Door Controls - Closers.
 - .5 ANSI/BHMA A156.5-2001, Auxiliary Locks and Associated Products.
 - .6 ANSI/BHMA A156.6-2010, Architectural Door Trim.
 - .7 ANSI/BHMA A156.13-2002, Mortise Locks and Latches Series 1000.
 - .8 ANSI/BHMA A156.16-2002, Auxiliary Hardware.
 - .9 ANSI/BHMA A156.19-2002, Power Assist and Low Energy Power - Operated Doors.
 - .10 ANSI/BHMA A156.31-2013, Electric Strikes and Frame Mounted Actuators.
 - .11 ANSI/BHMA A156.115W-2006 – Hardware Preparations in Wood Doors.
- .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
- .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 (Fire) 80 - Standard for Fire Doors and Other Opening Protectives, 2007 edition.
 - .2 NFPA (Fire) 252 - Fire Tests of Door Assemblies, 2012 edition.

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; 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 hardware schedule set number, brand name and number, finish, and hardware set number.
- .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 Locks and latches:
 - .1 Mortise locks and latches: To BHMA A156.13, series 1000 mortise lock, Grade 1.
 - .1 Case: Wrought steel, zinc dichromate plated, 3 mm thick.
 - .2 Latchbolt: Minimum 19 mm throw.
 - .3 Deadbolt: Minimum 25 mm throw.
 - .4 Normal strikes: Box type, lip projection not beyond jamb.
 - .5 Function:
 - .1 Storeroom deadbolt: Latchbolt retracted by key outside and knob/lever inside; deadbolt operated by key outside and thumbturn inside; outside knob/lever rigid at all times; anti-panic operation; deadlocking latchbolt.
 - .2 Intruder deadbolt lock: Latchbolt retracted by lever either side unless outside knob/lever is locked by key; deadbolt operated by key either side; when deadbolt projected, outside lever is automatically locked; key retraction of deadbolt unlocks outside lever; anti-panic operation – operating inside lever retracts deadbolt and latchbolt simultaneously, automatically unlocking outside lever; deadlocking latchbolt.
 - .2 Electric strikes: To ANSI/BHMA A156.31, Grade 1; heavy duty stainless steel.
 - .1 Conforms to CAN4-S104.
 - .2 Static strength: 1320 kg (3000 lbs).
 - .3 Dynamic strength: 475 N-m (350 ft-lbs).
 - .3 Mortise keyswitch: To support electric lock control, momentary SPDT switch, bi-colour LED, 5 amp rated plunger switch.
 - .4 Hinges: To BHMA A156.1, five-knuckle, standard weight, 0.134 gauge steel.
 - .5 Cylinders:
 - .1 To BHMA A156.5, solid brass, 6 pin, to suit mortise lock. Finish: To match existing.
 - .6 Door closers: To BHMA A156.4, Grade 1, and ANSI A117.1, rack and pinion operation, cast aluminum body, adjustable backcheck intensity.
 - .1 Mounting: As indicated in Schedule.
 - .7 Door operators:

- .1 Power assist and low energy power operated doors: To BHMA A156.19, ANSI BHMA A156.4, and ANSI A117.1, rack and pinion design contained within cast aluminum housing, 170° swing.
 - .1 Door switch: SPDT, UL listed, 15 amp at 120 VAC, stainless steel plate with blue letters.
- .8 Door bottom: Aluminum case with movable drop bar seal. Seal actuated by plunger contacting jamb. Aluminum with sponge neoprene insert.
- .9 Floor stops: To BHMA A156.16, solid cast brass, heavy duty casting with solid pin, complete with rubber bumper.
- .10 Wall stops: Brass, bronze, and stainless steel with rubber bumper, 63 mm diameter, 19 mm projection, concealed mounting.
 - .1 Bumper: Convex or concave as indicated in schedule.
- .11 Flush bolts: To ANSI/BHMA A156.16; cast brass, 19 mm bolt throw, 19 mm backset.
 - .1 Dust proof strike: Brass; compatible with flush bolt; adjustable height, barrel 22 mm diameter x 51 mm depth.
- .12 Gasketing:
 - .1 Type 1:
 - .1 Extruded high-temperature silicone, adhesive backed.
 - .2 Air infiltration: To ASTM E283, maximum 0.9 cfm/foot.
 - .2 Type 2:
 - .1 Extruded tempered aluminum with black sponge silicone insert.
- .13 Astragal: Extruded clear anodized aluminum with black sponge neoprene insert.
- .14 Viewers: To ANSI A156.16 L03221/L03171, brass with bright chrome finish, UL 90 minute fire rating, heavy duty privacy cover, 190° viewing field.
- .15 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 Refer to Door Hardware Schedule.
- .2 Contact Departmental Representative for Keying Strategy.
- .3 Provide keys in duplicate for every lock.
- .4 Provide four master keys for each master key group.
- .5 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 Where doorstop contacts door pulls, mount stop to strike bottom of pull.
- .6 Use only manufacturer's supplied fasteners.
 - .1 Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.
- .7 Remove temporary cores when directed by Departmental Representative.
 - .1 Install permanent cores and ensure locks operate correctly.

3.2 ADJUSTING

- .1 Adjust door hardware, operators, closures and controls for optimum, smooth operating condition, safety and for weather tight closure.
- .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 – Doors D100a and D106b

3 Hinge	TA2314 NRP 4-1/2" x 4"	US26D	MK
1 Storeroom Lock	28 10G04 LL	US26D	SA
1 Electric Strike	1006CLB-LBM	630	HS
1 Strike Latch Guard	150		HS
1 Concealed Overhead Stop	6-X36	630	RF
1 Door Operator	6020	689	NO
1 Kick Plate	K1050 12"	US32D	RO
1 Threshold	172A		PE
3 Gasketing	290AS		PE
1 Sweep	315CN		PE
1 Actuator	639		NO
1 Guide Rail with Actuator	Curran CE-810-H-615 Manitoba	AL	00
1 Card Reader	By Others		00
1 Request to Exit (if required)	By Others		00
1 Power Supply	By Others		00

Notes: Use 'D' drop plate with operator if required. Exterior actuator normally disabled. Swiping valid card will release the electric strike and enable the outside actuator. Inside actuator, and outside actuator when enabled will release the electric strike and power open the door.

Set: 2.0 – Door 100b

3 Hinge	TA2714 NRP 4-1/2" x 4"	US26D	MK
1 Storeroom Lock	28 10G04 LL	US26D	SA
1 Electric Strike	1006CLB-LBM	630	HS
1 Door Operator	6020	689	NO
1 Kick Plate	K1050 12"	US32D	RO
1 Wall Stop	406	US32D	RO
1 Actuator	639		NO

1 Card Reader	By Others	00
1 Request to Exit (if required)	By Others	00
1 Power Supply	By Others	00

Notes: Use 'D' drop plate with operator if required. Pull side actuator normally disabled. Swiping valid card will release the electric strike and enable the outside actuator. Push side actuator, and pull side actuator when enabled will release the electric strike and power open the door.

Set: 3.0 – Doors D101a, D103c and D106c

3 Hinge	TA2314 NRP 4-1/2" x 4"	US26D	MK
1 Storeroom Lock	28 10G04 LL	US26D	SA
1 Electric Strike	1006CLB-LBM	630	HS
1 Concealed Overhead Stop	6-X36	630	RF
1 Door Closer	1431 P9	EN	SA
1 Kick Plate	K1050 12"	US32D	RO
1 Threshold	172A		PE
1 Gasketing	2891AS		PE
2 Gasketing	290AS		PE
1 Sweep	315CN		PE
1 Card Reader	By Others		00
1 Request to Exit (if required)	By Others		00
1 Power Supply	By Others		00
1 Latch Protector	320CXL	US32D	RO

Notes: Exterior actuator normally disabled. Swiping valid card will release the electric strike and enable the outside actuator. Inside actuator, and outside actuator when enabled will release the electric strike and power open the door.

Mount 2891AS gasketing to head of frame. Mount closer to gasketing.

Set: 4.0 – Door D101b

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Passage Set	28 10U15 LL	US26D	SA
1 Door Closer	1431 PS	EN	SA
1 Kick Plate	K1050 12"	US32D	RO

Set: 5.0 – Door D102a

8 Hinge	TA2714 4-1/2" x 4"	US26D	MK
2 Pull Plate	107x70C	US32D	RO
2 Push Plate	70C	US32D	RO
2 Concealed Overhead Stop	6-X36	630	RF
2 Door Operator	6020	689	NO
4 Kick Plate	K1050 12"	US32D	RO
2 Motion Sensor	663		NO

Notes: Motion sensor to be used on both sides of door. Approaching door from either side will open both doors. Use 'D' drop plate for operators if required.

Set: 6.0 – Door D103a

5 Hinge	TA2314 NRP 4-1/2" x 4"	US26D	MK
1 Hinge	TA2314 CC4 NRP 4-1/2" x 4"	US26D	MK
2 Flush Bolt	555	US26D	RO
1 Storeroom Lock	28 10G04 LL	US26D	SA
1 Electric Strike	1006CLB-LBM	630	HS
2 Concealed Overhead Stop	6-X36	630	RF
1 Door Closer	1431 P9	EN	SA
2 Kick Plate	K1050 12"	US32D	RO
1 Threshold	172A		PE
1 Gasketing	2891AS		PE
2 Gasketing	290AS		PE
2 Sweep	315CN		PE
1 Astragal	By Door Supplier		00
1 Card Reader	By Others		00
1 Request to Exit (if required)	By Others		00
1 Power Supply	By Others		00

Notes: Swiping valid credential will release the electric strike. Mount 2891AS gasketing to head of frame. Mount closer to gasketing.

Set: 7.0 – Door D103b

8 Hinge	TA2714 NRP 4-1/2" x 4"	US26D	MK
1 Flush Bolt	555	US26D	RO
1 Flush Bolt	555-24	US26D	RO
1 Classroom Lock	28 10G37 LL	US26D	SA
2 Concealed Overhead Stop	6-X36	630	RF
1 Door Closer	1431 P9	EN	SA
4 Kick Plate	K1050 12"	US32D	RO
1 Astragal	By Door Supplier		00

Set: 8.0 – Door D104

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Classroom Lock	28 10G37 LL	US26D	SA
1 Door Closer	1431 O	EN	SA
2 Kick Plate	K1050 12"	US32D	RO
3 Gasketing	290AS		PE
1 Gasketing	S88BL		PE
1 Door Bottom	4131CRL		PE

Set: 9.0 – Doors D105a and D106a

All Hardware by Door Supplier

Set: 10.0 – Door D107

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Storeroom Lock	28 10G04 LL	US26D	SA
1 Electric Strike	1006CLB-LBM	630	HS
1 Door Closer	1431 O	EN	SA
1 Kick Plate	K1050 12"	US32D	RO
1 Wall Stop	406	US32D	RO
3 Gasketing	290AS		PE
1 Gasketing	S88BL		PE
1 Door Bottom	4131CRL		PE
1 Card Reader	By Others		00
1 Request to Exit (if required)	By Others		00
1 Power Supply	By Others		00

Notes: Swiping valid card will release the electric strike.

Set: 11.0 – Doors D108 and D109

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Pull Plate	107x70C	US32D	RO
1 Push Plate	70C	US32D	RO
1 Automatic Operator	5710	689	NO
1 Kick Plate	K1050 12"	US32D	RO
1 Wall Stop	406	US32D	RO
2 Actuator	639		NO

Notes: Pressing actuator on either side of door will power open the door.

Set: 12.0 – Door D110a

6 Hinge	TA2314 NRP 4-1/2" x 4"	US26D	MK
2 Flush Bolt	555	US26D	RO
1 Storeroom Lock	28 10G04 LL	US26D	SA
2 Concealed Overhead Stop	6-X36	630	RF
1 Door Closer	1431 P9	EN	SA
2 Kick Plate	K1050 12"	US32D	RO
1 Threshold	172A		PE
1 Gasketing	2891AS		PE
2 Gasketing	290AS		PE
2 Sweep	315CN		PE
1 Astragal	By Door Supplier		00

Notes: Mount 2891AS gasketing to head of frame. Mount closer to gasketing.

Set: 13.0 – Door D110b

3 Hinge	TA2714 4-1/2" x 4"	US26D	MK
1 Storeroom Lock	28 10G04 LL	US26D	SA
1 Door Closer	1431 O	EN	SA
1 Kick Plate	K1050 12"	US32D	RO
1 Wall Stop	406	US32D	RO

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM C542-05 (2011), Standard Specification for Lock-Strip Gaskets.
 - .2 ASTM D790-10, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - .3 ASTM D1003-13, Standard Test Method for Haze and Luminous Transmittance of Plastics.
 - .4 ASTM D1929-14, Standard Test Method for Determining Ignition Temperature of Plastics.
 - .5 ASTM D2240-05 (2010), Standard Test Method for Rubber Property - Durometer Hardness.
 - .6 ASTM E84-14, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .7 ASTM E330/E330M-14, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
 - .8 ASTM F1233-08 (2013), Standard Test Method for Security Glazing Materials and Systems.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 12.1-M90, Tempered or Laminated Safety Glass.
 - .2 CAN/CGSB 12.8-97, Insulating Glass Units.
- .3 Glass Association of North American (GANA)
 - .1 GANA Glazing Manual – current edition.

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 glass, sealants, and glazing accessories and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 If required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
- .4 Samples:
 - .1 Submit duplicate 200 x 200 mm size samples of insulated glazing units.

- .5 Certificates: Submit 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 glazing 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 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.

1.5 AMBIENT CONDITIONS

- .1 Ambient Requirements:
 - .1 Install glazing when ambient temperature is 10°C minimum. Maintain ventilated environment for 24 hours after application.
 - .2 Maintain minimum ambient temperature before, during, and 24 hours after installation of glazing compounds.

Part 2 Products

2.1 MATERIALS

- .1 Design Criteria:
 - .1 Ensure continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:
 - .1 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
 - .2 Size glass to withstand wind loads, dead loads and positive and negative live loads acting normal to plane of glass to design pressure as calculated using climatic data for building location.
 - .3 Limit glass deflection to 1/200 with full recovery of glazing materials.
 - .1 Type 2-tempered.

- .2 Class B-float.
- .3 Category 11.
- .4 Edge treatment.
- .2 Insulated Glass Units: CAN/CGSB-12.8, double pane; outer and inner panes of 6 mm thick clear tempered glass; interpane space filled with argon gas, with low conductivity spacer.
- .3 Sealant: In accordance with Section 07 92 00 - Joint Sealants.

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.
- .5 Glazing clips: Manufacturer's standard type.
- .6 Lock-strip gaskets: To ASTM C542.

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: EXTERIOR - DRY METHOD (PREFORMED GLAZING)

- .1 Manufacturer's Instructions: Comply with manufacturer's written data, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.
- .2 Perform work in accordance with GANA Glazing Manual for glazing installation methods.
- .3 Cut glazing tape or spline to length; install on glazing light. Butt-joint tape or spline and seal junctions with sealant.
- .4 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .5 Rest glass unit on setting blocks; apply pressure against fixed stop for full continuous contact.
- .6 Install removable stops without displacing glazing tape or spline. Apply pressure for full continuous contact.
- .7 Trim protruding tape edge flush with stop.

3.4 INSTALLATION: EXTERIOR - WET METHOD (SEALANT AND SEALANT)

- .1 Perform work in accordance with GANA Glazing Manual for glazing installation methods.
- .2 Place setting blocks at 1/4 points and install glazing unit.
- .3 Install removable stops with glass unit centred in space by inserting spacer shims both sides at 600 mm intervals, 6 mm below sight line.
- .4 Fill gaps between glazing and stops with sealant to depth of bite on glazing, maximum 9 mm below sight line to ensure full contact with glazing and continue air and vapour seal.
- .5 Apply sealant to uniform line, flush with sight line. Tool sealant surface smooth.

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

- .1 Perform work in accordance with GANA Glazing 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.

3.6 INSTALLATION: INTERIOR WET/DRY METHOD (TAPE AND SEALANT)

- .1 Perform work in accordance with GANA Glazing Manual for glazing installation methods.
- .2 Cut glazing tape to length and install against permanent stops, projecting 1.6 mm above sight line.
- .3 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .4 Set glass unit on setting blocks and apply pressure against tape for full contact at perimeter of light or unit.
- .5 Install removable stops, with spacer shims inserted between glazing and applied stops at 600 mm intervals, 6 mm below sight line.
- .6 Fill gaps between glass and applied stop with sealant to depth equal to bite of frame on glazing, to uniform and level line. Tool sealant
- .7 Trim protruding tape edge.

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.
 - .1 Remove traces of primer, caulking.
 - .2 Remove glazing materials from finish surfaces.
 - .3 Remove labels.
 - .4 Clean glass [and mirrors] 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.

3.8 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.
 - .1 Do not mark heat absorbing or reflective glass units.
- .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 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.
- .4 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Standard Method of Test for 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 instructions, printed product literature and data sheets for gypsum board assemblies. Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit duplicate 300 mm long samples of corner and casing beads.

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.
- .2 Carrying Channels: Cold rolled steel to ASTM C645, galvanized.
- .3 Stainless steel wall protection panels: Type 304, 1.27 mm (18 gauge) thickness, No. 4 satin finish.
 - .1 Provide panels with 12.7 mm (1/2 inch) offset overlap joints.

- .2 Provide purpose-made inside and outside corners with offset overlap joints.
- .3 Adhesive: As recommended by manufacturer.
- .4 Tie Wire: To ASTM C754.
- .5 Hangers: To ASTM C754, galvanized.
- .6 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .7 Steel drill screws: ASTM C1002.
- .8 Stud adhesive: ASTM C557.
- .9 Casing beads, corner beads, control joints and edge trim: ASTM C1047, zinc-coated by hot-dip process or electrolytic process, 0.5 mm base thickness, perforated flanges, one piece length per location.
- .10 Sealants: In accordance with Section 07 92 00 - Joint Sealants.
- .11 Polyethylene: CAN/CGSB 51.34, Type 2.
- .12 Joint tape: ASTM C475, 52 mm wide fibre paper tape.
- .13 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.

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 DCC 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, grilles.
- .3 Install furring channels parallel to, and at exact locations of, steel stud partition header track.
- .4 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.
- .5 Install furring as required for fire resistance ratings indicated.
- .6 Furr openings and around built-in equipment on four sides. Extend furring into reveals. Check clearances with equipment suppliers.

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 gypsum board to furring or framing using screw fasteners. Maximum spacing of screws 300 mm on centre.
 - .1 Single-Layer Application:
 - .1 Apply gypsum board on ceilings to ASTM C840 prior to application of walls.
 - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
 - .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 Install gypsum board on walls vertically to avoid end-butt joints.

- .6 Install gypsum board with face side out.
- .7 Do not install damaged or damp boards.
- .8 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 where indicated on Drawings.
 - .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.
- .13 Finish gypsum board walls and ceilings to following levels in accordance with GA-214:
 - .1 Levels of finish:

- .1 Level 1 - Concealed areas: 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 Level 4 - Exposed areas: 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 STAINLESS STEEL WALL PROTECTION INSTALLATION

- .1 Ensure substrate is free dust, debris, loose particles, and protrusions.
- .2 Install with adhesive to manufacturer's written instructions.
- .3 Install wall protection sheets level and plumb at height indicated on drawings.

3.6 ACOUSTIC ACCESSORIES INSTALLATION

- .1 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.
- .1 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, in partitions where perimeter sealed with acoustic sealant.
- .2 Apply two 12 mm beads of acoustic sealant to bottoms of floor tracks and tops of ceiling tracks.

3.7 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.

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 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.

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, sizes as shown, roll formed from hot dipped galvanized steel sheet, for screw attachment of gypsum board.

- .1 Knock-out service holes at 460 mm centres.
- .2 Floor and ceiling tracks: To ASTM C645, in widths to suit stud sizes, 32 mm flange height.
- .3 Furring channel: To ASTM C645, hat-shaped profile.
- .4 Metal channel stiffener: Cold rolled steel, coated with rust inhibitive coating.
- .5 Acoustical sealant: In accordance with Section 07 92 00 - Joint Sealants.
- .6 Insulating strip: Rubberized, moisture resistant 3 mm thick foam strip, 12 mm wide, with self sticking adhesive on one face, lengths as required.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate previously installed under other Sections or Contracts 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 secure at 600 mm on centre maximum.
- .2 Install damp proof course under stud shoe tracks of partitions on slabs on grade.
- .3 Place studs vertically at 400 mm on centre and 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.
- .4 Erect metal studding to tolerance of 1:1000.
- .5 Attach studs to bottom track using screws.
- .6 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .7 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .8 Install heavy gauge single jamb studs at openings.
- .9 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.
- .10 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .11 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .12 Extend partitions to ceiling height except where noted otherwise on drawings.
- .13 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs.
- .1 Use double track slip joint.
- .14 Install continuous insulating strips to isolate studs from uninsulated surfaces.
- .15 Install two continuous 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 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 E84-15a, Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .6 ASTM E1264-14, Standard Classification for Acoustical Ceiling Products.
 - .7 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 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Underwriter's 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 in accordance with Section 01 35 29.06 – Health and Safety Requirements.
- .3 Samples:

- .1 Samples: Submit two (2) full size samples illustrating material and finish of acoustic units.
- .2 Samples: Submit two (2) samples of suspension system, 300 mm (12 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 Health and Safety:
 - .1 Perform construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.
- .3 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 installed area for each pattern and type 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.
- .4 Waste Management and Disposal:
 - .1 Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 ENVIRONMENTAL REQUIREMENTS

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

- .2 Maintain uniform minimum temperature of 15°C and 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 Fire Rated Grid: ASTM C635/C635M, intermediate duty cold rolled steel with hot dipped galvanized coating; listed by ULC/UL for use in fire-rated assembly; components die cut and interlocking.
 - .3 Grid Materials: Commercial quality cold rolled steel with galvanized coating.
 - .4 Edge Profile: Square.
 - .5 Grid Finish: Painted white.
- .2 Acoustic units for suspended ceiling system: To CAN/CGSB 92.1 and ASTM E1264.
 - .1 Type IV, Form 2, Pattern E.
 - .2 Fire Class A.
 - .3 Composition: Wet-formed mineral fibre. Textures: Fine.
 - .5 Fire ratings to CAN/ULC S102:
 - .1 Flame spread: Maximum 25.
 - .2 Smoke developed: Maximum 50.
 - .6 Noise Reduction Coefficient (NRC) to ASTM C423: Minimum 0.75.
 - .7 Ceiling Attenuation Class (CAC) rating to ASTM E1414/E1414M: Minimum 35.
 - .8 Light Reflectance (LR): 0.85 typical.
 - .9 Edge type: Square.
 - .10 Colour: White.
 - .11 Thickness: Minimum 19 mm.
 - .12 Size: As shown in drawings.
 - .13 Surface coverings: Scrim with factory applied latex paint.
- .3 Adhesive: Low VOC type recommended by acoustic unit manufacturer.
- .4 Staples, nails and screws: To CSA B111 non-corrosive finish as recommended by acoustic unit manufacturer.
- .5 Hold down clips: Purpose made clips to secure tile to suspension system, approved for use in fire-rated systems.
- .6 Adhesives and mounting accessories as recommended by manufacturer.

- .7 Attachment devices: Size for five times design load indicated in ASTM C635/C635M, Table 1, Direct Hung, unless otherwise indicated.
- .8 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.
- .9 Touch-Up Paint: Type and colour to match acoustic and grid units.

Part 3 Execution

3.1 EXAMINATION

- .1 Do not install acoustical panels and tiles until work above ceiling has been inspected by Departmental Representative.
- .2 Verify conditions of substrates are acceptable for acoustic panel ceiling installation in accordance with ASTM C636/C636M and manufacturer's instructions.
 - .1 Visually inspect substrate.
 - .2 Inform Departmental Representative of unacceptable conditions upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Install acoustical panels and tiles in ceiling suspension system.
- .2 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.

3.3 APPLICATION

- .1 Install acoustic units to clean, dry and firm substrate.
- .2 Install acoustical units. Refer to reflected ceiling plan.
- .3 Scribe acoustic units to fit adjacent work. Butt joints tight.

3.4 INTERFACE WITH OTHER WORK

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM D2047-11, Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.
 - .2 ASTM E1155-14/E1155M, Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers.
 - .3 ASTM F970-15, Static Load Limit.
 - .4 ASTM F1913-04 (2014), Vinyl Sheet Floor Covering without Backing.
- .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 instructions, printed product literature and data sheets for adhesive and 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 300 x 300 mm pieces of flooring material, in proposed colours and patterns.
 - .2 Submit duplicate 300 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 Seam layout.
 - .2 Cut-outs: Show locations where cut-outs are required.
 - .3 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.
- .2 Waste Management and Disposal:

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

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 of resilient sheet flooring and adhesives in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Provide 5% of actual installed flooring, of each colour, pattern and type of flooring material required for project for maintenance use.
 - .3 Supply extra materials in one piece and from same production run as installed materials.
 - .4 Identify each roll of sheet flooring and each container of adhesive.
 - .5 Deliver to Departmental Representative, upon completion of the work of this section.
 - .6 Store where directed by Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Sheet vinyl without backing: To ASTM F1913.
 - .1 Colour and pattern through total thickness of material.
 - .2 Total thickness: 2.0 mm.
 - .3 Static load limit to ASTM F970: 250 psi.
 - .4 Static co-efficient of friction to ASTM D2047: Minimum 0.6.
 - .5 Colour: As selected by Departmental Representative.
 - .6 Welding Rod: To match flooring.
- .2 Resilient base: Continuous, top set, complete with pre-moulded end stops and external corners:
 - .1 Type: Rubber.
 - .2 Style: Coved.
 - .3 Thickness: 2.0 mm.
 - .4 Height: 102 mm.
 - .5 Lengths: Cut lengths minimum 2400 mm.
 - .6 Colour: As selected by Departmental Representative.
- .3 Primers and adhesives: Types recommended by resilient flooring manufacturer for specific material on applicable substrate.

- .4 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.
- .5 Metal edge strips:
 - .1 Aluminum extruded, smooth, mill finish with lip to extend under floor finish, shoulder flush with top of adjacent floor finish.
- .6 Edging to floor penetrations: Aluminum, 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.
- .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. Border widths minimum 1/3 width of full material.
- .4 Run sheets in direction of traffic. Double cut sheet joints and heat weld according to manufacturer's printed instructions.
- .5 As installation progresses, and after installation, roll flooring with 45 kg minimum roller to ensure full adhesion.
- .6 Cut flooring around fixed objects.
- .7 Continue flooring over areas that will be under built-in furniture.
- .8 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .9 Install metal edge strips at unprotected or exposed edges where flooring terminates.

3.5 APPLICATION: BASE

- .1 Lay out base to keep number of joints at minimum.
- .2 Clean substrate and prime with one coat of adhesive.
- .3 Apply adhesive to back of base.
- .4 Set base against wall and floor surfaces tightly by using 3 kg hand roller.
- .5 Install straight and level to variation of 1:1000.
- .6 Scribe and fit to door frames and other obstructions. Use pre-moulded end pieces at flush door frames.
- .7 Cope internal corners. Use pre-moulded corner units for right angle external corners. Use formed straight base material for external corners of other angles.
- .8 Heat weld base in accordance with manufacturer's printed instructions.

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11 - Cleaning.
- .2 Remove excess adhesive from floor, base, and wall surfaces without damage.
- .3 Clean floor and base surface to flooring manufacturer's printed instructions.

3.7 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 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .2 Environmental Protection Agency (EPA)
 - .1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 - 1995, (for Surface Coatings).
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Master Painters Institute (MPI)
 - .1 MPI Architectural Painting Specifications Manual, current edition.
 - .2 MPI Architectural Repainting Manual, current edition.
- .5 National Fire Code of Canada – 2010.
- .6 Society for Protective Coatings (SSPC)
 - .1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.
- .7 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

1.2 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.

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) in accordance with Section 01 33 00 - Submittal Procedures. 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 200 mm sample panels of each paint with specified paint or coating in colours, gloss/sheen, and textures required, to MPI Architectural Painting Specification Manual standards 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 that 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 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 and finish coating. Identify colour and paint type in relation to established colour schedule and finish system.

- .3 Delivery, storage, and protection: Comply with Departmental Representative requirements for delivery and storage of extra materials.

1.6 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 Acceptance at Site:
 - .1 Identify products and materials with labels indicating:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .3 Remove damaged, opened and rejected materials from site.
- .4 Storage and Protection:
 - .1 Provide and maintain dry, temperature controlled, secure storage.
 - .2 Store materials and supplies away from heat generating devices.
 - .3 Store materials and equipment in well-ventilated area with temperature range 7°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 Place materials defined as hazardous or toxic in designated containers.
 - .2 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional, and Municipal regulations.
 - .3 Ensure emptied containers are sealed and stored safely.
 - .4 Unused paint and coating materials must be disposed of at official hazardous material collections site as approved by Departmental Representative.

- .5 Paint 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.
- .6 Material that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- .7 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- .8 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).
- .9 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.

1.7 SITE CONDITIONS

- .1 Heating, Ventilation, and Lighting:
 - .1 Provide continuous ventilation for seven days after completion of application of paint.
 - .2 Coordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.
 - .3 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.
 - .4 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 The 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.
- .5 Rain or snow is forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining, or snowing at site.
- .6 Ensure that conditions are within specified limits during drying or curing process, until newly applied coating can itself withstand 'normal' adverse environmental factors.
- .2 Perform painting work when maximum moisture content of the substrate is below:
 - .1 12% for plaster and gypsum board.
- .3 Test for moisture using calibrated electronic Moisture Meter.
- .4 Test concrete, masonry and plaster surfaces for alkalinity as required.
- .3 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits.
 - .3 Apply paint when previous coat of paint is dry or adequately cured.
- .4 Additional interior application requirements:
 - .1 Apply paint finishes when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.
 - .2 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

Part 2 Products

2.1 MATERIALS

- .1 Paint materials listed in the MPI Approved Products List (APL) are acceptable for use on this project.
- .2 Provide paint materials for paint systems from single manufacturer.
- .3 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 Paints, coatings, adhesives, solvents, cleaners, lubricants, and other fluids:
 - .1 Water clean-up.
 - .2 Non-flammable.
 - .3 Manufactured without compounds that contribute to ozone depletion in the upper atmosphere.
 - .4 Manufactured without compounds that contribute to smog in the lower atmosphere.
 - .5 Do not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
- .7 Formulate and manufacture water-borne surface coatings with no aromatic solvents, formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.
- .8 Flash point: 61.0°C or greater for water-borne surface coatings and recycled water-borne surface coatings.
- .9 Ensure manufacture and process of both water-borne surface coatings and recycled water-borne surface coatings does not release:
 - .1 Matter in undiluted production plant effluent generating 'Biochemical Oxygen Demand' (BOD) in excess of 15 mg/L to natural watercourse or sewage treatment facility lacking secondary treatment.
 - .2 Total Suspended Solids (TSS) in undiluted production plant effluent in excess of 15 mg/L to natural watercourse or a sewage treatment facility lacking secondary treatment.

2.2 COLOURS

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

2.3 MIXING AND TINTING

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

2.5 INTERIOR PAINTING SYSTEMS

- .1 Structural steel: Metal fabrications.
.1 INT 5.1Q – latex over quick drying alkyd primer, G5 finish.
- .2 Galvanized metal (doors and door frames).
.1 INT 5.3N – Institutional low odour/low VOC, G5 finish.
- .3 Gypsum board:
.1 INT 9.2M - Institutional low odour/low VOC finish.
.1 Walls: G4 finish.
.2 Ceilings: G3 finish.
- .4 Wood: Plywood installed to mechanical/electrical areas:
.1 INT 6.4PP – Fire retardant, pigmented, water borne, G1 finish.

2.6 EXTERIOR PAINTING SYSTEMS

- .1 Galvanized steel: Metal fabrications.
.1 EXT 5.3L – Polyurethane, pigmented, over epoxy primer, G6 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 Stucco, plaster and 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 passing pedestrians, building occupants, and general public in and about the building.
- .2 Surface Preparation:
 - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-installed after painting is completed.
 - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.

- .3 Place "WET PAINT" signs in occupied areas as painting operations progress. Signs to approval of Departmental Representative.
- .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, or 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 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 closets and alcoves as specified for adjoining rooms.
- .9 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 a distance of 1000 mm at 90 degrees to surface.
- .2 Ceilings: no defects visible from floor at 45 degrees to surface when viewed using final lighting source.
- .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

3.7 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 International
 - .1 ASTM A240/A240M-15, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - .2 ASTM A653/A653M-13, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 CSA International
 - .1 CSA B651-12, Accessible Design for the Built Environment.

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 toilet compartments; include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Installation Drawings:
 - .1 If required, submit drawings stamped and signed by professional engineer registered or licensed in Province of Manitoba.
 - .2 Indicate fabrication details, plans, elevations, hardware, and installation details.
- .4 Samples:
 - .1 Submit duplicate 250 x 250 mm samples of panel showing finished edge and corner construction and core construction.
 - .2 Submit duplicate representative samples of hardware items, including brackets, fastenings, and trim.

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

Part 2 Products

2.1 MATERIALS

- .1 Sheet steel: Galvannealed steel to ASTM A653/A653M, ZF120 (A40).
 - .1 Minimum base steel thickness:
 - .1 Panels, doors, and pilasters: 1.0 mm (20 gauge).
- .2 Headrails: Clear anodized aluminum, 6063-T5, anti-grip design.
- .3 Pilaster shoe: 0.95 mm (20 gauge) thick, Type 304 stainless steel to ASTM A240, 100 mm high, with continuous self-locking edges.
- .4 Door hardware, panel and pilaster brackets: Chrome-plated zinc die castings.

2.2 COMPONENTS

- .1 Hinges:
 - .1 Swing: As shown on drawings.
 - .2 Return movement: Gravity.
- .2 Wall and connecting brackets: Chrome plated non-ferrous extrusion or casting.
- .3 Door latch: Concealed, vandal-proof, accessible from exterior in case of emergencies, suitable for disabled persons.
- .4 Doorstop and keeper: Complete with slotted hole for latch bolt, and rubber bumper.
- .5 Coat hook: Combination hook and rubber door bumper.

2.3 FABRICATION

- .1 Doors, panels and screens: 32 mm thick, two steel sheets faces pressure bonded to honeycomb core, to sizes indicated.
 - .1 Height: 1461 mm (57-1/2 inches).
- .2 Pilasters: 32 mm thick, constructed same as door, to sizes indicated.
 - .1 Height: 2057 mm (81 inches).
- .3 Floor channel: 1.61 mm thick (16 gauge) galvannealed steel, with adjustability for pilaster installation.
- .4 Include formed and closed edges for doors, panels and pilasters.
 - .1 Miter and weld corners and grind smooth.

- .5 Door hinge attachment: Housings recessed into door.
- .6 Include internal reinforcement at areas of attached hardware and fittings.
 - .1 Temporarily mark location of reinforcement for tissue holders and grab bars.

2.4 FINISHES

- .1 Clean, degrease and neutralize steel components with phosphate or chromate treatment.
- .2 Paint: Powder coating.
 - .1 Colour as selected by Departmental Representative from manufacturer's standard colour range.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for metal toilet compartment 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 PREPARATION

- .1 Ensure supplementary anchorage, if required, is in place.

3.4 ERECTION

- .1 Perform work in accordance with CSA B651.
- .2 Partition erection:
 - .1 Install partitions secure, plumb, and square.
 - .2 Leave 12 mm space between wall and panel or end pilaster.
 - .3 Anchor floor mounting brackets to masonry/concrete surfaces using expansion anchors:
 - .4 Anchor to hollow walls using screws to blocking/backing must be provided.
 - .5 Allow for adjustment of floor-braced pilasters variations with screw jack through steel saddles made integral with pilaster.

- .1 Conceal floor fixings with stainless steel shoes.
- .6 Equip doors with hinges, latch set, and each stall with coat hook mounted on door.
 - .1 Adjust and align hardware for smooth, proper function. Set door open position at 30 degrees to front.
 - .2 Install door bumper, door mounting.
- .7 Equip out-swinging doors with D-type door pulls on inside and outside of door in accordance with CSA B651.
- .8 Install hardware and grab bars where indicated.
- .3 Floor supported and overhead braced partition erection.
 - .1 Attach pilasters to floor with floor channel; adjust and level, plumb, and tighten installation secure to floor channel.
 - .1 Secure pilaster shoes in position.
 - .2 Secure headrail to pilaster.
 - .3 Set tops of doors parallel with overhead brace when doors are in closed position.

3.5 ADJUSTING

- .1 Adjust doors and locks for optimum, smooth operating condition.
- .2 Lubricate hardware and other moving parts.

3.6 CLEANING

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

3.7 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 surfaces after installation using manufacturer's recommended cleaning procedures.
 - .2 Clean and polish hardware.
- .4 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 metal toilet compartment installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 44.40-2001, 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, hooks, shelves, bases, trim, numbering, filler panels, end/back panels, doors, handles, 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 1 - Single full-height lockers, Class 2 - A bank of two or more lockers.
 - .1 Size: As shown on drawings.
 - .2 Frame: 1.61 mm (16 gauge) formed steel channel, welded.

- .3 Bodies: 0.70 mm (24 gauge) galvanized steel.
- .4 Assembly: Welded construction.
- .5 Top: Flat.
- .6 Doors: Welded, double-wall envelope construction, reinforced with structural paper honeycomb.
 - .1 Outer panel: 1.01 mm (20 gauge).
 - .2 Inner panel: 0.70 mm (24 gauge).
- .7 Door handle: Recessed box-style handle and pull, stainless steel, integral slot for padlock hasp.
- .8 Ventilation slots: At top and bottom of locker doors.
- .9 Finish: Powder coat paint, colour as selected by Departmental Representative from manufacturer's standard range.

2.2 ACCESSORIES

- .1 Locking system: Padlock hasps.
- .2 Options: To CAN/CGSB 44.40, steel end panels, steel trim.
- .3 Number plates: Manufacturer's standards.
- .4 Coat hooks: Metal, chromium, or nickel finish; three per locker compartment, tamperproof fastener attachment.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify conditions of substrates and surfaces 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 finished end panels to exposed ends of locker banks.
- .4 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 International
 - .1 ASTM A653/A653M-08, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM D412-06a (2013), Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
 - .3 ASTM D523-14, Standard Test Method for Specular Gloss.
 - .4 ASTM D822/D822M-13, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
 - .5 ASTM E96/E96M-05, Water Vapor Transmission of Materials.
 - .6 ASTM E283-04 (2012), Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
 - .7 ASTM E2357-11, Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB 37.5-M89, Cutback Asphalt Plastic Cement.
 - .2 CAN/CGSB-37.29-M89, Rubber-Asphalt Sealing Compound.
 - .3 CAN/CGSB-19.13M-M87, Sealing Compound, One Component, Elastomeric Chemical Curing.
 - .4 CAN/CGSB-19.24M-M90, Multi-Component, Chemical Curing Sealing Compound.
 - .5 CGSB 19-GP-14M-84, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing.
 - .6 CGSB 37-GP-56M-1985, Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.
- .3 Canadian Sheet Steel Building Institute (CSSBI)
 - .1 CSSBI 10M-13: Steel Roof Deck.
 - .2 CSSBI 20M-15: Sheet Steel Cladding for Architectural, Industrial and Commercial Building Applications.
 - .3 CSSBI 30M-06, Standard for Steel Building Systems.
- .4 Canadian Standards Association (CSA)
 - .1 CSA S136-12, Design of Cold Formed Steel Structural Members.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting 1 week prior to beginning on-site installation, with Contractor's Representative and 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 sub-trades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.
 - .2 Arrange for site visit with Departmental Representative prior to start of Work to examine existing site conditions adjacent to demolition work.
 - .3 Hold project meetings every week.
 - .4 Ensure key personnel attend.
 - .5 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 sealants, insulation, and building materials. Include product characteristics, performance criteria, physical size, finishes, and limitations.
 - .2 Submit 2 copies of WHMIS MSDS for the following.
 - .1 Sealants.
 - .2 Tape.
 - .3 Proprietary joints.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Manitoba.
 - .1 Submit drawings for fabricator-designed assemblies, components and connections.
- .4 Delegated Design Submittals:
 - .1 Indicate plans and grid lines, structural members and connection details, bearing and anchorage details, roof cladding, wall cladding, framed openings, accessories, schedule of materials and finishes, camber and loadings, fasteners, and welds.
 - .2 Indicate detailed description of mechanical, electrical and other systems in Work.

- .3 Describe requirements of other systems of components related to this Work but provided by others.
 - .1 Obtain necessary information required to detail this Work including methods of integration and securing.
- .4 Submit erection drawings to Departmental Representative for approval, before construction.
- .5 Indicate erection dimensions and methods.
- .5 Manufacturer's Instructions: Submit application instructions for caulking, tape, and sealant.
- .6 Manufacturer's Field Reports: Submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store, and handle materials in accordance 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 components and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 DESIGN REQUIREMENTS

- .1 Design cladding system in accordance with:
 - .1 CSA S136.
 - .2 CSSBI 10M.
 - .3 CSSBI 20M.
 - .4 National Building Code of Canada.
- .2 Design wall system to resist:
 - .1 Wind loads, positive and negative, expected in geographical region of project with 50 year probability.
- .3 Deflection of the wall system is not to exceed $1/180^{\text{th}}$ of the span for the wind load based on serviceability limit states.
- .4 Maximum deflection for roofing under full specified live load: $1/360$ of clear span.
- .5 Maintain following tolerances for building structure and enclosure elements.

- .1 Maximum variation from plane or location shown on shop drawings: 1 mm/1 m of length and up to 1 mm/5 m maximum.
- .2 Maximum offset from true alignment between two adjacent members abutting end to end, in line: 0.75 mm.
- .6 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, overstressing of components, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
- .7 Design expansion joints to accommodate movement in cladding and between cladding and structure to prevent permanent distortion or damage to the cladding.
- .8 Design building to meet or exceed applicable portions of Manitoba Building Code.
- .9 Design building envelope to have watertight construction.
- .10 Design building for rodent resistance. Design building envelope penetrations to prevent entry by mice.
- .11 Vapour seal building enclosure to withstand, without failure, design RH at design ambient temperature condition, maintained against interior atmospheric pressure of 250 Pa.
- .12 Design building enclosure elements to accommodate, by means of expansion joints, movement in wall and structural movements without permanent distortion, damage to infills, racking of joints, breakage of seals, water penetration or glass breakage.
- .13 Design foundations in accordance with Manitoba Building Code requirements to permissible soil loads listed in soils report.
- .14 Design, assemble, and secure building elements to building frame to ensure stresses in sealants and seals are within sealant manufacturer's recommended maximum.
- .15 Design building assembly to permit easy replacement and disassembly of components.
 - .1 Use non-welded construction.
- .16 Allow for ceiling, piping, conduit and other interior dead loads imposed on this structure.

2.2 WALL AND ROOF SYSTEM

- .1 Roof: As specified in Section 07 61 00 – Sheet Metal Roofing.
- .2 Walls: As specified in Section 07 46 13 – Preformed Metal Walls.

2.3 METAL DOORS AND FRAMES

- .1 As specified in Section 08 11 00.

2.4 OVERHEAD DOOR

- .1 Overhead Doors: Specified in Section 08 33 23.

2.5 WINDOWS

- .1 Windows: Specified in Section 08 50 00.

2.6 ACCESSORIES

- .1 Joint Seal Gaskets: Manufacturer's standard.
- .2 Bituminous Paint: Asphaltic type.
- .3 Sealant: Manufacturer's standard.
- .4 Snow retention devices: Manufacturer's standard.
- .5 Trim, Closure Pieces, Caps, Flashings, Rain Water Diverter, Fascias, Infills: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

2.7 FABRICATION - FRAMING

- .1 Refer to Structural.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that conditions are acceptable for prefabricated building 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 Perform prefabricated metal building Work to CSSBI 30M.
- .2 Erect building structure and enclosure elements for a complete weather-tight insulation.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer's 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 Ensure manufacturer's representative is present before and during critical periods of installation.
- .4 Schedule site visits:
 - .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.

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 Remove excess sealant by moderate use of low VOC mineral spirits or other solvent as directed by sealant manufacturer.
 - .2 Clean surfaces.
- .3 Waste Management: Remove waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

3.5 PROTECTION

- .1 Protect finished surfaces with strippable coatings, strippable wrappers, plywood, or sheet materials as required before acceptance of Work.
- .2 Protect installed products and components from damage during construction.
- .3 Repair damage to adjacent materials caused by sealants, insulation, and building materials installation.

END OF SECTION

Part 1 General

1.1 References

1.2 Regulatory Requirements

- .1 Refer carefully to other parts of the specifications.
- .2 Conform to the requirements and recommendations of all local municipal, provincial and federal by-laws and ordinances.
- .3 Do not reduce the quality of work specified and/or shown on the drawings because of the Regulatory requirements.

1.3 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 National Plumbing Code of Canada
 - .12 Canadian Council of Ministers of the Environment Codes.
 - .13 Underwriters' Laboratories of Canada.
 - .14 Provincial Workplace Safety and Health Regulations.
 - .15 Provincial Labour Regulations.

1.4 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.

1.5 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:

- .1 Submit manufacturer's instructions, printed product literature and data sheets for 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.

1.6 Authorities Having Jurisdiction (Ahj)

- .1 Comply with all requirements of Authorities with competent jurisdiction, including authorized inspectors, without additional compensation.

1.7 Permits, Fees And Certificates

- .1 In addition to the requirements in Division 1, 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 Plumbing inspection certificate.
 - .3 Backflow prevention certificate.
- .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 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.
- .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 22 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 plumbing 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 plumbing 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 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, review manufacturer's instructions, 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 each test 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.

1.14 Trial Usage

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

1.15 Cleaning

- .1 Refer to Section 01 74 11 – Cleaning.
- .2 Clean interior and exterior of all systems including strainers.

1.16 Functional Testing

- .1 Test all plumbing equipment, fixtures and systems. Test as required by the AHJ 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 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 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 cartridge for each filter.
 - .2 One cartridge for each size of each type centre set, faucet, flush valve, mix valve, shower valve, and safety equipment water control valve.
 - .3 Six complete valves for each size type up to 38 mm, and one for each larger size and type.

1.19 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 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, 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.

1.20 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.
- .4 Furnish one commercial quality grease gun, grease and adapters to suit different types of grease and grease fittings.

1.21 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.

1.22 Substantial Completion

- .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. Show 2 weeks on construction schedule.
- .2 A minimum of three (3) working days before substantial completion is to be declared, submit the following:
 - .1 All certificates and documentation recommended by NFPA standards and required by these specifications and AHJ that are applicable to the project.
 - .2 Operation and Maintenance Manuals, complete with revisions as directed.
 - .3 Confirm all fire protection equipment is operational, under control, indicating exceptions and temporary controls/arrangements, including 'tenant' areas.
- .3 Confirm systems are ready for occupancy and use for intended purpose in every respect. Submit a letter signed by the manager or president of the prime contractor under Div 21 (i.e. the fire protection contractor) stating as such upon request of the Departmental Representative .
- .4 Before certification date submit detailed written confirmation of completion of deficient life safety work noted in the documentation listed in previous paragraphs, including date completed. Provide schedule for any outstanding or deferred non-life safety work that is to be completed.

1.23 Quality Of Materials

- .1 Furnish new materials, apparatus or products required for the work, of first class quality, delivered, erected, connected up and finished in every detail.
- .2 The use of any or all materials is subject to the approval of the Departmental Representative .
- .3 Unless otherwise specified, all products shall be CSA approved.
- .4 All fire protection materials, apparatus or products shall be ULC approved.

- .5 If materials, apparatus or products are not CSA or ULC approved, obtain approval of the provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
- .6 Confirm colours with the Departmental Representative before ordering.

1.24 Safety Features

- .1 Provide safety features on all equipment to ensure safe operation and maintenance including belt, coupling, and other guards, screened fan intakes and discharges where inadequate ductwork for protection, safety interlocks and labels.
- .2

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 22 05 03 – Acceptable Plumbing 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 10 HP: 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 10 HP 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 AHJ.

2.6 Accessibility

- .1 Refer to Section 10 90 00 – Miscellaneous Specialties for access door specification.
- .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.

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 set screws 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.

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 10 feet 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 The mechanical contractor, with all trades involved shall provide 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 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 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. Work installed before full coordination is subject to removal and replacement without additional compensation.

- .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 including location of other equipment not installed by Division 22, such as ducts, cable trays, other piping, 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. Provide access doors as required to ensure sufficient access for service and inspection. Make minor modifications to routing and locations of equipment indicated on drawings as required to improve access to equipment. Obtain direction from the Departmental Representative where major modifications are necessary to provide sufficient access.

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 Engineer.
- .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 System Cleaning

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

3.13 System Cleaning

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

3.14 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.

3.15 Demonstration

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 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.
- .3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Departmental Representative will record these demonstrations on video tape for future reference.

3.16 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.

3.17 Protection

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

3.18 Equipment Start-Up

- .1 Mechanical contractor shall ensure that all electrical/mechanical components match and that it is safe to start up plumbing equipment. See also Functional Testing.

- .2 All support such as electrical contractor, controls contractor, etc., shall be arranged by the mechanical and all trades directly involved in mechanical equipment being started shall be present for start up.

3.19 Manufacturers' Recommendations

- .1 Install, adjust, test, start-up, and maintain all mechanical equipment in strict accordance with the manufacturer's recommendations. If in conflict with the drawings and specifications, contact the Departmental Representative for clarification. Include edited data in O&M manuals.
- .2 Ensure that the manufacturer recommends the product for its intended use. If in doubt, contact the Departmental Representative .

3.20 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 (¼") 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 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME)
 - .1 ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
 - .2 ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .2 ASTM International Inc.
 - .1 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM A536, Standard Specification for Ductile Iron Castings.
 - .3 ASTM B88M, Standard Specification for Seamless Copper Water Tube (Metric).
- .3 American National Standards Institute/American Water Works Association (ANSI)/(AWWA)
 - .1 ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
- .5 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999, c. 33 (CEPA).
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
 - .1 MSS-SP-67, Butterfly Valves.
 - .2 MSS-SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.
 - .3 MSS-SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
 - .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
- .8 National Research Council (NRC)/Institute for Research in Construction
 - .1 NRCC 38728, National Plumbing Code of Canada (NPC).
- .9 Transport Canada (TC)

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

1.2 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .1 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.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with Regional and Municipal regulations.

Part 2 Products

2.1 Piping

- .1 Domestic hot, cold and recirculation systems, within building, all sizes:
 - .1 Above ground: copper tube, hard drawn temper, type L: to ASTM B88M.
 - .2 Buried or embedded:
 - .1 Copper tube, soft annealed, type K: to ASTM B88M, in long lengths with no buried joints.
 - .2 Cross-linked polyethylene piping to Series 160 of CSA B137.9.

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: ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.
- .6 NPS 1 and smaller: wrought copper to ANSI/ASME B16.22; with 301 stainless steel internal components and EPDM seals. Suitable for operating pressure to 1380 kPa.

2.3 Joints

- .1 Rubber gaskets, latex-free 1.6 mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: 95/5 tin copper alloy.
- .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.

2.4 Gate Valves

- .1 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.
- .2 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.

2.5 Globe Valves

- .1 NPS 2 and under, soldered:
 - .1 To MSS-SP-80, Class 150, 1 MPa, bronze body, renewable PTFE disc, screwed over bonnet, bronze seat.
- .2 NPS 2 and under, screwed:
 - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, screwed over bonnet, renewable composition disc, bronze seat.
- .3 Provide lockshield handles where valve is used for balancing, such as in recirculation system.

2.6 Swing Check Valves

- .1 NPS 3 and under, soldered:
 - .1 To MSS-SP-80, Class 150, 1 MPa, bronze body, brass swing disc for sizes 19mm and under, bronze swing disc for sizes 25mm and greater, screw in cap.
- .2 NPS 3 and under, screwed:

- .1 To MSS-SP-80, Class 150, 1 MPa, bronze body, brass swing disc for sizes 19mm and under, bronze swing disc for sizes 25mm and greater, screw in cap.

2.7 Ball Valves

- .1 NPS 3 and under, screwed:
 - .1 To MSS-SP-110, Class 150, bronze body, chrome plated brass ball, brass stem, PTFE adjustable packing, PTFE seat, steel lever handle.
- .2 NPS 3 and under, soldered:
 - .1 To MSS-SP-110, Class 150, bronze body, chrome plated brass ball, brass stem, PTFE adjustable packing, PTFE seat, steel lever handle.

2.8 Butterfly Valves

- .1 NPS 2-1/2 and over, grooved ends:
 - .1 Class 300, bubble tight shut-off, bronze body.
 - .2 Operator:
 - .1 NPS 6 and under: lever handles.

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 General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, except where deviations to layout are approved on coordination drawings.
- .2 Install components having pressure rating equal to or greater than system operating pressure.
- .3 Install piping free of sags, bends, and kinks.
- .4 Install fittings for changes in direction and branch connections in hard drawn copper tube.
- .5 Install drains at low points and in trapped sections, to ensure entire system can be drained.
- .6 Install in accordance with NPC, Provincial Plumbing Codes and local authority having jurisdiction

- .7 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- .8 Assemble piping using fittings manufactured to ANSI standards.
- .9 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.
- .10 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .11 Buried tubing:
 - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
 - .2 Bend tubing without crimping or constriction. Minimize use of fittings.

3.3 Piping Joint Construction

- .1 Join pipe and fittings as follows:
 - .1 Ream ends of pipe and tube and remove burrs to restore full inside diameter.
 - .2 Remove scale, slag, dirt, and debris from inside and outside of pipe, tube, and fittings before assembly.
 - .3 Soldered Joints: Construct joints according to ASTM B 828.
 - .4 Brazed Joints: Construct joints according to ANSI/AWS C3.4.
 - .5 Threaded Joints: Construct in accordance with industry standard practices and manufacturer's recommendations.
 - .6 Flanged Joints: Construct in accordance with industry standard practices and manufacturer's recommendations.
 - .7 Mechanical Joints: Grooved copper tube and grooved-tube fitting joints shall be assembled with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's standard written procedure. Grooved ends on copper and copper alloy tube shall be roll-formed only using the appropriate roll-groove tool to construct a groove meeting the coupling and fitting manufacturer's written specifications. Cut grooving methods shall not be used on copper and copper alloy tube.

3.4 Piping Connections

- .1 Make piping connections as specified below:
 - .1 Install solder-joint to male-thread adapters, or solder-joint to male-thread unions meeting the requirements of ASME B16.18 or ASME B16.22, adjacent to each threaded valve and threaded equipment connection in a copper tube system.
 - .2 Install ASME B16.24 cast copper alloy pipe flanges adjacent to each flanged valve and flanged equipment connection in a copper tube system.

3.5 Valves

- .1 Isolate equipment, fixtures and branches with ball valves, unless otherwise indicated.
- .2 Balance recirculation system using lockshield globe valves. Mark settings and record on as-built drawings on completion.

3.6 Pressure Tests

- .1 Test pressure: greater of 1 times maximum system operating pressure or 860 kPa.

3.7 Flushing, Cleaning And Disinfection

- .1 Flush, clean and disinfect the entire system in accordance with applicable standards, to the requirements of the authority having jurisdiction.
- .2 Upon completion of flushing, cleaning and disinfection, draw off sample from longest run and submit to laboratory for testing. Provide laboratory test reports on water quality for Engineer approval.
- .3 Provide necessary fittings, valves and connections as required to flush, clean and disinfect the system

3.8 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.

3.9 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, and safety devices for normal and safe operation.

- .4 Rectify start-up deficiencies.

3.10 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 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

3.11 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.

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 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 D2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
 - .2 ASTM D2564, Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-Series B1800, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.
- .3 Green Seal Environmental Standards (GSES)
 - .1 Standard GS-36, Commercial Adhesives.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 South Coast Air Quality Management District (SCAQMD), California State
 - .1 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.
- .1 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 Piping And Fittings

- .1 For buried and above ground DWV piping to:
 - .1 CAN/CSA B1800.

2.2 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 National Plumbing Code, Provincial Plumbing Code and local authority having jurisdiction.

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 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 Boiler and Pressure Vessel Code Section VIII Pressure Vessels.
 - .1 BPVC-VIII B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 1.
 - .2 BPVC-VIII-2 B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 2 - Alternative Rules.
 - .3 BPVC-VIII-3 B, BPVC Section VIII - Rules for Construction of Pressure Vessels Division 3 - Alternative Rules High Press Vessels.
 - .2 ASME B16.5, Pipe Flanges and Flanged Fittings.
 - .3 ASME B16.11, Forged Fittings, Socket-Welding and Threaded.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A181/A181M, Standard Specification for Carbon Steel Forgings for General Purpose Piping.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 Action And Informational Submittals

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
 - .2 Submit WHMIS MSDS in accordance with Section 01 47 15 - Sustainable Requirements: Construction and Section 02 81 01 - Hazardous Materials. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Shop Drawings:
 - .1 Submit shop drawings to indicate project layout including layout, dimensions and extent of piping system.
 - .1 Vertical and horizontal piping locations and elevations and connections details.
 - .2 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with

specifications for specified performance characteristics and physical properties.

- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Instructions: submit manufacturer's installation instructions.
- .5 Closeout Submittals: submit maintenance and engineering 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 Materials

2.2 Air Compressor

- .1 General:
 - .1 Variable speed, air-cooled, fully enclosed, oil-injected rotary screw air compressor unit.
 - .2 Integrated receiver, cycling refrigerated dryer, capacity and dryer bypass.
 - .3 Integrated high efficiency coalescing and particulate filters.
 - .4 Electronic drain valve.
 - .5 Pneumatic flow controller.
 - .6 System shall come factory tested as a complete package.
 - .7 Provide spare oil, sufficient for one oil change.
- .2 Capacities and Specifications:
 - .1 Air flow: 1.47 m³/min (52 CFM)
 - .2 Max rated operating pressure: 5.6 bar (125 psi)
 - .3 Rated discharge pressure: 8 bar (116 psi)
 - .4 Motor: Variable Speed Drive (VSD), 15 hp.
 - .5 Sound Level: 69 dBA
- .3 Enclosure

- .1 Enclosure is powder coated steel, with acoustic foam to keep sound levels to a minimum and is separated into three distinct, sections, the blower, the drive and the compressor module.
- .4 The enclosure gives easy access for service and maintenance.
- .5 Control:
 - .1 Located on the front of the compressor for good visibility. The control panel includes hour meter - and, start button, power on and standby indicator lamps, and maintenance indicator.
 - .2 Emergency stop button. Optional maintenance indicator is available
- .6 Air intakes:
 - .1 Complete with replaceable cartridge type intake filter and silencer.
- .7 Vibration isolation:
 - .1 95% minimum efficiency.
- .8 Coolers:
 - .1 Integrally mounted air-cooled combination cooler of tube and fin design. Constructed from aluminium, it is rated for full load continuous duty. The after cooler cools the compressed air prior to discharge from the package and is rated to operate in ambient temperatures from 2 C (35°F) up to 40 C (104°F)
- .9 Air Receiver
 - .1 Integral to unit.
 - .2 Horizontal air storage receiver
 - .3 620 mm diameter, 1700 mm length with 19 mm ball valve connection
 - .4 455 litres (120 gal).
- .10 Refrigerated Air Dryer
 - .1 Integrated within the package and using the same cooling air flow. The air dryer which cycles on and off with the compressor, uses a unique stainless steel plate heat exchanger, environmentally sound R-134a refrigeration cycle and a high efficiency "micro channel" condenser. Water is removed from the airflow directly after the evaporator by a high efficiency, external cyclone separator.
 - .2 Condensate is discharged by solenoid drain from a manifold in parallel with other drain points.
- .11 Compressed Air Filtration
 - .1 Two stages of filtration, minimum on outlet.
 - .2 The inlet air filter is 99.9% efficient at 3 microns and above.
 - .3 Provide complete spare set of filters.
- .12 Air Regulator
 - .1 Air regulator to provide controlled & consistent air pressure. Adjustment range of 0-9.6 bar (0-140 psig).

- .2 NPT Size: 19 mm (3/4")
- .3 Max Pressure: 1720 kPa (250 psi)
- .4 Max Flow Capacity: 137 l/s (290 cfm)

2.3 Piping

- .1 Piping: to ASTM A53/A53M, schedule 80 seamless black steel.
- .2 Fittings:
 - .1 NPS2 and smaller: to ASME B16.11, schedule 80 steel, socket welded.
 - .2 NPS2 1/2 and larger: to ASME B16.11, schedule 80 steel, butt or socket welded.
- .3 Couplings: to ASME B16.11, socket welded or threaded half coupling type.
- .4 Unions: 1000 kPa malleable iron with brass-to-iron ground seat.
- .5 Dissimilar metal junctions: use dielectric unions.
- .6 Flanges:
 - .1 NPS2 and smaller: to ASME B16.5, forged steel, raised face and socket welded.
 - .2 NPS2 1/2 and larger: to ASME B16.5, forged steel, raised face and slip-on or weld neck.
- .7 Joints:
 - .1 NPS2 and smaller: socket welded.
 - .2 NPS2 1/2 and larger: butt welded.

2.4 Ball Valves

- .1 Three piece design or top entry for ease of in-line maintenance.
 - .1 To ASTM A181/A181M, Class 70, brass body with stainless steel ball and associated trim suitable for compressed air application.
 - .2 To withstand 1034 kPa maximum pressure.

2.5 Couplers/Connectors

- .1 Industrial interchange series, full-bore.
- .2 Maximum inlet pressure: 1700 kPa.
- .3 Valve seat: moulded nylon.
- .4 Body: zinc plated steel.
- .5 Threads: NPT.

2.6 Hose Reel

- .1 Heavy duty spring retractable hose reel, steel base and guide arm, 13mm (1/2") I. D. hose x 15 m length, 3/8 NPTF outlet, 1/2 NPTF inlet, 21 bar (300 psi) pressure rating, complete with bumper.

- .2 Top channel and beam clamps for one reel.

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 Compressor Station

- .1 Install on vibration isolators on housekeeping pad as indicated.

3.3 Compressed Air Line Filter

- .1 Install on discharge line from refrigerated air dryer.

3.4 Main Air Pressure Regulators

- .1 Install additional regulators on connections to equipment such as:
 - .1 Central vacuum
 - .2 Dust collector

3.5 Compressed Air Piping Connections And Installation

- .1 Install shut-off valves at outlets, major branch lines and in locations as indicated.
- .2 Install quick-coupler chucks and pressure gauges on drop pipes.
- .3 Install unions to permit removal or replacement of equipment.
- .4 Install tees in lieu of elbows at changes in direction of piping. Install plug in open ends of tees.
- .5 Grade piping at 1% slope minimum.
- .6 Install compressed air trap and pressure equalizing pipe at moisture collecting points. Drain pipe to nearest floor drain.
- .7 Make branch connections from top of main.
- .8 Install compressed air trap at bottom of risers and at low points in mains, piped to nearest drain. Distance between drain points to be 30 m maximum.
- .9 Provide drain from refrigerated air dryer.

3.6 Hose Reels

- .1 Provide where indicated on drawings.

3.7 Field Quality Control

- .1 Site Tests/Inspection:

- .1 Testing: pressure test in accordance with requirements of Section 22 05 00 - Common Work Results for Plumbing, for 4 h minimum, to 1100 kPa, with outlets closed and with compressor isolated from system. Pressure drop not to exceed 10 kPa.
- .2 Manufacturer's Field Services:
 - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
 - .2 Provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.

3.8 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/Canadian Standards Association (ANSI/CSA)
 - .1 ANSI Z21.10.1/CSA 4.1, Gas Water Heaters - Volume I, Storage Water Heaters With Input Ratings of 75,000 Btu Per Hour or Less.
 - .2 ANSI Z21.10.1A/CSA 4.1A, Addenda 1 to ANSI Z21.10.1-2004/CSA 4.1-2004, Gas Water Heaters Volume I, Storage Water Heaters With Input Ratings of 75,000 Btu Per Hour or Less.
 - .3 ANSI Z21.10.1b/CSA 4.1b, Addenda 2 to ANSI Z21.10.1-2004/CSA 4.1-2004, Gas Water Heaters - Volume I, Storage Water Heaters With Input Ratings of 75,000 Btu Per Hour or Less.
 - .4 ANSI Z21.10.3A/CSA 4.3, Gas Water Heaters - Volume III - Storage Water Heaters, with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
 - .2 CAN/CSA-B139, Installation Code for Oil Burning Equipment.
 - .3 CAN/CSA-B140.0, Oil Burning Equipment: General Requirements.
 - .4 CAN/CSA-B149.1, Natural Gas and Propane Installation Code.
 - .5 CAN/CSA-B149.2, Propane Storage and Handling Code.
 - .6 CSA B140.12, Oil-Burning Equipment: Service Water Heaters for Domestic Hot Water, Space Heating, and Swimming Pools.
 - .7 CAN/CSA C22.2 No.110, Construction and Test of Electric Storage Tank Water Heaters.
 - .8 CAN/CSA-C191, Performance of Electric Storage Tank Water Heaters for Household Service.
 - .9 CAN/CSA-C309, Performance Requirements for Glass-Lined Storage Tanks for Household Hot Water Service.

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 domestic water heater, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate:

- .1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.

1.3 Closeout Submittals

- .1 Provide maintenance and engineering 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.

Part 2 Products

2.1 Electric Water Heater

- .1 To CAN/CSA C22.2 No.110, CAN/CSA-C191 and CAN/CSA-C309 for glass-lined storage tanks, with immersion type elements, wattage as indicated on drawing schedules, and surface mounted or immersion type adjustable thermostats.
- .2 Tank: glass lined steel, 50 mm mineral wool or fibreglass insulation, enamelled steel jacket.

2.2 Trim And Instrumentation

- .1 Drain valve: NPS 1 with hose end.
- .2 Thermometer: 100 mm dial type with red pointer and thermowell filled with conductive paste.
- .3 Pressure gauge: 75 mm dial type with red pointer, syphon, and shut-off cock.
- .4 Thermowell filled with conductive paste for control valve temperature sensor.
- .5 ASME rated temperature and pressure relief valve sized for full capacity of heater, having discharge terminating over floor drain and visible to operators.
- .6 Magnesium anodes adequate for 20 years of operation and located for easy replacement.

2.3 Anchor Bolts And Templates

- .1 Supply anchor bolts and templates for installation in concrete support pad in accordance with Section 03 30 00 - Cast-in-Place Concrete.

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 manufacturer's recommendations and authority having jurisdiction.

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 CAN/CSA-B45 Series, Plumbing Fixtures, (Consists of B45.0, B45.1, B45.2, B45.3, B45.4, B45.5, B45.6, B45.7, B45.8 and B45.9).
 - .2 CSA B125.3, Plumbing Fittings.
 - .3 CSA B651, Accessible Design for the Built Environment.
- .2 Green Seal (GS)
 - .1 GS-36, Adhesives for Commercial Use.
- .3 South Coast Air Quality Management District (SCAQMD)
 - .1 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.
- .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 Include:
 - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
 - .2 Details of operation, servicing, maintenance.
 - .3 List of recommended spare parts.

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 Manufactured Units

- .1 Refer to schedules.
- .2 Fixtures: manufacture in accordance with CAN/CSA-B45 series.
- .3 Trim, fittings: manufacture in accordance with CSA B125.3.
- .4 Exposed plumbing brass to be chrome plated.
- .5 Number, locations: as indicated.
- .6 Fixtures in any one location to be product of one manufacturer and of same type.
- .7 Trim in any one location to be product of one manufacturer and of same type.
- .8 Fixture piping:
 - .1 Hot and cold water supplies to fixtures:
 - .1 Chrome plated flexible supply pipes with screwdriver stop, reducers, escutcheon.
 - .2 Waste:
 - .1 Brass P trap with clean out on fixtures not having integral trap.
 - .2 Chrome plated in exposed places.
- .9 Chair carriers:
 - .1 Factory manufactured floor-mounted carrier systems for wall-mounted fixtures.
- .10 Water closet seats:
 - .1 Open front with replaceable bumpers and stainless steel self-sustaining check hinges.
 - .2 Colour: white, unless otherwise specified by the Architect.
- .11 Water closet flush valves: As specified with fixture plus rubber toilet seat bumpers to suit seat style, screwdriver stop, vacuum breaker, and all exposed parts chrome plated.
- .12 Sealant: Colour- white, confirm with the Architect.

2.2 Barrier-Free Plumbing Fixtures

- .1 Provide approved barrier-free fixtures and brass where indicated on mechanical or architectural drawings.
- .2 Provide offset P-traps.
- .3 Leg protection:
 - .1 Lavatories: shroud/knee contact guard, colour – white, unless otherwise specified by the Architect.
 - .2 All exposed piping shall be completely covered, including screwdriver stops.

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 Mounting heights:
 - .1 Standard: as indicated on architectural drawings.
 - .2 Barrier-free: to most stringent NBC.

3.3 Adjusting

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments:
 - .1 Adjust water flow rate to design flow rates.
 - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
 - .3 Adjust flush valves to suit actual site conditions.
 - .4 Adjust urinal flush timing mechanisms.
 - .5 Set controls of automatic flush valves for WCs and urinals to prevent unnecessary flush cycles.
- .3 Checks:
 - .1 Water closets, urinals: flushing action.
 - .2 Aerators: operation, cleanliness.
 - .3 Vacuum breakers, backflow preventers: operation under all conditions.
- .4 Thermostatic controls:
 - .1 Verify temperature settings, operation of control, limit and safety controls.

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 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.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.2 Closeout Submittals

- .1 Provide maintenance data in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Include:
 - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
 - .2 Details of operation, servicing, maintenance.
 - .3 List of recommended spare parts.

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 Manufactured Units

- .1 Refer to schedules.
- .2 Fixtures: manufacture in accordance with CAN/CSA-B45 series.
- .3 Trim, fittings: manufacture in accordance with CAN/CSA-B125.
- .4 Exposed plumbing brass to be chrome plated.

- .5 Number, locations: architectural drawings to govern.
- .6 Fixtures to be product of one manufacturer.
- .7 Trim to be product of one manufacturer.
- .8 Fixture piping:
 - .1 Hot and cold water supplies to each fixture:
 - .1 Chrome plated flexible supply pipes each with screwdriver stop, reducers, escutcheon.
 - .2 Waste:
 - .1 Brass P trap with clean out on each fixture not having integral trap.
 - .2 Chrome plated in all exposed places.
- .9 Chair carriers:
 - .1 Factory manufactured floor-mounted carrier systems for all wall-mounted fixtures.

2.2 Barrier-Free Plumbing Fixtures

- .1 Provide approved barrier-free fixtures and brass where indicated on mechanical or architectural drawings.
- .2 Provide offset P-traps.
- .3 Leg protection:
 - .1 Lavatories: shroud/knee contact guard, colour – white, unless otherwise specified by the Architect.
 - .2 All exposed piping shall be completely covered, including screwdriver stops.

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 Mounting heights:
 - .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.
 - .2 Wall-hung fixtures: as indicated on architectural drawings, measured from finished floor.
 - .3 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA-B651.

3.3 Adjusting

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments:
 - .1 Adjust water flow rate to design flow rates.
 - .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
- .3 Checks:
 - .1 Aerators: operation, cleanliness.
 - .2 Vacuum breakers, backflow preventers: operation under all conditions.
 - .3 Wash fountains: operation of flow-actuating devices.
- .4 Thermostatic controls:
 - .1 Verify temperature settings, operation of control, limit and safety controls.

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 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

1.2 Regulatory Requirements

- .1 Refer carefully to other parts of the specifications.
- .2 Conform to the requirements and recommendations of all local municipal, provincial and federal codes, by-laws and ordinances.
- .3 Do not reduce the quality of work specified and/or shown on the drawings because of the Regulatory requirements.

1.3 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.

1.4 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.

1.5 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for 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.

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 Refer also to Section 25 30 10 Controls/Instrumentation – Sequence of Operations.
- .2 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.
- .3 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.
- .4 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 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.

1.14 Trial Usage

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

1.15 Functional Testing

- .1 Test all HVAC equipment, devices and systems. Test as required by the AHJ 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.

1.16 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 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.

1.17 Spare Parts

- .1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals and as follows:
 - .1 One set of packing for each packed pump.
 - .2 One mechanical seal for each size and type of pump utilizing a mechanical seal.
 - .3 One casing joint gasket for each size and type of pump.
 - .4 One head gasket for each tube-in-shell heat exchanger.
 - .5 One plate gasket set for each plate-and-frame heat exchanger.
 - .6 One glass for each gauge glass.
 - .7 One set of filter media/cartridges, for each filter or filter bank in addition to final operating set.
 - .8 One set of belts for each piece of belt-driven equipment.

1.18 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.

1.19 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.
 - .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.

1.20 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 head gasket set for each heat exchanger.
 - .4 One glass for each gauge glass.
 - .5 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.
- .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.

1.21 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.

1.22 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.

1.23 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 AHJ.

2.6 Accessibility

- .1 Refer to Section 10 90 00 – Miscellaneous Specialties for access door specification.
- .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 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 System Cleaning

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

3.13 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.

3.14 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.

3.15 Protection

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

3.16 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.

3.17 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.

3.18 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.
- .1 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 and as required.
- .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 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 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.
- .2 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 Pework

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pework: 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 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 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.

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 gasketed 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 1/4 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 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:
 - .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.

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 Concrete: to Division 03 - Cast-in-place Concrete.

2.11 Other Equipment Supports

- .1 Fabricate equipment supports from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings.
- .2 Submit structural calculations with shop drawings.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 Installation

- .1 Install in accordance with:
 - .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.

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 Locations:
 - .1 Terminal cabinets, control panels: use size # 5.

- .2 Equipment in Mechanical Rooms: use size # 9.
- .5 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 Natural gas: to CSA/CGA B149.1.
 - .2 Propane gas: to CSA/CGA B149.1.
 - .3 Sprinklers: to NFPA 13.
 - .4 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 [plastic-coated cloth] [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
Domestic hot water supply	Green	DOM. HW SUPPLY
Dom. HWS recirculation	Green	DOM. HW CIRC
Domestic cold water supply	Green	DOM. CWS
Waste water	Green	WASTE WATER
Sanitary	Green	SAN
Plumbing vent	Green	SAN. VENT
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Natural gas	to Codes	
Gas regulator vents	to Codes	
Compressed air	Green	COMP. AIR [] psi
Vacuum	Green	VACUUM
Dust Collection	Green	DUST COLLECTION

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.

2.9 Language

- .1 Identification in English.

Part 3 Execution

3.1 Manufacturer's Instructions

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

3.2 Timing

- .1 Provide identification only after painting 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.
- .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 weatherstripping, 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 Laboratory HVAC systems: plus 10 %, minus 0] %.
 - .2 Other HVAC systems: plus 5 %, minus 5 %.
 - .3 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 Ventilation Systems including:
 - .1 Fans
 - .2 Heat/Energy Recovery Ventilators
 - .3 Air handling units
 - .4 Supply air outlets
- .2 Dust Collection System including:
 - .1 Collection hoods
 - .2 All inlets
- .3 Test and tag all fire dampers
- .3 Qualifications: personnel performing TAB current member in good standing of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified by AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, 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).
- .8 Building pressure conditions:
 - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
 - .2 TAB procedures:
 - .1 Set AHU relief based on space static pressure. Ensure spaces are not over pressurized
- .9 Zone pressure differences:
 - .1 Adjust HVAC systems, equipment, controls to establish specified air pressure differentials, with systems in every possible combinations of normal operating modes.
 - .2 TAB procedures:
 - .1 Maintain positive pressure to keep contaminants from "dirty" spaces from enter the "clean" area and offices.

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%.
 - .4 HP duct systems up to 1000 Pa pressure classification, including upstream side of VAV boxes: leakage 1%.
- .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.

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	50
Mixing plenums	C-1	yes	25
Exhaust duct between dampers and louvres	C-1	no	25
Rectangular ducts outside	C-1	special	50
Round ducts outside	C-1	special	50
Acoustically lined ducts	C-1		
Exterior ducts	C-1	yes	50

- .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 precipitation	CRF/3	CRD/4
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, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings
 - .4 CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.3 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.

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.

Applica-tion	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)										
Domestic	A-1	25	25	25	38	38	38						

HWS													
Domestic DCW, with vapour barrier	A-3	25	25	25	25	25	25						
Refrigerant, hot gas, liquid, suction	4 - 13	A-6	25	25	25	25	25	25					
Refrigerant, hot gas, liquid, suction	below 4	A-6	25	25	38	38	38	38					

.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 Summary

.1 Section Includes:

- .1 Materials and installation for piping, valves and fittings for gas fired equipment.

1.2 References

.1 American Society of Mechanical Engineers (ASME)

- .1 ASME B16.5, Pipe Flanges and Flanged Fittings.
- .2 ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .3 ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .4 ASME B18.2.1, Square and Hex Bolts and Screws Inch Series.

.2 American Society for Testing and Materials International (ASTM)

- .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
- .2 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- .3 ASTM B75M, Standard Specification for Seamless Copper Tube [Metric].
- .4 ASTM B837, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.

.3 Canadian Standards Association (CSA International)

- .1 CSA W47.1, Certification of Companies for Fusion Welding of Steel.

.4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)

- .1 CAN/CSA B149.1HB, Natural Gas and Propane Installation Code Handbook.
- .2 CAN/CSA B149.2, Propane Storage and Handling Code.

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

- .1 Material Safety Data Sheets (MSDS).

1.3 Action And Informational Submittals

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

.2 Product Data:

- .1 Submit manufacturer's printed product literature, specifications and datasheet for piping, fittings and equipment.
- .2 Indicate on manufacturers catalogue literature following: valves.

- .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.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Closeout Submittals: submit maintenance and engineering 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.

Part 2 Products

2.1 Materials

2.2 Pipe

- .1 Above Ground:
 - .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS 2 1/2 and over, plain end.
 - .2 Copper tube: to ASTM B837.
- .2 Buried:
 - .1 Polyethylene Piping system, manufacturer for conveying of natural gas below ground.
 - .2 Provide above ground transitions to metallic piping.

2.3 Jointing Material

- .1 Screwed fittings: pulverized lead paste.
- .2 Welded fittings: to CSA W47.1.
- .3 Flange gaskets: nonmetallic flat.
- .4 Brazing: to ASTM B837.

2.4 Fittings

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Welding: butt-welding fittings.
 - .4 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .5 Bolts and nuts: to ASME B18.2.1.
 - .6 Nipples: schedule 40, to ASTM A53/A53M.
- .2 Copper pipe fittings, screwed, flanged or soldered:
 - .1 Cast copper fittings: to ASME B16.18.
 - .2 Wrought copper fittings: to ASME B16.22.

2.5 Valves

- .1 Provincial Code approved, lubricated ball 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 datasheet.

3.2 Piping

- .1 Install in accordance with Section 23 05 05 - Installation of Pipework, applicable Provincial/Territorial Codes, CAN/CSA B149.1, CAN/CSA B149.2, supplemented as specified.
- .2 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.

3.3 Valves

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

3.4 Adjusting

- .1 Purging: purge after pressure test in accordance with CAN/CSA B149.1.
- .2 Pre-Start-Up Inspections:
 - .1 Check vents from regulators, control valves, terminate outside building in approved location, protected against blockage, damage.

- .2 Check gas trains, entire installation is approved by authority having jurisdiction.

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 Refrigerant piping and accessories

1.2 References

.1 American Society of Mechanical Engineers (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, 400, 600, 900, 1500 and 2500.
- .3 ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
- .4 ASME B31.5, Refrigeration Piping.

.2 American Society for Testing and Materials (ASTM)

- .1 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
- .2 ASTM B280, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.3 Canadian Standards Association (CSA)

- .1 CSA B52, Mechanical Refrigeration Code.

.4 Environment Canada (EC)

.5 EPS 1/RA/1, Environmental Code of Practice for the Reduction of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

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 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 1210C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, copper-phosphorous, 95% 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 General

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5.

3.2 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.

3.3 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 above.
 - .2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

3.4 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 2MPa and 1MPa 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.

3.5 Dehydration And Charging

- .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 130C 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 5Pa 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 14Pa absolute and hold for 4 h.
- .2 Break vacuum with refrigerant to 14kPa.
- .3 Final to 5Pa absolute and hold for at least 12 h.
- .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
- .5 Submit test results to Engineer.
- .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 Engineer.

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 Industrial and Governmental Hygienists handbook for dust collector ductwork.
- .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:

Systems	Pressure Class (Pa)	Seal class
Supply ducts	+250	B
Return and Exhaust ducts	-250	B
Dust Collector	-2500	A

- .2 Seal Classification:
 - .1 Class A: longitudinal seams, transverse joints and connections made airtight with sealant
 - .2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant and tape or combination thereof.
 - .3 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 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 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.

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 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:
 - .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 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.

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.

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 complete.

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 manufacturer'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.

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. Insulation and vapour barrier on type NM-IL flexible ducts shall be secured with a combination of tape and duct clamps.
- .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.

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. EC)/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. EC)/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 Action And Informational Submittals

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

.1 Product Data:

.1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, sound characteristics, finish and limitations.

.2 Closeout Submittals:

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

1.2 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 Place materials defined as hazardous or toxic in designated containers.

.5 Handle and dispose of hazardous materials in accordance with Regional and Municipal regulations.

1.3 Closeout Submittals

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

Part 2 Products

2.1 Industrial Stationary Central Vacuum

.1 Capacity: 210 CFM at 7.78 inHg, 10 hp.

.2 Heavy Duty industrial indoor vacuum, mounted on pad, fully assembled at the factory.

- .3 Multi-stage centrifugal, standard overhung direct drive, up blast exhaust, sound pressure level from 83dBA at 3 ft.
- .4 Hot rolled steel casing with epoxy primer and top coat.
- .5 Direct drive, multi-stage, centrifugal design with aluminum impellers.
- .6 Drip proof motor enclosure.
- .7 Up blast exhaust discharged to outdoors with silencer.
- .8 Separator
 - .1 Cotton filter bag material with 99.9% average filtration efficiency at 3 microns.
 - .2 Removable dirt can.
 - .3 Hinged inspection door.
- .9 Include accessories and features as per schedule and as follows:
 - .1 Features:
 - .1 Cartridge jet pulse design
 - .2 PTFE Spun Bond Cartridge filters for 90 sq ft filter area
 - .3 2-1/4 cu ft dirt can
 - .4 10HP 575/3/60 TEFC longshaft standard eff. Motor
 - .5 Explosion vent
 - .6 Differential pressure gauge
 - .7 Bleed Hardware Assembly
 - .8 NEMA 12 Visual setpoint bleed control
 - .9 Current Transformer
 - .10 6" air gate valve
 - .11 6" discharge silencer
 - .2 Accessories:
 - .1 Provide 2 kits, each with 15' long, 1-1/2" diameter hose with coupling, duck foot cleaning tool and tool holder.
 - .1 Hose to be heavy-duty rubber type.

2.2 Central Vacuum Tubing

- .1 Galvanized tubing, sizes as indicated on drawings.
 - .1 Tubing Gauge as follows:
 - .1 2" to 4" tubing = 16 gauge
 - .2 5" to 8" tubing = 14 gauge
 - .2 Joints.
 - .1 Utilize tubing manufacturers quick clamp coupling.
- .2 Provide inlets as shown in drawings.

- .1 Inlets to be quick connect to accept male hose coupling to the piping system. Cover is self-closing and includes a hook to prevent the hose from being pulled out. Valves bodies are forged brass, covers are steel, and the entire valve is nickel plated.

Part 3 Execution

3.1 Installation

- .1 Install in accordance with manufacturer's instructions.
- .2 Interlock with fire alarm for shut down.
- .3 All low voltage wiring to be installed by mechanical division in conduit provided by electrical division.

END OF SECTION

Part 1 General

1.1 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for specified equipment and include product characteristics, performance criteria, physical size, sound characteristics, finish and limitations.
- .2 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

1.2 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 Place materials defined as hazardous or toxic in designated containers.
- .5 Handle and dispose of hazardous materials in accordance with Regional and Municipal regulations.

1.3 Closeout Submittals

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

Part 2 Products

2.1 Jet Pulse Cartridge Dust Collector

- .1 Furnish and install, where shown on the plans, a self cleaning cartridge style dust collector for automatic continuous operation with integral blower sized for design air flow of 2830 l/s @ 2.5 kPa (6,000CFM @ 10" W.C. Ext. SP).

- .2 Dust laden air shall be filtered by filter cartridges constructed of non-woven (treated cellulose) (spun polyester) corrugated into a cylinder and bonded to steel end caps. The top end cap shall be fitted with a continuous neoprene gasket. There shall be bands on the clean air side of each cartridge to prevent the filter media from flexing during back flushing. Each filter cartridge shall be 13" diameter and 26" long and rated 99% at 0.5 micron and virtually 100% at 10 micron and above.
- .3 The filter cartridges shall be installed by sliding on tracks which are accessible from the access doors. There shall be no more than two (2) cartridges per row. Each row shall be locked in place by means of a positive seal locking mechanism located adjacent to the door. (Filter cartridges for Model SPV 4 shall be individually secured by a knob located at the bottom of each cartridge.) Physical entry through the access doors shall not be required.
- .4 Filter pressure drop monitored by programmable pulse controller.
- .5 Filter cartridges shall be continuously and automatically cleaned by compressed air reverse flow. Each row of filter cartridges shall have its own solenoid valve which is activated by a solid state timer with adjustable pulse interval and duration in NEMA 4 enclosure, shipped loose. Unit requires clean and dry compressed air of 3.0 to 6.4 SCFM at 100 PSI.
- .6 Unit of airtight all steel construction with sealed seams and not less than 12 ga. hot rolled steel rated - 20" H2O for negative pressure.
- .7 Hopper to be pyramid type and have a minimum of 55 degree slope. A 55 gallon drum, gasketed drum cover, flexible hoses and clamps for use under suction shall be furnished by dust collector manufacturer.
- .8 The integral direct drive blower shall be located on the clean air side of the filters, top mounted at the factory and be of backward inclined design with a dynamically balanced impeller. It shall be driven by a 20 HP, 575 volt, 3450 RPM, TEFC motor.
- .9 Interior and exterior carbon steel surfaces shall be coated with epoxy primer and exterior finished with gray urethane enamel.
- .10 Provide all required starters, control panel and interfaces as required to achieve and working system.
- .11 Unit shall be Sternvent Sternpulse Model SPV 1620-HAXL-1 or approved equal.
- .12 Unit shall be capable of operating in recirculating, mixed and 100% exhaust.
 - .1 Provide motorized insulated dampers (total of three) for mixed/recirculating air. Building DDC system shall control dampers for recirculation (in winter) and free cooling (in summer).
- .13 Included Options:
 - .1 Discharge damper

- .2 Discharge silencer
- .3 Weather discharge with bird screen
- .4 Special filter media
- .5 Final filters to permit safe recirculation of air, if permitted by codes
- .6 Explosion vent
- .7 Rotary airlock

2.2 Extraction Arms

- .1 Free from internal mechanisms, easily operated and fully flexible.
- .2 Uninterrupted airflow allows for high air velocity, capturing coarse dust.
- .3 Features:
 - .1 Constructed of 100 mm tube diameter, in two sections with a total of 3 elbow joints to create a fully articulating extraction arm.
 - .2 Clear-thru design allows maximum air velocity, low pressure drop, low noise level and low energy cost
 - .3 Conical hood at inlet with mesh grille.
 - .4 The arm, in any position, shall be self supporting enabling it to hold its position.
 - .5 Reach above mounting height offers maximum reach
 - .6 Supplied fully assembled saves installation time
 - .7 Exterior joints allow ease of adjustment, smooth operation and ease of service
 - .8 360-degree rotation, 1.5 m reach
 - .9 Provide bracket for wall mounted application.
 - .10 Provide white colour unit.

Part 3 Execution

3.1 Installation

- .1 Install in accordance with manufacturer's instructions.
- .2 Interlock with fire alarm for shut down.
- .3 All low voltage wiring to be installed by mechanical division in conduit provided by electrical division.
- .4 Install controller for start/stop and monitoring on inside wall, adjacent to unit location.
- .5 Insulate all exterior ductwork with 50mm rigid insulation and provide aluminum jacketing.

- .6 Support exterior ductwork on galvanized angle iron stand. Submit shop drawings and coordinate with unit height duct inlet and discharge
- .7 Install extraction arms as per locations shown on drawings.

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.

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 attenuator section shall not to exceed 37 Pa.
- .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.
- .8 Electric heating coils: Electric coils shall be supplied and installed on the terminal by the terminal manufacturer. Coils shall be ETL listed. Coils shall be housed in an attenuator section integral with the terminal with element grid recessed from unit discharge a minimum of 125 mm to prevent damage to elements during shipping and installation. Elements shall be 80/20 nickel chrome, supported by ceramic isolators a maximum of 87.5 mm apart, staggered for maximum thermal transfer and element life and balanced to ensure equal output per step. The integral control panel shall be housed in a NEMA 1 enclosure with hinged access door for access to all controls and safety devices. Electric coils shall contain a primary automatic reset thermal cut-out, , differential pressure airflow switch for proof of flow, and line terminal block. Non-interlocking type disconnects are not acceptable. All individual components shall be UL listed or recognized. Electric coils shall include line fusing, contactors mounted and wired within the control enclosure. Capacities and performance as scheduled. Unit shall include warning label to disconnect power before servicing.

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 Outlets and Inlets

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.

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.

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 Summary****.1** Section includes:

- .1 Packaged air cooled refrigerant condensing unit.

1.2 Shop Drawings And Product Data

- .1 Submit shop drawing and product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate the following: Diagrams of field installation, internal wiring and piping for field assembly, with refrigerant flow directions, pipe sizes, pressures drops in equipment and suction lines.

1.3 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 Factory assembled, single piece, air cooled condensing unit designed for outdoor installation.
- .2 Factory wired, piped, and tested for leakage and functionality to assure trouble-free installation and startup.
- .3 Rated in accordance with AHRI Standard 340/360.
- .4 Manufactured in a facility registered under the ISO 9002 manufacturing quality standard.
- .5 Designed and tested in accordance with ASHRAE 15 Safety Code for Mechanical Refrigeration and comply with NEC.
- .6 Cooling performance rated in accordance with DOE and AHRI test procedures.
- .7 CSA listed and classified to UL 1995/CAN/CSA No. 236- M90 standards.
- .8 Operating Characteristics
 - .1 Operating Range shall be between 52°C to 4°C (125° F to 40° F) in cooling as standard from factory.

- .2 The capacity of the condensing unit shall meet or exceed 108,000 BTU at a suction temperature of 45 F. The power consumption at full load shall not exceed 9.1 kW.
- .3 The system shall have an EER of 11.8 Btuh/ Watt or greater at standard AHRI conditions.

2.2 Unit Construction

- .1 Constructed of zinc-coated, galvanized steel.
- .2 Exterior surfaces bonded and coated with baked enamel finish by a powder paint process capable of withstanding a minimum of 1000 salt spray hours according to ASTM B117.
- .3 Cabinet screws that comply with ASTM B117 salt spray test for a minimum of 750 hours.
- .4 Permanently attached heavy-gage perimeter base rails with forklift slots and lifting holes.
- .5 Removable access panels to all internal components.
- .6 Separate access panel to controls.
- .7 Access panels to allow outdoor coil cleaning.

2.3 Compressors

- .1 Hermetic scroll type, internally protected with high pressure relief and over temperature protection.
- .2 Two stage units operate in 50% capacity increments.
- .3 Suction gas cooled
- .4 Voltage range of $\pm 10\%$ of unit nameplate voltage.
- .5 Neoprene isolators minimize sound transmission and vibration.
- .6 Belly-band crankcase heaters keep refrigerant from diluting sump oil.
- .7 Full charge of compressor oil
- .8 Low ambient lockout.

2.4 Condensor

- .1 Coil:
 - .1 Draw thru configuration
 - .2 Constructed with Micro-channel aluminum fins and aluminum tubing. All refrigerant tubing must share a common header.
- .2 Condenser Fans
 - .1 Direct driven propeller-type fans
 - .2 Statically and dynamically balanced
 - .3 Aluminum blades riveted to corrosion resistant steel spider brackets.
 - .4 Arranged for vertical air discharge.

.5 Equipped with PVC coated steel wire safety guards.

.3 Condenser Motors

.1 Totally enclosed, air over cooled.

.2 Inherent overload protection.

.3 Permanently lubricated bearings.

.4 Must cycle to allow cooling operation down to 40°F.

2.5 Refrigerant Piping

.1 Solid core filter-drier(s) ship loose for field installation.

.2 Liquid and suction line service valves with gauge ports.

.3 Suction and discharge line service ports accessible from unit. Ports capped for leak prevention.

.4 Liquid line magnetic check valves

.5 Holding charge of R410A refrigerant.

2.6 Controls

.1 All 24-volt control circuit, powered by a 24 volt transformer(s) and protected by a resettable breaker.

.2 Conventional thermostat must provide operation for both condensing units and heat pumps without an "O" output from the thermostat.

.3 Low voltage terminal strip for simple hook-up.

.4 Compressor motor protection shuts down unit for motor over-current, over-temperature or low voltage conditions.

.5 Safety lockouts provide reset capability at the space thermostat or base unit should any of the following standard safety devices trip and shut off compressor:

.6 Loss-of-charge/Low-pressure switch.

.7 High-pressure switch.

.8 Control board diagnostics and fault message display.

.9 Safety lockouts send a 24 volt signal to the control board's "X" terminal, allowing notification to the user via the thermostat fault light (if present). e. In the unlikely event any faults should occur, the unit control board will store the faults in its internal memory. The LCD display will scroll the 5 MOST critical faults, however, all fault messages can be extracted via USB device, displayed real-time via the

MAP Gateway as well as be broadcasted through a BAS system (if applicable). The UCB will provide fault messages in plain English to ensure the user can easily understand the specific fault.

- .10 Provide dry contact on each compressor that can be used to report failure alarm back to the DDC system.

2.7 Schedule

- .1 Scheduled characteristics govern where they conflict with the general descriptions herein.

PART 3 Execution

- .1 Install in full accordance with Manufacturers requirements.
- .2 Locate condensing units as indicated on drawings, including service access spacing as required by manufacturer. Adjust and level condensing unit on supporting structure.
- .3 Provide and install all auxiliary devices and accessories for fully operational condensing units.
- .4 Coordinate electrical requirements and connections for all power feeds with Electrical Contractor.
- .5 Coordinate all control requirements and connections with Controls Contractor.

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 Bearings and seals.
 - .2 Addresses of suppliers.
 - .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.

Part 2 Products

2.1 General

- .1 Comply with ASHRAE 84.

2.2 Enthalpy Type Air To Air Heat Exchanger

- .1 Refer to schedules.
- .2 The energy recovery component shall be of fixed-plate cross-flow construction, with no moving parts.
- .3 The unit case shall be constructed of G90 galvanized, 20-gauge steel, with lapped corners and zinc plated screw fasteners.
- .4 Access doors shall provide easy access to blowers, ERV cores, and filters. Doors shall have an airtight compression seal using closed cell foam gaskets. Pressure taps, with captive plugs, shall be provided allowing cross-core pressure measurement allowing for accurate airflow measurement.
- .5 Case walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high-density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with minimum R-value of 4.3 (hr·ft²·°F/BTU).
- .6 The ERV cores shall be protected by a MERV-8 rated, 2" nominal, pleated, disposable filter in both airstreams.
- .7 Unit shall have single-point power connection and a single-point 24 VAC contactor control connection.
- .8 Blower motors shall be Premium Efficiency, EISA compliant for energy efficiency. The blower motors shall be totally enclosed (TEFC) and be shall be supplied with factory installed motor starters. Direct drive models shall be EISA-compliant for energy efficiency with open drip proof design and integral thermal protection.
- .9 Blowers shall be quiet running, forward curve type and be either direct drive or belt drive. Belt drive motors shall be provided with adjustable pulleys and motor mounts allowing for blower speed adjustment, proper motor The unit electrical box shall include a factory installed, non-fused disconnect switch and a 24 VAC, Class II transformer/relay package.
- .10 The ERV shall be provided "inverter-ready" allowing for applications of inverters supplied and installed by others.
- .11 Performance characteristics: as scheduled.

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.

OF SECTION

Part 1 General

1.1 References

- .1 American National Standards Institute/Air-Conditioning, Heating and Refrigeration Institute (ANSI/AHRI)
 - .1 ANSI/AHRI 430, Performance Rating of Central Station Air-Handling Units.
- .2 American National Standards Institute/American Society of Heating, Refrigeration and Air Condition Engineers/Illuminating Engineering Society (ANSI/ASHRAE/IES)
 - .1 ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
 - .2 ANSI/ASHRAE/IES 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 Green Seal (GS)
 - .1 GS-11, Standard for Paints and Coatings.
 - .2 GS-36, Standard for Adhesives for Commercial Use.
- .4 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - [current edition].
 - .1 MPI #18.
- .5 South Coast Air Quality Management District (SCAQMD)
 - .1 SCAQMD Rule 1113, Architectural Coatings.
 - .2 SCAQMD Rule 1168, Adhesives and Sealants.

1.2 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for [insulation, filters, adhesives, and paints] and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings: fan, fan curves showing point of operation, motor drive, filters, mixing box, dampers, heating and cooling sections; include performance data.

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 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Provide 1 spare set of filters.
- .3 Provide list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing or replacing, for placement into operating manual.
- .4 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply 1 complete set of filters for each filter unit or filter bank.

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.

Part 2 Products

2.1 General

- .1 Indirect fired heat vent unit designed for indoor installation. The capacity and configuration shall be as detailed on the drawings. The unit shall be ETL certified and listed to be in compliance with the current ANSI Z83.8 second edition; CSA/CGA 2.6-2002; Addenda A-2003; Addenda B-2004.
- .2 The burners, gas train and controls are to be in accordance with ANSI, FM, and IRI requirements. Both burner and blower shall be compensated for altitude of operation.
- .3 The unit is to be completely factory test fired to verify proper operation. The unit capacity is to be validated with an instantaneous flow meter. A complete electrical circuit analysis is to be conducted and all systems operated and measured. A combustion analyzer is to be employed while unit is operating at full capacity to verify combustion emissions. Burner combustion must be clean and odorless and no aliphatic aldehyde's are to be detectable. Combustion efficiency is to be at least 80% while maintaining clean emissions. Factory assembled components to form unit[s] supplying air at designed conditions, as indicated.
- .4 Horizontal type, as indicated, having air tight modular components, consisting of casing, fan section with motor and drive, filter section, dampers, indirect gas fired heating section, direct expansion cooling coil, mixing box.

2.2 Casings

- .1 Unit construction is to be of industrial quality heavy gauge bonderized steel. The unit design shall incorporate a full base pan supported by an integral heavy base.
- .2 To ensure the casings are airtight and weatherproof, all panels are to be caulked during assembly. All casings are to be hand fitted and secured with gasketed self-tapping screws. Roof casing are to feature three-break standing seam panel design.
- .3 Entire unit casing and accessories are to be insulated with fiberglass insulation with hard neoprene facing. (1 or 2 in. thick 1-1/2# or 2# density) insulation is to be secured with industrial glue and welded pin spots. Insulation is to be certified to fire and flamespread ratings as outlined by the ANSI code. The entire floor of the unit is to feature a steel liner sandwiching the insulation.
- .4 Units are to be equipped with access doors to all serviceable components. Access doors are to have full-length stainless steel piano hinges. All access doors are to be equipped with an insulation liner, positive seal latches and gasketing . Access doors are to open outward on negative pressure sections and inward on positive pressure sections. Access doors to feature 6 in. handles with locking roller mechanism for ease of latching. All outdoor unit access doors are to be equipped with drain troughs.
- .5 Units are to be finished with an industrial grade chain stop alkyd enamel paint. The medium grey finish coat is to be a minimum of 3 mils thick and provide 100% coverage.

2.3 Acoustic Liner

- .1 Ensure that expanded polystyrene and polyurethane insulation materials were not produced with ozone depleting substances.
- .2 Insulate internal surface of panels with 50 mm neoprene coated rigid duct liner of 72 kg/m³ density.

2.4 Drain Pans

- .1 Construction: non-ferrous, rounded corners.
- .2 Insulation: external foam type, minimum 13 mm thick.
- .3 Drain connection: in bottom at low point.
- .4 Installation: slope without sag minimum 1% to ensure no standing water at any time or at any point.
- .5 Dimensions: minimum 75 mm from upstream face of coil to 150 mm beyond downstream face of coil or eliminator and to include return bends and headers.

2.5 Fans

- .1 Unit shall be supplied with a single AMCA rated centrifugal forward curved industrial statically and dynamically balanced blower. The fan shall be mounted on a heavy duty machined and polished shaft. The shafts maximum operating speed is not to exceed 75% of its first critical speed. The bearings and motor

shall be mounted in the airstream. The T-frame motor shall be mounted in a motor compartment on a fully adjustable base. The bearings are to be industrial pillow block type supplied with extended grease lines. The blower is to be driven with an adjustable V-belt drive package concealed in a belt guard.

2.6 Vibration Isolation

- .1 Flexible connections at inlet and outlet of fan: to Section 23 33 00 - Air Duct Accessories.
- .2 Vibration isolators on fan section.

2.7 Variable Volume Devices

- .1 Supply fan to be equipped from factory with variable speed drives

2.8 Furnace Section

- .1 The furnace section shall be positioned downstream of the blower section to ensure it is operating in a positive pressure chamber. The furnace is to be constructed of minimum 16 gauge heavy duty 409 stainless steel tubes. The furnace shall include heavy duty in shot burners.
- .2 The furnace section will operate under a negative pressure as induced by the power venter. The power venter will be two speed to provide optimum combustion and efficiency levels on reduced capacities. The power vent shall come standard with a blocked flue switch, and the burner equipped with a flame roll out switch. A modulating electro-mechanical valve will reduce gas flow in response to the signal from the unit mounted PLC. The modulation will allow reduction of capacity down to 1/6 of high fire per furnace.
- .3 Indoor units shall be suitable for sidewall venting, and shall come with optional sealed combustion kit.

2.9 Filter

- .1 Material to match casing. For flat type filter
 - .1 Provide access to filter through hinged door with suitable hardware.
- .2 Provide blank-off plates and gaskets to prevent air bypass.
- .3 Filters:
 - .1 Minimum Efficiency Reporting Value (MERV) value 8 filtration media [to ANSI/ASHRAE 52.2, to be used on return air section of air handling unit.
 - .2 Immediately prior to occupancy, replace filtration media with new filtration media with Minimum Efficiency Reporting Value (MERV) of 10 in accordance with ANSI/ASHRAE 52.2.

2.10 Mixing Box

- .1 Material to match casing and produce uniformly mixed air temperature within plus or minus 5 degrees C of design across face of outlet.

- .2 Provide dampers on return and on outside air connections. Ensure outside air damper is insulated and thermally broken.

2.11 Cooling Coil

- .1 Direct expansion refrigerant coils:
 - .1 Serpentine type, arranged to prevent trapping of oil.
 - .1 Liquid distributors to ensure even distribution of liquid refrigerant to all circuits.
 - .2 Silver solder or braze joints in refrigerant tubing.
 - .3 Evacuate and charge coil with nitrogen and seal before sending to site.
 - .2 Tubes: copper.
 - .3 Fins: Aluminum.
 - .4 Headers: copper.
 - .5 Pressure tests: to Canadian Refrigeration Code. Dehydrated. Sealed with nitrogen charge.

2.12 Control/Manifold Compartment

- .1 Unit control enclosure to have hinged access. Terminal strip and all wiring shall be numbered. The controls for the heater shall include;
 - .1 Blower motor starter w/ambient compensated overloads and auxiliary contact.
 - .2 Primary to 120v control transformer
 - .3 6000 volt ignition transformer
 - .4 Control circuit breaker and service switch
 - .5 Manual reset temperature high limit
 - .6 Flame safe guard circuit
 - .7 Discharge temperature control sensor
 - .8 Differential air proving safety switch
- .2 All wiring external to control enclosure shall be run in conduit. The gas manifold shall include;
 - .1 Main gas pressure regulator
 - .2 Manual shutoff & test firing valve
 - .3 Main gas automatic shutoff valve
 - .4 Auxiliary main gas automatic shutoff valve
 - .5 Modulating control system
 - .6 Pilot pressure regulator
 - .7 Pilot automatic shutoff valve
 - .8 Pilot manual shutoff valve
 - .9 Pilot needle valve
 - .10 Multiple test ports.

Part 3 Execution

3.1 General

- .1 Install air handling units, including components and controls required for operation, in accordance with air handling unit manufacturer's written instructions and recommendations.
- .2 Access clearance: Install AHU's with sufficient access space around each AHU to meet manufacturer's recommended clearances for regular service access, coil pull and fan removal. As a minimum, this clearance shall equal to the width of the AHU on one side.
- .3 Install one complete set of filters for testing, balancing and commissioning. Install second complete set of filters at time of transfer to Owner.
- .4 Install AHU's plumb and level, to ensure free draining and venting through the manufacturer-provided vent and drain on each coil. Follow manufacturer labels for inlet and outlet of coil headers to ensure proper direction of coil fluid flow.
- .5 Install units on a level surface that has sufficient strength to support the units.
- .6 Thoroughly seal penetrations to ensure water tightness.
- .7 Install flexible connections at fan inlets and outlets:
 - .1 Ensure metal bands of connectors are parallel and not touching when fan is running and when fan is stopped.
 - .2 Ensure that fan outlet and duct are aligned when fan is running.
- .8 Provide deep seal P-traps and trap seal primer on drain connections in accordance with the manufacturer's recommendations. Depth of water seal to be not less than 1.5 times the static pressure at the drain location. Connect all drains and pipe to nearest building drain.
- .9 Provide certified wiring schematics to the electrical division for the equipment and controls.
- .10 Provide all necessary control wiring as recommended by the manufacturer.
- .11 Provide motor sheaves and belts required for final air balance.

3.2 Field Quality Control

- .1 Store per AHU's manufacturer's written recommendations. Store indoors in a warm, clean, dry place where the units will be protected from weather, construction traffic, dirt, dust, water and moisture. If units will sit idle for more than 6 months, obtain written recommendations from the manufacturer for long-term storage. Follow these recommendations to ensure warranty coverage.
- .2 Follow manufacturer's written instructions for rigging, off-loading, and use of rigging tools such as spreader bars, forklifts, come-a-longs, and shackles.

3.3 Ahu Inspection

- .1 Hire the manufacturer's factory-trained and factory-employed service technician to perform an inspection of the AHU's and the AHU installations prior to proceeding with fan assembly inspection and start-up. Technician shall inspect and verify the following as a minimum:
 - .1 Damage of any kind.
 - .2 Level installation of the AHU.
 - .3 Proper reassembly and sealing of unit segments at shipping splits (if applicable).
 - .4 Installation of shipped-loose parts, including filters, air hoods, bird screens and mist eliminators.
 - .5 Proper electrical, ductwork and piping connections.
 - .6 Tight seals around wiring, conduit and piping penetrations through AHU casing.
 - .7 Supply of electricity from the building's permanent source.
 - .8 Integrity of condensate trap for positive or negative pressure operation.
 - .9 Condensate traps charged with water.
 - .10 Removal of shipping bolts and shipping restraints.
 - .11 Tightness and full motion range of damper linkages (operate manually).
 - .12 Complete installation of control system including end devices and wiring.
 - .13 Cleanliness of AHU interior and connecting ductwork.
 - .14 Proper service and access clearances.
 - .15 Proper installation of filters.
 - .16 Filter gauges properly calibrated.
- .2 Resolve any non-compliant items prior to authorizing manufacturer to proceed with the inspection of the fan assembly.

3.4 Inspection And Adjustment: Ahu Fan Assembly

- .1 Hire the manufacturer's factory-trained and factory-employed service technician perform an inspection of each AHU fan assembly prior to startup. Technician shall inspect and verify the following as a minimum:
 - .1 Fan isolation base and thrust restraint alignment.
 - .2 Tight set screws on pulleys, bearings and fan.
 - .3 Tight fan bearing bolts.
 - .4 Tight fan and motor sheaves.
 - .5 Tight motor base and mounting bolts.
 - .6 Blower wheel tight and aligned to fan shaft.
 - .7 Sheave alignment and belt tension.
 - .8 Fan discharge alignment with discharge opening.
 - .9 Fan bearing lubrication.
 - .10 Free rotation of moving components (rotate manually).

- .2 Should any of the above need adjustment, hire manufacturer to perform the necessary adjustments to return the items to within factory specifications.

3.5 Startup Service

- .1 Hire the manufacturer's factory-trained and factory-employed service technician to startup AHU's. Technician shall perform the following steps as a minimum:
 - .1 Energize the unit disconnect switch.
 - .2 Verify correct voltage, phases and cycles.
 - .3 Energize fan motor briefly ("bump") and verify correct direction of rotation.
 - .4 Re-check damper operation; verify that unit will not operate without both an inlet and an outlet damper open.
 - .5 Energize fan motors and verify that motor FLA is within manufacturer's tolerance of nameplate FLA for each phase.
- .2 If AHU is provided with a variable frequency drive (VFD), the VFD manufacturer's factory-trained and factory-employed service technician shall inspect, test, adjust, program and start the VFD. Ensure that critical resonant frequencies are programmed as 'skip frequencies' in the VFD controller.
- .3 Coordinate startup of AHU's, controls and VFD's with representative personnel from each supplier.
- .4 Submit a startup report summarizing findings and activities performed.

3.6 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.

3.7 Fans

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

3.8 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

1.1 General

- .1 All drawings and all sections of the specifications shall apply to and form an integral part of this section. Refer to Section 22 05 00 Common Work Results For Plumbing and 23 05 00 Common Work Results For HVAC.
- .2 Wherever words "shall be capable of" appear in specifications, interpret as meaning that; where feature or performance referred to is being applied, that feature or performance shall be provided. Where feature or performance is not applied now, but will be applied in future (i.e. Card Access Control), system shall be provided with all necessary central hardware and software required to support that feature or performance, with only addition of field hardware being required at that future time.

1.2 Work Included

- .1 Include complete system of temperature control and temperature indication as manufactured and installed by the existing controls at the facility, Honeywell. Control components to be installed by trained control mechanics, regularly employed by Division 25.
- .2 Include complete system of Central Control & Monitoring System (C.C.M.S.) hardware and software as manufactured and installed by Honeywell. Components and interconnecting systems to be installed by trained control mechanics, regularly employed by Division 25.
- .3 Refer to Section 25 30 10 Controls/Instrumentation - Sequences of Operation.
- .4 Refer to drawings, detail sheets and individual clauses in this section for points to be connected to C.C.M.S. All points connected to D.D.C. control panels shall be connected to C.C.M.S.

1.3 Work By Other Sections And Divisions

- .1 Divisions 22 & 23 to distribute and mount all pipe connected equipment including valves, immersion controllers, thermometers, humidifiers, orifice flanges, flow switches etc. in their respective locations, as supervised by Division 25.
- .2 Division 23 to distribute and mount all motorized dampers, air measuring stations, etc. in their respective locations, as supervised by Division 25.
- .3 Division 23 shall provide additional galv. iron baffles as required at all mixed air plenums to ensure good air mix so controllers can function properly. Division 25 shall assist Division 23 in establishing locations of such baffles.

1.4 Licensing

- .1 Contractor to include additional licensing for Brandon Research Centre based on number of added points.

1.5 Existing Building System

- .1 During tender period visit jobsite to review section of existing controls and C.C.M.S. relating to the new installation.
- .2 Co-ordinate new installation with existing system. Make revisions to existing controls and C.C.M.S. as noted on drawings and/or in specifications.

1.6 Interconnection With Central Control And Monitoring System (C.C.M.S.)

- .1 BRC has installed C.C.M.S.
- .2 Connect new system to existing CCMS as follows:
 - .1 Provide the required BNA's, LON Routers, Terminal Servers etc. which will connect to the new CCMS network switch.
- .3 All input, output, pseudo points for D.D.C. panels shall be monitored by C.C.M.S. Provide all D.D.C. panel and C.C.M.S. software revisions and/or modifications to complete the C.C.M.S. connection.
- .4 System programming shall include following provisions:
 - .1 Analog alarm limits on all analog sensing points (high and low where applicable). All alarm points shall have enable/disable capability.
 - .2 Sliding limits where set point moves in controlled manner.
 - .3 Current set point provided as C.C.M.S. point.
 - .4 Keyname listing as indicated on detail sheets.
- .5 Provide colour graphics for all systems as described herein. This to include schematic diagram of system along with point information and keyname.
- .6 This section shall provide all necessary software to incorporate points listed in input/output schedules connected to D.D.C. control panels into C.C.M.S. This shall include, but not be limited to, following:
 - .1 All software and or software revisions for DDC panels.
 - .2 All software and/or software revisions for C.C.M.S. including servers and workstations.
- .7 Update all C.C.M.S. drawings and documentation.
- .8 Division 25 shall provide all data entry information and programming revisions or modifications as to the C.C.M.S. and DDC panels.

1.7 Ccms Graphics Colour Schedule

- .1 Domestic Hot & Cold Water Systems - Lime Green
- .2 Heating & Radiant Panel Systems - Light Blue

- .3 Fan Systems - Green
- .4 Dampers - Green
- .5 Filters - Yellow
- .6 Cooling Coils - Dark Blue
- .7 Domestic Water Pumps (Hot or Cold) - Lime Green

1.8 Operating Instructions And As-Built Information

- .1 Operating instructions shall be provided in accordance with Section 01 77 00 and shall include schematic drawings of all control systems including control sequence write-up.
- .2 Provide six hard cover copies of complete information pertaining to temperature control system and C.C.M.S. for the Owner's permanent record. This to include following:
 - .1 As-built schematic control diagrams with complete control sequence write-up.
 - .2 Operator's manual including maintenance instructions.
 - .3 Engineering data and data product sheets.
 - .4 Parts list of all components including repair instructions.
 - .5 Suggested spare parts list.
- .3 Provide one electronic copy which has AutoCAD .DWG files for as-built control drawings, sequence of operation for all systems, CCMS network wiring, DDC panel programming backups, and Controller Data file calibration info, etc.
- .4 In addition, each mechanical room shall have respective control diagrams, control sequence and equipment model numbers, and input/output points, parameters, alarm lists, etc. installed in panel in securely fastened plastic pouches.
- .5 Provide DDC operator's manual, details of all functions, operator interaction with system c/w examples. Manual shall be written by professional technical writers. Provide operator's pocket guides for quick reference on day-to-day routine operations.
 - .1 Include electronic copy of DDC panel programming.
 - .2 Include copy of as-built field control drawings.
 - .3 Include data file programming sheets for AI, AO, DI, and DO.
 - .4 Include alarm lists with alarm set points.
 - .5 Provide plastic pouch on back of DDC field panel door and include:
 - .1 One copy of as-built drawings
 - .2 Revised list of input/output points
 - .3 List of alarm messages applicable to controller

1.9 Service And Warranty

- .1 Upon completion of the installation, all thermostats, control valves, and all C.C.M.S. components and other equipment shall be adjusted as required to place system in complete operating condition subject to Departmental Representative's approval. All adjustments shall be made in collaboration with the field engineer responsible for balancing air and water system. Ensure that safety controls have been wired in series with both "HAND" and "AUTO" starter switch positions.
- .2 If within one year from date of completion as interpreted by Departmental Representative, any of equipment herein described is proven to be defective in workmanship or materials, it shall be replaced or repaired free of charge to BRC.
- .3 After installation completion, provide any service incidental to proper performance of control system under guarantees outlined above for guarantee period. Normal maintenance of system or adjustment of components is not to be considered part of guarantee.

1.10 Equipment Room Signage

- .1 Within equipment rooms, provide signage inside of door stating "Equipment under automatic control. Will start without warning."

1.11 Identification Of Equipment - General

- .1 Provide identification plastized "luggage tag" for field devices (not local thermostats) which are part of control systems.
- .2 All manual switches, unless they come with standard nameplates, shall be labelled with lamacoid.
- .3 Equipment installed on surface of local panels shall be labelled with lamacoid identification plates.
- .4 Equipment mounted inside local panels, must have permanent labels 13mm white with black lettering. i.e. P-Touch labels.
- .5 Lamacoid plates shall be black background with minimum 5mm high white letters, unless specified otherwise.
- .6 Lamacoids shall be of size to accommodate lettering.
- .7 Fasten lamacoid identification plates with rivets or self-tapping screws. Locate adjacent to device if there is not adequate space.
 - .1 Plastized "Luggage Tag" to list:
 - .1 Point Keyname
 - .2 Point Technical Address
 - .3 Point Type
 - .4 Point Description
 - .5 Device Part Number

- .8 In general, information on lamacoid identification plates and plastized "luggage tag" to be consistent with "as-built" control drawings.
- .9 Prior to lamacoid and plastized "luggage tag" fabrication, submit copies of control drawings and complete list of proposed wording for each lamacoid and plastized "luggage tag", for approval by Departmental Representative and BRC Include copy of approved lamacoid and plastized "luggage tag" list in each Maintenance/Operating Manual.
- .10 Electrical systems identification to be as described in Division 26.

1.12 Identification Of D.D.C. Panels

- .1 Provide lamacoid nameplates to identify following:
 - .1 Controller address.
 - .2 Controller name.
- .2 Fasten nameplates with rivets or self-tapping screws to exterior of DDC Panel door.
- .3 Refer to subsection "Identification of Equipment - General", and comply with all requirements related to lamacoid nameplates.

1.13 Control Valve And Vav Access Identification

- .1 Points of access to radiant panel reheat coil, and VAV box control valves shall be identified with 13mm white with black lettering. i.e. P-Touch labels fastened either onto ceiling T-bar grid or onto access door.
- .2 Label shall state:
 - .1 "RAD. HTG. PANEL"
 - .2 "HTG. COIL HC- (STATE NO.)"
 - .3 "VAV" BOX - (STATE NO.)

1.14 Instrument Mounting

- .1 Mount transmitters and sensing elements on pipe work at location where temperature is to be sensed. Care shall be taken to prevent breaking of insulation barrier and where practicable instruments shall be stood off on sheet metal brackets to allow installation of insulation behind instrument. Pipe wells as required shall be furnished to Sections 22 40 10, 22 40 20 and Section 23 70 10 for installation at appropriate sensing points in pipe work. Void between inside of well and outside of sensing bulb shall be filled with heat transmission grease.
- .2 Provide at each system or groups of systems, a cabinet type metal control panel with all instruments mounted inside locking cover. All panels shall have same key. Temperature indication and control point adjustments and gauges labelled as to function with lamacoid nametags fixed to panel face with self-tapping screws. All electrical equipment mounted in cabinet to be pre-wired to labelled terminal strips.

Mount panels in Electrical/Mechanical rooms at 44" above floor level upon BRC approved locations.

END OF SECTION

1.1 General

- .1 All drawings and all sections of the specifications shall apply to and form an integral part of this section. Refer to Section 22 05 00 Common Work Results For Plumbing and 23 05 00 Common Work Results For HVAC.

1.2 Work Included

- .1 Include complete system of temperature control and temperature indication as manufactured and installed by Honeywell. Control components to be installed by trained control mechanics, regularly employed by Division 25.

1.3 Low Temperature Cutouts

- .1 Provide on coils or where noted, low temperature cutouts with 6096mm temperature sensitive elements wound across downstream face of coil. Wire into "HAND" and "AUTO" positions of fan starter switch circuits, or if there is none, wire into local fan circuit such that, when any 305mm section of element senses temperature below +2 deg.C, supply fan to de-energize and O.A. dampers to close. All wiring to be home run to panel to facilitate checkout. Do not use series connections with other devices.
- .2 All air systems introducing O.A. shall have a low temperature cut-out switch. If a system does not have a steam or water coil ahead of the supply fan, the safety control can be located on leaving side of fan.
- .3 Cut-outs must have manual reset unless noted otherwise.
- .4 Provide extra alarm contact to be used for C.C.M.S.
- .5 Provide dry alarm contact and pilot light indication to indicate low temp. trip condition after time delay has timed out for future connection to C.C.M.S.

1.4 Miscellaneous Devices

- .1 Provide necessary relays, cumulators, three-way air valves, positioners, pneumatic electric switches, three-way solenoid valves, two-way and three-way air switches, clocks, transformers, etc. to make a complete and operable system.
- .2 Locate in local panels, unless noted otherwise.

1.5 Local Alarm Sequence

- .1 Where reference is made to alarm annunciation in any operation sequences at remote location unless otherwise noted, provide equipment to accomplish following sequence for each point annunciated.
 - .1 Alarm condition - audible on, corresponding visual on steady.
 - .2 Silence - audible off, visual on steady.
 - .3 Normal - audible off, visual off.

- .4 Test - audible on, visual on steady.
- .2 Each subsequent alarm condition shall cause a repeated sequence as detailed above whether or not previous alarm condition has been acknowledged.

1.6 Control Dampers

- .1 Provide all control dampers of type and sizes indicated. All outside, exhaust and relief control dampers to be opposed blade low leakage dampers. Frames to be heavy gauge galv. steel formed for extra strength with mounting holes for flange and enclosed duct mounting. Dampers available in 50mm size increments from 203mm horizontal and vertical to 1219mm. Requirements over 1219mm to be standard modules with interconnecting hardware. 1.6mm damper blades, galv. steel, roll formed for high velocity performance. Blades must be not over 203mm wide; blade seals and spring loaded stainless side seals. Dampers and seals to be suitable for temperature ranges of -40 deg.C to 100 deg.C. Leakage shall not exceed 1% with approach velocity of 457.2M/min. when damper is closed against 100mm of water.
- .2 Linkage hardware to be readily accessible for maintenance after installation.
- .3 Where dampers are required to be assembled from multiple sections, each section shall be driven by an independent operator, with no single operator driving a damper section having a surface area greater than 2.5 sq.m. Dampers greater than 1.2m wide shall have motor at each end of damper.
- .4 Vortex dampers for fans are supplied by fan manufacturer.

1.7 Damper Operators

- .1 Electric:
 - .1 Electric proportional or two position type as required, with adjustable forward and return stops, aluminum housing and spring return.
 - .2 Operators mounted outside shall be complete with internal heater.
 - .3 Valve operators shall be of type to withstand temperatures likely to be encountered in application.
- .2 Size operators to guarantee component operation under maximum load. No damper operator shall be required to drive more than 2.5 sq. m. of damper.

1.8 Reset Timers

- .1 Driven by timing motor connected to independent circuit from load being controlled. Motor shall be suitable for operation on 120V AC, 60 Hz. power.
- .2 Timer shall have 0 - 6 hour range complete with 6 min. graduations on dial face. Timer shall have 'hold' position eliminated.
- .3 Contacts shall be S.P.D.T. rated at 120 Volts, 10 Amps, complete with independent N.O. connection for timer motor.

- .4 Timers shall be suitable for panel or surface mounting to suit application.
- .5 Final location of reset timers shall be approved by Departmental Representative prior to installation.
- .6 Reset timers may be mounted remote from system equipment being controlled.

1.9 Sensors

.1 General:

- .1 All temperature, R.H., pressure, etc. sensors shall be corrosively resistant with all internal parts assembled in watertight, shockproof, vibration proof, heat resistant assembly.
- .2 All sensors shall be installed in strict accordance with manufacturer's recommendations.
- .3 All motor (fans, compressors, pumps, etc.) operating status shall be obtained by using current sensing relays as described herein. Auxiliary contacts in magnetic starters shall not be used to obtain motor status. Where CSR is not possible, provide flow sensing device approved by Departmental Representative.
- .4 All temperature, R.H., pressure, etc. sensors shall be electronic type. Pneumatic sensors shall not be acceptable.

.2 Temperature Sensors:

- .1 Temp. sensors shall be precision elements with sensing to readout accurately of ± 0.5 C over entire range of element.
- .2 Temp. element range shall be -40 deg.C to 60 deg.C or 40 deg.C to 120 deg.C as required by particular temperature being sensed.
- .3 Duct mounted sensors shall be point type for use in return air systems and shall be averaging type for all other duct locations. Averaged sensors shall be of sufficient length to accurately determine correct average temperature.
- .4 Room sensors shall be wall mounted with vented cover, back box and tamper proof screws.
- .5 O.A. sensors shall be c/w weatherproof enclosure and sun shield. Mount sensors on north side of building minimum 2.4m above grade; Locate away from exhaust air outlets. Do not locate in building areaways where there is adequate ventilation.

.3 Relative Humidity Sensors:

- .1 R.H. elements shall be precision type with sensing to readout accuracy of $\pm 1\%$ R.H. over entire range of element.
- .2 R.H. elements shall be 5% R.H. to 90% R.H.
- .3 Duct mounted sensors shall have stainless steel sheath construction complete with integral shroud. Sensor shall be located in approximate centre of duct. Mount return air sensors on positive side of return fan.

- .4 Room R.H. sensors shall be wall mounted with vented cover, back box, and tamper proof screws.
- .5 Sensors located outdoors shall be c/w non-corroding outdoor shield and sun shield.
- .4 Analog Differential Pressure:
 - .1 Internal materials to be suitable for continuous contact with the process material measured including compressed air, water, glycol, or steam as applicable.
 - .2 Output variation of less than 0.2% full scale for supply voltage variations of +/- 10%.
 - .3 Combined non-linearity repeatability and hysteresis effects not to exceed +/- 0.5% of full scale output over entire range.
 - .4 Over-pressure input protection to a minimum of twice rated input.
 - .5 Differential pressure ranges shall be +/- 0.25, +/- 0.50, or +/- 1.0 as required to suit flow conditions.
 - .6 Provide isolation valves between sensor and fluid line.
 - .7 Steam flow shall be sensed using orifice plates. Provide differential pressure transducer and all necessary devices to ensure proper operation with the C.C.M.S.
 - .8 Standard of Acceptance: Static Pressure - SETRA C-264 Steam - Honeywell 411.
- .5 Binary Differential Pressure:
 - .1 Pressure or differential pressure switches shall have ranges and rating applicable to pump and fan application as required.
 - .2 Pressure sensing elements shall be Bourdon tube, bellows, or diaphragm type.
 - .3 Adjustable set point and differential.
 - .4 Pressure switches shall be snap action type rated at 120 Volts, 15 Amps AC or 24 Volts DC.
 - .5 Sensor assembly shall operate automatically and reset automatically when condition returns to normal.
 - .6 All sensor shall have an isolation valve installed between the sensor and pressure source.
 - .7 Generally, current sensing relays shall be used for sensing fan, compressor, and pump operating status, unless specifically indicated, otherwise. In applications where use of binary differential pressure switch is specifically noted, obtain operating status of fan, compressors, or pump directly from binary differential pressure switch. Do not use auxilliary contacts in magnetic starters.
- .6 Relays:
 - .1 DPDT relay with coils rated for 120V AC or 24V DC as required.
 - .2 Contacts rated at 5 Amps at 120V AC.
 - .3 Relays to be plug in type with termination base.

- .7 Pressure to Electric Transducers:
 - .1 Internal materials of transducer suitable for continuous contact with industrial standard instrument air or as applicable.
 - .2 Output variations of less than 0.2% full scale for supply voltage variations of +/- 10%.
 - .3 Combined non-linearity, repeatability and hysteresis effects not to exceed +/- 0.5% of full scale output over entire range.
 - .4 Integral zero and span adjustment.
 - .5 Output short circuit and open circuit protection.
 - .6 Over-pressure input protection to minimum of twice rated input.
- .8 Electric to Pressure Transducers:
 - .1 Input range as suitable for interfacing with C.C.M.S.
 - .2 Directly proportioned output range of 20 - 104 kPa.
 - .3 Panel mounted.
 - .4 Internal materials of converter suitable for continuous contact with industrial standard instrument air or as applicable.
 - .5 Combined non-linearity, repeatability and hysteresis effects not to exceed +/- 2% of full scale over the entire range.
 - .6 Integral, accessible zero and span adjustment.
- .9 Watt Meters:
 - .1 Meter installed by Division 26 shall be complete with 'pulse initiators'. This Section shall provide necessary internal devices to ensure proper metering of normal and emergency power sources.
- .10 Current Sensing Transmitter:
 - .1 Transmitter solid core current sensing transmitter capable of sensing 0.1 to 200 Amp range, with 4-20ma output.
 - .2 Accuracy to be +/- 1% of full scale
 - .3 Response is 100 ms over 0-90% range
 - .4 Current sensing transmitters shall be used for sensing fan, compressor, and pump operating status, as per sequence of operation for system.

1.10 "Failsafe" Hardware Interlocks

- .1 To prevent damage to systems, provide all necessary hardware interlock components (E/P relays, current sensing relays, differential pressure switches, etc.) to ensure 100% "failsafe" operation of final control elements. (eg. damper actuators, valve actuators, vortex actuators, etc.).
- .2 Prior to system operation, field calibrate all hardware interlock components. Then field simulate various failures and verify actual "failsafe" operation. For example, current sensing relays shall be field calibrated for correct output and then field verified in both belt/coupling disconnected and connected modes.

1.11 Direct Digital Control System (General)

- .1 DDC panels shall be factory wired and tested. Encoding and decoding equipment shall be of printed circuit board construction.
- .2 Each DDC panel shall be capable of accepting an additional average of 25% spare point capacity for future use. This may be averaged over a mechanical room (i.e. 15% binary, 10% analog).
- .3 Design panel such that in case of localized trouble, panel can be isolated from system for testing and repairs without effecting normal operation of total system.
- .4 Locations of DDC panels shall be approved by Departmental Representative and HSC representative prior to installation.
- .5 DDC panel shall be capable of handling multiple systems with ability to have at least two different and not necessarily sequential systems assigned to one DDC panel.
- .6 On power failure at DDC panel, each panel shall run through power failure routine so that no data will be lost either remotely or centrally. After power failure, each affected start/stop fan or motor to remain OFF until automatic power fail restart programme starts. Power failure at one building shall not interrupt operation of remainder of system.
- .7 DDC panels shall be individually fused for input power and separately fused for all control voltages.

1.12 Ddc Software Application - General

- .1 Implement following control strategies and techniques within the DDC software developed for all systems controlled by DDC controllers. Control set-points shall be as described in individual system sequences of operation specified in this section. Where local indication manual adjustments are specified, they shall be obtained and/or adjusted utilizing the operator's terminal specified in clause 'Direct Digital Control System'.
- .2 Ramp functions - where control loops are subject to rapid load changes (i.e. supply fan volume control on system start-up, O.A. damper control on system start-up, mixed air and discharge air temperature control when systems are manually switched to 100% O.A. mode of operation, etc.). Ramp functions shall be implemented to prevent system overshoot, cycling and nuisance tripping of low limit protection devices.
- .3 Reset Schedules - Where control loops have reset schedules associated with them, (i.e. hot water supply temperature reset based on O.A. temperature) high and low temperature alarm indication shall also be on a sliding schedule. As an example: If alarm limits are set at +/- 2 deg.C from setpoint, an alarm will be generated only if the sensed temperature is above or below the present set point by 2 deg.C (i.e. if present setpoint is 85 deg.C then the alarm limits are 83 deg.C and 87 deg.C). Indication available to the operator shall include, low end point of

reset schedule, high end point of reset schedule, present setpoint, present high and low alarm limits and sensed temperatures.

- .4 Control Loops - All control loops shall have PID (Proportional - Integral - Derivative) control. System operator shall have capability of adjusting proportional, integral and derivative functions independently through software parameter adjustment.
- .5 All start/stop points with an associated status point shall alarm after delay on a failure at CCMS.

1.13 Excel 800 Controller Hardware/Software

.1 DIGITAL CONTROLLER Hardware

- .1 Digital Plant Control Processors (PCPs) shall be 16 bit microprocessor types with EPROM OS and EEPROM or flash memory for all data file and control programs. PCPs shall have internal real-time clocks with 30 day battery backup power.
- .2 PCPs shall be provided where shown or specified with capacity to accommodate input/output (I/O) points required for the application plus spare points specified. These panels shall be configured with analog and digital inputs and outputs, and pulse counting totalizers and such that the input, the output and all control logic shall be resident in a single microprocessor to provide stand-alone closed loop DDC. Each panel shall be modular and configured with an array of analog and digital input and output boards to meet the application requirements, including specified spares. Analog outputs shall have a minimum incremental resolution of one percent of the operating range of the controlled device. Each panel shall be provided with a socket for a Portable Operators Terminal (POT).
- .3 PCPs shall have LEDs for continuous indication of power and operational status. PCPs shall also have LEDs to indicate the status of each digital input and each output (analog output LEDs shall be variable intensity). Each output shall have an associated on-off-auto or open-closed-auto switch. All LEDs and switches shall be visible without opening the panel door, but not accessible without opening the panel door.
- .4 All panel electronics shall be installed in suitable enclosures. Equipment room panels shall have hinged doors and shall also contain all load relays, transducers, and associated equipment.

.2 Software

- .1 PCPs shall be provided with energy management and control software as required to meet the detailed sequence of operation specified.

- .2 Optimum Start, Night Cycling and Night Purge for free cooling shall address the unique requirement of each systems Unoccupied Period, which may include one or more of the following as specified:
 - .1 Delay equipment start-up based on outdoor temperature, space temperature, and system response to assure that comfort conditions are reached at scheduled occupancy time (occupancy schedules are defined under time programs), and operate in both heating and cooling cycles. In all cases, the optimum start program shall operate fully stand-alone in the PCP.
 - .2 Night Cycle program shall apply to (heating cycle only) (both heating and cooling cycle) with the outdoor air dampers closed. The space temperature shall be used to determine the "fan on" and/or "supply heat" command to maintain a low limit of 50-55 degrees for the heating cycle and the "fan on" and "supply cooling" command to maintain 82 degrees for the cooling cycle.
 - .3 Night Purge program shall apply to cooling cycle only. Night Purge shall introduce 100% outdoor air any time the outdoor air is above 50 degrees F, the space temperature is above 75 degrees F, the outdoor temperature is below space temperature, and the outdoor air dewpoint is less than 60 degrees. Purging shall stop when outdoor air is below 50 degrees F, or space temperature is below 75 degrees F, or outdoor temperature is less than 5 degrees cooler than space temperature, or outdoor air dewpoint is greater than 60 degrees.
- .3 Provide an economizer cycle changeover program which shall automatically switch each AHUs into the economizer mode based upon a comparison of an outside air (OA) dry bulb temperature to the AHUs respective return air temperature.
- .4 A load reset program shall be provided to assure that only the minimum amount of heating, cooling, and electrical energy is supplied to satisfy zone temperature requirements. The program shall be applicable to hot decks and cold decks. Individual programs are to be provided each sensing the worst case zone requirements and providing only the minimum energy source media to satisfy the need.
- .5 Control Software:
 - .1 Each PCP shall contain up to 20 unique user modifiable time programs (TP).
 - .2 Each TP shall consist of daily, weekly, and annual programs plus a "TODAY" temporary function.
 - .3 DAILY programs shall be definable for day types such as working day, half day, holiday, weekend, etc. Each daily program shall allow a list of time based (or optimum time based) analog and digital commands to be issued to user selected plant elements and points.

- .4 WEEKLY programs shall allow a user selected set of daily programs to be defined for each day of the week (Monday through Sunday).
 - .5 The ANNUAL program shall initially be an automatic compilation of 52 weekly programs. Selecting a date of the ANNUAL program shall allow modification of the daily selection entered into the weekly program (such as changing Dec. 25 from a working day to a holiday).
 - .6 Control Application Software shall be customized strictly to meet the detailed requirements of the "Sequence of Operation" specified hereinafter. PCPs shall be fully programmable. Initial software shall be fully modifiable, and not restricted by vendor's specific configuration guidelines. All PCP control software shall be designed via a graphic programming facility, the detailed graphic design of which shall be provided as system documentation. All control strategies shall be advanced as noted with stabilizing setpoint ramps and procedures to assure slow loading of variable load equipment and economizer modes to prevent unsafe overshoot of controlled pressure and unsafe undershoot of mixed air temperatures during start-up and transition periods.
- .6 Management Software:
- .1 Each PCP shall be provided with a trend archive of at least the last 200 events (digital transitions or analog value changes) of any user selected group of up to 20 points. A stored event shall include date and time, and value or status. Events occurring in excess of 200 shall overwrite the oldest events, except where a modem module is specified, events shall be uploaded to the modem module. Point events shall be displayable on the POT as trend logs for evaluation of control system performance.
 - .2 Each PCP shall monitor all analog input points and specified digital points for off-normal conditions. Each alarm shall have an "alarm delay" attribute which shall determine how long (in seconds) a point must be in an off-normal state prior to being considered in an alarm state. Alarms shall be displayable on the POT.

1.14 XI10 Fan Coil Controller

- .1 Provide a stand alone DDC Fan Coil Controller for common two pipe or four pipe fan coil units featuring preprogrammed heating and cooling control algorithms for single or up to three fan speed applications.
- .2 Controller shall use Echelon LonWorks communication technology for field bus and shall utilize the LonMark Fan Coil Unit (FCU) communication profile for Interoperability with third party LonMark devices in network applications.
- .3 Controllers shall have integral transformers and fan speed relays directly wired to line voltage power 115Vac and 230Vac.

- .4 Controller application software shall include a setpoint reset for energy demand limit control. Separate unoccupied heating and cooling setpoints shall be provided. A standby feature shall be provided to reset the occupied temperature set point back to a user definable limit based on status from an auxiliary device, such as an occupancy sensor or window contact.
- .5 Controller shall include a temperature wall module connection which may be used in any applications where the wall module must: sense temperature, control set point temperature, control OCC/UNOCC control fan speed. In addition to internal I/O selected for the application, controller shall also support distributed I/O from the network.

1.15 Remote Input/Output Controller

- .1 Provide a remote input/output module which connects sensors and actuators onto the Echelon field bus network for use with Zone Manager and Unitary DDC Controllers.
- .2 Zone Manager shall be configured to read and command these points as required or specified.
- .3 I/O Device shall use Echelon LonWorks communication technology for network and controller-to controller communications and shall conform to LonMark specification.
- .4 I/O Device shall have extended operating temperature rating from -40F to +150F so Device can be mounted directly in wiring cabinet of monitored appliances.
- .5 I/O Device shall include a temperature wall module connection which may be used in any applications where the wall module must: sense temperature, control set point temperature, control OCC/UNOCC control fan speed.

1.16 Comfortpoint Ipc Network Controllers

- .1 The Network Controllers shall be a Native BACnet® controller based on 32 bit technology to provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NC. The NC shall conform to BACnet® Building Controller (B-BC) profile and be provided with appropriate PIC statement defining BACnet® services and objects supported. BACnet® Data Sharing BIBBs supported shall include at a minimum: RP, RPM, WP, WPM, COV. Alarm and Event, Trending, and scheduling including SCHED-A BIBBs support shall also be supported in BACnet® native communications. The NC shall physically connect to the LAN without the need for additional Router hardware. The NC shall support transmitting and receiving segmented messages as well as BACnet® Broadcast Messages over IP. It should be possible to define any NC in an IP subnet as a BBMD device. The NC shall also support both Secure (https://) and non secure (http://) remote web server access using commonly used web browsers. It shall be capable of executing application control programs to provide:

- .1 Calendar functions
 - .2 Scheduling
 - .3 Trending and Trending Backfill
 - .4 Alarm monitoring and routing
 - .5 Time synchronization
 - .6 Integration of BACnet® devices and BACnet® controller data
 - .7 Integration of MODBUS devices and MODBUS controller data
- .2 The Network Controller must provide the following hardware features as a minimum:
 - .1 One Ethernet Port -10 / 100 Mbps RJ45
 - .2 One RS-232 port
 - .3 One RS 485 port
 - .4 Three independent BACnet® MS/TP Channel capable of supporting up to 90 Unitary controllers
 - .5 A minimum of 24 On-board I/O, expandable up to 128 hardware points
 - .6 Battery Backup using Gold Capacitor to avoid low battery alarms and subsequent replacement during service life of the controller.
 - .7 Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
 - .8 A Reset Button
 - .9 The NC must be capable of operation over a temperature range of 0 to 50°C
 - .10 The NC must be capable of withstanding storage temperatures of between 5 and 70°C
 - .11 The NC must be capable of operation over a humidity range of 5 to 93% RH, non-condensing
- .3 Integration
 - .1 Any or all the 3 independent MS/TP channels may be used to integrate MODBUS devices like Energy Meters etc. or BACnet® devices and BACnet® controller data. The FMS contractor shall include if any, license required for this interface within their scope.
- .4 Event Alarm Notification and actions
 - .1 The NC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
 - .2 Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
 - .1 To alarm
 - .2 Return to normal
 - .3 To fault

- .3 Provide for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms based on priority
- .4 Provide timed (schedule) routing of alarms by class, object, group, or priority.
- .5 Provide alarm generation from binary object "runtime" and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- .5 Control equipment and network failures shall be treated as alarms and annunciated.
- .6 A log of alarms shall be maintained by the NC
- .7 Provide a "query" feature to allow review of specific alarms by user defined parameters.
- .8 A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- .9 An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

1.17 Ddc – Room Thermostats

- .1 Room thermostats shall be connected to CP-VAV Controllers. All wall modules shall contain temperature sensor only and will only be adjustable from the C.C.M.S. system. The points from the CP-VAV controllers shall communicate to the C.C.M.S. system and all field controllers.
- .2 The DDC controller will modulate the radiant heat valve to maintain space.
- .3 The following points will be mapped to the C.C.M.S. system:
 - .1 Space Temperature
 - .2 Space Temperature Set point
 - .3 OCC/UNOCC status
 - .4 Valve position
- .4 Provide blank covers with concealed adjustment and thermometers inside cover in public areas. Private rooms will have exposed thermometer and adjustment.
- .5 Provide heavy duty plastic guard on thermostats in public areas such as entranceways, washrooms, corridors and other unsupervised areas.

1.18 Comfortpoint Spc Application Specific Controllers

- .1 Controllers shall be 32 bit microprocessor based BACnet® Application Specific Controller in accordance with the ANSI/ASHRAE Standard 135-2004. Application Specific Controller shall be provided for small Air Handling Units and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates

the sensor signals. The CCMS Contractor must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-2004.

- .2 All Application Specific Controller shall be fully programmable as per application with the help of Windows based software programming tool. Controllers offering application selection only (non-programmable), require a 15% spare point capacity to be provided for all applications. All control sequences within or programmed into the B-ASC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
- .3 Stand-alone, Native BACnet®, UL Listed Application Controllers shall be used to provide direct digital control of HVAC equipment. In addition to their standalone capabilities, they shall also provide the ability networked in a peer-to-peer, BACnet® MS/TP field network to other controllers, or as part of a complete facilities management system which integrates multiple field networks. These controllers may be used to optimize the energy consumption by implementing various control strategies such as temperature setup/setback etc.
- .4 Standard features for all Application Specific Controllers shall include:
 - .1 32 bit microprocessor based controllers
 - .2 Stand-alone or networked peer-to-peer capabilities as MS/TP, Masters to slave devices are not acceptable
 - .3 Should have on-board Real Time Clock
 - .4 Should support BACnet® intrinsic alarm reporting
 - .5 Should support BACnet® B-ASC profile and BTL
 - .6 BACnet® MS/TP LAN with configurable baud rate from 9600 to 76.8k baud
 - .7 All Inputs to be Universal Inputs with 12 bit resolution- software selectable as analog or digital with standard and custom ranges.
 - .8 Pulse counting shall be available for any one of binary inputs up to 15Hz frequency
 - .9 All Outputs to be Universal Outputs with 8 bit resolution - software selectable for analog or digital with standard and custom ranges
 - .10 Maximum 90 objects
 - .11 Standard P, PI, or PID BACnet® Loop Objects.
 - .12 Minimum of 1 Loop Object for each output.
 - .13 In the particular case of Programmable Small Point Controllers (SPC), the following shall apply in addition to the standard features listed above:
 - .1 Standard FCU control sequences are incorporated to provide control of Fan Coil Unit
 - .2 Programmable control basic to allow customizing of the standard sequences for temperature setback, overrides, proportional wet reheat and other user defined sequences to adapt to changing building conditions. The ability to only change operating

parameters or substitute between configurable applications shall not be considered acceptable

- .3 Should be easily programmable using Microsoft Windows based programming utility.
- .4 The SPC shall communicate with the main network controller at a baud rate of not less than 38.4K baud. The SPC shall provide LED indication of communication and controller performance to the technician, without cover removal

END OF SECTION

1.1 General

- .1 All drawings and all sections of the specifications shall apply to and form an integral part of this section. Refer to Section 21 05 00 - Basic Materials and Methods.

1.2 Work Included

- .1 Include complete system of variable frequency drives for mechanical equipment.
- .2 General
 - .1 This specification describes a complete Variable Frequency AC Drive (VFD) used to control the speed of induction motors.
 - .2 The drive manufacturer shall supply the Drive and all necessary controls as herein specified.
 - .3 The VFD shall be manufactured by a company with at least ten (10) years experience in the production of this type of equipment.
 - .4 All VFD's for this project shall be from the same manufacturer
- .3 Quality Assurance
 - .1 The Drive manufacturing facility shall be ISO 9001.
 - .2 The drive manufacturer shall have an analysis laboratory to evaluate the failure of any component.
- .4 Support
 - .1 The manufacturer shall maintain factory trained and authorized service facilities within 150 miles of the project and shall have a demonstrated record of service for at least the previous ten years owned and operated by the VFD drive manufacturer.
 - .2 The manufacturer shall provide all required start-up and training services
 - .3 A 24/365 technical support line shall be available on a toll-free-line.
- .5 References and Regulations
 - .1 The VFD's and all components including the enclosure housing the VFD shall be designed, manufactured and tested in accordance with the latest applicable but not limited to the following standards:
 - .1 American National Standards Institute (ANSI)
 - .1 ANSI C57.13 - American National Standards Institute - Instrument Transformers
 - .2 Canadian Standard Association
 - .1 CSA 22.1 Canadian Electrical Code
 - .2 CSA-C22 No. 14 - Canadian Standards Association, Industrial Control Equipment
 - .3 CSA 22.2 No. 100- Canadian Standards Association, Motors and Generators

- .4 The entire VFD assembly including all additional accessories, controls, wiring, components, etc. and the enclosure housing all above mentioned components shall be CSA approved as a whole assembly.
- .3 Institute of Electrical & Electronic Engineers (IEEE)
 - .1 IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
 - .2 IEEE C57.18.10-1998, IEEE Standard Practices and Requirements for Semiconductor Power Rectifier Transformers.
- .4 International Electrotechnical Commission (IEC)
 - .1 IEC 61800-3 Power Drive Systems
 - .2 IEC 61800-5-2 Adjustable Speed Electrical Power Drive Systems
 - .3 IEC1000-4-2 Electrostatic immunity test
 - .4 IEC1000-4-4 Fast transient immunity test
 - .5 IEC1000-4-5 Surge immunity test
- .5 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems.
 - .2 NEMA ICS7 : Industrial Control and Systems Variable Speed Drives
- .6 Underwriters Laboratories (UL)
 - .1 UL 508C Standard for Power Conversion Equipment
- .7 Other applicable CSA, CUL, NEMA, IEC, etc. Standards, Codes and Regulations and Health Canada regulations where used in a hospital environment.
- .8 Acceptable VFD manufacturers.
 - .1 Allen Bradley (Rockwell Automation)
 - .2 ABB
 - .3 Toshiba
- .6 It is Contractors responsibility to become familiar with the above standards and this specification and ensure that provided drives are meeting the requirements outlined in the above mentioned standards and the specification.
- .7 Motor Compatibility
 - .1 The variable frequency drive shall be compatible with the motor and shall be capable to operate the motor over the specified power and speed range. Refer to motor specification.
 - .2 The motor insulation system shall not be compromised thermally or due to dv/dt stress
 - .3 The variable frequency drive shall provide stable operation of the motor without compromising the motor insulation system, regardless of motor cable distance. The vendor shall clearly state the limitations in motor cable distance with the proposal. If an output filter is required to mitigate

reflected waves, or to meet any special requirements of the application or the applicable standards, it must be provided and wired to the VFD and the motor.

.8 Submittals

.1 The Submittals shall include the following information:

.1 Shop Drawings and Product Data

.1 Submit shop drawings to Departmental Representative for review. Shop Drawings shall include but not be limited to the following submissions:

- .1 Catalogue and technical data.
- .2 A "comply/non-comply" list of the shop drawing submissions, addressing each item of the specification indicating that it complies with the specification, or else stating the deviation.
- .3 All clarifications and exceptions must be clearly identified.
- .4 Outline dimensions, weights etc. including any special locating/installation instructions.
- .5 Heat loss at full load.
- .6 Control drawings and schematic diagrams including all connections to external equipment and devices. Include single line and impedance diagrams.
- .7 Include internal circuit schematics and the layout of all electronic and electrical components. Provide details on the following:
 - .1 Line reactor,
 - .2 DC Choke,
 - .3 Input harmonic filtering,
 - .4 EMI/RFI filtering,
 - .5 Output harmonic filtering,
 - .6 Output dV/dt values (must meet NEMA MG1 Part 31)
- .8 Instruction manuals for programming and installation.
- .9 Include a list of all initial values of parameter settings. Optimize the parameter settings for this application.
- .10 Manufacturer's installation instructions for the VFD, line and load reactors, control cabling, filters, VFD shielded cabling, motor etc.

.9 Ratings

- .1 The drive horsepower and voltage rating shall be in accordance with the controlled motor load. Refer to motor schedule and/or electrical drawings.

- .2 The Drive shall be rated to operate from 3-phase power +10/-10% of the nominal voltage. The overvoltage trip level shall be a minimum of 30% over nominal, and the undervoltage trip level shall be a minimum 35% under the nominal voltage.
- .3 The Drive shall be rated to operate at the following environmental operating conditions: ambient temperature 0 to 40°C continuous. VFDs that can operate at 40° C intermittently (during a 24 hour period) are not acceptable and must be oversized. Altitude 0 to 3300 feet above sea level without derating, less than 95% humidity, non-condensing.
- .4 The Drive shall be rated to operate from input power from 48Hz to 63Hz.
- .5 Output voltage and current ratings shall match the adjustable frequency operating requirements of standard NEMA design A or NEMA design B motors.
- .6 The overload current capacity shall be 110% of rated current for one (1) minute out of five (5) or 150% of rated current for one (1) minute out of five (5).
- .7 The VFD efficiency shall be 97% or better of the full rated capability of the VFD at full speed and load. In case an alternative solution is offered, the overall efficiency of the VFD and the harmonic mitigation components shall meet the efficiency requirement.
- .10 Construction
 - .1 All models shall provide a complete, ready-to-install solution.
 - .2 Six pulse input rectifier.
 - .3 The latest, most efficient IGBT power technology shall be used. This technology shall be used for all power and voltage ranges offered by the manufacturer.
 - .4 The VFD shall offer microprocessor based control logic that is isolated from power circuitry.
 - .5 The VFD shall use the same main control board for each drive of the same power ratings.
 - .6 Control connections shall remain consistent for all drive of the same power ratings.
 - .7 The VFD shall be air cooled. Where ventilation fans are provided for air cooling they shall be c/w replaceable dust filters and finger guards.
 - .8 All devices such as: line reactor, input transformer, disconnect switch, harmonic filters, transformers, ventilation fans, rectifier modules, capacitors, control modules, temperature controller, output filters, terminals, etc. to be housed in metallic NEMA rated sprinklerproof enclosure.
 - .9 Enclosure to be complete with hinged door and 1/4 turn screw driver locks.
 - .10 Provide a door-interlocked disconnect switch.
 - .11 Drive controls and keypad shall extend through the enclosure door for easy access.

- .12 The enclosure shall be designed and tested to applicable EMI/RFI standards.
- .13 The power modules in the cabinet shall be of a modular construction for quick removal and replacement.
- .14 Harmonic and EMI/RFI filtering:
 - .1 5% input line reactor or internal 5% DC choke.
 - .2 EMI/RFI filter for First Environment, Restricted.
 - .3 Output line reactor, dv/dt filter or sinusoidal filter as required to meet NEMA MG1 Part 31.
- .15 All optional features shall be furnished and mounted by the drive manufacturer.
- .11 Operator Interface
 - .1 The Drive shall be equipped with a front mounted operator control panel consisting of a minimum four (4) line by 20-character back-lit alphanumeric LCD display and a keypad with keys for Run/Stop, Local/Remote, Increase/Decrease, Reset, Menu navigation and Parameter select/edit.
 - .2 Provide separate H-O-A (hand-off-auto) switch, (Ø30.5mm industrial type), on face of enclosure to allow switching of drive from automatic (control via Central Controlling & Monitoring System, C.C.M.S., provided by Division 25) to hand (control via keypad). Also provide auxiliary dry contact on switch which closes in the 'hand' to signal outside air/exhaust air dampers to open when in 'hand' position. The VFD will remain under control of the C.C.M.S when in 'auto' position.
 - .3 The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
 - .4 The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
 - .5 The main LCD display of the control unit shall have the following features:
 - .1 The LCD display shall have contrast adjustment provisions to optimize viewing at angle.
 - .2 All parameter names, fault messages, warnings and other information shall be displayed in complete English words or standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
 - .3 During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse and local/remote status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. The selection shall include at least the following values:

- .1 Speed/torque in percent (%), RPM or user-scaled units
 - .2 Output frequency, voltage, current and torque
 - .3 Input voltage, power and kilowatt hours
 - .4 Heatsink temperature and DC bus voltage
 - .5 Status of discrete inputs and outputs
 - .6 Values of analog input and output signals
 - .7 Values of proportional/integral/derivative controller reference (PID) feedback and error signals
- .6 The keypad shall be used for local control, for setting all parameters, and for stepping through the displays and menus.
- .7 A copy function to upload and store parameter settings from a Drive and download stored parameter settings to the same Drive or to another Drive shall exist.
- .8 An intelligent start-up assistant shall be provided as standard. The Start-up routine will guide the user through all necessary adjustments to optimize operation.
 - .1 The Start-Up routine shall include "plug and produce" operation, which automatically recognizes the addition of options and fieldbus adapters and provides the necessary adjustment assistance.
 - .2 The Start-Up routine shall prompt the user for Motor Nameplate Data including power, speed, voltage, frequency and current.
 - .3 An auto-tune function shall identify the optimal motor tuning parameters for typical applications.
 - .4 An auto-tune function shall also be available to tune the PID speed regulator loop. Manual adjustments shall also be allowed.
 - .5 A selection of at least six (6) pre-programmed application macro parameter sets shall be provided to minimize the number of parameter adjustments required during start-up. Macros offered shall include Factory Default, Hand/Auto, PID Control, and Torque Control. A selection of two (2) user defined macros shall also be available.
 - .6 Selection shall be offered for both 2-wire and 3-wire Start/Stop control.
- .12 Protective Features
 - .1 For each programmed warning and fault protection function, the Drive shall display a message in complete English words or Standard English abbreviations. The five (5) most recent fault messages and times shall be stored in the Drive's fault history.
 - .2 Output short circuit and ground fault protection shall be provided.
 - .3 Motor phase loss protection shall be provided.
 - .4 The Drive shall provide electronic motor overload protection.
 - .5 Protection shall be provided for AC line or DC bus overvoltage at 130% of maximum rated voltage or undervoltage at 65% of min. rated voltage.
 - .6 The Drive shall protect itself against input phase loss.

- .7 Stall protection shall be programmable to provide a warning or stop the Drive after the motor has operated above a programmed torque level for a programmed time limit.
- .8 Underload protection shall be programmable to provide a warning or stop the Drive after the motor has operated below a selected underload curve for a programmed time limit.
- .9 Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
- .10 Input terminals shall be provided for connecting a motor temperature sensor to the Drive's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact.
- .11 All harmonic mitigation devices must be internal to the Drive enclosure and supplied as a complete solution.
- .13 Control Inputs and Outputs
 - .1 Discrete Inputs
 - .1 Six (6) discrete inputs shall be provided.
 - .2 All inputs shall be independently programmable with function selections (run/stop, hand-off-auto, etc.).
 - .3 Inputs shall be designed for "dry contact" inputs used with either the Drive's internal 24 VDC supply or a customer supplied external 24 VDC supply.
 - .2 Discrete outputs
 - .1 Three (3) form C relay contact outputs shall be provided
 - .2 All outputs shall be independently programmable to activate with at least 30 function selections including;
 - .1 Operating conditions such as drive ready, drive running, reversed and at set speed.
 - .2 General warning and fault conditions.
 - .3 Adjustable supervision limit indications based on programmed values of operating speed, speed reference, current, torque and PID feedback.
 - .4 Relay contacts shall be rated to switch 2 Amps at 24 VDC or 115/230 VAC.
 - .3 Analog Inputs
 - .1 Three (3) analog inputs shall be provided:
 - .1 One (1) -10 / 0 / 2 to 10 VDC
 - .2 Two (2) 0 / 4 – 20 mA
 - .2 All inputs shall be independently programmable with input function selections.
 - .3 A differential input isolation amplifier shall be provided for each input.
 - .4 Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion.
 - .5 If the input reference is lost, the Drive shall give the user the option of the following:

- .1 Stopping and displaying a fault.
 - .2 Running at a programmable preset speed.
 - .3 Hold the Drive speed based on the last good reference received.
 - .4 The Drive shall be programmable to signal this condition on the main LCD screen, relay output and/or over the serial communications bus.
- .6 When inputs are used as speed references, reference signal processing shall include increase/decrease floating point control and control of speed and direction using a "joystick" reference signal. Two (2) analog inputs shall be programmable to form a reference by addition, subtraction, multiplication, minimum selection or maximum selection.
- .4 Analog Outputs
 - .1 Two (2) 0 / 4-20 mA analog outputs shall be provided.
 - .2 Outputs shall be independently programmable to provide signals proportional to output function selections including output speed, frequency, voltage, current and power.
- .5 All input and output wiring (power and control) shall be terminated at terminals with the appropriate ratings (control signals: start/stop, safety shutdown, speed control 0-10VDC, speed feedback, motor current feedback, fan torque status, VFD fault, HOA 'auto' position).
- .14 Serial Communications
 - .1 The Drive shall be capable of communicating with other drives or controllers via a serial communications link. A variety of communications interface modules for the typical overriding control systems shall be available.
 - .2 Interface modules shall be available for a wide selection of protocols including but not limited to:
 - .1 Modbus RTU
 - .2 BacNet (MS/TP)
 - .3 Siemens Building Technologies FLN (P1)
 - .4 Johnson Controls N2
 - .5 Profibus
 - .3 Interface modules shall mount directly to the Drive control board or be connected via fiber optic cables to minimize interference and provide maximum throughput.
 - .4 I/O shall be accessible through the serial communications adapter. Serial communication capabilities shall include, but not be limited to:
 - .1 Run-Stop control
 - .2 Hand-Off-Auto Control
 - .3 Speed Adjustment
 - .4 PID (proportional/integral/derivative) control adjustments
 - .5 Current Limit

- .6 Accel/Decel time adjustments
- .5 The Drive shall have the capability of allowing the overriding controller to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information.
- .6 A connection shall also be provided for personal computer interface. Software shall be available for Drive setup, diagnostic analysis, monitoring and control. The software shall provide real time graphical displays of Drive performance.
- .15 Control Functions and Adjustments
 - .1 Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation.
 - .2 Stop mode selections shall include coast to stop and ramp to stop.
 - .3 The Drive shall be capable of controlling deceleration of a load without generating an overvoltage fault caused by excessive regenerated energy. Overvoltage control on deceleration shall extend the ramp time beyond the programmed value to keep the amount of regenerated energy below the point that causes overvoltage trip.
 - .4 The Drive shall be capable of starting into a rotating load (flying start) regardless of motor direction. It should then accelerate or decelerate to the active reference without tripping on fault or causing component damage. The Drive shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
 - .5 The Drive shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
 - .6 Control functions shall include two (2) sets of acceleration and deceleration ramp time adjustments with linear and an s-curve ramp time selection.
 - .7 Speed control functions shall include:
 - .1 Adjustable min/max speed limits.
 - .2 Selection of up to 15 preset speed settings for external speed control.
 - .3 Three sets of critical speed lockout adjustments.
 - .4 A built-in PID controller to control a process variable such as pressure, flow or fluid level.
 - .8 Functions shall include flux optimization to limit the audible noise produced by the motor and to maximize efficiency by providing the optimum magnetic flux for any given speed operating point.
 - .9 The Drive shall be capable of sensing a loss of load (broken belt / broken coupling) and signal the loss of load condition. The Drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. Relay output shall include

- programmable time delays that will allow for Drive acceleration from zero speed without signaling a false underload condition.
- .10 Three (3) programmable critical frequency lockout ranges shall be provided to prevent the Drive from operating the load continuously at an unstable speed.
- .11 The Drive shall offer software to select the Drives action in the event of a loss of the primary speed reference.
- .12 The Drive shall have internal adaptive programming blocks capable of twenty (20) different functions. These blocks shall be connectable to Drive's actual signals and functions allowing the user to tailor the Drive to the specific application requirements without additional hardware. These blocks shall be programmable through the standard operator panel and through the use of programming software.
- .16 Bypass Switch
- .1 Where required, provide bypass switch and bypass controller in separate metallic enclosure adjacent to VFD enclosure. Refer to motor schedules. Bypass switch NEMA rating to match VFD enclosure.
1. Enclosure to be complete with hinged door and 1/4 turn screw driver locks.
 2. A complete factory wired and tested bypass system consisting of a door interlocked padlockable motor circuit protector, thermal overload protection, output contactor, bypass contactor, and fast acting VFD isolation fuses.
 3. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
 4. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the nameplate.
 5. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs, which have no such fuses will not be accepted.
 6. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
 7. The bypass shall maintain positive contactor control throughout the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
 8. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.

9. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for stand alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.
10. Serial communications – the bypass shall be capable of being monitored and / or controlled via serial communications. On-board communications protocols shall include:
 - a. BacNet (MS/TP)
11. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the variable air volume (VAV) boxes to open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
12. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the up to four (4) customer safety contacts is open over the serial communications connection.

.17 Installation

- .1 Confirm to specified service conditions during and after installation of products
- .2 Maintain area free of dirt and dust during and after installation of products
- .3 The VFD manufacturer shall provide adequate drawings and instruction material to facilitate installation of the VFD by qualified electrical and mechanical personnel employed by others.
- .4 The drive is to be installed to CSA 22.1, current codes, standards, and other sections of this specification. The drive is to be installed to manufacturer's recommendations.
- .5 Install the variable frequency drive, cabling, ancillary equipment etc. to the manufacturer's instructions.
- .6 Include all material and labor necessary to interconnect any VFD system elements, even if shipped separately.
- .7 The manufacturer of the VFD is to coordinate and review the installation of the VFD with Division 26.
- .8 The drive is to be wired to achieve the following functions:
 - .1 Remote start and stop (isolated input at 24 VDC or 120 VAC)
 - .2 Speed to be adjusted by a remote analogue input i.e. 4-20ma.
 - .3 Wire and connect control wiring to pre-set speed control equipment. Set and adjust as pre-set speeds as indicated in other sections of this specification. Configure trimming of pre-set speeds by analogue inputs to the VFD from remote equipment as indicated in other sections.
 - .4 Those as required by other sections of the specification.

- .9 Install the VFD drive securely on a flat wall surface, as close to the motor as possible, within the distance allowed by the maximum conductor length specified by the drive manufacturer.
- .10 Install the VFD as far as practical from medical, telecommunications equipment, control equipment and wiring. Maintain a minimum distance of three meters from the VFD and its feeders to telecommunication and control cables. VFD input and output cables are to cross communication and control cables at 90 degrees.
- .11 Division 26 to provide Teck Drive RX cable from the VFD to the motor for all 600V and 208V motors. The Teck Drive RX cable is specifically manufactured for use with variable frequency drives. Connectors for the Drive RX cables are to be specifically designed for use with this type of cable, as per the cable manufacturer's instructions. The cable is to be bonded as per the VFD manufacturer's instructions. Division 25 is to coordinate with Division 26.
 - .1 Grounding is to be as per the manufacturer of the VFD's instructions and CSA requirements for safety and to reduce RFI and EMI.
 - .2 Low voltage control wiring between motor and VFD (such as thermistor wiring, speed feedback, etc.) shall be by Division 25 Contractor. All wiring shall be in conduit. Refer to Division 26 specifications.
 - .3 All control conductors are to be shielded of a type specified by the manufacturer. The shields are to be grounded as per the manufacturer's instructions. All control wiring shall be in conduit. All conduits used for control wiring shall include a separate insulated ground conductor, #12 AWG minimum.
 - .4 The conduit for the control conductors shall not be installed within 600mm of the power conductors for the VFD. The shields of the cables shall be grounded according to the manufacturer's instructions for:
 - .1 Analogue signals
 - .2 Digital signals
 - .5 The control cables shall be terminated in terminals (supplied with the VFD enclosure). Shielded cables shall be grounded according to the VFD manufacturer's instructions.
 - .6 The VFD shall be programmed, commissioned, set-up and tested by the manufacturer's representative. The drive shall be set-up to optimize the operation with the specific equipment that the drive has been specified with, in other Sections of this Specification.
 - .7 Examine the Division 25 shop drawings for the motors that are supplied by the equipment supplier. The motors must be suitable for the intended use and shall be labelled as such, as required by CSA C22.2 No. 100-95. Ensure that the labels are on the motor before connecting. If the motor is not suitable for use with the VFD and/or is not labelled, notify the Division 25 contractor immediately.
- .18 Factory Tests

- .1 The VFD shall be factory pre-wired, assembled and tested as a complete package by the VFD supplier. Customer specific drive, motor, and application data shall be pre-loaded into the operator interface and tested prior to shipment.
- .2 All printed circuit boards shall be completely tested before being assembled into the complete VFD.
- .3 The VFD shall be subjected to the following factory tests, which shall be carried out in accordance with applicable requirements and/or specifications of Canadian Standards Association (CSA), Underwriters Laboratories (cUL), National Electrical Manufacturers Association (NEMA), and International Electrotechnical Commission (IEC):
 - .1 Functional checks shall be performed wherever possible; otherwise, inspection and continuity checks shall be made.
 - .2 A "HI-POT" dielectric withstand test shall be performed on all buswork and cables from phase-to-phase and phase-to-ground (except solid-state components, low voltage controls and instrument transformers). The voltage level used for this test depends on the product's nominal AC voltage.
 - .3 Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.
 - .4 Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.
 - .5 Drives shall be inspected for the following:
 - .1 Control Power Failure Test
 - .2 Rectifier Gating Checks
 - .3 Inverter Gating Checks
 - .4 Line Converter Tests
 - .5 Cycle testing and load testing
- .4 Cycle Testing
 - .1 Drives shall be accelerated to the test motor's nominal frequency, under load.
 - .2 Drives shall be decelerated to 10 Hz and then accelerated back to test motor's nominal frequency with a ramp time of approximately ten seconds.
 - .3 This cycle shall be repeated continuously for up to one hour.
- .5 Load Testing
 - .1 Drives shall be tested under load at the test motor's nominal frequency.
 - .2 Each Drive shall be factory load tested with an induction motor for a minimum of (4) four hours at full rated load and cycled load.
- .6 Factory test results shall be provided to Departmental Representative for review prior to shipping.
- .19 Commissioning and start up

- .1 The service division of the variable frequency drive manufacturer shall perform all commissioning and startup services. The use of third party supplier start-up personnel is not allowed.
- .2 Testing, commissioning first and final parameter adjustment and performance tests are carried out by the factory engineer with the Owner and or Departmental Representative present.
- .3 Provide a minimum of 8 hours of on-site start-up service.
- .4 As a minimum, the start-up service shall include the following:
 - .1 Pre-Installation Meeting
 - .1 The start-up plan
 - .2 The start-up schedule
 - .3 The drive's installation requirements
 - .2 Pre-Power Check
 - .1 Physical Inspection
 - .1 The product must meet all applicable engineering and workmanship standards and specifications. All components shall be verified against engineering documentation to be present and correctly installed.
 - .2 All bus and bus connections shall be checked for proper clearance, creepage, phasing, and torque.
 - .3 Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.
 - .4 Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
 - .5 Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
 - .6 Operation of isolation switch handle and door interlocks must be verified. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved to the full ON position.
 - .7 Inspect the drive's mechanical and electrical devices enclosed
 - .8 Perform a tug test on all internal connections within the drive and verify wiring.
 - .9 Verify critical mechanical connections for proper torque requirements.
 - .10 Verify and adjust mechanical interlocks for permanent location.

- .11 Confirm all sectional wiring is connected properly.
- .12 Re-verify control wiring from any external control devices.
- .13 Set up all drive internal power supplies and thyristor control circuits.
- .14 Verify proper phasing from isolation transformer to drive.
- .15 Confirm cabling of drive to motor, isolation transformer and line feed.
- .16 Megger Motor Resistances.
- .2 Drive Power-up and Commissioning
 - .1 Apply voltage to the drive and perform operational checks.
 - .2 Bump motor and tune drive to the system attributes.
 - .3 Run the drive motor system throughout the operational range to verify proper performance.
- .3 Record all measurements.
- .4 Provide drive parameter listing, all measurements, check lists and test results to Departmental Representative for review.
- .5 Include all drive parameter listings, commissioning documentation, including all test results in the maintenance manuals.
- .6 Provide certification that the timing devices required in the starting circuitry are properly adjusted.
- .7 Contractor shall provide certification that the variable frequency drive has been installed in accordance with the manufacturer's instructions.
- .3 Final Drawings. The manufacturer shall provide final drawings reflecting the "As-Shipped" status of the VFD. The contractor shall be responsible for making any changes to the "As-Shipped" drawings from the manufacturer to reflect any field modifications.
- .5 Cost for commissioning, travel to the jobsite and living expenses during the period of work shall be included in the bid proposal.
- .20 Training
 - .1 Provide training for each type of VFD in addition to the site specific training supplied by Division 25 for the equipment with which the VFD has been supplied.
 - .2 Manufacturer to provide one (1) session of on-site instruction for a maximum of eight (8) participants.
 - .3 The manufacturer shall outline the training session duration and content.
 - .4 Ensure that manuals and drawings are available for the training.

- .5 The training shall include specific information relating to the application as specified in other sections of the specifications as well as general operation and maintenance of the VFD.
 - .1 Include procedures for the setting of parameters within the VFD for the particular application(s) specified as well as an explanation of the purpose of each parameter that is accessible to the maintenance personnel and the specific instructions required to alter the parameters.
 - .2 The instructions will include a written record of the final parameter settings after set-up and commissioning, for each VFD supplied as part of the project. General or generic values are not permitted. Record and turn over the values set in each VFD.
- .6 As a minimum, the training shall:
 - .1 Review of the engineered drawings identifying the components shown on the drawings.
 - .2 Review starting / stopping and speed control options for the controller.
 - .3 Review operation of the Operator Interface for programming and monitoring of the variable frequency drive.
 - .4 Review cooling system operation.
 - .5 Review the maintenance requirements of the variable frequency drive.
 - .1 Board replacement procedures
 - .2 Power device replacement procedures
 - .3 Fault analysis and troubleshooting
 - .4 Preventative maintenance procedures
 - .6 Review safety concerns with operating the variable frequency drive.
- .7 The Purchaser reserves the right to videotape the training sessions.
- .8 Cost for training, travel to the jobsite and living expenses during the period of work shall be included in the bid proposal.
- .21 Spare Parts
 - .1 Recommend spare parts list and list prices shall be supplied. Identify the following spare parts:
 - .1 Critical Spares - Spare parts that are identified as being associated with long lead times and/or are critical to the unit's operation. These spares should be held in reserve by the Purchaser to limit unforeseen downtime.
 - .2 Maintenance Spares - Spare parts that are identified as being required to regularly perform scheduled maintenance on their equipment. These spares include, but are not limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.

- .2 The Drive manufacturer shall provide a complete list of spare parts for the VFD.
- .3 The Drive manufacturer shall provide local support for renewal parts and stock spares within Canada.
- .4 As a minimum, the VFD manufacturer shall include these spare parts as part of the bid:
 - .1 For each size drive and type:
 - .1 Three of each type power and control fuses.
 - .2 Two power modules (Cells, SGCT or IGCT) or 20%, whichever is greater.
 - .3 Two spare LEDs of each type used.
 - .4 Two spare control relays of each type used.
 - .5 Two sets of all replacement air filters.
 - .6 One set of all control printed circuit boards.
 - .7 Special tools for testing or maintaining equipment.
 - .5 All spare printed circuit boards shall be individually packed.
- .22 Warranty
 - .1 Standard Warranty shall be (3) years from the date of start-up, not to exceed (18) eighteen months from the date of shipment. The warranty shall include all parts.
 - .2 The manufacturer shall confirm this warranty as part of the submittal.
 - .3 This warranty applies to variable frequency drive systems.
- .23 Delivery, Storage and Handling
 - .1 Contractor shall coordinate the shipping of equipment with the manufacturer.
 - .2 Contractor shall store the equipment in a clean and dry space.
 - .3 The contractor shall protect the units from dirt, water, construction debris and traffic.
- .24 Shipment
 - .1 Drives shall be individually crated and tagged with proper identification.

END OF SECTION

1.1 General

- .1 All drawings and all sections of the specifications shall apply to and form an integral part of this section.

1.2 Work Included

- .1 Include complete system of temperature control and temperature indication as manufactured and installed by Honeywell. Control components to be installed by trained control mechanics, regularly employed by Division 25.

1.3 General Requirements

- .1 Local controller shall allow operator to access all connected input points, and operator commandable points and operator selectable parameters and setpoints.
- .2 Controllers shall be connected to C.C.M.S. LAN system as directed by BRC - Property Services.
- .3 Provide C.C.M.S. Colour Graphic for all systems unless otherwise specified.

1.4 Fan System Controls - General

- .1 Mixed air temperature control - O.A., return air and relief air dampers shall modulate to maintain mixed air temperature. Mixed air temperature control shall interact with minimum O.A. control and system shall interact with minimum O.A. control and system shall revert to min. O.A. on signal from dry bulb, enthalpy or other economizer control as specified in individual sequences of operation in this section.
- .2 Minimum O.A. control (variable volume systems) - calculate actual quantity (L/s) of O.A. provided by utilizing O.A., return air and mixed air temperatures and system total flow (sensed by supply air flow station). Override mixed air control sequence if necessary to ensure minimum O.A. quantity is maintained. If S.A. temperature falls more than 2 deg.C (4 deg.F) below setpoint minimum O.A. quantity shall be reduced to provide largest O.A. quantity possible while discharge air temperature is maintained. NOTE: When space static pressure is used (in lieu of flow station) space static pressure control shall override mixed air control if necessary to maintain positive space static pressure. Actual percent of O.A. shall be calculated using O.A., return and mixed air temps. If S.A. temp. falls more than 2 deg.C (4 deg.F) below set point minimum O.A. quantity shall be reduced to provide largest O.A. quantity possible while maintaining discharge air temperature.
- .3 Supply air volume control (variable volume system) - modulate supply fan volume to maintain supply duct static pressure. S.A. volume control shall interact with S.A. temperature control.
- .4 Supply air temp. control (variable volume systems) - modulate, when applicable, O.A. and return air dampers, heating and cooling equipment in sequence to

maintain S.A. temperature. Where noted in individual sequences of operation in this section, S.A. temperature setpoint shall be automatically reset warmer as total S.A. flow drops (as sensed by supply flow monitoring station). NOTE: Where no air flow monitoring station is used the reset shall be based on the percentage output to the S.A. volume control device (i.e. damper operator variable frequency controller, etc.).

- .5 Following control sequences shall apply to all supply fan systems whether specifically noted in sequence of operation or not.
- .6 Where fan systems have outdoor and return air dampers modulated to maintain mixed air, discharge air, or room temperature, provide adjustable ramp feature to retard opening of O.A. damper on system start up and enable heating source controls to come into control and prevent nuisance tripping of low limit protection controls.
- .7 Provide "failsafe hardware" interlocks (eg. relays, CSR's, differential pressure switches, etc.) to ensure system controls energize and associated return and/or exhaust fans run when supply fan runs.
- .8 Provide interlocks to ensure auxiliary equipment such as humidifiers, humidifier valves, outdoor air dampers, relief air dampers, etc. are shut off and/or closed when supply fan is off, and operations of all final control elements (eg. damper actuators, valve actuators, humidifiers etc) are 100% "failsafe" to prevent system damage.
- .9 Provide all fan systems that introduce O.A. with low limit control in discharge air to shut down supply fan when discharge air temp. drops below 3 deg.C. Locate low limit in manner that shall protect heating and cooling coils, and at same time not be subject to nuisance tripping. On 100% outside air systems provide adjustable time delay on start-up to prevent unit from shutting down while controls stabilize.
- .10 Where fan systems are roof-top mounted, packaged type, low limit control shall be automatic reset type connected to a time delay and alarm system to provide the following sequence: On system start-up low limit shall be overridden for 1 min. (adjustable) to enable heating section to come into control. Following this 1 min. period, tripping of the low limit shall immediately shut down fan, sound local alarm, and fan shall be unable to restart until alarm reset button is pushed.
- .11 Provide all fan systems that introduce O.A. with adjustable O.A. damper minimum position controls.
- .12 Where relief air dampers are not directly ducted to supply/return fans, provide backdraft control to prevent a backdraft condition from occurring.
- .13 Provide differential pressure switches across each filter bank to indicate filter differential pressure. Pressure shall be alarmed (delay on fan start-up) when it exceeds alarm set-point (parameter adjustable).

- .14 Where direct expansion cooling systems are utilized this section shall provide all necessary devices to ensure proper interface.
- .15 On variable volume systems with supply duct static pressure control of supply fan volume, static pressure sensor shall be located at the end of the longest duct run. Coordinate with TAB Contractor. Should relocation of static pressure sensor be required to provide proper system control, Division 25 shall relocate sensor as directed by Departmental Representative. Provide second independent static pressure sensor located in supply fan discharge to function as high limit and override control of supply fan volume device to prevent overpressurization of system.
- .16 On variable volume systems, provide interlocks to ensure fan inlet vortex dampers are fully closed when fan is off.
- .17 On 100% O.A. systems, provide end switch on O.A. damper to ensure O.A. damper is fully open prior to starting fan.
- .18 On D.D.C. systems, if inputs or outputs, not specified, are required in order to provide sequence or operation specified, these inputs/outputs shall be included.
- .19 On systems which have Hand-Off-Auto switch alarm, when switch is not in Auto position, alarm shall annunciate. This shall trigger normal fan shutdown thereby eliminating fan failure alarms.
- .20 Sensor shall override the signal to the relief damper to maintain a minimum temperature at the sensor of 5C (adjustable).
- .21 Local controller shall allow operator to access all connected input points, and operator commandable points and operator selectable parameters and set points.
- .22 Provide supply air sensor to provide high and low limit indication at CCMS.
- .23 Provide CCMS colour graphic for this system.
- .24 Incorporate supply fan into run time, start and stop totalization programs.
- .25

1.5 Ahu-1

- .1 Equipment:
 - .1 Indoor air handling unit, c/w supply fan, indirect gas heating section, DX cooling coil and outdoor condensing unit, economizer, and filter section.
- .2 Temperature Sensors:
 - .1 OA (common).
 - .2 RAT.
 - .3 MAT.
 - .4 SAT.
- .3 Other Sensors:

- .1 Filter differential pressure (each filter section).
- .4 Temperature Limits:
 - .1 Low SAT.
 - .2 High and low MAT.
- .5 Humidity Limits:
 - .1 High SA RH.
- .6 Alarms:
 - .1 SF failure.
 - .2 RF failure.
 - .3 Low SAT.
 - .4 High filter differential pressure.
 - .5 High SA RH.
- .7 Control Loops:
 - .1 Time:
 - .1 Occupied/unoccupied schedule.
 - .2 Occupied – normal sequences.
 - .3 Unoccupied – AHU off. Provide a wall mounted pushbutton control with LED indication to override unoccupied mode for a preprogrammed length of time; mount in a readily accessible location approved by the Engineer.
 - .2 Heating:
 - .1 Stage gas heating to maintain optimized SAT setpoint. Transmit any alarm if supply air temperature varies from setpoint by a user defined amount.
 - .2 Heating shall be provided using zone electric reheat coils as the second stage of heating and AHU heating coil as the first stage of heat.
 - .3 Cooling:
 - .1 Use free cooling when space temperature conditions and outdoor air temperatures warrant. Under free cooling, mechanical cooling and heating are OFF and the outdoor air dampers modulate to maintain supply air temperature setpoint. The outdoor air damper shall at no time modulate to less than the set ASHRAE 62 minimum.
 - .2 The free cooling program shall apply to cooling cycle only. Free cooling shall only be used if the outdoor air temperature is at least 3 C below the supply air setpoint. Free cooling shall stop when the supply air temperature setpoint cannot be maintained without the addition of mechanical cooling or heating.
 - .3 The free cooling purge program shall apply to cooling cycle only. The program shall test both outdoor and space conditions listed below to determine if a free cooling cycle purge mode is beneficial. Under free cooling purge mode, the heating is OFF, the outdoor air dampers open to introduce 100% outdoor air and relief air

- dampers shall modulate to the setpoint. The heating coil shall be OFF, and the relief damper shall be open
- .4 Free cooling purge shall start when all of the following conditions are met:
- .1 Outdoor air is between 8 C and user define maximum.
 - .2 Maximum space temperature is above 20 C in summer and 22C in the spring and the fall.
 - .3 Outdoor air temperature is at least 3 C below maximum space temperature.
 - .4 Within four hours of scheduled occupancy period but not before 4 AM.
- .5 Free cooling purge shall stop when one or more of the following conditions are met:
- .1 Outdoor air is outside the 8 C and user defined maximum range (initially set to 13 C).
 - .2 Minimum space temperature is below 19 C in supper and 20 C in spring and the fall.
 - .3 Outdoor air temperature is less than 3 C cooler than maximum space temperature.
 - .4 There shall be a user defined minimum run time.
- .6 Use mechanical cooling when space conditions and outdoor air warrant. Under mechanical cooling, the heating is OFF. The outdoor air damper is set to the ASHRAE 62 minimum.
- .1 There shall be a mechanical cooling temperature space setpoint of 23 C (or as assigned by operator) in the mechanical cooling season. If the maximum space setpoint exceeds 23 C and the outside air temperature is above the free cooling conditions defined above, the AHU shall start the mechanical cooling system.
 - .2 Cycle cooling stages ON and OFF to maintain supply air setpoint between 16 C and 19 C (under floor air distribution temperatures). If the coil is a split circuit type in a multi-staged DX system, start both stages initially and shut down the second stage once the cooling conditions are satisfied. Contractor is responsible for controlling stage individually. Send out alarm if supply air temperature varies from setpoint by user defined amount.
- .7 The maximum occupied zone space temperature input shall control cooling in any cycle. The minimum occupied zone space temperature shall control heating in any cycle.
- .4 Fans:
- .1 The supply fan shall use a supply duct static pressure reset strategy.
 - .2 Once the supply fan is running, modulate the supply fan VSD to satisfy the duct static pressure setpoint using the space as the static pressure reference point (initially set to 375 Pa [1.5" w.c.]).

The maximum supply duct static pressure setpoint must be determined in the field in conjunction with TAB as follows:

- .1 Set all boxes downstream of the static pressure sensor to operate at maximum air flow setpoints.
- .2 Set all boxes upstream of the static pressure sensor to full shut off (zero flow).
- .3 Manually lower fan speed slowly while observing VAV box air flow rates downstream of the static pressure sensor. Stop lowering speed when on or more VAV box airflow rates just drops 10% below maximum air flow rate setpoint.
- .3 Monitor VAV box damper position for all zones and adjust the supply duct static pressure setpoint so that the damper in the most demanding zone is close to 100% open. Monitor VAV air flow rates and slowly lower the supply duct static air pressure setpoint as long as all zones are meeting their air flow rate setpoint. As the supply duct static pressure setpoint is lowered and one or more zones fail to satisfy their air flow rate setpoints, slightly increase the supply duct static pressure setpoint again.
- .4 Modulate return fan VSD based on the differential static pressure of the space relative to outdoor reference. Assume that the initial static pressure setpoint is 12.5 Pa [0.05" w.c.]. The final value will be set by the TAB contractor.
- .5 Provide LOW and HIGH static alarm for supply duct, space static and relief static. Except for the high static alarms, alarms shall not be enabled until the system pressure has ramped up and stabilized. Disable static pressure alarms when the fans are OFF.
- .6 If there is a supply duct static high pressure alarm, generate the alarm and modulate the supply VSD to low speed. If the alarm exists after a user defined time, shut down the supply and return fans and provide a critical alarm. Fans shall then be restarted manually by operator. Provide a separate duct static high limit at AHU supply discharge (initially set to 750 Pa [3.0" w.c.]).
- .7 If there is a supply duct low pressure alarm, generate the alarm and modulate the supply VSD to high speed to satisfy the duct static condition.
- .8 If there is a relief plenum high static pressure alarm, generate the alarm and modulate return fan VSD to low speed and open the relief damper. . If the alarm exists after a user defined time, stop all fans and provide a critical alarm. Restart fans once conditions return to normal after a user specified time period.
- .9 If there is a relief plenum low or negative static pressure alarm, generate the alarm and modulate the return fan to high speed and close relief damper. If the alarm exists after a user defined time, turn the return fan OFF and transmit a critical alarm.
- .10 If there is a space static high pressure alarm, generate the alarm and modulate the relief air dampers OPEN and run return fan VSD to high speed. If the alarm exists after a user defined time, shut

- both fans down, return all dampers to fail-safe position and transmit a critical alarm.
- .11 If low temperature limit alarms trip, stop the AHU fan, return all dampers to fail safe position and generate an alarm.
- .12 The AHU supply and return fan shall shut down when the building is in a fire alarm condition. Fan shall not run until the fire alarm condition is cleared.
- .5 Dampers:
 - .1 Modulate outdoor air, mixed air and relief dampers to operating positions once fans have run for a user defined period. Contractor shall work with TAB subcontractor to set the minimum positions on outdoor air dampers to maintain ASHRAE 62 outdoor air requirements.
 - .2 Modulate mixed air dampers to maintain whichever test criteria requires the most amount of outdoor air:
 - .1 The optimize mixed air setpoint,
 - .2 Or the set minimum outdoor air position.
 - .3 Room sensors shall be used to reset air handling unit discharge air temperatures to optimize mixed air temperature to minimize required tempering (use the minimum space temperature in heating mode; use the maximum space temperature in cooling mode).
 - .4 Modulate relief air damper to maintain the differential static pressure between the space static pressure and the outdoor reference.
 - .5 Outdoor air dampers shall close during preheat or precool and open during free cooling or purge.
 - .6 Provide an alarm if the return air temperature varies from mixed air temperature by a user defined amount when the outdoor air dampers are closed (this is evidence of damper leakage). Provide an alarm if the outdoor air temperature varies from mixed air temperature by a user defined amount when the dampers are fully open (this is evidence that the outdoor air dampers are not opening). Provide percent outdoor air calculation using return, mixed and outdoor air temperatures. Provide analog output feed back alarm on all damper operators.
- .6 Ventilation:
 - .1 Occupied – AHU provides continuous ventilation for occupants and pollutant control.
 - .2 Unoccupied – AHU off.

1.6 Electric Perimeter Heating

- .1 Equipment: Radiant electric panels, and other perimeter heaters.
 - .1 DDC system shall control electric perimeter heating units in conjunction with AHU-1 and VAV reheat coils.
 - .2 Use zone heating as final and 3rd stage of heating.

- .3 Wall controls by Div 25, low voltage relay by Div 26. Coordinate location and wiring.

1.7 Erv-1

- .1 Interlock operation of ERV-1 with AHU-1 and run ERV-1 continuously during occupied hours as schedule by the DDC system.
 - .1 Provide four detectors (one per washroom, kitchenette, office area and clean room) to override unoccupied mode when motion is detected.
- .2 Provide manufacturers supplied central wall controller in mechanical room for user override and control of ERV-1
- .3 ERV-1 shall have packaged controls for operation of defrost cycle.

1.8 Erv-2

- .1 Provide one motion detector in the dirty room to start ERV-2.
- .2 Provide manufacturers supplied central wall controller in dirty room area for user override and control of ERV-2
- .3 ERV-2 shall have packaged controls for operation of defrost cycle.

1.9 Dirty Room Exhaust Fan

- .1 Exhaust fan shall start by signal from DDC. Intake damper on opposite end of room shall be confirmed open prior to start of fan.
- .2 Exhaust fan shall start when room temperature is above room setpoint, initially set to 25 C (adjustable) and stop when space temperature is satisfied.
- .3 Override and lock out fan on low space temperature alarm or low outside ambient temperature 3C or less (adjustable).

1.10 Mechanical/Electrical Room Supply Fan

- .1 Supply fan shall start by signal from DDC.
- .2 Supply fan shall start when room temperature is above room setpoint, initially set to 25 C (adjustable) and stop when space temperature is satisfied.
- .3 Override and lock out fan on low space temperature alarm.

1.11 Dust Collector Mixed Air System

- .1 The dust collector is capable of running in full recirculation (winter) or mixed air mode (summer).
- .2 Provide control panel to allow user to select the mode of operation.

- .3 Full Recirculation (Winter):
 - .1 Use full recirculation when space is calling for heating.
 - .2 In full recirculation mode, the dust collector intake and relief damper are fully closed and return damper is 100% open.
- .4 Mixed Air Mode (Summer):
 - .1 Use mixed air mode if space is not calling heating and is above 23 C (adjustable). Otherwise, override use selection and run in full recirculation mode.
 - .2 In mixed air mode, modulate dust collector return air, mixed air, and relief air dampers to supply air at 18 C (adjustable).
 - .3 Once space temperature reaches 23C, modulate dampers to maintain 23 C. If outside temperature is greater than 23C, run system with return air damper closed, intake and relief dampers wide open (i.e 100% outside air).
- .5 Interlocks:
 - .1 Provide interlocks with all user equipment to start dust collector when equipment is in use. Provide all necessary equipment, relays, sensors as required to provide interlocks.

1.12 Alarms/Monitoring

- .1 AHU-1
 - .1 Monitor alarms for gas heating failure, fan failure, low and high duct pressure.
- .2 Condensing Unit
 - .1 Failure alarm
- .3 Dust Collection System:
 - .1 Monitor filter pressure drop and alarm at user defined setpoint.
- .4 Air Compressor:
 - .1 Failure alarm
- .5 Low Temperature:
 - .1 Provide temperature sensor in spaces that are conditioned (1 per space) and transmit alarm of temperature in space is below 10 C (adjustable) for a sustained period of time 10 minutes (adjustable)

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 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.
- .2 Reference Standards:
 - .1 CSA Group
 - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd 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 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 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 main electrical room.
- .4 Submit for review fire alarm riser diagram, plan and zoning of building under plexiglass at fire alarm control panel and annunciator.
- .5 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 required copies of 600 x 600 mm minimum size drawings and product data to authority having jurisdiction and inspection authorities.
- .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .6 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, 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.
- .7 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.
- .8 Submit in accordance with Section [01 78 00 - Closeout Submittals].
- .9 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.

1.4 Delivery, Storage And Handling

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

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification labels 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 or equipment are not available, obtain special approval from inspection authorities before delivery to site and submit such approval as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

2.3 Electric Motors, Equipment And Controls

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.
- .2 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 specified in mechanical sections.

2.4 Warning Signs

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction or inspection authorities.

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 nameplates and labels as follows:
 - .1 Nameplates: lamicoid 3 mm thick plastic engraving sheet, black face, white core, lettering accurately aligned and engraved into core 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 nameplates and labels to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per label.
- .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, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.

- .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 2 mm wide auxiliary colour.

Prime	Auxiliary	
up to 250 V	Yellow	
up to 600 V	Yellow	Green
up to 5 kV	Yellow	Blue
up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.9 Finishes

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
- .1 Paint indoor 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 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: schedule 40 pipe PVC, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 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 follow CSA-B651, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400 mm.
 - .2 Wall receptacles:
 - .1 General: 300 mm.
 - .2 Above top of continuous baseboard heater: 200 mm.
 - .3 Above top of counters or counter splash backs: 175 mm.
 - .4 In mechanical rooms: 1400 mm.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: 300 mm.

- .5 Wall mounted telephone and interphone outlets: 1500 mm.
- .6 Fire alarm stations: 1500 mm.
- .7 Doorbell pushbuttons: 1500 mm.

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 Power distribution 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 and communications.
 - .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 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 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.18-98(R2003), Outlet Boxes, Conduit Boxes and Fittings.
 - .2 CAN/CSA-C22.2 No.65-03(R2008), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2-1961, 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 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect wire and box connectors from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

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 NEMA to consist of:
 - .1 Connector body and stud clamp for stranded copper conductors.
 - .2 Clamp for stranded copper conductors.
 - .3 Stud clamp bolts.
 - .4 Bolts for copper conductors.
 - .5 Sized for conductors as indicated.
- .4 Clamps or connectors for armoured cable, TECK cable aluminum sheathed cable, flexible conduit, non-metallic sheathed 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 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 NEMA.

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 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 600 V insulation of cross-linked thermosetting polyethylene material rated RW90 XLPE, Jacketted.
- .3 Copper conductors: size as indicated, with thermoplastic insulation type TWH rated at 600 V.
- .4 Neutral supported cable: 1, 2, 3 phase insulated conductors of Copper and one neutral conductor of Copper steel reinforced, size as indicated.

2.2 Cable Identification

- .1 Cables to be identified with wire markers.
- .2 Machine printed self laminating label type.
- .3 Thermal transfer type with printable area and translucent vinyl film.

2.3 Conductors In Conduit:

- .1 Type: RW90, RWU90
- .2 Conductors for panel and branch circuits:
 - .1 Solid copper #10 AWG and smaller
 - .2 Stranded copper #8 AWG and larger.
 - .3 Sized as required (minimum #12 AWG).

- .3 Insulation:
 - .1 Cross link polyethylene (XLPE), 90°C.
- .4 Configuration:
 - .1 Single conductor.
- .5 Voltage Rating: 600V.
- .6 Certification:
 - .1 CSA C22.22 No. 38 or latest revision.

2.4 Armoured Cable Ac90 (Bx)

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90 - lead sheath over cable assembly and under armour.
- .3 Armour: interlocking type fabricated from galvanized steel strip.
- .4 Type: PVC flame retardant jacket over thermoplastic armour and compliant to applicable Building Code classification for this project.
- .5 Connectors: anti short connectors.

2.5 Armoured Cable Teck 90

- .1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper as indicated, size as indicated.
- .3 Insulation:
 - .1 Cross-linked polyethylene XLPE.
 - .2 Rating: 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.
- .6 Fastenings:
 - .1 One hole aluminum 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.
- .7 Connectors:
 - .1 Watertight approved for TECK cable.

2.6 Aluminum Sheathed Cable

- .1 Type: RA-90 (Corflex)

- .2 Conductors:
 - .1 Solid copper #10 AWG and smaller.
 - .2 Stranded copper #8 AWG and larger.
 - .3 Sized as required (minimum #12 AWG).
- .3 Insulation:
 - .1 Cross link polyethylene (XLPE), 90°C. (194°F).
- .4 Configuration:
 - .1 Single or multi-conductor as required.
- .5 Voltage Rating: 600V.
- .6 Aluminum Sheath:
 - .1 Liquid and vapour tight solid corrugation.
- .7 Outer Jacket:
 - .1 Polyvinyl chloride (PVC), -40°C (-40°F).
 - .2 Low flame spread (LFS).
 - .3 Low gas emission (LGE).
- .8 Fire Rating: FT4, AG14.
- .9 Certification:
 - .1 CSA C22.22 No. 123 or latest revision.

2.7 Electronic Cables

- .1 Conductors:
 - .1 #18 AWG - STC solid copper.
- .2 Insulation:
 - .1 Polyvinyl chloride (PVC).
- .3 Configuration:
 - .1 Twisted pairs (number as required).
- .4 Shielding:
 - .1 Copper braid.
- .5 Voltage Rating: 300V.
- .6 Certification:
 - .1 CSA.

2.8 Fire Alarm Cables

- .1 Conductor:
 - .1 Solid copper minimum #18 AWG.

- .2 Minimum #12 AWG for signaling circuits, in accordance with Manufacturer's recommendations.
- .2 Insulation:
 - .1 105°C. (221°F) flame retardant PVC.
- .3 Configuration:
 - .1 Multi-conductor (minimum 4 conductors per cable).
- .4 Voltage Rating: 300V.
- .5 Conductor Identification:
 - .1 Colour coded.
- .6 Shielding:
 - .1 Aluminum mylar foil.
- .7 Outer Jacket:
 - .1 105°C. (221°F) red PVC jacket.
- .8 Certification:
 - .1 CSA Class #5851-01 File #LR41741.
 - .2 UL subject 1424 File #E-83163.

2.9 Low Voltage Control Cables

- .1 Type: LVT.
- .2 Conductors:
 - .1 Solid copper #18 AWG.
- .3 Insulation:
 - .1 Thermoplastic, colour coded.
- .4 Configuration:
 - .1 Single, two conductors – parallel.
 - .2 Three or more conductors – twisted.
- .5 Voltage Rating: 30V.
- .6 Outer Jacket:
 - .1 Thermoplastic.
- .7 Certification:
 - .1 CSA C22.22 No. 35.

2.10 Instrumentation Cables

- .1 Type: Instrumentation cable.
- .2 Conductors:

- .1 7-wire, concentric lay, Class B tinned copper, #18 or #14 AWG as required.
- .3 Voltage Rating: 300V or 600V as required.
- .4 Insulation:
 - .1 Fire retardant - cross link polyethylene (XLPE), 90°C.
- .5 Configuration:
 - .1 Single or multi pairs or triads, as required.
- .6 Shielding:
 - .1 Aluminum/mylar shield with drain wire for each pair triad.
 - .2 Overall aluminum/mylar shield with drain wire.
- .7 Drain Wires:
 - .1 7-wire, concentric lay, Class B tinned copper.
 - .2 Individual shields to be one size smaller than conductor size.
 - .3 Overall shields to be the same as conductor size.
- .8 Colour Codes:
 - .1 300V Pairs:
 - .1 black, white and number code.
 - .2 300V Triads:
 - .1 black, white and number code.
 - .3 600V Pairs:
 - .1 black, red and number code.
 - .4 600V Triads:
 - .1 black, red, yellow and number code.
- .9 Armour:
 - .1 Inter-locked aluminum.
- .10 Outer Jacket:
 - .1 Grey polyvinyl chloride (PVC).
 - .2 Low flame spread (LFS).
 - .3 Low gas emission (LGE).
- .11 Fire Rating: FT4.
- .12 Certification:
 - .1 CSA C21.1 or latest revision.
 - .2 CSA C22.2 No. 174 or latest revision.

2.11 Medium Voltage

- .1 Type: 15 kV rated 100% insulation and shielded single conductor.
- .2 Conductors: #1/0 AWG, 19 wires compressed Class B strand bare copper.

- .3 Voltage rating: 15 kV.
- .4 Conductor shield: Extruded semi-conducting thermoset polymer.
- .5 Insulation: Extruded tree retardant crosslinked polyethylene.
- .6 Insulation shield: Extruded semi-conducting thermoset polymer.
- .7 26 x #14 AWG bare copper concentric neutral wires helically applied.
- .8 Outer jacket: extruded PVC -40°C.
- .9 Refer to single line distribution drawing.
- .10 Cable shall be as manufactured by General Cable or approved equal.

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 over installation.
- .3 Perform tests before energizing electrical system.

3.2 General Cable Installation

- .1 Install cables for feeders or branch circuits in raceways, wireways or trenches.
- .2 Install cable in trenches in accordance with Section 33 71 73.02 - Underground Electrical Service.
- .3 Prevent over-heating by induction in accordance with rule 12-3024(7) and 12-3024(8) and Appendix B Canadian Electric Code, Part 1 where single conductor cables connect to boxes and cabinets.
- .4 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .5 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.
- .6 Conductor length for parallel feeders to be identical.
- .7 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .8 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.
- .9 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.
- .10 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

- .11 Provide mechanical protection for cables where cables are turned up above the floor through sleeves or slots. Provide channels, angle sills or rigid conduit sleeves which protrude at least 150 mm above the finished floor.
- .12 Support on channels where cables are grouped and not run in tray.
- .13 Run cables parallel to the lines of the building.
- .14 Bends to be concentric.
- .15 Seal cables which penetrate air barrier and vapour boxes to barrier and boxes.

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.

3.4 Installation Of Teck90 Cable (0 -600 V)

- .1 Group cables wherever possible on channels.
- .2 Install cable concealed, securely supported by staples.

3.5 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 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 CSA Group
 - .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd 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.

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 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 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 Copper long barrel compression connectors to CSA C22.2 No.65 as required sized for conductors.
- .2 2, 3, 4 way joint boxes dry location type in accordance with Section 26 05 33 - Raceway and Boxes for Electrical Systems.

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 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 837-02, Qualifying Permanent Connections Used in Substation Grounding.

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.
- .3 Quality assurance submittals: provide 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, cleaning and procedures

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 Materials

- .1 Rod electrodes: copper clad steel, 19 mm diameter by 3 m long.
- .2 Conductors: bare, stranded, tinned soft annealed copper wire, size No. 3/0AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections.
- .3 Conductors: bare, stranded untinned soft annealed copper wire, size No. 4 AWG for grounding cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers.
- .4 Conductors: pvc insulated coloured green, stranded untinned soft annealed copper wire No. 10 AWG for grounding meter and relay cases.

- .5 Conductors: No. 3/0 AWG extra flexible (425 strands) copper conductor for connection of switch mechanism operating rod to gradient control mat, fence gates, vault doors.
- .6 Bolted removable test links.
- .7 Accessories: non-corroding, necessary for complete grounding system, type, size material as indicated, including:
 - .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.
- .8 Wire connectors and terminations: as indicated.

Part 3 Execution

3.1 Installation

- .1 Grounding impedance for primary power to be verified and corrected to ensure safety.
- .2 Install continuous grounding system including, electrodes, conductors, connectors and accessories as indicated and to requirements of local authority having jurisdiction.
- .3 Ground fences to grounding system independent of station ground.
- .4 Install connectors and cadweld in accordance with manufacturer's instructions.
- .5 Protect exposed grounding conductors during and after construction.
- .6 Make buried connections, and connections to electrodes, structural steel work, using permanent mechanical connectors to ANSI/IEEE 837.
- .7 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .8 Use No. 3/0 AWG bare copper cable for main ground bus of substation and No. 2/0 AWG bare copper cable for taps on risers from main ground bus to equipment.
- .9 Use tinned copper conductors for aluminum structures.
- .10 Do not use bare copper conductors near un-jacketed lead sheath cables.

3.2 Electrode Installation

- .1 Install ground rod electrodes. Make grounding connections to station equipment.
- .2 Install ground rod electrodes at transformer and switchgear locations.

- .3 Install gradient control mats. Connect mats to station ground electrode and switch mechanism operating rods.
- .4 Make special provision for installing electrodes that will give acceptable resistance to ground value, where rock or sand terrain prevails.

3.3 Equipment Grounding

- .1 Install grounding connections as indicated to typical station equipment including: metallic water main, line sky wire, neutral, gradient control mats. Non current carrying parts of: transformers, generators, motors, circuit breakers, reclosers, current transformers, frames of gang-operated switches and fuse cutout bases. Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers. Meter and relay cases. Any exposed building metal, within or forming part of station enclosure. Sub-station fences, pothead bodies. Outdoor lighting.
- .2 Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper.
- .3 Connect metallic piping (water, oil, air, etc.) inside station to main ground bus at several locations, including each service location within station.

3.4 Neutral Grounding

- .1 Connect transformer neutral and distribution neutral together using 1000 V insulated conductor to one side of ground test link, the other side of the test link being connected directly to main station ground. Ensure distribution neutral and neutrals of potential transformers and service banks are bonded directly to transformer neutral and not to main station ground.
- .2 Interconnect electrodes and neutrals at each grounding installation.
- .3 Connect neutral of station service transformer to main neutral bus with tap of same size as secondary neutral.
- .4 Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to primary neutral. Connect neutral bushing at transformer to primary neutral in same manner.

3.5 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Engage an independent testing agent to inspect grounding and perform ground resistance test before backfill.
- .3 Perform earth loop test and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction.
- .4 Perform test before energizing electrical system.

- .5 Provide step-and-touch potential calculations using measured station ground resistance measurements. Submit test result and inspection certificate before energizing electrical system.

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 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 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 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, tinned, soft annealed, size as required.
- .3 Rod electrodes: copper clad steel 19 mm diameter by minimum 3 m long.
- .4 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.
- .5 Insulated grounding conductors: green, copper conductors, size as indicated.
- .6 Ground bus: copper, size as required, 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 permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.
- .8 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .9 Install separate ground conductor to outdoor lighting standards.
- .10 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 and 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 water meter shunt.
- .3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
- .4 Install rod electrodes and make grounding connections as indicated.
- .5 Bond separate, multiple electrodes together.
- .6 Use size 3/0 AWG copper conductors for connections to electrodes.
- .7 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 primary 600 V system, secondary 120/208 V 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 telephone, sound, fire alarm, security systems, intercommunication systems as follows:
 - .1 Telephones: make telephone grounding system in accordance with telephone company's requirements.
 - .2 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 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 01 61 00 - Common Product Requirements] [with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in dry location 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, surface mounted, suspended in walls and ceilings.

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 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 as per CEC 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 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 C22.1-15, Canadian Electrical Code, Part 1, 23rd Edition.

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.
- .3 Provide shop drawings: in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products**2.1 Splitters**

- .1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Terminations: main and branch lugs connection blocks to match required size and number of incoming and outgoing conductors as indicated.
- .3 Spare Terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

2.2 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.

2.3 Cabinets

- .1 Construction: welded sheet steel hinged door, handle, latch, lock 2 keys and catch
- .2 Type E Empty: surface return flange mounting.

- .3 Type T Terminal: flush overlapping sides mounting containing sheet steel 19 mm G1S fir plywood backboard.

Part 3 Execution

3.1 Splitter Installation

- .1 Mount plumb, true and square to building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 Junction, Pull Boxes And Cabinets Installation

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Install terminal block] as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.

3.3 Identification

- .1 Equipment Identification: to Section 26 05 00 - Common Work Results for Electrical.
- .2 Identification Labels: size 2 indicating system name voltage and phase or as indicated.

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 C22.1-15, Canadian Electrical Code, Part 1, 23rd Edition.

1.3 Action And Informational Submittals

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

1.4 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 Combination boxes with barriers where outlets for more than one system are grouped.

2.2 Galvanized Steel Outlet Boxes

- .1 One-piece electro-galvanized construction.
- .2 Single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.
- .4 102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5 Extension and plaster rings for flush mounting devices in finished tile walls.

2.3 Conduit Boxes

- .1 Cast FS, FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

2.4 Outlet Boxes For Non-Metallic Sheathed Cable

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

2.5 Fittings - General

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to [35]mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

2.6 Service Fittings

- .1 'High tension' receptacle fitting made of 2 piece die-cast aluminum with brushed aluminum housing finish for 1 single, 1 duplex, two duplex receptacles. Bottom plate with two knockouts for centered or offset installation. 12 x 102 mm extension piece as indicated.

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 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 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 45-M1981(R2003), Rigid Metal Conduit.
 - .3 CSA C22.2 No. 56-04, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .4 CSA C22.2 No. 83-M1985(R2003), Electrical Metallic Tubing.
 - .5 CSA C22.2 No. 211.2-M1984(R2003), Rigid PVC (Unplasticized) Conduit.
 - .6 CAN/CSA C22.2 No. 227.3-05, Nonmetallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.3 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.

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.
- .3 Identify cables for exclusively dc applications.

- .4 Reel and mark shielded cables rated volts as indicated.

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 and expanded ends.
- .4 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.
- .6 Flexible pvc conduit: to CAN/CSA-C22.2 No. 227.3 (R2010).

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 1500 mm 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.

2.5 Expansion Fittings For Rigid Conduit

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

2.6 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 mechanical and electrical service rooms or in unfinished areas.
- .3 Use rigid galvanized steel threaded conduit where required.
- .4 Use epoxy coated conduit underground in corrosive areas.
- .5 Use electrical metallic tubing (EMT) except in cast concrete above 2.4 m not subject to mechanical injury.
- .6 Use rigid pvc conduit underground or in corrosive areas.
- .7 Use flexible metal conduit for connection to motors in dry areas of work.
- .8 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment.
- .9 Minimum conduit size for lighting and power circuits: 19 mm.
- .10 Install EMT conduit from computer room branch circuit panel to outlet boxes.
- .11 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .12 Mechanically bend steel conduit over 19 mm diameter.
- .13 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .14 Install fish cord in empty conduits.
- .15 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .16 Dry conduits out before installing wire.

3.3 Surface Conduits

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended channels.

- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.
- .7 Do not locate conduits within 300mm of flues, steam or hot water lines.
- .8 When a conduit can be run surface, it shall be primed and painted with two coats to match the wall.

3.4 Concealed Conduits

- .1 Run parallel or perpendicular to building lines.

3.5 Conduits In Cast-In-Place Concrete

- .1 Locate to suit reinforcing steel.
 - .1 Install in centre one third of slab.
- .2 Do not strap directly to parallel reinforcing steel (and reduce concrete bond). Strap to reinforcing steel perpendicular to conduit.
- .3 Protect conduits from damage where they stub out of concrete.
- .4 Install sleeves where conduits pass through slab or wall.
- .5 Conduits in slabs: minimum slab thickness 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.
- .8 Obtain approval from Departmental Representative:
 - .1 Where conduits are spaced closer than 3 diameters.
 - .2 For conduits greater than 53mm diameter.
 - .3 Where conduits must be run less than 8 diameters from columns.
- .9 Protect conduits from damage where they stub out of concrete.

3.6 Conduits In Cast-In-Place Slabs On Grade

- .1 Run conduits 25 mm and larger below slab and encase in 75 mm concrete envelope.
 - .1 Provide 50 mm of sand over concrete envelope below floor slab.
- .2 Installation of conduits in cast-in-place slabs on grade is acceptable for feeding free-standing equipment only. Installation of conduits in cast-in-place slabs on grade shall not be permitted for any other application.

3.7 Conduits Underground

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

3.8 Installation Of Emt Conduit

- .1 Use EMT strictly in accordance with Rules 12-1400 to 12-1412 inclusive of CEC.

3.9 Installation Of Fire Alarm Emt

- .1 Installation to be as for EMT.

3.10 Installation Of Rigid Metal Conduit

- .1 Touch up damage to epoxy finish on rigid conduit fittings with touch-up paint supplied by manufacturer. Paint exposed threads on rigid conduit with epoxy paint.

3.11 Installation Of Rigid Pvc Conduit

- .1 Use strictly in accordance with Rules 12-1100 inclusive of CEC.
- .2 When not encased in concrete:
 - .1 Provide expansion joints and follow manufacturer's recommendations and code requirements with respect to expansion/contraction, particularly where temperature variations are anticipated.
 - .2 Install conduits loosely with straps and clamps to allow movement.
 - .3 Provide bonding and grounding.

3.12 Installation Of Liquid Tight Flexible Conduit

- .1 Provide a separate ground conductor within flexible conduit, bonded to motor frames and system ground.
- .2 Install conduit to prevent liquids draining to connectors.

3.13 Conduit And Cable Identification

- .1 As per corresponding section.

3.14 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 Sections of Divisions 26 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 CSA International
 - .1 CAN/CSA-C22.2 No.47-M90(R2007), Air-Cooled Transformers (Dry Type).
 - .2 CSA C9-02(R2007), Dry-Type Transformers.
 - .3 CAN/CSA-C802.2-06, 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 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 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 Type: ANN.
 - .2 3 phase, kVA as indicated on drawings, 600V input, 120/208 V output, 60 Hz.
 - .3 Voltage taps: 2x2.5% FCAN and 2x2.5% FCBN.
 - .4 Insulation: Class 220, 150 degrees C temperature rise.
 - .5 Basic Impulse Level (BIL): standard.
 - .6 Hipot: standard.
 - .7 Average sound level: standard
 - .8 Impedance at 17 degrees C: standard
 - .9 Enclosure: NEMA, removable metal front panel.
 - .10 Mounting: as indicated.
 - .11 Finish: in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .12 Copper windings.
 - .13 Winding configuration to be as noted on drawings.
 - .14 Harmonic Mitigating Phase Shifting transformers as indicated on drawings.
 - .15 KL-Rated Transformers as indicated on drawings.
 - .16 Voltage Regulation to be 4% or better.

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 Provide concrete 100mm thick housekeeping pad c/w 100mm perimeter edge around enclosure.

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.

1.2 References

1.3 Action And Informational Submittals

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

1.4 Delivery, Storage And Handling

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

Part 2 Products

2.1 Equipment

- .1 Fused disconnect switch: in accordance with Section 26 28 23 - Disconnect Switches - Fused and Non-Fused, rating[as indicated.
- .2 Enclosed circuit breaker: in accordance with Section 26 28 16.02 - Moulded Case Circuit Breakers, rating as indicated.
- .3 Panelboard breaker type: in accordance with Section 26 24 16.01
- .4 Cabinet type 'A' for utility revenue metering: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets, size 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 service equipment installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative DCC 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 service equipment.
- .2 Connect to incoming service.
- .3 Connect to outgoing load circuits.
- .4 Install ground fault equipment.
- .5 Make grounding connections in accordance with Section 26 05 28 - Grounding - Secondary.
- .6 Make provision for power supply authority's metering.

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 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 CSA Group
 - .1 CSA C22.2 No.31-10, Switchgear Assemblies.
 - .2 CAN/CSA C22.2, No5-15, Surge Protection

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 service entrance board and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Indicate on drawings:
 - .1 Floor anchoring method and foundation template.
 - .2 Dimensioned cable entry and exit locations.
 - .3 Dimensioned position and size of bus.
 - .4 Overall length, height and depth.
 - .5 Dimensioned layout of internal and front panel mounted components.
 - .2 Include time-current characteristic curves for circuit breakers and fuses.

1.4 Maintenance Material Submittals

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

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 service entrance board for incorporation into manual.
- .3 Submit 3 copies of operation and maintenance manual.

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

Part 2 Products

2.1 Service Entrance Board

- .1 Service Entrance Board: to CSA C22.2 No.31.
- .2 Rating: 400A-347/600 V, 3 phase, 4 wire, 400A, short circuit current 25 kA (rms symmetrical), built-in SPD, 240KA(surge current rating) c/w test diagnostic switches, red and green, status LED's per phase, audible arm with disable switch, surge counter.
- .3 Bottom entry.
- .4 Cubicles: pad/wall-mounted, size as indicated.
- .5 Barrier metering section from adjoining Sections.
- .6 Distribution section.
- .7 Hinged access panels with captive knurled thumb screws.
- .8 Bus bars and main connections: 99.3% copper.
- .9 Identify phases with colour coding.

2.2 METER

- .1 To consist of electronic stand-alone meter, current transformers, and a communications system as described herein.
- .2 To measure true line/phase/max/min RMS voltages and currents, neutral currents, frequency, harmonics, KW, KVAR, KVA, power factor, and complete with Ethernet communication ports, communication software and modem.
- .3 System ready to permit both local (PC based) and remote monitoring by modem connection without additional equipment or modifications.
- .4 Meters to be used for Customer Billing of tenant gas usage, water usage, and electricity usage, demand and power factor.
- .5 The meters will be capable of remote communication utilizing an ethernet port installed in meter.

- .6 System to have backup storage power to key components so that no data is lost during power outages. The system shall continue to function after resumption of power. Data to be retained for 8500 hours with a 20 year shelf life.
- .7 System unit and have sufficient memory to record seven days of data without writing over recorded data in the event of a communications failure.
- .8 Failure of the building electrical normal power system shall not result in loss of date and will not require manual restarting of the metering system.
- .9 System to be fully solid state and compatible with all associated equipment and be supplied complete with all required current and potential transformers and communications software.

2.3 POWER SUPPLY AUTHORITY METERING

- .1 Separate cubicle and metal raceway for exclusive use of power supply authority metering.
- .2 Mounting accessories and wiring for metering supplied by power supply authority:
 - .1 Potential transformers.
 - .2 Current transformers.
 - .3 Watthour meter.
 - .4 Demand meter with kWh register.

2.4 Moulded Case Circuit Breakers

- .1 Refer to specification section 26 28 12.02 – Moulded Case bolt on Circuit Breakers.

2.5 Grounding

- .1 Copper ground bus extending full width of cubicles and located at bottom.
- .2 Lugs at each end for size #4 and #1 AWG grounding cable.

2.6 Finishes

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results for Electrical.
 - .1 Service entrance board exterior: gray.

2.7 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Nameplates:
 - .1 White plate, black letters, size 7.
 - .2 Complete board labelled: "600 V."
 - .3 Main disconnect labelled: "Main Breaker".

- .4 Branch disconnects labelled: "Feeder No . 1", "Feeder No. 2", "Feeder No. 3", etc.

2.8 Source Quality Control

- .1 Departmental Representative to witness final factory tests.
- .2 Notify Departmental Representative in writing 5 days in advance that service entrance board is ready for testing.

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 service entrance board 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 service entrance board and fasten to wall.
- .2 Connect main secondary service to line terminals of main breaker.
- .3 Connect load terminals of distribution's breaker's to feeders.
- .4 Check factory made connections for mechanical security and electrical continuity.
- .5 Run one grounding conductor #4 and #1 AWG bare copper in 25 mm conduit from ground bus to building ground.
- .6 Check trip unit settings against co-ordination study to ensure proper working and protection of components.

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 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 rated for 14 or 65 kA (symmetrical) interrupting capacity or as indicated.
- .3 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .4 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated.
- .5 Minimum of 2 flush locks for each panel board.
- .6 Two keys for each panelboard and key panelboards alike.
- .7 Copper bus with neutral of same ampere rating of mains.
- .8 Mains: suitable for bolt-on breakers.
- .9 Trim with concealed front bolts and hinges.
- .10 Trim and door finish: baked enamel.
- .11 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 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 CSA International
 - .1 CAN/CSA C22.2 No.94.1-07, Enclosures for Electrical Equipment, Non Environment Considerations.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA 250-2008, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .3 The Munsell System of Colour Notation

1.3 Action And Informational Submittals

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for electrical cabinets and enclosures 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 electrical cabinets and enclosures 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 electrical cabinets and enclosures from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 Materials

- .1 Enclosure constructed with 2.7 mm thick minimum steel, with weather and corrosion resistant finish to CAN/CSA C22.2, Munsell Notation 7.5GY3.5/1.5, size as indicated.
- .2 Entire enclosure to be capable of withstanding maximum impact force of 86 MN/m² area without rupture of material.
- .3 Removable enclosure panels with formed edges, galvanized steel external fasteners removable only from inside enclosure.
- .4 Equip enclosure with hot dipped galvanized mounting rails 1m adjustable horizontally and vertically to enable mounting of equipment at any location within housing.
 - .1 Rails: 14 mm holes and 50 x 14 mm slots on 100 mm centres for horizontal adjustment.
 - .2 Holes in side panel flanges in 60 mm increments for vertical adjustment.
- .5 Cover: tamperproof, bolt-on, domed to shed water.
- .6 Door: 3 point latching, with padlocking means.
- .7 Ventilation panel constructed to allow air circulation yet preventing entry of foreign objects, wild life, and vermin.
- .8 Enclosure construction such as to allow configuration of single or ganged enclosures.
- .9 Enclosure capable of being shipped in knocked-down condition.

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electrical cabinet and enclosure 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 Assemble enclosure in accordance with manufacturer's instructions and securely mount on building structure with channels, supports and fastenings.
- .2 Mount equipment in enclosure.

- .3 Label electrical cabinets and enclosure to Section 26 05 00 - Common Work Results for Electrical.

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 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .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.111-10, General-Use Snap Switches (Bi-national standard, with UL 20).

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

Part 2 Products

2.1 Switches

- .1 15A, 120V AC, premium specification grade, single pole, commercial decorator paddle type and complete with the following features:
 - .1 Terminal holes approved for #10 AWG wiring.
 - .2 Silver alloy contacts.
 - .3 Urea molding.
 - .4 Suitable for side and back wiring.
 - .5 Fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity for motor loads.
 - .6 Standard of acceptance: Arrow Hart 7601AM White. Other acceptable manufacturers: Pass & Seymour-Legrand, Hubbell, Bryant.
 - .7 Impact Resistant
- .2 Switches of one manufacturer throughout project.
- .3 Complete with pilot light as indicated. Pilot lights to be illuminated in the "off" position.
- .4 Acceptable manufacturer: Bryant, Arrow Hart, Pass and Seymour.

2.2 Receptacles

- .1 Duplex receptacles, NEMA No. 5-15 R, 125 VAC, 15 A, parallel slot, U ground, with the following features:
 - .1 Suitable for #10 AWG back and side wiring.
 - .2 Break-off links for use as split receptacles.
 - .3 Double wipe contacts and non-riveted grounding contacts.
 - .4 Aluminum yokes, blades or terminals or with CU/AL rating will not be accepted.
 - .5 Acceptable manufacturer: Arrow Hart #5262, Bryant #5262, Pass and Seymour #5262
- .2 Single receptacles NEMA No. 5-15R, 125V AC, 15A, U-ground, suitable for #10 back and side wiring.
- .3 Other receptacles with ampacity and voltage as required.
- .4 Receptacles of one manufacturer throughout project.
- .5 Colour of receptacles shall be as follows:
 - .1 White for normal power.
- .6 Duplex receptacles, NEMA No. 5-20 R, T slot, 125 VAC, U ground, with the following features:

- .1 Nylon face.
 - .2 Suitable for #10 AWG back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Double wipe contacts and non-riveted grounding contacts.
 - .5 Aluminum yokes, blades or terminals or with CU/AL rating will not be accepted.
 - .6 Acceptable manufacturers: Bryant #5362, Arrow Hart #5362, Pass & Seymour #5362.
- .7 Duplex receptacles, NEMA No. 6-30 R, 250 VAC, with the following features:
- .1 Nylon face.
 - .2 Suitable for #8 AWG back and side wiring.
 - .3 Double wipe contacts and non-riveted grounding contacts.
 - .4 Aluminum yokes, blades or terminals or with CU/AL rating will not be accepted.
- .8 Standard of acceptance: Pass & Seymour-Legrand #1801. Other acceptable manufacturers: Bryant, Arrow Hart.

2.3 Special Wiring Devices

- .1 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for weatherproof duplex receptacles.
- .2 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.
- .3 Provide special receptacles as required to suit specific equipment requirements as follows:
 - .1 30 amp, 125/250V, 3-pole, 4-wire receptacle NEMA #14-30R.
 - .2 20 amp, 125V, 2-pole, 3-wire universal receptacle NEMA #5-20RA.
 - .3 50 amp, 250V, 2-pole, 3-wire universal receptacle NEMA #6-50RA.
 - .4 Refer to floor plans for locations.
- .4 Ground fault circuit interrupting receptacle (GFCI), 15A, 125V, nylon face, feed-thru feature, contrasting colour band on reset button, screw terminals, white-coloured face.
Standard of acceptance: Pass & Seymour-Legrand 1595 White.
Other acceptable manufacturers: Bryant, Arrow Hart.
- .5 Ground fault circuit interrupting receptacle (GFCI), 20A, 125V, nylon face, feed-thru feature, contrasting colour band on reset button, screw terminals, white-coloured face.
Standard of acceptance: Pass & Seymour-Legrand 2095 White.
Other acceptable manufacturers: Bryant, Arrow Hart.

- .6 Ground fault circuit interrupter receptacle: Class A rated, CSA type 5-15R, 125V, 15A feed through rated to: CSA-C22.2 No. 144 with the following features:
 - .1 Specification grade.
 - .2 Nylon moulded housing.
 - .3 Decora style.
 - .4 Suitable for No. 10 AWG for side and back wiring.
 - .5 Solid state ground sensing device.
 - .6 Testing and reset buttons.
 - .7 Indicator light to show status of GFCI protection operation.
 - .8 Malfunction protection. Device cannot be reset if GFCI is non operational or unit is wired incorrectly.
 - .9 30mA trip level.
- .7 Ground fault circuit interrupter receptacle: Class A rated, CSA type 5-20R, 125V, 20A T-Slot feed through rated to: CSA-C22.2 No. 144 with the following features:
 - .1 Specification grade.
 - .2 Nylon moulded housing.
 - .3 Decora style.
 - .4 Suitable for No. 10 AWG for side and back wiring.
 - .5 Solid state ground sensing device.
 - .6 Testing and reset buttons.
 - .7 Indicator light to show status of GFCI protection operation.
 - .8 Malfunction protection. Device cannot be reset if GFCI is non operational or unit is wired incorrectly.
 - .9 30mA trip level.

2.4 Metal While-In-Use Weather Protective Cover Boxes

- .1 Device To Meet Cec For Receptacles In Damp Or Wet Locations.**
- .2 Diecast Powder Coated Aluminum. Vertical Or Horizontal As Indicated.**
- .3 Nema 3R Rating**
- .4 Complete With Gasket, Mounting Hardware, Duplex Receptacle Insert And Gfci Receptacle Insert**
- .5 Lockable To Prevent Accidental Disconnects.**

2.5 Cover Plates

- .1 Provide cover plates for all wiring devices.
- .2 Cover plates from one manufacturer throughout project.
- .3 Coverplates for surface mounted receptacles and switches on exposed conduit systems shall be stainless steel 12mm raised type.

- .4 Stainless steel coverplates, thickness 1mm for wiring devices mounted in flush-mounted outlet box.
- .5 Cast gasketed coverplates for wiring devices mounted in surface-mounted cast Feraloy type conduit boxes.
- .6 Duplex cast aluminum spring-loaded weatherproof coverplates for exterior mounted wiring devices, flush mounted or surface mounted in FS or FD boxes.
- .7 Acceptable manufacturer: Pass and Seymour, Arrow Hart, Bryant.

2.6 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 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 Not used

1.3 Action And Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Provide fuse performance data characteristics for each fuse type and size. Performance data to include: average melting time-current characteristics.
- .3 Shop Drawings:
 - .1 Provide shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

1.4 Delivery, Storage And Handling

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet.

1.5 Extra Materials

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Six spare fuses of each type and size installed.

Part 2 Products

2.1 Fuses - General

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.

2.2 Fuse Types

- .1 Class L fuses.

- .1 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
- .2 Type L2, fast acting.
- .2 Class J fuses.
 - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type J2, fast acting.
- .3 Class R -R fuses.
 - .1 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, to meet UL Class RK1 maximum let-through limits.
 - .2 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .3 Type R3, (UL Class RK1), fast acting Class R, to meet UL Class RK1 maximum let-through limits.
- .4 Class C fuses.

2.3 Fuse Storage Cabinet

- .1 Fuse storage cabinet, manufactured from 2.0 mm thick aluminum 750 mm high, 600 mm wide, 300 mm deep, hinged, lockable front access door finished in accordance with Section 26 05 00 - Common Work Results for Electrical.

Part 3 Execution

3.1 Installation

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
 - .1 Install rejection clips for Class R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.
- .5 Install spare fuses in fuse storage cabinet.

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 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 [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 22,000 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 adjustable trips to range from 3-8 times current rating.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 10kA 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 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

1.1 Related Requirements

- .1 This Section covers items common to Sections of Divisions 26 and 28. These Sections supplement requirements of Division 1.

1.2 Payment

- .1 Payment for field testing of ground fault equipment performed by Contractor in accordance with Section 01 29 83 - Payment Procedures: Testing Laboratory Services.

1.3 References

- .1 CSA International
 - .1 CAN/CSA C22.2 No.144-M91(R2006), Ground Fault Circuit Interrupters.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA PG 2.2-1999(R2009), Application Guide for Ground Fault Protection Devices for Equipment.

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 ground fault circuit interrupters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Test and Evaluation Reports: submit test report for field testing of ground fault equipment to Departmental Representative and certificate that system as installed meets criteria specified.

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 ground fault circuit interrupters for incorporation into manual.

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

Part 2 Products

2.1 Materials

- .1 Equipment and components for ground fault circuit interrupters (GFCI): to CAN/CSA C22.2 No.144.
- .2 Components comprising ground fault protective system to be of same manufacturer.

2.2 Breaker Type Ground Fault Interrupter

- .1 Single pole ground fault circuit interrupter for 15A, 120V, 1 phase circuit c/w test and reset facilities.

2.3 Ground Fault Protector Unit

- .1 Self-contained with 15 A, 120 V circuit interrupter and duplex receptacle complete with:
 - .1 Solid state ground sensing device.
 - .2 Facility for testing and reset.
 - .3 CSA Enclosure 1, surface mounted with stainless steel face plate.

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 ground fault circuit interrupters 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 not ground neutral on load side of ground fault relay.
- .2 Pass phase conductors including neutral through zero sequence transformers.

- .3 Connect supply and load wiring to equipment in accordance with manufacturer's recommendations.

3.3 Field Quality Control

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and co-ordinate with Section 01 45 00 - Quality Control if required.
- .2 Arrange for field testing of ground fault equipment by independent testing laboratory before commissioning service.
- .3 Demonstrate simulated ground fault tests.

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 and 28. These Sections supplement requirements of Division 1.

1.2 References

- .1 CSA Group
 - .1 CAN/CSA-C22.2 No.4-04(R2009), Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
 - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

1.3 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 disconnect switches - fused and non-fused 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 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 Non-fusible, Horsepower rated disconnect switch in CSA enclosure, to CAN/CSA-C22.2 No.4 size as indicated.
- .2 Provision for padlocking in on-off switch position by 3 locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.

- .4 Fuses: size as indicated, in accordance with Section 26 28 13.01 - Fuses - Low Voltage.
- .5 Fuseholders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 Equipment Identification

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Indicate name of load controlled on size 4 nameplate.

Part 3 Execution

3.1 Examination

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 Installation

- .1 Install disconnect switches complete with fuses if applicable.

3.3 Cleaning

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

- .1 American National Standards Institute (ANSI)
- .2 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.
- .3 ASTM International Inc.
 - .1 ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
- .4 Canadian Standards Association (CSA International)
- .5 ICES-005-07, Radio Frequency Lighting Devices.
- .6 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 approval by Departmental Representative.
 - .3 Photometric data to include: spacing criterion.
- .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, cleaning procedures.
- .4 Submit application for Manitoba Hydro Power Smart Commercial Lighting Rebate along with all lighting shop drawing

1.4 Quality Assurance

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

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, address.

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 or rigid conduit for luminaires as indicated.

3.3 Luminaire Supports

- .1 For suspended ceiling installations support luminaires independently of ceiling, support luminaires from ceiling grid in accordance with local inspection requirements.

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 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.
- .4

1.6 Warranty

- .1 For batteries in this Section 26 52 00 - Emergency Lighting, 12 months warranty period is extended to 120 months.

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 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.

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 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 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 Indicate on shop drawings:
 - .1 Detail assembly and internal wiring diagrams for control unit[s]. Consoles and Auxiliary cabinets.
 - .2 Overall system riser wiring diagram identifying control equipment, initiating zones, signaling circuits; 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 Verification

- .1 The complete system in the entire Building shall be tested and verified in accordance with Standard CAN/ULC-S537, Standard for the Verification of Fire Alarm System Installation. Upon completion, a Certificate of Verification and a copy of the Verification Report shall be submitted to the Engineer.

1.5 Witness Test

- .1 Provide witness test after fire alarm has been verified. Provide document stamped and sealed by a professional Engineer registered in the Province of Manitoba

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 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.

1.7 Maintenance Material Submittals

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

1.8 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 Description

- .1 Fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital, and multiplexing techniques for data transmission.
- .2 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to monitoring agency.
- .3 Zoned, non-coded single stage.
- .4 Modular in design to allow for future expansion.
- .5 Operation of system shall not require personnel with special computer skills.
- .6 System to include:
 - .1 Central Control Unit in separate enclosure with power supply, stand-by batteries, central processor with microprocessor and logic interface, main system memory, input-output interfaces for alarm receiving, annunciation/display, and program control/signalling.
 - .2 Data Gathering Panels/Transponders with stand-alone capabilities.
 - .3 Power supplies.
 - .4 Initiating/input circuits.
 - .5 Output circuits.
 - .6 Auxiliary circuits.
 - .7 Wiring.
 - .8 Manual and automatic initiating devices.
 - .9 Audible and visual signalling devices.
 - .10 End-of-line resistors.
 - .11 Local and Remote annunciators.
 - .12 Historic event recorder.
- .7 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .8 Power supply: to CAN/ULC-S524.
- .9 Audible signal devices: to CAN/ULC-S524.
- .10 Visual signal devices: to CAN/ULC-S526.
- .11 Control unit: to CAN/ULC-S527.
- .12 Manual pull stations: to CAN/ULC-S528.
- .13 Thermal detectors: to CAN/ULC-S530.
- .14 Smoke detectors: to CAN/ULC-S529.
- .15 Smoke alarms: to CAN/ULC-S531.

.16 Regulatory Requirements:

- .1 To TBS 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, Local, Provincial Building Code, and meet requirements of local authority having jurisdiction.

2.2 System Operation: Single Stage - Signals Only

.1 Actuation of any alarm initiating device 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 remote annunciator.
- .3 Cause audible signalling devices to sound continuously throughout building and at central control unit.
- .4 Transmit signal to fire department via 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.
- .7 Cause elevators to return to floor of egress, or to alternate floor, as required.

.2 Acknowledging alarm: indicated at central control unit.

.3 Ensure that it is possible to silence signals by "alarm silence" switch at control unit, after 60 seconds period of operation.

.4 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.

.5 Actuation of supervisory devices 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 and at remote annunciator.
- .3 Cause audible signal at central control unit to sound.
- .4 Activate common supervisory sequence.

.6 Resetting alarm device not to return system indications/functions back to normal until control unit has been reset.

.7 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;

whereas visual indication to remain until trouble is cleared and system is back to normal.

- .8 Trouble on system: suppressed during course of alarm.
- .9 Trouble condition on any circuit in system not to initiate alarm conditions.

2.3 Control Panel

- .1 Central control unit (CCU).
 - .1 Suitable for DCLA communication style: to CAN/ULC-S524.
 - .2 Features specified are minimum requirements for microprocessor-based system with digital data control and digital multiplexing techniques for data transmission.
 - .3 Minimum capacity of minimum 200 addressable monitoring and 100 addressable control/signal points. Points may be divided between 2 communication channels in distributed system, each channel operating independently of other. Faults on one communication channel not to affect operation of other channel.
 - .4 System to provide for priority reporting levels, with fire alarm points assigned highest priority, supervisory and monitoring lower priority, and third priority for troubles. Possible to assign control priorities to control points in system to guarantee operation or allow emergency override as required.
 - .5 Integral power supply, battery charger and standby batteries.
 - .6 Basic life safety software: retained in non-volatile Erasable Programmable Read-Only-Memory (EPROM). Extra memory chips: easily field-installed. Random-Access-Memory (RAM) chips in panel to facilitate password-protected field editing of simple software functions (i.e. zone labels, priorities) [and changing of system operation software].
 - .7 Circuitry to continuously monitor communications and data processing cycles of microprocessor. Upon failure, audible and visual trouble indication to activate.
 - .8 Communication between CCU and remote DGP's/TPR's to be supervised, DCLA. Should communications fail between CCU and remote units, audible and visual trouble to be indicated at CCU. Data communication to be binary DC, baseband, time-division multiplex, half-duplex. Each data channel: capable of communicating up to distance of 3,000 m.
 - .1 Communication between nodes in networked system to be supervised, DCLA. Should communications fail between any 2 nodes, other nodes on loop to continue to communicate with each other and programmed functions on communicating nodes to continue operating.
 - .9 Equipped with software routines to provide Event-Initiated-Programs (EIP); change is status of one or more monitor points, may be programmed to operate any or all of system's control points.

- .10 Software and hardware to maintain time of day, day of week, day of month, month and year.
- .11 Software to operate variable sensitivity addressable smoke detectors and annunciate their status and sensitivity settings at control panel.

2.4 Data Gathering Panels (Dgp's)/Transponders

2.5 Power Supplies

- .1 120 V, 60 Hz as primary source of power for system.
- .2 Voltage regulated, current limited distributed system power.
- .3 Primary power failure or power loss (less than 102 V) will activate common trouble sequence.
- .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
- .5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.
- .6 Standby batteries: sealed, maintenance free.
- .7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

2.6 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".

2.7 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 horns continuously at 20 spm 2 A, 24 VDC; fuse-protected from overloading/overcurrent.
 - .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

2.8 Auxiliary Circuits

- .1 Auxiliary contacts for control functions.
- .2 Actual status indication (positive feedback) from controlled device.
- .3 Alarm 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.

2.9 Wiring

- .1 Twisted copper conductors: rated 600 V.
- .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.

2.10 Manual Alarm Stations

- .1 Manual alarm stations: pull lever, wall mounted surface type, non-coded single pole normally open contact for single stage and general alarm English signage.
- .2 Addressable manual pull station.
 - .1 Pull lever, surface wall mounted type, single action, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field.

2.11 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 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 57degrees C, rate of rise 8.3 degrees C per minute.

- .1 Electronics to communicate detector's status to addressable module/transponder.
- .2 Detector address to be set on detector base in field.
- .4 Smoke detector: [ionization] [photo-electric] type air duct type with sampling tubes with protective housing.
 - .1 Twistlock Plug-in type with fixed base.
 - .2 Wire-in base assembly with integral red alarm LED, and terminals for remote relay alarm LED.
- .5 Addressable smoke detector.
 - .1 Ionization and Photo-electric type.
 - .2 Electronics to communicate detector's status to addressable module/transponder.
 - .3 Detector address to be set on detector base in field.
- .6 Addressable variable-sensitivity smoke detectors.
 - .1 Ionization and Photo-electric type.
 - .2 Electronics to communicate detector's status to addressable module/transponder.
 - .3 Detector address to be set on detector base in field.
 - .4 Sensitivity settings: 7 settings, determined and operated by control panel. No shifting in detector sensitivity due to atmospheric conditions (dust, dirt) within certain parameters.
 - .5 Ability to annunciate minimum of 2 levels of detector contamination automatically with trouble condition at control panel.

2.12 Audible Signal Devices

- .1 Horns: 85 db, 24 V dc.

2.13 Visual Alarm Signal Devices

- .1 Strobe type: flashing, 24 V dc.
- .2 Designed for surface mounting on walls as indicated.

2.14 End-Of-Line Devices

- .1 End-of-line devices to control supervisory current in alarm circuits and 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.

2.15 Remote Annunciators

- .1 LED remote alphanumeric type, with designation cards to indicate zones.
- .2 Display:
 - .1 Alarms and troubles for alarm initiating circuits.

- .2 common supervisory alarm for supervisory initiating circuits.
- .3 Common system trouble.
- .3 Trouble buzzer:
 - .1 Acknowledging trouble at main panel to silence trouble buzzers in system.
- .4 Supervised, with LED test button trouble acknowledge button.
- .5 Minimum wiring configuration with main panel and other remote annunciators.

2.16 Graphic Display

- .1 Passive type.

2.17 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.

2.18 As-Built Riser Diagram

- .1 Fire alarm system riser diagram: in glazed frame on black lamacoid sheet with bevelled edges, white lettering and designations, minimum size 600 x 600 mm.

2.19 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.
- .2 Install central control unit and connect to ac power supply, dc standby power.
- .3 Install manual alarm stations and connect to alarm circuit wiring.

- .4 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.
- .5 Connect alarm circuits to main control panel.
- .6 Install horns and visual signal devices and connect to signalling circuits.
- .7 Connect signalling circuits to main control panel.
- .8 Install end-of-line devices at end of alarm and signalling circuits.
- .9 Install remote annunciator panels and connect to annunciator circuit wiring.
- .10 Install door releasing devices.
- .11 Install remote relay units to control fan shut down.
- .12 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .13 Room detection system.
 - .1 Install detectors. Make necessary connections between room detection panel and main fire alarm panel.
 - .2 Locate and install audible signals 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.
- .14 Connect fire suppression systems to control panel.
- .15 Splices are not permitted.
- .16 Provide necessary raceways, cable and wiring to make interconnections to terminal boxes, annunciator equipment and CCU, as required by equipment manufacturer.
- .17 Ensure that wiring is free of opens, shorts or grounds, before system testing and handing over.
- .18 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 Test such device and alarm circuit to ensure manual stations, smoke detectors transmit alarm to control panel and actuate 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.
 - .3 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.
- 3.7 Maintenance**
- .1 Provide individual price on tender form for subsequent PROM re-burns. Price: good for 5 years from date of project completion.
 - .2 Provide individual price on tender form for temporary program changes during construction period, to include zone labels, control functions, system operation.

END OF SECTION

Part 1 General

1.1 Related Requirements

- .1 Note Used

1.2 References

- .1 Refer to section 27 05 00 for references applicable to this project.

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 communications equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Construction/Demolition Waste Management and Disposal in accordance with Section 10 74 21

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect communications equipment 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
Packaging Waste Management: remove for reuse and return by manufacturer of 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 Equipment Rack

- .1 EIA compliant adjustable mounting rails.

- .2 UL Listed 2416 - meets new UL requirements for wall mount cabinets.
- .3 UL rated for up to 350 lbs (159 kg) static load rating.
- .4 Vented 63% perforated front door.
- .5 Center section features:
 - .1 Heavy duty spring-hinge pin for easy installation and removal.
 - .2 Side panel that includes two (2) vents and fan grill.
- .6 Rear section features:
 - .1 Top and side conduit knock-outs for cable entry.
 - .2 Generous cable management lances located on the rear section as well as on mounting rails.
 - .3 Mounting points for Outlet Strip (uses HWMPCLIP).
 - .4 Heavy duty keyhole for wall mounting.
 - .5 Large opening in rear for cable access.
- .7 Front door and center section keyed the same (optional key available).
- .8 Specifications:
 - .1 14-gauge welded rear section; 16-gauge center section and doors.
 - .2 EIA compliant adjustable depth mounting rails.
 - .3 Includes one (1) pair of tapped (10-32) mounting rails.
 - .4 Grounding lugs located on top and bottom of the door, center and rear sections.
 - .5 Rugged sand-textured black powder paint (reduced fingerprints and marks).
 - .6 RoHS Compliant.
 - .7 Overall dimensions of rack shall be 627mm W x 1238mm H x 804mm D with 26 useable rack spaces.
 - .8 Acceptable Product: Hammond HWM2424U26BK, Middle Atlantic, Electron Metal. Complete with 6 duplex outlet surge protected power bar, outlets facing rear.

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 communications 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

- .1 Install grounding conductor between new telecom room 104 grounding bus bar and existing telecom room 206.
- .2 Install 2-post rack in telecom room 104
- .3 Install Small equipment rack in room 110, coordinate with millwork supplier the installation of rack and with 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 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.

2.4 Protection

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

END OF SECTION

Part 1 General

1.1 References

- .1 American National Standards Institute
 - .1 ANSI J-STD-607-B-2011, Joint Standard - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.
- .2 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)
 - .1 TIA/EIA-606-B-2012, Administration Standard for the Commercial Telecommunications Infrastructure.
- .3 U.S. Department of Labor/Occupational Safety and Health Administration (OSHA)
 - .1 Nationally Recognized Testing Laboratory (NRTL).
- .4 Canadian Standards Association (CSA International)
 - .1 CSA C22.1-15, Canadian Electrical Code 23rd Ed.
- .5 Building Industry Consulting Services International (BICSI)
 - .1 BICSI Telecommunications Distribution Methods Manual 13th Edition

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 and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products**2.1 Telecommunications Grounding Busbar (Tgb)**

- .1 A Pre-drilled electroplated copper Busbar with holes for use with standard 2 hole lugs with standard NEMA bolt hole sizing and spacing..
- .2 Shall be sized accordance with the immediate connection requirements with a minimum of 4 extra sets of holes.
- .3 Shall be a minimum size of 6mm thick, 53mm high and variable in length.
- .4 Shall include Insulated supports with a minimum of 50mm separation from mount.
- .5 Shall be listed by a nationally recognized testing laboratory.
- .6 Acceptable Products: Cable-Talk CT-BIBB 2X10-12, Panduit GB2B0306TPI-1, Erico TGB-A14L06PT.

2.2 Bonding Conductor For Telecommunications

- .1 3/0 AWG stranded copper conductor, green insulated marked to: ANSI J-STD-607-B.

2.3 Telecommunications Bonding Backbone (Tbb)

- .1 3/0 AWG stranded copper conductor, green insulated marked to: ANSI J-STD-607-B.

2.4 Equipment Bonding Conductor (Ec)

- .1 6 AWG stranded copper conductor, green insulated marked to: ANSI J-STD-607-B.

2.5 Raceway Bonding Conductor (Rbc)

- .1 6 AWG stranded copper conductor, green insulated marked to: ANSI J-STD-607-B.

2.6 Bonding Conductor Termination

- .1 Two-Hole compression lugs, long barrel type, sized as per AWG of cable.
- .2 High conductivity wrought copper.
- .3 Electro tin plated
- .4 Hole spacing as per TMGB and TGB.

2.7 Insulated Conduit Ground Bushings

- .1 Each Metal Conduit originating in the Telecom Entrance Facility, Telecom Room or Equipment Room shall be directly connected to the TMGB or TGB via a compression lug.
- .2 Ground bushing shall be insulated.

2.8 Bonding And Grounding Clamps

- .1 All ground wires originating at the TMGB or TGB shall be clamped to the plywood backboard "B" ground wire clamps.
- .2 Shall be mechanically galvanized ASTM B695
- .3 5.6mm hole diameter

2.9 Cable Tray Bonding Clamps

- .1 Shall be constructed of malleable iron
- .2 Zinc plated
- .3 Shall allow for clamping of ground wire of multiple gauges.

2.10 Warning Labels

- .1 Non-metallic warning labels in English and French to: ANSI J-STD-607-B.
- .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 General Installation Requirements**

- .1 Install all Bonding Conductors as per CEC. And manufacturers recommended installation procedures.

3.2 Telecommunications Grounding Busbar (Tgb)

- .1 Install TGB in main terminal/equipment room and each telecommunications room.
- .2 Install 3/0 AWG copper bonding conductor from TGB to alternating current equipment ground (ACEG) of serving electrical power panel (panelboard) or main electrical grounding bus bar.

3.3 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 and #6 AWG copper conductor.

3.4 Bonding Conductor For Telecommunications

- .1 Install bonding conductor for telecommunications from TMGB to service equipment (power) ground.
- .2 Use approved 2-hole compression lugs for connection to TMGB.

3.5 Telecommunications Bonding Backbone (Tbb)

- .1 Install TBB from TMGB to each TGB as indicated.
- .2 Use approved 2-hole compression lugs for connection to TMGB and TGBs.

3.6 Grounding Equalizer (Ge)

- .1 Install GE between TBBs in multi-storey building by bonding TGBs with GE on top floor and every third floor in between top and bottom floors.

3.7 Bonding To Tgb

- .1 Bond metallic raceways in telecommunications room to TGB using #6 AWG green insulated copper conductor.
- .2 For cables within telecommunications room having shield or metallic member, bond shield or metallic member to TGB using #12 AWG green insulated copper conductor.
- .3 Bond equipment rack and cabinet located in telecommunications room to TGB using #6 AWG green insulated copper conductor.

3.8 Labelling

- .1 Apply warning labels to telecommunications bonding and grounding conductors.
- .2 Apply additional administrative labels to: TIA/EIA-606-B.

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 C22.1-15, 23rd Edition 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.
- .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 System Description

- .1 Empty telecommunications raceways system consists of outlet boxes, cover plates, single gang raise plaster adapter ring, distribution cabinets, conduits, cable trays, pull boxes, sleeves and caps, fish wires, service poles, service fittings, surface raceways, floor boxes.
- .2 Overhead main cable tray distribution system and combination J-hook/conduit to device outlet installed in accessible ceiling space.
- .3 Voice and data cabling installation is not in contract. Shared Service Canada (SSC) is responsible for the installation, termination and testing of voice and data cabling.

2.2 Cable Trays: Basket Style Cable Tray

- .1 Shall be a pre-fabricated structure, minimum 300 mm wide by 103mm tall consisting of a Basket bottom within basket two side rails.
- .2 Shall be supported on 2 sides and as per manufacturer's instruction and applicable codes.
- .3 Use proper manufactured fittings; accessories and fittings such as cable drop-out fitting, 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, Hubbell, Thomas and Betts

2.3 Hangers And Supports For Communications Systems

- .1 Cable tray shall be supported by Cantilever brackets, Trapeze Brackets, or individual rod suspension. Supports shall be approved types of wall brackets or trapeze hangers. Additional bracing may be required for seismic restraints. Mono support is not acceptable.
- .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 Unistrut or B-line channel, meeting all the manufacturers' requirements for loading.
- .4 Conduits should 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 authorized for Communications Distribution installed in T-bar ceiling space.

2.4 Conduit, Pull Boxes And Outlet Boxes For Communications And Security Systems

- .1 Metallic Conduit
 - .1 Thin Wall EMT, reamed and bushed at both ends.
 - .2 Minimum Size for communications is 27mm inside diameter.
 - .3 Installed above ceilings, under access floors and in walls only; not acceptable for in floor use.
 - .4 Conduits, conduit fittings, hanger and supports: in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings, Section 26 05 29 Hangers and Support for Electrical Systems, Section 26 05 33 Raceway and Boxes for Electrical System
 - .5 Fish wire: polypropylene type.
- .2 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 ANSI/TIA/EIA-569B, Table 12.
 - .4 Pull Boxes for Security systems shall not have pre-punched knockouts.
 - .5 Junction boxes, cabinets type: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
- .3 Outlet Boxes for communications systems
 - .1 Shall be a minimum size of 100mm x 100mm x 65mm deep.
 - .2 Shall have a raised Plaster adapter ring sized for a single gang opening for communications Outlets.
 - .3 Shall have raised plaster adapter ring sized for Access Control devices.
 - .4 Shall have raised plaster adapter ring sized for Digital Wall clock.
 - .5 Shall have raised plaster adapter ring sized for Intrusion Alarm devices.
 - .6 Outlet boxes 2-gang type with single gang plaster ring, conduit, and fittings: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

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 Install empty raceway system, including underfloor overhead distribution system, pull 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.
- .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 and CEC.
- .3 Provide separate conduit/cable tray system for the following systems:
 - .1 Access Control System
 - .2 Voice and Data System
 - .3 Video Surveillance and Access Control
- .4 Electrical Metallic Tubing (EMT) conduits for all Voice Data Systems, Audio/Video system,. Access Control and Video Surveillance systems minimum size to be 27mm unless specified otherwise.
- .5 Electrical Metallic Tubing (EMT) conduits for all Intrusion Alarm and Public Address/Audio systems minimum size to be 21mm unless specified otherwise.
- .6 Provide the following separation from Electrical Power systems installed in conduits:
 - .1 300mm 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 Electrical or Mechanical systems cannot share the same cable tray or be racked on the same support structure.
- .7 Heights of Communications system Outlet Boxes:
 - .1 Telecommunications outlets, 400mm Above Finished Floor (AFF) (the same height as adjacent receptacles)
 - .2 Wall Mounted Telephones or Intercom, 1220mm AFF.
 - .3 Access control Card readers, 1100mm AFF.
 - .4 Intrusion alarm keypads, 1400mm AFF
 - .5 Barrier Free Buttons, 900mm AFF
 - .6 Door Contacts, on leading edge of door frame at top of frame.

3.3 Installation Of Hangers And Supports For Communications Systems.

- .1 Support Cable tray of approved types of wall brackets, trapeze supports. Plumbers perforated straps are not permitted means of supports.
- .2 Centre hung cable tray is not acceptable for communications 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 Communications outlet boxes shall not be placed back to back with another communications outlet box or any other box.
- .6 Maximum Height for installed communications 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 communications racking.

3.4 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 communications outlet per 27mm conduit run.
 - .5 Back to back or offset outlets shall not be used.
 - .6 All Conduits shall originate in the communications 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 communications 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 communications
 - .12 Conduits protruding through the floor shall be terminated 25-50 mm above the finished floor.

- .13 Riser sleeves protruding through the floor shall be terminated 25-75mm above the finished floor, including sleeve and bonding bushing.
- .14 Conduits entering and exiting through the ceiling of a communications Room (TR) shall protrude into the room 25-50mm above the 2400mm level.
- .15 All zone conduits entering a TR (unless otherwise stipulated will protrude into the TR from 25-50 mm without a bend.
- .16 The maximum fill rate authorized for conduits is 40 percent.
- .17 Pull boxes shall not be installed higher than 3353mm above finished floor. Approval of this deviation is on a case by case basis.
- .18 Communications 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 Intrusion Alarm, Sound Masking, Public Address and Access control 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 Communications outlet cannot share the same conduit system or pull boxes.
- .3 OUTLET BOX INSTALLATION REQUIREMENTS

- .1 Install communications Outlet boxes for voice data systems same level as adjacent receptacles and flush to the wall wherever possible.
- .2 Where communications 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 communications 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.

3.5 Cable Tray For Communications Systems

- .1 Cable tray shall be installed above false ceilings or below access floors. Under no circumstances should cable tray be installed above a fixed ceiling. Provide a minimum of two 103mm conduits to transition the fixed ceiling portions. Install additional conduits if the fill rating of the cable requires 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 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.
- .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 manufacturer's 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 a minimum of 300mm from fluorescent luminaries, Power cables shall cross at right angles to communications cables with the separation distances as indicated.
- .8 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.
- .9 Install Grounding and Bonding in accordance with section 27 05 26 and CEC.

- .10 Ensure other building components, i.e.: mechanical ducts, sprinkler pipes, luminaries, etc do not restrict access to Communications cable tray.
- .11 Mark Cable Tray at each transition or connection.
- .12 Provide cable water fall down to 2-post rack.

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 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.

3.7 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 Abbreviations:

- .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.

.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 ULC-S318-96, Standard for Power Supplies for Burglar Alarm Systems.
 - .2 ULC-C634-86, Guide for the Investigation of Connectors and Switches for Use with Burglar Alarm Systems.
- .3 Underwriters' Laboratories (UL)
 - .1 UL 294-2009, Access Control System Units.
 - .2 UL 603-08, Power Supplies for Use with Burglar Alarm Systems.
 - .3 UL 1076-2005, Safety for Proprietary Burglar Alarm Units and 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 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 Alberta, 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 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 Management Plan highlighting recycling and salvage requirements.
 - .2 Submit Construction/Demolition Waste Management and Disposal in accordance with Section 01 74 21.

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 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.

1.4 Delivery, Storage And Handling

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements [with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors 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 Develop Construction Waste Management Plan related to Work of this Section.
- .5 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 Warranty

- .1 For Access control equipment and materials the 12 month warranty period.
- .2 Manufacturer's Warranty: submit, for Landlord's acceptance, manufacturer's standard warranty document executed by authorized company official.

Part 2 Products

2.1 Access Control Cabinet

- .1 Features:
 - .1 Full-sized Cabinet
 - .2 Key-locked Door to prevent tampering

- .3 UL listed control unit enclosure meeting UL 864 standards
- .4 Similar appearance for HVAC control, fire security and automation control panels
- .5 Doors can be installed to open from left or right
- .6 Knockouts for electrical pneumatic, and raceway piping
- .7 Wall mounting or floor mounting with optional Free-Standing Mounting Legs
- .8 Optional Canopy Light
- .9 Optional Back Cover plate
- .10 Optional Tamper Switch
- .2 Description
 - .1 The General Purpose Cabinet ("Cabinet") is constructed from a separately ordered Rough-in Ring, Subpanel and Door with a lock. Lighting and hardware accessories are available to complete a surface-mounted, a flush-mounted or a lighted, freestanding installation. The Cabinets are used in HVAC control, fire alarm, security and automation control systems. One or more Cabinets can be mounted together to form a panel. For ease of piping and wiring, the usual limit is six Cabinets to a panel.
 - .3 Acceptable Products or equals: Honeywell 14506636-001

2.2 Access Control Units

- .1 The Access Control Unit is used as the sub-component to the Security Management System for the purpose of initiating all decision making criteria as it relates to the cardholders, readers and the associated hardware connected. Decisions made by the LPC are uploaded to the host computer as historical events. Each LPC shall:
 - .1 The LPC shall be listed for Underwriters Laboratory (UL):
 - .1 UL 294 (Access Control System)
 - .2 UL 1076 (Proprietary Alarm Monitoring System)
 - .3 CE Mark
 - .2 Support year 2009 compliance without the need for future software of hardware updates
 - .3 Operate without the need for the host to be on-line. No decisions shall be reliable on the host.
 - .4 Utilize RS485 multi-point communications to the host for communications integrity. Any system that cannot maintain communications integrity when one or more LPC is off-line shall not be accepted.
 - .5 Have the ability of supporting a minimum of 4 individual readers within a single enclosure with the ability of expanding to 12 readers while consuming only one terminal address.
 - .6 Have a minimum of 12 inputs and 6 outputs expandable to 42 input points and 38 output points.

- .7 Include a request-to-exit and door status contact input for each reader without the need for additional modules.
- .8 Detect "forced entry" and "door left open". A separate action is required for each.
- .9 Allow mapping of readers to any output address within the same controller.
- .10 Support up to 64 time periods:
 - .1 A total of 7 start/7 stop intervals, per time period, shall be included.
- .11 Support up to 999 authorization group:
 - .1 Each authorization group shall include one (1) time period.
 - .2 Each cardholder shall support four (4) authorization group.
 - .3 Each authorization group shall have an alphanumeric description.
- .12 Support up to 365 user selected holidays.
- .13 Allow all unused door logic, such as door strike relays, request-to-exit inputs, and door status inputs to be assigned as general-purpose points.
- .14 Support optional modules for additional customization of inputs and outputs. The following modules shall be available:
 - .1 Supervised Alarm Modules: a minimum of 8 or 16 additional supervised inputs shall be provided for the detection of alarms.
 - .2 Output Point Module: a minimum of 16 additional output points shall be provided.
 - .3 Combination Module: where inputs and outputs are necessary within the same enclosure, a combination of 16 inputs and 16 outputs shall be provided.
- .15 Support a minimum of 20,000 cardholder assignments.
- .16 Support a minimum of 4,000 historical transactions in the event communications to the host is disrupted.
 - .1 Each LPC transaction shall be time-stamped with the following:
 - .1 Date (Month, Day, Year)
 - .2 Time (Hours, Minutes)
 - .3 Message Text (Description of transaction)
- .17 Support the downloading of cardholder names in addition to the cardholder number.
- .18 Support "reader detection: in the event the reader has been removed or cut. No additional wires or switches shall be used. An alarm condition shall be enunciated.
- .19 Backup programmed data for a minimum of five (5) years without AC power. Battery protected memory for non-volatility.
- .20 Maintain historical information for a minimum of five (5) years with AC power.
- .21 Support direct or voice grade 3002 phone line connection.

- .22 Automatically adjusts for daylight savings time and leap year independent of the host system.
- .23 Be supplied with battery backup for a period of four (4) years.
- .24 Support a variety of reader technologies. Only non-proprietary readers shall be approved. Include manufacturer, model number and cut sheet with proposal.
 - .1 Readers shall be provided with the ability of showing a red and green LED.
 - .2 The LPC shall show the following characteristics using the bi-color LED's:
 - .1 Power LED (constant red LED)
 - .2 Card data being processed (fast blink red and green LEDs)
 - .3 Access authorized (solid green LED)
 - .4 Denied access (constant red after card data processing)
 - .5 Escort authorized (slow blink red and green LEDs)
 - .6 Two man rule (slow blink red/green LEDs)
 - .3 Card read errors of four (4) or more within one minute shall be reported to the host.
- .25 Support the following card/reader technologies as a minimum:
 - .1 Proximity
 - .2 Biometrics
 - .3 Wiegand
 - .4 Protech barium ferrite
 - .5 Keypad
- .26 Support card plus pin, card, or pin only type readers.
- .27 Support a minimum of three (3) "Card Classes" which can be utilized with User Programmable Logic to interact with external devices or functions, such as light, sirens, or HVAC.
- .28 Integrate each physical input independent of its polarity.
- .29 Maintain the expiration date for each cardholder. Once the date is reached, the card will automatically be disabled. No access shall be authorized.
- .30 Maintain a second expiration date for each cardholder. This date shall be used to prevent access to a unique group of readers, such as parking lots or recreational facilities. Once the date has expired the card shall be disabled only for this group of readers.
- .31 Maintain three (3) access times for each door location; Standard, long and Egress.
 - .1 STANDARD access time shall be used for the majority of the cardholders and shall support a range from 0-254 seconds.
 - .2 LONG access time shall be assigned to cardholders who require extra time to enter/exit a location, such as delivery persons, or to meet American with Disabilities Act (ADA) requirements. The

- Long access time shall support from 0-254 seconds. A Long shunt time shall also be required to prevent a door held open alarm exceeding the standard shunt time. The time shall not require additional hardware nor be dependent on the host for the decision.
- .3 EGRESS time shall be used for requires to exit devices and support a time between 0-254 seconds.
 - .32 Have the ability to maintain an automatic door unlock during specific hours and days.
 - .33 Be required to activate the automatic unlock only after the first valid card access at that location within a predefined period of time.
 - .34 Support three (3) "zones" of Anti-Passback; Building, Department, Parking.
 - .35 Support three (3) "levels" of Anti-Passback; Strict, Soft and Lenient.
 - .1 STRICT Anti-Passback prevents access after the first attempt and forwards a message to the host. An exit reader shall be used to exit the door location.
 - .2 SOFT Anti-Passback authorizes access with the use of the card the second time using an "in" reader. An event message shall be forwarded to the host indicating entry/exit out of sequence.
 - .3 LENIENT Anti-Passback uses the Entry/Exit criteria, but allows automatic sequencing between Department and Building Status if not in proper sequence.
 - .36 Utilize User Programmable Logic (UPL) for the manipulation of inputs, card status, outputs and elevators.
 - .1 Each ACU shall allow the following inputs to trigger UPL:
 - .1 Card Access/Card Denied
 - .2 Physical Input Point
 - .3 Time Periods
 - .2 Each ACU shall support the following computations for UPL:
 - .1 Increment Count (range 0-65000)
 - .2 Decrement Count (range 0-65000)
 - .3 Increment by Seconds or Minutes (0-65000)
 - .4 Decrement by Seconds or Minutes (0-65000)
 - .5 Clear
 - .6 Reset
 - .7 Flip/Flop (Flip output-toggle)
 - .8 Each ACU shall support the following results from UPL:
 - .9 Activate/De-Activate
 - .10 Shunt/Un-shunt
 - .11 Pause/Resume (suspend/restore)
 - .12 Override for 1 Cycle
 - .3 Escort/Visitor Control

- .1 Maintain the assignment of access cards for Visitor Control. Each visitor shall be assigned an "Escort Required" status requiring an employee or "Escort Capable" cardholder to grant a valid entry. The decision shall not be dependent on the host.
 - .4 All visitor badges shall expire automatically at midnight of the date issued without operator date IQseriesguidespec.doc.
 - .5 Two-Person Minimum Occupancy Rule (TPMOR) for high security applications.
 - .1 The TPMOR feature requires the first two (2) people to badge into an area at the same time before access is granted. An exit reader shall be used for decrementing the count.
- .2 Acceptable manufacturer: Honeywell model PCSC IQ 1200, shall match existing access control system. To be integrated and programmed to existing building system access control system. Contractor to provide additional required license.

2.3 Card Readers

- .1 Read Range
 - .1 iCLASS card: up to 4.25"
 - .2 iCLASS key/Tag: up to 2"
- .2 Mounting
 - .1 The R40 is designed to mount and cover single gang switch boxes primarily used in the United States and includes a slotted mounting plate for European and Asian back box spacing.
- .3 Dimensions
 - .1 3.30" x 4.80" x .85" (8.38cm x 12.19cm x 1.26 cm)
- .4 Power Supply
 - .1 Power supply - 5-16 VDC, Linear supply recommended.
- .5 Current Requirements
 - .1 50/75 mA @ 12VDC
- .6 Operating Temperature
 - .1 -40° to 150°F (-40° to 65°C)
- .7 Operating Humidity
 - .1 5% to 95% relative humidity non-condensing
- .8 Transmit Frequency
 - .1 13.56 MHz
- .9 Cable Distance
 - .1 Wiegand Interface 500 ft (150m) 22 AWG

- .10 Card Compatibility
 - .1 15693 – read only; 2k bit (256 Byte), 1.6k bit (2k Byte), 32k bit (4k Byte) iCLASS credentials, CSN
 - .2 14443B – read only; 2k bit (256 Byte), 16k bit (2k Byte), 32k bit (4k Byte) iCLASS credentials
 - .3 14443A – read only; MIFARE and DESFire (serial number)
- .11 Certifications
 - .1 UL 294/cUL, FCC Certification, Canada Certification
 - .2 CE Mark (Europe), New Zealand, Australia c-Tick
 - .3 Pending Certifications: Taiwan, Singapore, Germany VdS
 - .4 Housing Material
 - .5 UL94 Polycarbonate
- .12 Acceptable manufacturer: HIDiClass Multiclass RP40, shall match card used in existing building.

2.4 Access Cards

- .1 All Access cards shall be the same size of a standard credit card, measuring approximately 86 X 54 X .076mm. Shall match existing card used in existing building.
- .2 Each card shall have a permanent identification number printed onto it. The Card numbering shall be random non-matching, the internal number shall be random numbers, the external number will be sequential, and the external number will not match.
- .3 Access card shall be printable directly on the card by dye sub lamination and printable on both sides.
- .4 Access cards shall have a polyester composition and shall have a option of a slot punch.
- .5 Provide a initial shipment of 500 Proximity stripe cards
- .6 The Access cards shall be completely compatible with any existing systems, and shall use the same facility codes, if partitioning of a system in multi tenant buildings the cards shall work on both the landlord system for elevator and public areas and the tenants facility, however other tenants card will not work on other tenants spaces.
- .7 Proximity Cards
 - .1 Proximity cards shall have up to 26-55 programmable bits of weigand formatted information for universal compatibility with all wiegand readers.
 - .2 Proximity cards shall be passive
 - .3 Proximity cards shall have a lifetime warranty

2.5 Request To Exit Devices

- .1 Use contacts integral to electric strike as request to exit.

2.6 Magnetic Door Contacts

- .1 Standard doors
 - .1 Provide 1 inch Rare earth magnet, wide gap
 - .2 Colour to match door frames, and identical throughout the installation.
 - .3 Provide connection to access control system
 - .4 Provide one magnetic door contact per leaf
 - .5 All End-of line resistors to be installed in at the field device

2.7 Power Supplies

- .1 24VDC @ 10 amp supply current
- .2 Power supply input options:
 - .1 One (1) common power input for ACM8/ACM8CB and lock power (factory installed).
 - .2 Two (2) isolated power inputs – one (1) to power the ACM8/ACM8CB and one (1) for lock accessory power, (external power supply is required). (Current is determined by the power supply connected, not to exceed a maximum of 10 amp total).
- .3 Eight (8) Access Control System trigger inputs. Input options:
 - .1 Eight (8) normally open (NO) inputs.
 - .2 Eight (8) open collector inputs
 - .3 Any combination of the above
- .4 Eight (8) independently controlled outputs; Output options:
 - .1 Eight (8) Fail-Safe and/or Fail-Secure power outputs.
 - .2 Eight (8) form “C” 5 amp rated relay outputs (AL1024ULACM only).
 - .3 Any combination of the above
- .5 Eight (8) auxiliary power outputs (unswitched)
- .6 Output ratings:
 - .1 Fuses are rated @ 3.5 amp (AL1024ULACM).
 - .2 PTCs are rated @ 2.5 (AL1024ULACMCB).
- .7 Input 115VAC 60Hz rated @ 4.4 amp.
- .8 Filtered and electronically regulated outputs (built-in power supply)
- .9 Short circuit and thermal overload protection.
- .10 Red LEDs indicate outputs are triggered (relays energized).

- .11 Fire Alarm disconnect (latching or non-latching) is individually selectable for any or all of the eight (8) outputs.
- .12 Fire Alarm disconnect input options:
 - .1 Normally open (NO) or normally closed (NC) dry contact input.
 - .2 Polarity reversal input from FACP signalling circuit.
- .13 Alarm output relay indicates that FACP input is triggered (form "C" contact rated @ 1 amp 28VDC not evaluated by UL).
- .14 Green LED indicates when FACP disconnect is triggered.
- .15 Built-in charger for sealed lead acid or gel type batteries.
- .16 AL1024ULXB (Power Supply Board) maximum charge current 3.6 amp.
- .17 Automatic switchover to stand-by battery when AC fails
- .18 Zero voltage drop when unit switches over to battery backup (AC failure condition).
- .19 AC fail supervision (form "C" contact).
- .20 Battery fail and battery presence supervision (form "C" contact)
- .21 AC input and DC output LED indicators.
- .22 Enclosure accommodates up to two (2) 12AH batteries.
- .23 Acceptable manufacturer: Altronix AL1024ULACM

2.8 Device Servers

- .1 Serial Interface
 - .1 Interface
 - .1 Software-selectable RS232, RS422 or RS485 (2 and 4 wire support)
 - .2 Connectors
 - .1 1 DB25F DCE serial port
 - .3 Data Rates
 - .1 Software-selectable baud rate from 300 to 230 KBaud
- .2 Serial Line Formats
 - .1 Characters
 - .1 7 or 8 data bits
 - .2 Parity
 - .1 Odd, even, none
 - .3 Stop Bits
 - .1 1 or 2
- .3 Flow Control
 - .1 Control Signals
 - .1 CTS/RTS (Hardware)

- .2 Flow Control
 - .1 XON/XOFF (Software)
- .4 Network Interface
 - .1 Interface
 - .1 10Base-T/100Base-TX Ethernet port
 - .2 Software Selectable Ethernet speed 10/100/Auto
 - .3 Software selectable Half/Full/Auto duplex
 - .2 Connector
 - .1 RJ45
 - .3 Standards
 - .1 ARP, UDP, TCP, ICMP, Telnet, TFTP, AutoP, DHCP, HTTP, SNMP TCP, UDP, and Telnet , TFTP
- .5 LED Indicators
 - .1 Power, 10/100 Link/Activity (green), 100/100
 - .2 Link/Activity (green), Diagnostics (red), Status (green)
- .6 Processor
 - .1 CPU
 - .1 Lantronix DSTNI-EX 48 MHz clock
 - .2 Memory
 - .1 256 KB zero wait state SRAM, 2 MB Flash
- .7 Management
 - .1 Lantronix Device Installer GUI, Serial login, SNMP, Telenet login, HTTP
- .8 Power
 - .1 9-30 VDC or 9-24 VAC on barrel connector (1.5 Watts maximum consumption)
 - .2 9-30 VDC on DB25F serial interface
- .9 Environmental
 - .1 Operating
 - .1 5° to 50° (41° to 122°F)
 - .2 Storage
 - .1 -40° to 66° C (-40° to 151°F)
 - .3 Agency Approvals
 - .1 UL, CSA, FCC, CE, TUV, CTick, VCCI
- .10 Software
 - .1 Windows 98/ME/NT/2000/XP-based Device Installer
 - .2 Configuration software, Com Port Redirector software and related utilities
- .11 Packaging

- .1 Material
 - .1 Metal enclosure with integrated wall mounts; optional 35 mm DIN-rail mount available
- .2 Dimensions
 - .1 (LxWxH): 9.0 x 6.4 x 2.3 cm
- .3 Weight
 - .1 0.20 kg
- .4 IP Rating
 - .1 30
- .12 Shipping Dimensions (LxWxH)
 - .1 Dimensions
 - .1 35.5 x 17.1 x 7.6 cm
 - .2 Weight
 - .1 1.5 kg
- .13 Warranty
 - .1 2 year limited warranty
- .14 Acceptable Product: Lantronix UDS 1100

2.9 Banana Peel Cable

- .1 Access Control Cable shall be Riser-CMR compose of the following cables;
 - .1 4-18 AWG conductors for use on lock power
 - .2 6-22 AWG conductors with Beldfoil® shield for use on card reader
 - .3 4-22 AWG conductors for use on door contact
 - .4 4-22 AWG conductors for use on Request to exit
 - .5 All conductors stranded bare copper with FR-PVC insulation, Each cable has PVC jacket, Banana Peel® No overall jacket.
 - .6 Electrical Characteristics
 - .1 Card Reader
 - .1 Nom. Capacitance Conductor to Shield: 1000
 - .2 Freq. (MHz) Capacitance (pF/m): 150.926
 - .2 Door Contact
 - .1 Nom. Capacitance Conductor to Shield: 1000
 - .2 Freq. (MHz) Capacitance (pF/m): 183.736
 - .3 REX/Spare
 - .1 Nom. Capacitance Conductor to Shield: 1000
 - .2 Freq. (MHz) Capacitance (pF/m): 101.711
 - .4 Lock Power
 - .1 Nom. Capacitance Conductor to Shield: 1000
 - .2 Freq. (MHz) Capacitance (pF/m): 124.678

- .7 Nom. Conductor DC Resistance, DCR @ 20°C (Ohm/km)
 - .1 Door Contact: 52.824
 - .2 Rex/Spare: 52.824
 - .3 Card Reader: 53.480
 - .4 Lock Power: 21.327
- .8 Nom. Inner Shield DC Resistance, DCR @ 20°C (Ohm/km)
 - .1 Card Reader: 45.606
- .9 Max. Operating Voltage - Other: 300 V RMS
- .10 Max. Recommended Current:
 - .1 Door Contact 2.8 Amps @ 25C ambient (10C temperature rise)
 - .2 Rex/Spare 2.8 Amps @ 25C ambient (10C temperature rise)
 - .3 Card Reader 2.0 Amps @ 25C ambient (10C temperature rise)
 - .4 Lock Power 4.0 Amps @ 25C ambient (10C temperature rise)
- .10 Acceptable Product: Belden 558Gms**

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 Consultant.
 - .2 Inform Landlord 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 Landlord.

3.2 Installation: Security Access

Install security access systems and components in accordance with CAN/ULC-S302 CAN/ULC-S310 .

Install components in accordance with manufacturer's written installation instructions to locations, heights and surfaces shown on reviewed shop drawings.

- .1 Install components secure to walls, ceilings or other substrates.
- .2 Install required boxes in inconspicuous accessible locations.
- .3 Conceal conduit and wiring.

3.3 Site Test And Inspection

- .1 Perform verification inspections and test in presence of Consultant.
 - .1 Provide all necessary tools, ladders and equipment.

- .2 Ensure appropriate subcontractors and manufacturer's representatives and security specialists are present for verification.
- .3 Ensure that the system is configured through the building Access control system.
- .2 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 Consultant 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, equipment cabinet pictorial, video and audio equipment details.
 - .3 Mechanical inspection:
 - .1 Consultant 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 tests:
 - .1 Dust, debris, etc. are cleaned and removed from site.
 - .2 Equipment is properly labelled.
 - .3 Equipment identified in system's equipment lists are in-place and properly installed.
 - .4 Each System ground method are installed in accordance with manufacturer's instructions and this specification.
- .3 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 Distribution or interface system:
 - .1 Check each door utilizing a volt/ohm (or signal level) meter to confirm each function and to insure that system meets all performance requirements.
 - .3 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 sub carrier, and control signals in accordance with this specification.
- .4 Safety:
 - .1 Demonstrate with documentation that access control system meets safety requirements specified in UL 294.
- .4 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.
- .5 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.
- .6 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.

3.4 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 critical periods of installation and testing.
- .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 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.

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.
 - .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 reuse and 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.

3.6 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 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C127-04, Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate.
 - .2 ASTM D698-00ae1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - .3 ASTM D1557-02e1, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - .4 ASTM D4253-00, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

1.2 Definitions

- .1 Corrected maximum dry density is defined as:
 - .1 $D = D1 \times D2 / (F1 \times D2) + (F2 \times D1)$
 - .2 $D = (F1 \times D1) + (0.9 \times D2 \times F2)$
 - .3 Where: D = corrected maximum dry density kg/m³.
 - .1 F1 = fraction (decimal) of total field sample passing 19 mm sieve
 - .2 F2 = fraction (decimal) of total field sample retained on 19 mm sieve (equal to 1.00 - F1)
 - .3 D1 = maximum dry density, kg/m³ of material passing 19 mm sieve
 - .4 D2 = bulk density, kg/m³, of material retained on 19 mm sieve, equal to 1000G where G is bulk specific gravity (dry basis) of material when tested to ASTM C127.

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 Society for Testing and Materials (ASTM)
 - .1 ASTM D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.2 Samples

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Allow continual sampling by Departmental Representative during production.
- .3 Provide Departmental Representative with access to source and processed material for sampling.
- .4 Install sampling facilities at discharge end of production conveyor, to allow Departmental Representative to obtain representative samples of items being produced. Stop conveyor belt when requested by Departmental Representative to permit full cross section sampling.
- .5 Pay cost of sampling and testing of aggregates which fail to meet specified requirements.

1.3 Waste Management And Disposal

- .1 Divert unused granular materials from landfill to local facility for reuse as directed by Departmental Representative.

Part 2 Products

2.1 Materials

- .1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, or other substances that would act in deleterious manner for use intended.
- .2 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:
 - .1 Natural sand.
 - .2 Manufactured sand.
 - .3 Screenings produced in crushing of quarried rock, boulders, gravel or slag.
- .3 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:

- .1 Crushed rock.
- .2 Crushed gravel composed of naturally formed particles of stone.

2.2 Source Quality Control

- .1 Inform Departmental Representative of proposed source of aggregates and provide access for sampling at least 4 weeks prior to commencing production.
- .2 If, in opinion of Departmental Representative, materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.
- .3 Advise Departmental Representative 4 weeks in advance of proposed change of material source.
- .4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

Part 3 Execution

3.1 Preparation

- .1 Topsoil stripping
 - .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.
 - .2 Begin topsoil stripping of areas as indicated on the drawings and as directed by Departmental Representative after area has been cleared of brush, weeds and grasses and removed from site.
 - .3 Strip topsoil to depths as indicated on the drawings and as directed by Departmental Representative. Avoid mixing topsoil with subsoil.
 - .4 Stockpile in locations as directed by Departmental Representative. Stockpile height not to exceed 2 m.
 - .5 Dispose of topsoil as directed by Departmental Representative.
- .2 Handling
 - .1 Handle and transport aggregates to avoid segregation, contamination and degradation.
- .3 Stockpiling
 - .1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Departmental Representative. Do not stockpile on completed pavement surfaces.
 - .2 Stockpile aggregates in sufficient quantities to meet Project schedules.

- .3 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.
- .4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into Work.
- .5 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.
- .6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Departmental Representative within 48 h of rejection.
- .7 Stockpile materials in uniform layers of thickness as follows:
 - .1 Max 1.5 m for coarse aggregate and base course materials.
 - .2 Max 1.5 m for fine aggregate and sub-base materials.
 - .3 Max 1.5 m for other materials.
- .8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
- .9 Do not cone piles or spill material over edges of piles.
- .10 Do not use conveying stackers.
- .11 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.2 Cleaning

- .1 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.
- .2 Leave any unused aggregates in neat compact stockpiles as directed by Departmental Representative.
- .3 For temporary or permanent abandonment of aggregate source, restore source to condition meeting requirements of authority having jurisdiction.

END OF SECTION

Part 1 General

1.1 References

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m).

1.2 Existing Conditions

- .1 Examine geotechnical investigation report which is provided in the Appendix of this specification.
- .2 Locate underground and surface utility lines and buried objects. Report discrepancies to Departmental Representative if they impact proposed work.
- .3 Any damage to utilities during construction are the responsibility of the Contractor and will be repaired at no additional cost to the Departmental Representative.

1.3 Protection

- .1 Protect existing fencing, trees, landscaping, natural features, bench marks, buildings, pavement, surface or underground utility lines which are to remain as noted on the drawings or directed by Departmental Representative. If damaged, restore to original or better condition unless directed otherwise.
- .2 Maintain access roads to prevent accumulation of construction related debris on roads.

Part 2 Products

2.1 Materials

- .1 Fill material in accordance with of Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Excavated or graded material existing on site may be suitable to use as fill for grading work if approved by Departmental Representative.

Part 3 Execution

3.1 STRIPPING OF TOPSOIL

- .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected as determined by Departmental Representative

- .2 Commence topsoil stripping of areas as directed by the Departmental Representative.
- .3 Strip topsoil to depths as directed by the Departmental Representative. Avoid mixing topsoil with subsoil.
- .4 Stockpile in locations as directed by the Departmental Representative.
- .5 Dispose of unused topsoil to location as directed by Departmental Representative.

3.2 Grading

- .1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.
- .2 Rough grade to following depths below finish grades:
 - .1 150 mm for grassed areas.
 - .2 Sub-grade elevation as indicated for gravel areas.
- .3 Slope rough grade away from building as indicated
- .4 Grade ditches to depth as indicated
- .5 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.
- .6 Compact filled and disturbed areas to corrected maximum dry density to ASTM D698, as follows:
 - .1 90% under landscaped areas.
 - .2 95% under parking and walk areas.
- .7 Do not disturb soil within branch spread of trees or shrubs to remain.

3.3 Testing

- .1 Inspection and testing of soil compaction will be carried out by a certified testing laboratory engaged and paid by the Contractor. Refer to Section 01 45 00 - Quality Control.
- .2 Submit testing procedure, frequency of tests, certified testing laboratory as designated by the Contractor to Departmental Representative for approval.

3.4 Surplus Material

- .1 Remove surplus material and material unsuitable for fill, grading or landscaping to a local site location as directed by Departmental Representative.

END OF SECTION

Part 1 General

1.1 References

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C117- 03 Standard Test Method for Material Finer Than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C136-01, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D422-63 2002, Standard Test Method for Particle-Size Analysis of Soils.
 - .4 ASTM D698-00ae1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³).
 - .5 ASTM D1557-02e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³).
 - .6 ASTM D4318-00, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000-03, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .2 CSA-A3001-03, Cementitious Materials for Use in Concrete.
 - .3 CAN/CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

1.2 Definitions

- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
 - .1 Rock: any solid material in excess of 0.50 m³ and which cannot be removed by means of heavy-duty excavating equipment with 0.95 to 1.15 m³ bucket. Frozen material not classified as rock.
 - .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.

- .3 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
- .4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .5 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .6 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136: Sieve sizes to CAN/CGSB-8.1.
 - .2 Table:

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 – 100
0.02 mm	10 - 80
0.005 mm	0 - 45
 - .3 Coarse-grained soils containing more than 20% by mass passing 0.075 mm sieve.
- .7 Unshrinkable fill: very weak mixture of Portland cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.3 SUBMITTALS

- .1 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Submit to Departmental Representative written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
 - .2 Submit to Departmental Representative written notice when bottom of excavation is reached.
 - .3 Submit to Departmental Representative testing results as described in PART 3 of this Section.
- .2 Preconstruction Submittals:
 - .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
 - .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field, clearance records from utility authorities, and location plan of and relocated and abandoned services, as required.

1.4 Quality Assurance

- .1 Qualification Statement: submit proof of insurance coverage for professional liability.
- .2 Submit design and supporting data at least 2 weeks prior to beginning Work.
- .3 Design and supporting data submitted to bear stamp and signature of qualified professional Engineer registered or licensed in Provinces of Manitoba, Canada.
- .4 Keep design and supporting data on site.
- .5 Engage services of qualified professional Engineer who is registered or licensed in Province of Manitoba, Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.
- .6 Do not use soil material until written report of soil test results are reviewed and approved by Departmental Representative.

1.5 Waste Management And Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert unused granular materials from landfill to local facility for reuse as directed by Departmental Representative.
- .3 Haul away unused excavated material to a local site location as directed by Departmental Representative.

1.6 Existing Conditions

- .1 Examine geotechnical investigation report which is provided in the Appendix of this specification.
- .2 Buried services:
 - .1 Before commencing work verify location of buried services on and adjacent to site.
 - .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
 - .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
 - .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
 - .5 Prior to beginning excavation Work, notify Departmental Representative and establish location and state of use of buried utilities and structures. Authorities having jurisdiction to clearly mark such locations to prevent disturbance during Work.
 - .6 Confirm locations of buried utilities by careful soil hydrovac methods.

- .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
- .8 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before re-routing. Costs for such Work to be paid by Departmental Representative.
- .9 Record location of maintained, re-routed and abandoned underground lines.
- .10 Confirm locations of recent excavations adjacent to area of excavation.
- .3 Existing buildings and surface features:
 - .1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative.
 - .3 Where required for excavation, cut roots or branches as directed by Departmental Representative.

Part 2 Products

2.1 Materials

- .1 Type 1 and Type 2 fill: properties to Section 31 05 16 - Aggregate Materials and the following requirements:
 - .1 Crushed, pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation	% Passing Type 1	Type 2
100 mm	100	-
75 mm	-	-
50 mm	-	-
37.5 mm	-	100
25 mm	-	85-100
19 mm	-	-
9.5 mm	-	-
4.75 mm	30-75	25-80
2.00 mm	-	-
0.075 mm	0-15	8-18

- .2 Type 3 fill: selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.
- .3 Unshrinkable fill: proportioned and mixed to provide:

- .1 Maximum compressive strength of 0.4 MPa at 28 days.
- .2 Maximum cement content of 25 kg/m³; to CSA-A3001, Type GU.
- .3 Minimum strength of 0.07 MPa at 24 h.
- .4 Concrete aggregates: to CSA-A23.1/A23.2.
- .5 Cement: Type GU.
- .6 Slump: 160 to 200 mm.
- .4 Shearmat: honeycomb type bio-degradable cardboard 100 mm thick, treated to provide sufficient structural support for poured concrete until concrete cured, or as indicated on the drawings.
- .5 Geotextiles: to Section 31 32 19.01 - Geotextiles.

Part 3 Execution

3.1 Temporary Erosion And Sedimentation Control

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 Site Preparation

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

3.3 Preparation/Protection

- .1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative approval.
- .4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
- .5 Protect buried services that are required to remain undisturbed.

3.4 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as directed by Departmental Representative after area has been cleared of brush, weeds and grasses and removed from site.
- .2 Strip topsoil to depths as directed by Departmental Representative.
 - .1 Do not mix topsoil with subsoil.
- .3 Stockpile in locations as directed by Departmental Representative.
 - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .4 Dispose of unused topsoil to a local site location as directed by Departmental Representative.

3.5 Stockpiling

- .1 Stockpile fill materials in areas designated by Departmental Representative.
 - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.
- .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.6 Dewatering And Heave Prevention

- .1 Keep excavations free of water while Work is in progress.
- .2 Provide for Departmental Representative details of proposed dewatering or heave prevention methods, including dikes, well points, and sheet pile cut-offs.
- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
 - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in accordance with Section 01 35 43 - Environmental Procedures to approved runoff areas and in a manner not detrimental to the property, or portion of Work completed or under construction.
 - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.
- .6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.7 Excavation

- .1 Advise Departmental Representative at least 7 days in advance of excavation operations for initial cross sections to be taken.
- .2 Excavate to lines, grades, elevations and dimensions as indicated and in accordance with the Safety Requirements in Section 01 00 20 General Instructions.
- .3 Remove paving and other obstructions encountered during excavation.
- .4 Excavation must not interfere with bearing capacity of adjacent foundations.
- .5 Do not disturb soil within branch spread of trees or shrubs that are to remain.
 - .1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
- .6 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30m of trench in advance of installation operations and do not leave open more than 15m at end of day's operation.
- .7 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
- .8 Restrict vehicle operations directly adjacent to open trenches.
- .9 Dispose of surplus and unsuitable excavated material to a local site location as directed by Departmental Representative.
- .10 Do not obstruct flow of surface drainage or natural watercourses.
- .11 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .12 Notify Departmental Representative when bottom of excavation is reached.
- .13 Obtain Departmental Representative approval of completed excavation.
- .14 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.
- .15 Correct unauthorized over-excavation as follows:
 - .1 Fill under other areas with Type 2 fill compacted to not less than 95% of corrected Standard Proctor maximum dry density.
- .16 Hand trim, make firm and remove loose material and debris from excavations.
 - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.

- .17 Install geotextiles in accordance with Section 31 32 19.01 - Geotextiles.

3.8 Fill Types And Compaction

- .1 Use types of fill as indicated or specified below. Compaction densities are percentages of maximum densities obtained in accordance with Section 31 05 10 - Corrected Maximum Dry Density for Fill.
 - .1 Exterior side of perimeter walls: use Type 2 fill to subgrade level. Compact to 95% of corrected maximum dry density.
 - .2 Within building area: in accordance to geotechnical investigation report recommendations, which is provided in the Appendix of the specification
 - .3 Place unshrinkable fill in areas as indicated.

3.9 Bedding And Surround Of Underground Services

- .1 Place and compact granular material for bedding and surround of underground services as indicated and as specified in Section 33 11 16 - Site Water Utility Distribution Piping and Section 33 31 13 - Public Sanitary Utility Sewerage Piping.
- .2 Place bedding and surround material in unfrozen condition.

3.10 BACKFILLING

- .1 Perform fill placement in accordance to geotechnical investigation report recommendations, which is provided in the Appendix of the specification.
- .2 Do not proceed with backfilling operations until completion of following:
 - .1 Departmental Representative has inspected and approved installations.
 - .2 Departmental Representative has inspected and approved of construction below finish grade.
 - .3 Inspection, testing, approval, and recording location of underground utilities.
 - .4 Removal of concrete formwork.
- .3 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .4 Do not use backfill material which is frozen or contains ice, snow or debris.
- .5 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .6 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
 - .2 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
- .7 Place unshrinkable fill in areas as indicated.

- .8 Consolidate and level unshrinkable fill with internal vibrators.

3.11 Restoration

- .1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 21 - Construction/Demolition Waste Management and Disposal, trim slopes, and correct defects as directed by Departmental Representative.
- .2 Replace topsoil as directed by Departmental Representative.
- .3 Reinstate lawns to elevation which existed before excavation.
- .4 Clean and reinstate areas affected by Work as directed by Departmental Representative.
- .5 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

Part 1 General

1.1 Section Includes

- .1 Materials and installation of polymeric geotextiles used in roadbeds purpose of which is to:
 - .1 Separate and prevent mixing of granular materials of different grading.
 - .2 Act as hydraulic filters permitting passage of water while retaining soil strength of granular structure.

1.2 References

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM D4491-99a(2014)e1, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - .2 ASTM D4595-11, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
 - .3 ASTM D4716-14, Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
 - .4 ASTM D4751-12, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-4.2 No. 11.2-M89(April 1997), Textile Test Methods - Bursting Strength - Ball Burst Test (Extension of September 1989).
 - .2 CAN/CGSB-148.1, Methods of Testing Geotextiles and Complete Geomembranes.
 - .1 No.2-M85, Methods of Testing Geosynthetics - Mass per Unit Area.
 - .2 No.3-M85, Methods of Testing Geosynthetics - Thickness of Geotextiles.
 - .3 No.6.1-93, Methods of Testing Geotextiles and Geomembranes - Bursting Strength of Geotextiles Under No Compressive Load.
 - .4 No.7.3-92, Methods of Testing Geotextiles and Geomembranes - Grab Tensile Test for Geotextiles.
 - .5 No. 10-94, Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-G40.20/G40.21-98, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

- .2 CAN/CSA-G164-M92(R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.

1.3 Submittals

- .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit to Departmental Representative copies of mill test data and certificate at least 4 weeks prior to start of Work, and in accordance with Section 01 33 00 - Submittal Procedures.

1.4 Delivery, Storage And Handling

- .1 During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

1.5 Waste Management And Disposal

- .1 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .2 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 Material

- .1 Geotextile: non-woven synthetic fibre fabric, supplied in rolls.
- .2 Physical properties requirements to ASTM 4759 and:
 - .1 Grab Tensile Strength, 900 N – minimum (ASTM D4632)
 - .2 CBR Puncture, 2200 N – minimum (ASTM D6241)
 - .3 Trapezoid Tear, 350 N – minimum (ASTM D4533)
 - .4 Apparent Opening Size, 0.18 mm – maximum (ASTM D4751)
 - .5 Permittivity, 1.4 sec-1 – minimum (ASTM D4491)
 - .6 Flow Rate, 4000 l/min/sq.m. – minimum (ASTM D4491)
 - .7 U.V. Resistance, 70% per 500 hrs – minimum (ASTM D4355)
- .3 Securing pins and washers: to CAN/CSA-G40.21, Grade 300W, hot-dipped galvanized with minimum zinc coating of 600 g/m2 to CAN/CSA G164.
- .4 Factory seams: sewn in accordance with manufacturer's recommendations.
- .5 Thread for sewn seams: equal or better resistance to chemical and biological degradation than geotextile.

Part 3 Execution

3.1 Installation

- .1 Place geotextile material by unrolling onto graded surface in accordance manufacturers recommendations.
- .2 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.
- .3 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.
- .4 Overlap each successive strip of geotextile 600 mm over previously laid strip.
- .5 Pin successive strips of geotextile with securing pins at mid point of lap.
- .6 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.
- .7 After geotextile installation, backfill with granular layer within 4 h of geotextile installation.
- .8 Replace damaged or deteriorated geotextile to approval of Departmental Representative.

3.2 Cleaning

- .1 Remove construction debris from Project site and dispose of debris in an environmentally responsible and legal manner.

3.3 Protection

- .1 Vehicular traffic not permitted directly on geotextile.

END OF SECTION

General

1.1 Related Work

- .1 Excavation and backfilling: Section 31 23 00
- .2 Concrete reinforcement, Section 03 20 00
- .3 Cast-in-place concrete, Section 03 30 00

1.2 References

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
 - .2 CAN/CSA-A23.5, Supplementary Cementing Materials.
 - .3 CAN/CSA-A23.4-00/A251-00, Qualification Code for Architectural and Structural Precast Concrete Products.
 - .4 CAN/CSA-G279
- .2 ASTM
 - .1 ASTM A 416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
 - .2 ASTM A 185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - .3 ASTM A 82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

1.3 Design Requirements

- .1 Design loads as indicated on Structural Drawings.
- .2 Do not splice piles without Consultant's permission. When permitted, provide details for Consultant review. Design details of splice to bear signature and stamp of professional engineer registered or licensed in Province of Manitoba.

1.4 Test Reports

- .1 Upon request, submit certified copies of quality control tests related to this project as specified in CSA A251.

1.5 Quality Assurance

- .1 Manufacturer of precast concrete components: certified by CSA as meeting requirements of CSA A251.
- .2 A Contractor experienced in the related type or work and having at their disposal all necessary equipment shall perform all work.
- .3 Allowable tolerances:
 - .1 Lateral tolerances: all units shall be located so as to have a maximum lateral deviation at the top of the unit of 50 mm.
 - .2 Vertical tolerance: all piles shall be driven without varying more than 2% from the vertical.

- .3 Pile cutoffs at elevations indicated +/- 25 mm.
- .4 Piles not meeting these requirements will be rejected.

- .4 Drive all units to develop loads indicated on drawings to the criteria in the Geotechnical Report.
- .5 Comply with all local and provincial safety codes and regulations.

1.6 Site Conditions

- .1 Visit the site to ascertain any special conditions that may affect the work.
- .2 A subsurface Geotechnical investigation report of the site has been prepared and has been included as part of this specification.
- .3 Review the Geotechnical Report to identify subsurface conditions that may be encountered.

1.7 Delivery And Storage

- .1 Minimum size holes are permitted and lifting to vertical position.
- .2 Provide identification for points of lifting by painted stripes or lift hooks set in.
- .3 Provide identification for points of support for storage. Store all units at site in such a way as to avoid undue stresses before driving.
- .4 During delivery and storage support long piles continuously along their lengths.
- .5 All foundation units delivered to site that do not conform to terms of this specification may be rejected by Consultant.

1.8 Waste Management And Disposal

- .1 Comply with Section 01 74 19.

1.9 Protection

- .1 Protect public and construction personnel, adjacent structures and work of other sections from hazards attributable to pile driving operations.
- .2 Protect pile surfaces from damage and spalling.

1.10 Scheduling

- .1 Submit schedule of planned sequence of driving to Departmental Representative for review, not less than two weeks prior to commencement of pile driving.
- .2 Do not commence pile driving until authorized by Consultant.

Products

1.11 Materials

- .1 All piles standard hexagonal, precast, prestressed, to sizes indicated on drawings by an approved supplier.
- .2 Cement: Type MS, sulphate resistant.

- .3 Concrete strength: minimum 32 MPa at the time of driving. Concrete strength at transfer of prestress minimum 25 MPa.
- .4 Prestressing steel: to ASTM A416, uncoated seven-wire stress-relieved strand, grade 270.
- .5 Welded wire mesh: to ASTM A-185.
- .6 Spiral reinforcement: to ASTM A82, cold drawn steel wire.

1.12 Fabrication

- .1 Fabricate precast concrete piles to lengths, cross sectional areas, reinforcement as required to meet capacities indicated.
- .2 Fabricate piles to following finish tolerances:
 - .1 Length: ± 3 mm per metre of length.
 - .2 Cross section: solid section -6 to +12 mm.
 - .3 Deviation from straight line: not more than 3 mm per metre of length, nor 12 mm in full length.
 - .4 Pile head: ± 10 mm per metre from true right angle plane. Surface irregularities ± 3 mm.
 - .5 Location of reinforcing steel: Main reinforcing cover: -3mm to +6 mm. Spacing of spiral ± 12 mm.

Execution

1.13 Installation

- .1 Provide approved type of protection cap with cushion block to top of pile when driving. Cushion block material softwood such as green hemlock. Plywood not acceptable.
- .2 Do not typically splice piles. If splicing of piles should be required, only pre-manufactured cast-in splice shoes approved by the Consultant will be considered.
- .3 On completion of driving, cut off pile at required elevation. Make circumferential cut with concrete saw to prevent spalling of pile below cut-off elevation. Make pile cut off absolutely horizontal.
- .4 Drive piles at locations indicated and to depth sufficient to develop required loading.
- .5 Minimum prebored depth for piles from excavation 4.0 metres.
- .6 Prebored holes to have 50 mm larger diameter than piles to be placed unless indicated otherwise on the drawings.
- .7 Remove boulders encountered in prebored holes using a core barrel or other approved method.
- .8 Remove, relocate, redrive and provide additional piles where directed when boulders or other obstructions prevent driving piles to an adequate bearing strata or within allowable tolerances in locations indicated on the drawings. Perform such work at no additional cost to the Contract.

- .9 Perform pile driving with a diesel hammer capable of delivering a rated energy of at least 30,000 joules.
- .10 Refusal criteria for driving piles shall be established by inspection at time of driving, and in accordance with the criteria in the Geotechnical Report. All plies shall have full time inspection provided by geotechnical engineer.
- .11 Replace piles that are excessively damaged through driving or which are believed to be broken with new piles at a suitable location at no additional cost to Contract.
- .12 Piles shall be of sufficient length to allow 450 mm of strand to extend into the structure above.
- .13 If a pile or piles should be driven below required elevation to accommodate exposed strand requirements, cut off such piles 450 mm below the top of pile (except at single pile caps) and install an extension to details as supplied by the Consultant at no extra cost to the Contract.
- .14 Drive all piles to required final set in competent hard glacial till deposit.
- .15 Drive piles continuously, without intermission until driven to required final set depth.
- .16 Observe and check pile upheaval. Redrive pile to refusal and final set any piles showing uplift after driving adjacent piles.

1.14 Clean-Up

- .1 After installation of foundation units, remove all excess concrete and other debris and leave site in clean condition.

END OF SECTION

Part 1 GENERAL

1.1 References

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM C117-95, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C131-96, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C136-96a, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM D698-00a, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600kN-m/m³).
 - .5 ASTM D1557-00, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³) (2,700kN-m/m³).
 - .6 ASTM D1883-99, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - .7 ASTM D4318-00, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Manitoba Infrastructure and Transportation Standard Construction Specifications (MIT)

1.2 Waste Management And Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Divert unused granular materials from landfill to local facility for reuse as directed by Departmental Representative.

Part 2 Products

2.1 Materials

- .1 Granular base: material to be used for parking lot construction in accordance with Section 31 05 16 - Aggregate Materials and the following requirements:
 - .1 Crushed gravel or limestone. Class 'A' to be used as base layer and Class 'B' to be used as sub-base layer.

- .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1.

- .1 Gradation Method # 1 to:

Sieve Designation	% Passing		Class 'C'	
	Class 'A'	Limestone	Gravel	Limestone
37.5			100	-
25 mm	-	-	85-100	100
19 mm	100	100	-	-
16 mm	80-100	-	-	-
4.75 mm	40-70	35-70	25-80	25-80
2.00 mm	25-55	-	-	-
0.425 mm	15-30	10-30	15-40	-
0.075 mm	8-15	8-17	8-18	8-20

- .2 Material to level surface depressions to meet gradation limits in accordance with Method #1.
- .3 Liquid limit: to ASTM D4318, maximum 25
- .4 Plasticity index: to ASTM D4318, maximum 6
- .5 Los Angeles degradation: to ASTM C131. Max. % loss by weight: 35
- .6 Crushed particles: at least 60% of particles by mass within each of following sieve designation ranges to have at least 1 freshly fractured face. Material to be divided into ranges using methods of ASTM C136.

Passing	Retained on
25 mm	to 19.0 mm
19.0 mm	to 4.75 mm

- .7 Soaked CBR: to ASTM D1883, min 80, when compacted to 100% of ASTM D698.

Part 3 Execution

3.1 Sequence Of Operation

- .1 Place granular base courses after sub-grade is reviewed and approved by the Departmental Representative.
- .2 Placing
- .1 Construct granular base course to depth and grade in areas indicated.
- .2 Ensure no frozen material is placed.
- .3 Place material only on clean unfrozen surface, free from snow and ice.

- .4 Begin spreading base material on crown line or on high side of one-way slope.
- .5 Place material using methods which do not lead to segregation or degradation of aggregate.
- .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
- .7 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. The Departmental Representative may authorize thicker lifts (layers) if specified compaction can be achieved.
- .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .9 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 **Compaction Equipment**
 - .1 Compaction equipment to be capable of obtaining required material densities.
 - .2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from the Departmental Representative before use.
- .4 **Compacting**
 - .1 Compact to density not less than 100% corrected maximum dry density unless noted otherwise in the Geotechnical Investigation Report.
 - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
 - .3 Apply water as necessary during compacting to obtain specified density.
 - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by the Departmental Representative.
 - .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
- .5 **Proof rolling**
 - .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires.
 - .2 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
 - .3 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove base and subgrade material to depth and extent as directed by the Departmental Representative.
 - .2 Backfill excavated subgrade with base course material and compact.
 - .4 Where proof rolling reveals defective base, remove defective materials to depth and extent as directed by the Departmental Representative and replace with new materials at no extra cost.

3.2 Site Tolerances

- .1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.3 Testing

- .1 Inspection and testing of base compaction will be carried out by a certified testing laboratory engaged and paid by the Contractor. Refer to Section 01 45 00 - Quality Control.
- .2 Submit testing procedure, frequency of tests, certified testing laboratory as designated by the Contractor to Departmental Representative for approval.

3.4 Protection

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by the Departmental Representative.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Agriculture and Agri-Food Canada
 - .1 The Canadian System of Soil Classification, Third Edition, 1998.
- .2 Canadian Council of Ministers of the Environment
 - .1 PN1340-2005, Guidelines for Compost Quality.

1.2 Definitions

- .1 Compost:
 - .1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil conditioner.
 - .2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.
 - .3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth C:N ratio below 25, and contain no toxic or growth inhibiting contaminants.
 - .4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category A.

1.3 Waste Management And Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Divert unused soil amendments from landfill to official hazardous material collections site approved by Departmental Representative.
- .3 Do not dispose of unused soil amendments into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 TOPSOIL

- .1 Topsoil for sod areas: mixture of particulates, micro organisms and organic matter which provides suitable medium for supporting intended plant growth.
 - .1 Soil texture based on The Canadian System of Soil Classification, to consist of 20 to 70 % sand, minimum 7% clay, and contain 2 to 10 % organic matter by weight.
 - .2 Contain no toxic elements or growth inhibiting materials.

- .3 Finished surface free from:
 - .1 Debris and stones over 50 mm diameter.
 - .2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.
- .4 Consistence: friable when moist.

2.2 Soil Amendments

- .1 Fertilizer:
 - .1 Fertility: major soil nutrients present in following amounts:
 - .2 Nitrogen (N): 20 to 40 micrograms of available Nitrogen per gram of topsoil.
 - .3 Phosphorus (P): 40 to 50 micrograms of phosphate per gram of topsoil.
 - .4 Potassium (K): 75 to 110 micrograms of potassium per gram of topsoil.
 - .5 Calcium, magnesium, sulfur and micro-nutrients present in balanced ratios to support germination and/or establishment of intended vegetation.
 - .6 Ph value: 6.5 to 8.0.
- .2 Peatmoss:
 - .1 Derived from partially decomposed species of Sphagnum Mosses.
 - .2 Elastic and homogeneous, brown in colour.
 - .3 Free of wood and deleterious material which could prohibit growth.
 - .4 Shredded particle minimum size: 5 mm.
- .3 Sand: washed coarse silica sand, medium to course textured.
- .4 Organic matter: compost Category A, in accordance with CCME PN1340, unprocessed organic matter, such as rotted manure, hay, straw, bark residue or sawdust, meeting the organic matter, stability and contaminant requirements.
- .5 Limestone:
 - .1 Ground agricultural limestone.
 - .2 Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.
- .6 Fertilizer: industry accepted standard medium containing nitrogen, phosphorous, potassium and other micro-nutrients suitable to specific plant species or application or defined by soil test.

2.3 Source Quality Control

- .1 Advise Departmental Representative of sources of topsoil to be utilized with sufficient lead time for testing.
- .2 Contractor is responsible for amendments to supply topsoil as specified.
- .3 Soil testing by recognized testing facility for PH, P and K, and organic matter.

- .4 Testing of topsoil will be carried out by testing laboratory designated by Departmental Representative.
 - .1 Soil sampling, testing and analysis to be in accordance with Provincial standards.

Part 3 Execution

3.1 PREPARATION OF EXISTING GRADE

- .1 Verify that grades are correct.
 - .1 If discrepancies occur, notify Departmental Representative and do not commence work until instructed by Departmental Representative.
- .2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage.
- .3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials.
 - .1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.
 - .2 Remove debris which protrudes more than 75 mm above surface.
 - .3 Dispose of removed material off site.
- .4 Cultivate entire area which is to receive topsoil to minimum depth of 100mm.

3.2 Placing And Spreading Of Topsoil/Planting Soil

- .1 Place topsoil after Departmental Representative has accepted subgrade.
- .2 Spread topsoil in uniform layers not exceeding 150 mm.
- .3 For seeded areas spread topsoil to finished grade, with a minimum depth of 150 mm after settlement.
- .4 For sodded areas spread topsoil to a depth below finished grade that is equal to the thickness of the sod to be used, after settlement.
- .5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

3.3 FINISH GRADING

- .1 Grade to eliminate rough spots and low areas and ensure positive drainage.
 - .1 Prepare loose friable bed by means of cultivation and subsequent raking.
- .2 Consolidate topsoil to required bulk density using equipment approved Departmental Representative.
 - .1 Leave surfaces smooth, uniform and firm against deep footprinting.

3.4 ACCEPTANCE

- .1 Departmental Representative will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

3.5 Cleaning

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 Submittals

.1 Product Data:

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Provide product data for:
 - .1 Seed.
 - .2 Fertilizer.

1.2 Quality Assurance

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.3 Waste Management And Disposal

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Divert unused fertilizer from landfill to official hazardous material collections site approved by Departmental Representative.
- .3 Do not dispose of unused fertilizer into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 GRASS SEED

- .1 Canada "Certified" seed, "Canada No. 1 or 2 Lawn Grass Mixture" in accordance with Government of Canada "Seeds Act" and "Seeds Regulations".
 - .1 Grass seed mixture.
 - .1 60% Kentucky Blue Grass, 30% Creeping Red Fescue, 10% Perennial Ryegrass.
- .2 In packages individually labelled in accordance with "Seeds Regulations" and indicating name of supplier.

2.2 Water

- .1 Free of impurities that would inhibit germination and growth.

- .2 Supplied by Contractor at designated source approved by the Departmental Representative.

2.3 Fertilizer

- .1 To Canada "Fertilizers Act" and "Fertilizers Regulations".
- .2 Complete synthetic fertilizer with guaranteed minimum analysis as specified.

Part 3 Execution

3.1 Quality Of Work

- .1 Do not perform work under adverse field conditions as determined by Departmental Representative
- .2 Remove and dispose of weeds; debris; stones 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; off site to a location as directed by Departmental Representative.

3.2 Seed Bed Preparation

- .1 Verify that grades are correct. If discrepancies occur, notify Departmental Representative and do not commence work until instructed.
- .2 Fine grade surface free of humps and hollows to smooth, even grade, to contours and elevations indicated to tolerance of plus or minus 15 mm, surface draining naturally.

3.3 SEED PLACEMENT

- .1 For mechanical seeding:
 - .1 Use "Brillion" type mechanical landscape seeder which accurately places seed at specified depth and rate and rolls in single operation.
 - .2 Use equipment and method acceptable to Departmental Representative.
- .2 For manual seeding:
 - .1 Use "Cyclone" type manually operated seeder.
 - .2 Use manually operated, water ballast, landscaping type, smooth steel drum roller. Ballast as directed by Departmental Representative.
 - .3 Use equipment and method acceptable to Departmental Representative.
- .3 Sow half of required amount of seed in one direction and remainder at right angles as applicable.
- .4 Incorporate seed by light raking in cross directions.

- .5 Consolidate mechanically seeded areas by rolling area if soil conditions warrant or if directed by Departmental Representative with equipment approved by Departmental Representative immediately after seeding.

3.4 Maintenance During Establishment Period

- .1 Perform following operations from time of seed application until acceptance by Departmental Representative
 - .1 Water seeded area to maintain optimum soil moisture level for germination and continued growth of grass. Control watering to prevent washouts.
 - .2 Repair and reseed dead or bare spots to allow establishment of seed prior to acceptance.
 - .3 Cut grass whenever it reaches height of 70 mm and remove clippings which will smother grass, as directed by Departmental Representative.
 - .4 Fertilize seeded areas in accordance with manufacturer's recommended fertilizing program.
 - .5 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.

3.5 FINAL ACCEPTANCE

- .1 Seeded areas will be accepted by Departmental Representative provided that:
 - .1 Areas are uniformly established and turf is free of rutted, eroded, bare or dead spots and free of weeds.
 - .2 Areas have been cut at least twice.
 - .3 Areas have been fertilized.
- .2 Areas seeded in fall will be accepted in following spring, one month after start of growing season provided acceptance conditions are fulfilled.

3.6 Maintenance During Warranty Period

- .1 Perform following operations from time of acceptance until end of warranty period.
 - .1 Water seeded area to maintain optimum soil moisture level for continued growth of grass. Control watering to prevent washouts.
 - .2 Repair and reseed dead or bare spots to satisfaction of Departmental Representative.
 - .3 Cut grass whenever it reaches height of 70 mm and remove clippings which will smother grass, as directed by Departmental Representative.
 - .4 Fertilize seeded areas in accordance with manufacturer's recommended fertilizing program.
 - .5 Control weeds by mechanical or chemical means utilizing acceptable integrated pest management practices.

3.7 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 General

1.1 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.2 Scheduling

- .1 Schedule sod laying to coincide with preparation of soil surface.
- .2 Schedule sod installation when frost is not present in ground.

1.3 Waste Management And Disposal

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Divert unused fertilizer from landfill to official hazardous material collections site approved by Departmental Representative.
- .3 Do not dispose of unused fertilizer into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

Part 2 Products

2.1 MATERIALS

- .1 Number One Turf Grass Nursery Sod: sod that has been especially sown and cultivated in nursery fields as turf grass crop.
 - .1 Turf Grass Nursery Sod types:
 - .1 Number One Kentucky Bluegrass Sod: Nursery Sod grown solely from seed of cultivars of Kentucky Bluegrass, containing not less than 50% Kentucky Bluegrass cultivars.
 - .2 Number One Kentucky Bluegrass Sod - Fescue Sod: Nursery Sod grown solely from seed mixture of cultivars of Kentucky Bluegrass and Chewing Fescue or Creeping Red Fescue, containing not less than 40% Kentucky Bluegrass cultivars and 30% Chewing Fescue or Creeping Red Fescue cultivar[s].
 - .3 Number One Named Cultivars: Nursery Sod grown from certified seed.
 - .2 Water:

- .1 Supplied by Departmental Representative at designated source.

.3 Fertilizer:

- .1 To Canada "Fertilizers Act" and "Fertilizers Regulations".
- .2 Complete, synthetic, slow release with 65% of nitrogen content in water-insoluble form.

2.2 Source Quality Control

- .1 Obtain approval from Departmental Representative of sod at source.
- .2 When proposed source of sod is approved, use no other source without written authorization from Departmental Representative.

Part 3 Execution

3.1 Preparation

- .1 Verify that grades are correct and prepared in accordance with Section 32 91 19.13 - Topsoil Placement and Grading. If discrepancies occur, notify Departmental Representative and do not commence work until instructed by Departmental Representative.
- .2 Do not perform work under adverse field conditions such as frozen soil, excessively wet soil or soil covered with snow, ice, or standing water.
- .3 Fine grade surface free of humps and hollows to smooth, even grade, to contours and elevations indicated, to tolerance of plus or minus 8 mm, for Turf Grass Nursery Sod, surface to drain naturally.
- .4 Remove and dispose of weeds; debris; stones 50mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; off site.

3.2 Sod Placement

- .1 Lay sod within 24 hours of being lifted if air temperature exceeds 20 degrees C.
- .2 Lay sod sections in rows, joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.
- .3 Roll sod as directed by Departmental Representative. Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.

3.3 Maintenance During Establishment Period

- .1 Perform following operations from time of installation until acceptance.

- .2 Water sodded areas a minimum of 3 times a week for 4 consecutive weeks in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 75 to 100mm.
- .3 Cut grass to 50mm when or prior to it reaching height of 75mm. Remove clippings which will smother grassed areas as directed by Departmental Representative.
- .4 Maintain sodded areas 95% weed free.

3.4 Acceptance

- .1 Turf Grass Nursery Sod areas will be accepted by Departmental Representative provided that:
 - .1 Sodded areas are properly established.
 - .2 Sod is free of bare and dead spots.
 - .3 No surface soil is visible from height of 1500 mm when grass has been cut to height of 50 mm.
 - .4 Sodded areas have been cut minimum 2 times prior to acceptance.
- .2 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

3.5 Maintenance During Warranty Period

- .1 Perform following operations from time of acceptance until end of warranty period:
 - .1 Water sodded Turf Grass Nursery Sod areas at weekly intervals to obtain optimum soil moisture conditions to depth of 100 mm.
- .2 Repair and resod dead or bare spots to satisfaction of Departmental Representative.
- .3 Cut grass and remove clippings that will smother grass Departmental Representative to height as follows:
 - .1 Turf Grass Nursery Sod:
 - .1 50mm during normal growing conditions.
 - .2 Cut grass at 2 week intervals.
 - .3 Eliminate weeds by mechanical or chemical means to extent acceptable to Departmental Representative.

3.6 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

END OF SECTION

Part 1 GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A48/A48M-00, Standard Specification for Gray Iron Castings.
 - .2 ASTM C117-04, Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - .3 ASTM C136-05, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM C139-05, Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
 - .5 ASTM C478M-06, Standard Specification for Precast Reinforced Concrete Manhole Sections Metric.
 - .6 ASTM D698-00a, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³(600 kN-m/m³)).
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A23.1-04/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA-A3000-03(R2005), Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .3 CSA-A3001-03, Cementitious Materials for Use in Concrete.
 - .4 CSA-A3002-03, Masonry and Mortar Cement.
- .4 City of Brandon Standard Construction Standard Specifications.

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 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 Submit manufacturer's test data and certification at least 4 weeks prior to beginning Work. Include manufacturer's drawings, information and shop drawings where pertinent.
- .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .3 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

1.3 Closeout Submittals

- .1 Provide record drawings, including details of manhole, maintenance and operating instructions in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Include horizontal location of manhole, inverts of pipes and rim elevation.

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.
- .2 Waste Management and Disposal:
 - .1 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 MATERIALS

- .1 Cast-in-place concrete for manhole benching and flow channels:
 - .1 Cement: to CAN/CSA-A3001, Type HS.
 - .2 Concrete mix design to produce 32 MPa minimum compressive strength at 28 days and containing 20 mm maximum size coarse aggregate, with water/cement ratio to CAN/CSA-A23.1, and 80 +/- 20 mm slump at time and point of deposit.
 - .1 Air entrainment 4-7% to CAN/CSA-A23.1.
- .2 Precast manhole units: to ASTM C478M, circular.
 - .1 Standard pre-cast concrete 1200mm diameter base and riser sections with flexible plastic gaskets between sections followed by a 1200mm x 750mm flat reducer on top.

- .3 Joints: made watertight using rubber rings, bituminous compound, epoxy resin cement or cement mortar.
- .4 Mortar:
 - .1 Equal parts of Type HS cement and clean sharp mortar sand mixed dry with sufficient water to make the mixture workable and of developing a 20 MPa compressive strength after 28 days.
- .5 Ladder rungs: to CAN/CSA-G30.18, No.25M billet steel deformed bars, hot dipped galvanized to CAN/CSA-G164.
 - .1 Rungs to be safety pattern (drop step type).
- .6 Adjusting rings: to ASTM C478M.
- .7 Frames, gratings, covers to dimensions as indicated and following requirements:
 - .1 Metal gratings and covers to bear evenly on frames.
 - .1 Frame with grating or cover to constitute one unit.
 - .2 Assemble and mark unit components before shipment.
 - .2 Gray iron castings: to ASTM A48/A48M, strength class 30B.
 - .3 Castings: coated with two applications of asphalt varnish.
 - .4 Manhole frames and covers: cover cast without perforations and complete with two 25 mm square lifting holes, or in accordance with approved products for use in the City of Brandon.
 - .5 Size: 762mm clear diameter.
- .8 Granular bedding and backfill: in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed stone, gravel and sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.

.3 Table:

Sieve Designation	% Passing Stone/Gravel	Gravel/Sand
200 mm	-	-
75 mm	-	-
50 mm	-	-
38.1 mm	-	-
25 mm	100	-
19 mm	-	-
12.5 mm	65-90	100
9.5 mm	-	-
4.75 mm	35-55	50-100
2.00 mm	-	30-90
0.425 mm	10-25	10-50
0.180 mm	-	-
0.075 mm	0-8	0-10

- .9 Unshrinkable fill: in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

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 Excavation And Backfill

- .1 Excavate and backfill in accordance with Section 31 23 10 – Excavating, Trenching and Backfilling and as indicated.
- .2 Obtain approval of Departmental Representative before installing manholes or catch basins.

3.3 Installation

- .1 Construct units in accordance with details indicated, plumb and true to alignment and grade.
- .2 Complete units as pipe laying progresses.
 - .1 Maximum of three units behind point of pipe laying will be allowed.
- .3 Dewater excavation to approval of Departmental Representative and remove soft and foreign material before placing concrete base.
- .4 Set precast concrete base on 150 mm minimum of granular bedding compacted to 100% corrected maximum dry density to ASTM D698.
- .5 Precast units:
 - .1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base.
 - .2 Make each successive joint watertight with Departmental Representative's approved rubber ring gaskets, bituminous compound, cement mortar, epoxy resin cement, or combination of these materials.
 - .3 Clean surplus mortar and joint compounds from interior surface of unit as work progresses.
 - .4 Plug lifting holes with precast concrete plugs set in cement mortar or mastic compound.
- .6 For sewers:
 - .1 Place stub outlets and bulkheads at elevations and in positions indicated.

- .2 Bench to provide smooth U-shaped channel.
 - .1 Side height of channel to be 0.75 times full diameter of sewer.
 - .2 Slope adjacent floor at 1 in 20.
 - .3 Curve channels smoothly.
 - .4 Slope invert to establish sewer grade.
- .7 Compact granular backfill to 95% corrected maximum dry density to ASTM D698.
- .8 Place unshrinkable backfill where indicated in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .9 Installing units in existing systems:
 - .1 Where new unit is installed in existing run of pipe, ensure full support of existing pipe during installation, and carefully remove that portion of existing pipe to dimensions required and install new unit as specified.
 - .2 Make joints watertight between new unit and existing pipe.
 - .3 Where deemed expedient to maintain service around existing pipes and when systems constructed under this project are ready for operation, complete installation with appropriate break-outs, removals, redirection of flows, blocking unused pipes or other necessary work.
- .10 Set frame and cover to required elevation on no more than four courses of brick.
 - .1 Make brick joints and join brick to frame with cement mortar.
 - .2 Parge and make smooth and watertight.
- .11 Place frame and cover on top section to elevation as indicated.
 - .1 If adjustment required use concrete ring.
- .12 Clean units of debris and foreign materials.
 - .1 Remove fins and sharp projections.
 - .2 Prevent debris from entering system.
- .13 Install safety platforms in manholes having depth of 5m or greater, as indicated.

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 Section Includes

- .1 Materials and installation for water mains, hydrants, valves, valve boxes, and valve chambers, including service connections.

1.2 References

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C651, Disinfecting Water Mains.
 - .2 ANSI/AWWA C800, Underground Service Line Valves and Fittings
 - .3 ANSI/AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch through 12 Inch (100 mm - 300 mm), for Water Distribution.
- .2 American Water Works Association (AWWA)/Manual of Practice
 - .1 AWWA M17, Installation, Field Testing, and Maintenance of Fire Hydrants.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000, Cementitious Materials Compendium
 - .1 CAN/CSA-A8, Masonry Cement.
 - .2 CSA B137 Series, Thermoplastic Pressure Piping Compendium.
 - .1 CSA B137.3, Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.
- .4 City of Brandon Standard Construction Standard Specifications

1.3 Submittals

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Inform Departmental Representative of proposed source of bedding materials and provide access for sampling at least 4 weeks prior to commencing work.
- .3 Submit manufacturer's test data and certification that pipe materials meet requirements of this section at least 4 weeks prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.
- .4 Pipe certification to be on pipe.

1.4 Closeout Submittals

- .1 Provide record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, maintenance and operating instructions in accordance with Section 01 78 00 - Closeout Submittals.

- .1 Include inverts of pipes, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.

1.5 Waste Management And Disposal

- .1 Separate 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 Divert unused metal and wiring materials from landfill to metal recycling facility as approved by Departmental Representative.
- .6 Divert unused concrete materials from landfill to local facility as approved by Departmental Representative.

1.6 Scheduling Of Work

- .1 Schedule Work to minimize interruptions to existing services.
- .2 Submit schedule of expected interruptions to Departmental Representative for approval and adhere to interruption schedule as approved by Departmental Representative.
- .3 Notify Departmental Representative minimum of 24 h in advance of interruption in service.
- .4 Notify fire department of any planned or accidental interruption of water supply to hydrants.
- .5 Provide "Out of Service" sign on hydrant not in use.

Part 2 Products

2.1 Pipe, Joints And Fittings

- .1 Polyvinyl chloride pressure pipe: to ANSI/AWWA C900, pressure class 150, DR 18, 1 MPa gasket bell end, cast iron outside diameter.
 - .1 Acceptable material: approved products for use in the City of Brandon.
 - .2 Pipe joints: bell and spigot push on type with rubber gasket seals in accordance with ASTM F477, capable of withstanding pressure equal to the rated pressure of the pipe and withstanding thermal expansion and contraction.

- .3 Fittings: injection moulded to AWWA C907 and CAN/CSA B137.2, and in accordance with approved products for use in the City of Brandon.

2.2 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise.
- .2 Gate valves: to ANSI/AWWA C500, standard iron body, resilient seated wedge valves with non-rising stems, suitable for 1 MPa with push-on joints compatible with the class and type of pipe to which it is intended to join, and in accordance with approved products for use in the City of Brandon.
- .3 Cast iron valve boxes: two piece extension type with a one piece slide on cast iron casing top and PVC DR18 pipe base, adjustable over minimum of 300 mm complete with a tubular extension spindle with a 50 mm square operating nut, a plastic centering disc, cast iron valve box cover, and hinged cast iron lid. Spindle length will be of such length that when set on valve operating nut top of rod will not be more than 150 mm below cover.
 - .1 Acceptable material: approved products for use in the City of Brandon.
 - .2 Top of box to be marked "W" for water, with lid aligned to flow of traffic.

2.3 Service Connections

- .1 Copper tubing: to ASTM B88M Type K, annealed.
- .2 Copper tubing joints: compression type suitable for 1 MPa working pressure.
- .3 Brass corporation stops: compression type having threads to ANSI/AWWA C800, and in accordance with approved products for use in the City of Brandon.
- .4 Brass curb stops: compression type with drain to ANSI/AWWA C800, and in accordance with approved products for use in the City of Brandon.
 - .1 Curb stops to have adjustable cast iron service box with stem to suit depth of bury.
- .5 Service connections for PVC pipe:
 - .1 Service connections less than 100 mm: Corporation stop, tapped to main using AWWA threads, complete with stainless service saddle. Service saddle to consist of circumferential band type complete with side bars and fingers, keeper bar, stud bolts, nuts, washers and gaskets.
- .6 Bronze type service clamps: for PVC pipe service connections.
 - .1 Service clamps to be of strap-type, with confined "O" ring seal cemented in place.
 - .2 Clamps to be tapped with threads to ANSI/AWWA C800.

2.4 Pipe Bedding And Surround Material

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Crushed stone, gravel and sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.

.3 Table:

Sieve Designation	% Passing Stone/Gravel	Gravel/Sand
200 mm	-	-
75 mm	-	-
50 mm	-	-
38.1 mm	-	-
25 mm	100	-
19 mm	-	-
12.5 mm	65-90	100
9.5 mm	-	-
4.75 mm	35-55	50-100
2.00 mm	-	30-90
0.425 mm	10-25	10-50
0.180 mm	-	-
0.075 mm	0-8	0-10

2.5 BACKFILL MATERIAL

- .1 Type 3, in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.6 Pipe Disinfection

- .1 Undertake disinfection of water mains using sodium hypochlorite or calcium hypochlorite in accordance with ANSI/AWWA C651, and City of Brandon standard procedures.

Part 3 Execution

3.1 Preparation

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects to approval of Departmental Representative.
 - .2 Remove defective materials from site as directed by Departmental Representative.

3.2 Trenching

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling.
- .2 Trench alignment and depth require Departmental Representative's approval prior to placing bedding material and pipe.

3.3 Granular Bedding

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% of corrected maximum dry density.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling with compacted bedding material.

3.4 Pipe Installation

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main. Install coupling necessary for connection to building plumbing. If plumbing is already installed, make connection; otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Lay pipes to manufacturer's standard instructions and specifications. Do not use blocks except as specified.
- .3 Join pipes in accordance with manufacturer's recommendations.
- .4 Bevel or taper ends of PVC pipe to match fittings.
- .5 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- .6 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.

- .7 Face socket ends of pipe in direction of laying.
- .8 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .9 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .10 Position and join pipes with equipment and methods approved by Departmental Representative.
- .11 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .12 Align pipes before jointing.
- .13 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .14 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
- .15 Complete each joint before laying next length of pipe.
- .16 Minimize deflection after joint has been made.
- .17 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .18 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Departmental Representative.
- .19 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- .20 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .21 Do not lay pipe on frozen bedding.
- .22 Backfill remainder of trench.

3.5 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.
- .2 Support valves located in valve boxes by means of bedding same as adjacent pipe. Maximum length of pipe on each end of valve shall be 1 m. Valves not to be supported by pipe.

3.6 Service Connections

- .1 Terminate building water service 1 m outside building wall opposite point of connection to main.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection, otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Construct service connections at right angles to water main unless otherwise directed. Locate curb stops as indicated.
- .3 Tappings on PVC pipe to be either bronze type service clamps, strap type with "O" ring seal cemented in place.
- .4 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .5 Install tap service connection on top half of main, between 45 degrees and 90 degrees measured from apex of pipe.
- .6 Leave corporation stop valves fully open.
- .7 In order to relieve strain on connections, install service pipe in "Goose Neck" form "laid over" into horizontal position.
- .8 Place temporary location marker at ends of plugged or capped unconnected water lines.
 - .1 Each marker to consist of 38 x 89 mm stake extending from pipe end at pipe level to [600] mm above grade.
 - .2 Paint exposed portion of stake blue with designation "WATER SERVICE LINE" in black.

3.7 Thrust Blocks And Restrained Joints

- .1 For thrust blocks: do concrete Work in accordance with City of Brandon Standard Construction Specifications.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Departmental Representative
- .3 Keep joints and couplings free of concrete.

3.8 Hydrostatic And Leakage Testing

- .1 Do tests in accordance with City of Brandon Standard Construction Specifications.
- .2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
- .3 Notify Departmental Representative at least 48 hours in advance of proposed tests.
 - .1 Perform tests in presence of Departmental Representative.
- .4 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete.
- .5 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes between joints with approved granular material placed o dimensions indicated.
- .6 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
- .7 Open valves.
- .8 Expel air from main by slowly filling main with potable water.
 - .1 Install corporation stops at high points in main where no air-vacuum release valves are installed.
 - .2 Remove stops after satisfactory completion of test and seal holes with plugs.
- .9 Apply leakage test pressure of 1035 kPa after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 1 hour.
- .10 Loss of pressure in excess of 14 kPa over the one hour test period will be considered a failure.
- .11 Locate and repair defects if loss of pressure is greater than amount specified.
- .12 Repeat test until leakage is within specified allowance for full length of water main.

3.9 Pipe Surround

- .1 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes as indicated.
- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.

- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Do not place material in frozen condition.
- .5 Compact each layer to at least 95% of corrected maximum dry density.

3.10 Backfill

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Compact backfill to at least 95% corrected maximum dry density.

3.11 FLUSHING AND DISINFECTING

- .1 Flushing and disinfecting operations: in accordance with City of Brandon Standard Construction Specifications and witnessed by Departmental Representative.
 - .1 Notify Departmental Representative at least 4 days in advance of proposed date when disinfecting operations will begin.
- .2 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 1.5 m/s, within pipe for minimum 10 minutes, or until foreign materials have been removed and flushed water is clear.
- .3 Provide connections and pumps for flushing as required.
- .4 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .5 When flushing has been completed to Departmental Representative approval, introduce strong solution of chlorine as approved by Departmental Representative into water main and ensure that it is distributed throughout entire system.
- .6 Rate of chlorine application to be proportional to rate of water entering pipe.
- .7 Chlorine application to be close to point of filling water main and to occur at same time.
- .8 Operate valves, hydrants and appurtenances while main contains chlorine solution.
- .9 Flush line to remove chlorine solution after 24 hours.
- .10 Measure chlorine residuals at extreme end of pipe-line being tested.

- .11 Perform bacteriological tests on water main, after chlorine solution has been flushed out.
 - .1 Take samples daily for minimum of two days.
 - .2 Should contamination remain or recur during this period, repeat disinfecting procedure.
- .12 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.
- .13 After adequate chlorine residual not less than 50 ppm has been obtained leave system charged with chlorine solution for 24 hours.
 - .1 After 24 hours, take further samples to ensure that there is still not less than 5 ppm of chlorine residual remaining throughout system.

3.12 Surface Restoration

- .1 After installing and backfilling over water mains, restore surface to original condition as directed by Departmental Representative.

END OF SECTION

Part 1 **GENERAL**

1.1 Section Includes

- .1 Materials and installation for gravity sanitary sewers

1.2 References

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft⁴-lbf/ft³ (600 kN-m/m³)).
 - .2 ASTM D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - .3 ASTM D3350], Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA B1800, Plastic Non-pressure Pipe Compendium - B1800 Series (Consists of B181.1, B181.2, B181.3, B181.5, B182.1, B182.2, B182.4, B182.6, B182.7, B182.8 and B182.11).
 - .2 CSA B182.2, PVC Sewer Pipe and Fittings (PSM Type).
 - .3 CSA B182.11, Recommended Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings.
- .3 City of Brandon Standard Construction Specifications

1.3 Definitions

- .1 Pipe section is defined as length of pipe between successive manholes and/or between manhole and any other structure which is part of sewer system.

1.4 Submittals

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of bedding materials and provide access for sampling.
- .3 Submit manufacturer's test data and certification at least 2 weeks prior to beginning Work.
- .4 Ensure certification is marked on pipe.
- .5 Submit manufacturers information data sheets and instructions in accordance with Section 01 33 00 - Submittal Procedures.

1.5 Closeout Submittals

- .1 Provide record drawings, including details of pipe material, in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Include inverts of pipes, horizontal location of all fittings.

1.6 Delivery, Storage And Handling

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

1.7 Waste Management And Disposal

- .1 Separate 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 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .5 Divert unused concrete materials from landfill to local facility as approved by Departmental Representative.
- .6 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.

1.8 Scheduling Of Work

- .1 Schedule Work to minimize interruptions to existing services and maintain existing sewage flows during construction.
- .2 Submit schedule of expected interruptions for approval and adhere to approved schedule.
- .3 Notify Departmental Representative 24 hours minimum in advance of any interruption in service.

Part 2 **PRODUCTS**

2.1 Plastic Pipe

- .1 Type PSM Polyvinyl Chloride (PVC): to ASTM D3034, CSA-B182.2.
 - .1 Standard Dimensional Ratio (SDR): 35
 - .2 Locked-in gasket and integral bell system.
 - .3 Nominal lengths: 4 m.

- .2 Acceptable material: approved products for use in the City of Brandon.

2.2 Pipe Bedding And Surround Material

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
- .1 Crushed stone, gravel and sand.
- .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.

.3 Table:

Sieve Designation	% Passing Stone/Gravel	Gravel/Sand
200 mm	-	-
75 mm	-	-
50 mm	-	-
38.1 mm	-	-
25 mm	100	-
19 mm	-	-
12.5 mm	65-90	100
9.5 mm	-	-
4.75 mm	35-55	50-100
2.00 mm	-	30-90
0.425 mm	10-25	10-50
0.180 mm	-	-
0.075 mm	0-8	0-10

2.3 Backfill Material

- .1 Type 3, in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

Part 3 EXECUTION

3.1 Preparation

- .1 Clean and dry pipes and fittings before installation.
- .2 Obtain Departmental Representative approval of pipes and fittings prior to installation.

3.2 Trenching

- .1 Do trenching work in accordance with Section 31 23 33.01 – Excavation, Trenching and Backfill.
- .2 Do not allow contents of any sewer or sewer connection to flow into trench.

- .3 Trench alignment and depth require Departmental Representative's approval prior to placing bedding material and pipe.

3.3 Granular Bedding

- .1 Place bedding in unfrozen condition.
- .2 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to at least 95% of corrected maximum dry density.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling with compacted bedding material.

3.4 Installation

- .1 Lay and join pipes in accordance with manufacturer's recommendations and to approval of [Engineer] [Consultant].
- .2 Handle pipe using methods approved by Departmental Representative.
- .3 Lay pipes on prepared bed, true to line and grade, with pipe invert smooth and free of sags or high points.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
- .4 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.
- .5 Do not exceed maximum joint deflection recommended by pipe manufacturer.
- .6 Do not allow water to flow through pipe during construction, except as may be permitted by Departmental Representative.
- .7 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .8 Install plastic pipe and fittings in accordance with CSA B182.11.
- .9 Pipe jointing:
 - .1 Install gaskets in accordance with manufacturer's recommendations.

- .2 Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .3 Align pipes before joining.
- .4 Maintain pipe joints free from mud, silt, gravel and other foreign material.
- .5 Avoid displacing gasket or contaminating with dirt or other foreign material. Gaskets so disturbed shall be removed, cleaned and lubricated and replaced before joining is attempted.
- .6 Complete each joint before laying next length of pipe.
- .7 Minimize joint deflection after joint has been made to avoid joint damage.
- .8 At rigid structures, install pipe joints not more than 1.2 m from side of structure.
- .9 Apply sufficient pressure in making joints to ensure that joint is complete as outlined in manufacturer's recommendations.
- .10 When stoppage of Work occurs, block pipes as directed by Departmental Representative to prevent creep during down time.
- .11 Cut pipes as required for special inserts, fittings or closure pieces as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
- .12 Make watertight connections to manholes.
 - .1 Use shrinkage compensating grout when suitable gaskets are not available.
- .13 Use prefabricated saddles or field connections approved by Departmental Representative for connecting pipes to existing sewer pipes.
 - .1 Joints to be structurally sound and watertight.

3.5 Pipe Surround

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Departmental Representative has inspected pipe joints, surround and cover pipes as indicated.
 - .1 Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
- .4 Place layers uniformly and simultaneously on each side of pipe.
- .5 Compact each layer to at least 95 % corrected maximum dry density.

3.6 Backfill

- .1 Place backfill material in unfrozen condition.

- .2 Place backfill material, above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .3 Compact backfill to at least 95 % corrected maximum dry density.

3.7 Service Connections

- .1 Install pipe to CSA B182.11 and manufacturer's instructions and specifications.
- .2 Service connections to main sewer: standard Tee.
- .3 Service connection pipe: not to extend into interior of main sewer.
- .4 Make up required horizontal and vertical bends from 45 degrees bends or less, separated by straight section of pipe with minimum length of four pipe diameters.
 - .1 Use long sweep bends where applicable.
- .5 Plug service laterals with water tight caps or plugs as approved by Departmental Representative.
- .6 Place location marker at ends of plugged or capped unconnected sewer lines.
 - .1 Each marker: 38 x 89 mm stake extending from pipe end at pipe level to 0.6 m above grade.
 - .2 Paint exposed portion of stake green with designation SAN SWR LINE in black.

3.8 Field Testing

- .1 Repair or replace pipe, pipe joint or bedding found defective.
- .2 Remove foreign material from sewers and related appurtenances by flushing with water.
- .3 Television and photographic inspections:
 - .1 Carry out inspection of installed sewers by television camera, as directed by Departmental Representative.
 - .2 Provide means of access to permit Departmental Representative to do inspections.

3.9 SURFACE RESTORATION

- .1 After installing and backfilling over sewer mains, restore surface to original condition as directed by Departmental Representative.

END OF SECTION

Part 1 General

1.1 Section Includes

- .1 Materials and installation for pipe culverts.

1.2 References

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C14M, Standard Specification for Concrete Sewer, Storm Drain and Culvert Pipe (Metric).
 - .2 ASTM C76M, Standard Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe (Metric).
 - .3 ASTM C117, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .4 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .5 ASTM C144, Standard Specification for Aggregate for Masonry Mortar.
 - .6 ASTM C443M, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
 - .7 ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - .8 ASTM D1248, Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
 - .9 ASTM F667, Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000 Cementitious Materials Compendium (Consists of A5-98, A8-98, A23.5-98, A362-98, A363-98, A456.1-98, A456.2-98, A456.3-98).
 - .1 CAN/CSA-A5, Portland Cement.
 - .2 CAN/CSA-A257 Series, Standards for Concrete Pipe.
 - .3 CSA-G401, Corrugated Steel Pipe Products.

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.

1.4 Closeout Submittals

- .1 Provide record drawings, including details of culverts, in accordance with Section 01 78 00 - Closeout Submittals.
 - .1 Include horizontal location of culverts and invert elevations at each end.

1.5 Delivery, Storage And Handling

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

1.6 Waste Management And Disposal

- .1 Separate 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 Divert unused metal materials from landfill to local facility for reuse as directed by Departmental Representative.
- .4 Fold up metal banding, flatten and place in designated area for recycling.

Part 2 Products

2.1 CORRUGATED STEEL PIPE

- .1 Corrugated steel pipe: to CSA-G401.
- .2 Water-tight cut-off collars: as indicated.

2.2 GRANULAR BEDDING AND BACKFILL

- .1 Granular bedding and backfill material in accordance with Section 31 23 33.01 – Excavation, Trenching and Backfill.

Part 3 Execution

3.1 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling.

- .2 Trench alignment and depth require Departmental Representative's approval prior to placing bedding material and pipe.

3.2 Bedding

- .1 Dewater excavation, as necessary, to allow placement of culvert bedding in dry condition.
- .2 Place minimum thickness of 200 mm of approved granular material on bottom of excavation and compact to minimum 95% maximum density to ASTM D698.
- .3 Shape bedding to fit lower segment of pipe exterior so that width of at least 50% of pipe diameter is in close contact with bedding and to camber as indicated or as directed by Departmental Representative, free from sags or high points.
- .4 Place bedding in unfrozen condition.

3.3 Laying Corrugated Steel Pipe Culverts

- .1 Begin pipe placing at downstream end.
- .2 Ensure bottom of pipe is in contact with shaped bed or compacted fill throughout its length.
- .3 Lay pipe with outside circumferential laps facing upstream.
- .4 Lay paved invert or partially lined pipe with longitudinal centre line of paved segment coinciding with flow line.
- .5 Do not allow water to flow through pipes during construction except as permitted by Departmental Representative.

3.4 Joints: Corrugated Steel Culverts

- .1 Corrugated steel pipe:
 - .1 Match corrugations or indentations of coupler with pipe sections before tightening.
 - .2 Tap couplers firmly as they are being tightened, to take up slack and ensure snug fit.
 - .3 Insert and tighten bolts.
 - .4 Repair spots where damage has occurred to spelter coating.

3.5 BACKFILLING

- .1 Backfill around and over culverts as indicated or as directed by Departmental Representative.
- .2 Place backfill material, approved by Departmental Representative, in 150 mm layers to full width, alternately on each side of culvert, so as not to displace it laterally or vertically.

- .3 Compact each layer to 95% maximum density to ASTM D698 taking special care to obtain required density under haunches.
- .4 Place backfill in unfrozen condition.

END OF SECTION

June 6, 2016

Our File No. 0169 006 00

Kellie J. Orr
President
HDK Consulting Inc.
55-81 Garry Street, Winnipeg, MB
R3C 4J9

RE Brandon Crop Services Building, Brandon, MB
Addendum No. 1 – Geotechnical Investigation Report

The following letter outlines Geotechnical recommendations with respect to construction of a concrete grade supported floor slab for the proposed Brandon Crop Services Building in Brandon, Manitoba. Geotechnical recommendations for a grade supported slab were requested by Lavergne Draward & Associates Inc. (LDA) on May 30, 2016. This letter serves as Addendum No. 1 to the Geotechnical Investigation Report (Revision No. 2) dated April 15, 2016 issued by TREK Geotechnical Inc. (TREK). The following changes shall be made to the existing Geotechnical report:

- Append Section **5.2 Grade Supported Slabs**;

5.2 Grade Supported Slabs

Based on the preliminary grading plan and main floor elevation of 387.5 m (provided by Sisun Blackburn Consulting Inc.), site grading requirements will result in cuts and fills ranging between 0 and 1.6 m within the proposed building footprint. These grading modifications are expected to result in moisture and volumetric changes (shrinking /swelling) within the sub-grade soils which may result in vertical movement of the grade supported slab. If the slab is subjected to freezing conditions, additional movements from freeze/thaw of the sub-grade soils may also occur. The potential for slab movements can be reduced or minimized with selection of fill materials that are less susceptible to volume changes and modifying techniques used to place and compact material below the slab. In this regard, recommendations provided are intended to reduce or minimize potential slab movements. It should be understood that even with implementing these recommendations, vertical slab movements in the order of 25 mm or more may be possible and therefore the slab should be designed to accommodate these movements.

Grade Supported Slab Recommendations

1. Organics, fill soils and any other deleterious material should be stripped such that the sub-grade consists of sandy silt or silty sand.
2. Excavation should be completed with an excavator equipped with a smooth bladed bucket operating from the edge of the excavation in order to minimize disturbance to the exposed sub-

- grade.
3. After excavation, the sub-grade should be inspected by qualified geotechnical personnel. The sub-grade should be proof-rolled and compacted to a minimum of 98% of standard proctor maximum dry density (SPMDD). Soft areas should be repaired as per recommendations provided by a geotechnical engineer. This will likely consist of additional excavation and replacement with compacted granular fill over a non-woven geotextile. Compaction of the subgrade should be undertaken using static methods (*e.g.* no vibratory compaction) to avoid softening of the sub-grade due the presence of potentially liquefiable silts and sands.
 4. Granular fill should be used to raise the sub-grade to the required design elevations (as granular material is less susceptible to volumetric changes), which could consist of MIT Class C granular base course (or an equivalent material) placed in lifts no greater than 150 mm and compacted to 98% of the SPMDD. Local sandy silt to silty sand material may be suitable to build up subgrade elevations subject to inspection and approval by a qualified geotechnical engineer once exposed during the construction phase.
 5. The sub-grade should be protected from freezing, drying, or inundation with water. If any of these conditions occur, the sub-grade should be scarified, moisture conditioned as appropriate, and re-compacted to a minimum of 98% of the SPMDD.
 6. Once the subgrade elevation has been achieved a non-woven geotextile should be installed prior to placement of the granular pavement structure.
 7. In heated areas, the floor slab should be placed on 150 mm of MIT Class A granular base course overlying 200 mm MIT Class C granular base course. In unheated areas, the floor slab should be placed on 150 mm of MIT Class A granular base course overlying 250 mm MIT Class C granular base course. The granular base should be placed in lifts no greater than 150 mm and compacted to 100% and 98% of the SPMDD for MIT Class A and Class C, respectively.
 8. Floor slabs should be designed to resist all structural loads and to minimize slab cracking associated with movements as a result of swelling, shrinkage, and thermal expansion and contraction of the sub-grade soils.
 9. To accommodate slab movements, it may be desirable to provide control joints to reduce random cracking and isolation joints to separate the slab from other structure elements. Allowances should be made to accommodate vertical movements of light-weight structures (*e.g.* partitions) bearing on the slab.
 10. A sub-grade drainage system consisting of a perimeter weeping tile drain should be considered.

Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If subsurface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.



All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work or standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of HDK Consulting Inc. (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be used or relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

We thank you for the opportunity to provide engineering services on this assignment. If you have any questions regarding the findings or recommendations presented, please contact the undersigned at your earliest convenience.

Kind Regards,

TREK Geotechnical

Per:

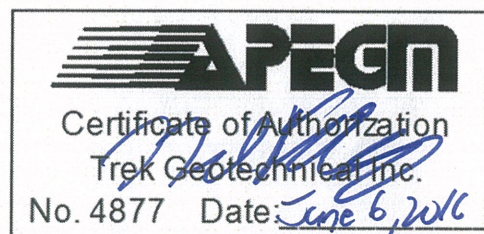
Shawn Beaudry, EIT
Geotechnical Engineer

Reviewed By:



Ryan Belbas, M.Sc., P.Eng.,
Geotechnical Engineer

Attach.





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HDK Consulting Inc.

**Brandon Crop Services Building
2701 Grand Valley Road – Brandon, MB
Geotechnical Investigation Report**

Prepared for:

Kellie J. Orr
President
HDK Consulting Inc.
55-81 Garry Street
Winnipeg MB R3C 4J9

Submitted to:

Kellie J. Orr, HDK Consulting Inc.

Project Number:

0169 006 00

Date:

April 15, 2016

April 15, 2016

Our File No. 0169 006 00

Kellie J. Orr
President
HDK Consulting Inc.
55-81 Garry Street, Winnipeg, MB
R3C 4J9

**RE: Brandon Crop Services Building – 2701 Grand Valley Road – Brandon, MB
 Revised Geotechnical Investigation Report_Rev2**

TREK Geotechnical Inc. is pleased to submit our revised Geotechnical Investigation Report for the above noted project located in Brandon, MB.

The report was revised based on updated design information received after issuing the initial report which included a geodetic ground contour map, a design main floor elevation, and a preliminary site grading plan.

Please contact the undersigned if you have any questions. Thank you for the opportunity to serve you on this assignment.

Sincerely,

TREK Geotechnical Inc.
Per:

A handwritten signature in blue ink, appearing to read "N. Ferreira", with a horizontal line extending to the right.

Nelson John Ferreira, M.Sc., P.Eng.
Principal
Tel: 204.975.9433 ext 103

Encl.

Revision History

Revision No.	Author	Issue Date	Description
0	SGB	April 1, 2016	Final Report
1	SGB	April 4, 2016	Revised Final Report
2	SGB	April 15, 2016	Revised Final Report

Authorization Signatures

Prepared By:


Shawn Beaudry, E.I.T.
Geotechnical Engineer



Reviewed By:

Ryan Belbas, M.Sc., P.Eng.
Geotechnical Engineer



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1.0 Introduction

This report summarizes the results of the geotechnical investigation completed by TREK Geotechnical Inc. (TREK) for the proposed Brandon Crop Services Building located at 2701 Grand Valley Road in Brandon, Manitoba. The scope of work includes a sub-surface investigation, laboratory testing, and provision of design and construction recommendations for foundations, floor slabs, and pavements. The terms of reference for the investigation are included in our proposal addressed to Mr. Kellie J. Orr from HDK Consulting Inc. dated February 10, 2016.

2.0 Background

The site is located at 2701 Grand Valley road which is east of 34 Street and South of Braecrest Drive, as shown on Figure 01. TREK understands that HDK Consulting Inc. plans to develop the site and construct a single story office building. At the time of the drilling investigation, the building location had not been finalized and test holes were situated in the vicinity of the proposed building footprint. Following the investigation, the proposed building location was revised and is as shown on Figure 01. The design elevation (geodetic) of the top of floor at the time of this report was set at 388.06 m. Based on the original ground contours shown on Figure 01, site grading for construction of the building will result in estimated cuts and fills ranging between approximately 0 to 1.6 m. It is also understood that the estimated foundation loads are between 300 kN to 500 kN.

3.0 Field Program

3.1 Site Conditions

At the time of sub-surface investigation, the site was open and grass-covered. The ground surface generally sloped towards the south-southwest from a distinct mound located at the northeast side of the property.

3.2 Sub-surface Investigation

A sub-surface investigation was undertaken between March 7 and 8, 2015 under the supervision of TREK personnel to determine the soil stratigraphy and groundwater conditions at the site. The investigation included drilling four test holes (TH16-01 to 04) using a Canterra CT-250 truck-mounted drill rig equipped with 125 mm solid stem augers and/or 170 mm hollow stem augers. The test holes were advanced to depths ranging between 15.2 and 15.7 m below ground surface within the proposed building area. The test holes were backfilled with auger cuttings.

Sub-surface soils observed during the drilling were visually classified based on the Unified Soil Classification System (USCS). Samples retrieved during drilling included disturbed grab samples, split spoon samples from standard penetration tests (SPT), and from thin-walled Shelby tubes. All samples retrieved during drilling were transported to TREK's testing laboratory in Winnipeg, Manitoba. Laboratory testing consisted of water content determination on all samples. Atterberg limit tests, bulk unit weight measurements, grain size analyses, and axial compression tests were performed on select samples.

Test hole logs are attached which describe the soil units encountered and other pertinent information such as test hole location, elevation, groundwater conditions and a summary of the laboratory testing results. Test hole locations were recorded using a hand held GPS. Geodetic test hole elevations were estimated using ground elevation contours provided by Agriculture and Agri-Foods Canada (AAFC). Detailed laboratory test results are included separately in Appendix A.

3.3 Sub-surface Conditions

3.3.1 Soil Stratigraphy

A brief description of the soil units encountered at the test hole locations is provided below. All interpretations of soil stratigraphy for the purposes of design should refer to the attached test hole logs. The sub-surface stratigraphy encountered from ground surface generally consisted of a thin layer (approximately 0.5 m) of silt topsoil overlying alternating layers of silts, sands and clay tills. The shallow soil units tended to be soft to firm or loose to compact extending down to the clay till unit. Stiff to hard clay till with interlayered sand of increasing density with depth was encountered in all test holes at elevations ranging between 382.7 and 384.4 m (1.5 to 4.3 m depth). A thick deposit of compact gravelly sand (> 4.0 m thick) was encountered at Elev. 377.6 m (11.2 m depth) below a clay till in TH16-02.

3.3.2 Seepage and Sloughing

Seepage and sloughing was observed from the clay till in all test holes at elevations ranging between 379.6 and 382 m (3.7 to 11.1 m depth). At the completion of drilling, water elevations were observed at 378.0, 386.6, 381.3 and 383.2 m in test holes TH16-01 to 04, respectively.

These observations are short-term and should not be considered reflective of (static) groundwater levels at the site which would require monitoring over an extended period of time to determine. It is important to recognize that groundwater conditions may vary seasonally, annually, or as a result of construction activities.

4.0 Foundation Recommendations

Based on the sub-surface conditions as well as laboratory and *in situ* testing results, driven concrete and timber piles are the preferred foundation types for the site. Recommendations for the design and construction of driven precast concrete and timber piles are provided in accordance with the National Building Code of Canada (NBCC, 2010). In consideration of the shallow groundwater table as well as weak, compressible and variable near surface bearing soils, shallow foundations were examined, but are not considered a preferred foundation alternative. Shallow foundations can be examined further upon request but would require a test pit sub-surface investigation within the revised building footprint to assess the soil and groundwater conditions, and to evaluate the design and constructability of shallow footings.

4.1 Limit States Design

Limit States Design recommendations for deep foundations in accordance with the National Building Code of Canada (NBCC, 2010) are provided below. Limit states design requires consideration of distinct loading scenarios comparing the structural loads to the foundation bearing capacity using resistance and load factors that are based on reliability criteria. Two general design scenarios are evaluated corresponding to the serviceability and ultimate capacity requirements.

The **Ultimate Limit State (ULS)** is concerned with ensuring that the maximum structural loads do not exceed the nominal (ultimate) capacity of the foundation units. The ULS foundation bearing capacity is obtained by multiplying the nominal (ultimate) bearing capacity by a resistance factor (reduction factor), which is then compared to the factored (increased) structural loads. The ULS bearing capacity must be greater or equal to the maximum factored load to provide an adequate margin of safety. Table 1 summarizes the resistance factors that can be used for the design of deep foundations as per the NBCC (2010) depending upon the method of analysis and verification testing completed during construction.

The **Service Limit State (SLS)** is concerned with limiting deformation or settlement of the foundation under service loading conditions such that the integrity of the structure will not be impacted. The Service Limit State should generally be analysed by calculating the settlement resulting from applied service loads and comparing this to the settlement tolerance of the structure. However, the settlement tolerance of the structure is typically not yet defined at the preliminary design stage. As such, SLS bearing capacities are often provided that are developed on the basis of limiting settlement to 25 mm or less. A more detailed settlement analysis should be conducted to refine the estimated settlement and/or adjust the SLS capacity if a more stringent settlement tolerance is required or if large groups of piles are used.

Table 1. ULS Resistance Factors for Deep Foundations (NBCC, 2010)

Bearing Resistance to Axial Load for Deep Foundations (Analysis Methods)	Resistance Factor
Semi-empirical analysis using laboratory and <i>in-situ</i> test data	0.4
Analysis using dynamic monitoring results	0.5
Analysis using static loading test results	0.6
Uplift resistance by semi-empirical analysis.	0.3
Uplift resistance using loading test results.	0.4

4.2 PDA Testing

Due to the inherent variability of the clay till, dynamic monitoring (*i.e.* PDA testing with CAPWAP analysis) during installation of driven piles is recommended to confirm pile capacity and determine an appropriate pile driving system. If PDA testing with CAPWAP analysis is performed, a resistance factor of 0.5 can be used for design of the factored ULS capacities of deep foundations, as described in Table

1. If PDA monitoring with CAPWAP analysis is not performed, a resistance factor of 0.4 must be used. In this regard, cost savings may be achieved by completion of dynamic testing, but more importantly, confidence in pile capacity and performance of the structure will be gained. A dynamic monitoring program should consist of testing about 2% of the piles; however, the scale of the testing program will depend on the building size and the number and sizes of piles to be installed. The dynamic monitoring program can be established prior to construction after the pile design and layout has been determined.

4.3 Driven Precast Prestressed Concrete Hexagonal Piles

Precast prestressed concrete hexagonal (PPCH) piles driven into clay till will derive a majority of their resistance in skin friction with some contribution from end bearing. The recommended SLS and ULS unit axial resistances for shaft adhesion and end bearing for this type of pile are provided in Table 2. Pile settlements are expected to be less than 10 mm at the pile tip (bottom of pile). The elastic shortening of the pile should be added to the tip displacement to calculate the pile head settlement.

Potential downdrag or dragload effects as a result of fill settlement around the piles based on a maximum fill height of 1.6 m were evaluated and are considered negligible. However, fill placement during general site grading should be performed in accordance with recommendations provided in Section 8.

Table 2. Recommended ULS and SLS Pile Resistances for Driven PPCH Piles

Elevation (m) ¹	Factored ULS Axial Unit Resistance (kPa)			SLS Axial-Compressive Unit Resistance Shaft Adhesion (kPa)
	Compression $\Phi=0.4$		Uplift $\Phi=0.3$	
	Shaft Adhesion	End Bearing	Shaft Adhesion	
Above 383.5 ²	7	n/a	5	7
383.5 to 377.5	28	n/a	21	28
Below 377.5	28	1200	21	28

Note 1: Geodetic elevation estimated from ground contours provided by AAFC.

Note 2: see Additional Driven PPCH Pile Design Recommendation No. 3 & 4 (below).

In Brandon, PPCH piles are typically available in 305, 356, and 406 mm diameter sizes which will factor in design. As such, PPCH pile sizes and lengths should be verified by the manufacturer/supplier.

It should be noted that driven concrete piles may refuse within the hard clay till; if this occurs, insulation may be required to prevent frost heave of piles supporting unheated structures and perimeter piles supporting heated structures. Additionally, piles that refuse within the hard clay till will have to be assessed to determine if the capacity meets design requirements.

Additional Driven PPCH Pile Design Recommendations

1. The weight of the embedded portion of the pile may be neglected.
2. Pile lengths should be limited to a 16 m depth below ground surface based on the depths of exploration.
3. From the original ground surface, shaft adhesion should be neglected within the upper 1.5 m of all

piles to account for soil shrinkage around the pile. For piles subjected to freezing conditions (including perimeter piles of heated structures), shaft adhesion within the upper 2.4 m should be neglected. If pre-boring is undertaken, shaft adhesion within the depth of the pre-bore must be neglected from design.

4. Shaft adhesion should also be neglected within zones of fill generated as a result of site grading.
5. Pile spacing should be at least 3 pile diameters, measured centre to centre. If a closer spacing is required, TREK should be contacted to provide an efficiency (reduction) factor to account for potential group effects.
6. The piles should be designed by a qualified structural engineer to withstand design loads, handling stresses, driving stresses, and tensile forces induced from seasonal movements of the bearing soils.

Additional Driven PPCH Pile Installation Recommendations

1. The pile-driving hammer should have the capability of adjusting the delivered energy to operate at higher settings during driving if the delivered energy is not sufficient to install the piles to the required depth. The driving system should also have the capability of adjusting the delivered energy to operate at lower settings during easy driving and to prevent pile damage upon sudden pile refusal.
2. The pile-driving hammer should be equipped with a pile cushion to protect the pile head from damage during driving from direct impact with the steel driving helmet. The pile cushion should consist of a minimum of 150 mm of compressible material such as plywood or hardwood (*e.g.* oak). The pile cushion should fit tightly inside the pile helmet.
3. The piles should be cured for at least 7 days prior to driving.
4. Piles should be driven continuously once driving is initiated until the pile is driven to length.
5. The requirement to monitor for pile heave during driving should be specified and all piles exhibiting heave should be re-driven to the design depth.
6. Pre-boring could be completed to reduce heave of adjacent piles as well as maintain verticality and alignment of the piles. Pre-bore diameter should be no more than 50 mm larger than the pile diameter. A typical pre-bore depth is 3 m; however, once the pile design is complete, TREK should be contacted to assist in developing an appropriate pre-boring plan for the piles prior to construction.
7. Pile verticality (plumbness) should be measured on all piles after driving to check if verticality is within the limits of the structural design. It is common local practice to specify a maximum acceptable percentage that the pile can be out of vertical plumbness (*e.g.* 2% out of plumb).
8. Any piles that are damaged, out of plumb an excessive amount or reach premature refusal may need to be replaced. The structural designer will have to assess non-conforming piles to determine if they are acceptable. PDA testing with CAPWAP analysis is recommended for any piles that are suspected to not meet the design capacity or to be damaged if a structural solution is not possible.

4.4 Driven Timber Piles

Timber piles driven to practical refusal in hard clay till will derive a majority of their resistance in end bearing with some contribution from shaft adhesion. Given the consistency of the clay till layer, timber pile capacity can be based on the structural strength of the timber material. Timber piles are typically tapered from the pile butt (top of pile) to the pile toe and are available in a variety of sizes, wood types and lengths, which factor in design. As such, available timber pile sizes, wood type and lengths should be verified by the manufacturer/supplier. In the Brandon and surrounding areas, 305 to 356 mm butt diameter timber piles consisting of Southern pine or Douglas fir are common when this pile type is used. Corresponding tip diameters typically range between 180 to 230 mm.

Assuming a 305 mm butt diameter and 180 mm tip diameter, timber piles consisting of Southern pine or Douglas fir driven to practical refusal in hard clay till can be designed using a factored ULS axial-compressive capacity of 240 kN and an SLS axial-compressive capacity of 200 kN. Pile settlements are expected to be less than 10 mm at the pile tip (bottom of pile). The elastic shortening of the pile should be added to the tip displacement to calculate the pile head settlement. Once the pile size and wood type are selected, TREK should be contacted to confirm geotechnical capacities, and the structural capacity of each pile should be confirmed by the Manufacturer/Supplier prior to driving.

Practical refusal criteria for timber piles depends on the pile size, wood type and type of pile driving hammer used to install the piles. As such, driving criteria cannot be determined until the pile size, wood type and piling hammer are selected and a drivability analysis is conducted.

It should be noted that driven timber piles may refuse above the hard clay till; if this occurs, insulation may be required to prevent frost heave of piles supporting unheated structures and perimeter piles supporting heated structures. Additionally, piles that refuse above the hard clay till will have to be assessed to determine if the capacity meets design requirements.

Additional Driven Timber Pile Design Recommendations:

1. Timber piles should be pressure treated and meet (or exceed) the requirements of CSA Standards *CAN/CSA-O56-10 Round Wood Piles* and *CAN/CSA-080 Series 08 Wood Preservation*, to protect the piles against biological attack and decay due to seasonal wetting and drying.
2. The weight of the embedded portion of the pile may be neglected
3. Pile spacing should be at least 2.5 pile butt diameters, measured centre to centre. If a closer spacing is required, TREK should be contacted to provide an efficiency (reduction) factor to account for potential group effects.
4. A factored ULS shaft adhesion of 15 kPa (a geotechnical resistance factor of 0.3 has been applied to this value) can be used to design for uplift resistance for timber piles. The upper 1.5 m for piles supporting heated structures (excluding perimeter piles) and upper 2.4 m of piles supporting unheated structures (including perimeter piles), as well as the entire pre-bore length should be neglected from uplift resistance. It should be noted that uplift loads will also be resisted by structural dead loads.
5. A qualified structural engineer should verify that the piles can withstand design loads, handling stresses, driving stresses, and tensile forces induced from seasonal movements of the bearing soils.

Additional Driven Timber Pile Installation Recommendations:

1. The Contractor should be required to submit a proposed driving system for approval prior to mobilizing to the site. A pile driving system (*i.e.* pile-driving hammer) capable of installing the timber piles to practical refusal without over-stressing or damaging the piles should be used.
2. A driveability analysis (*i.e.* wave equation analysis) should be performed prior to construction on the proposed driving system to:
 - a. establish the pile driving criteria (*i.e.* practical refusal criteria),
 - b. determine the minimum rated hammer energy required to drive the pile to the expected practical refusal depth,
 - c. assess the driving stresses and their potential impact on the structural integrity of the pile.
3. Pile driving stresses should not exceed 3 times the maximum allowable stress of the pile material (*i.e.* wood type) during installation.
4. Piles should be fitted with a steel driving shoe to protect the pile tip from damage during installation and to improve driveability. The piles should also be designed with a metal strapping around the pile butt to protect against crushing of the wood fibers (brooming) during driving.
5. The requirement to monitor for pile heave during driving should be specified and all piles exhibiting heave should be re-driven to practical refusal.
6. Pre-boring could be completed to reduce heave of adjacent piles as well as maintain verticality and alignment of the piles. Pre-bore diameter should be no more than 50 mm larger than the butt diameter. A typical pre-bore depth is 3 m; however, once the pile design is complete, TREK should be contacted to assist in developing an appropriate pre-boring plan for the piles prior to construction.
7. Pile verticality (plumbness) should be measured on all installed piles to check if verticality is within the limits of the structural design. It is common local practice to specify a maximum acceptable percentage that the pile can be out of vertical plumbness (*e.g.* 2% out of plumb).
8. Any piles that are damaged, out of plumb an excessive amount or reach premature refusal may need to be replaced. The structural designer will have to assess non-conforming piles to determine if they are acceptable. PDA testing with CAPWAP analysis is recommended for any piles that are suspected to not meet the design capacity or to be damaged if a structural solution is not possible.

4.5 Lateral Capacity

Lateral capacity is not expected to be a concern for design; however, limit states design values can be provided if necessary once lateral loads are known.

4.6 Ad-freezing Effects

Concrete piles caps, grade beams and walls should be designed to resist ad-freeze and uplift forces related to frost action acting along the vertical face of the member within the depth of frost penetration (2.4 m). In this regard, concrete pile caps, grade beams and walls may be subject to an ad-freeze bond stress of 65 kPa within the depth of frost penetration.

Ad-freeze forces will be resisted by structural dead loads and uplift resistance provided by the length of the pile below the depth of frost penetration. The following design recommendations apply to piles subject to ad-freeze forces:

1. An ad-freeze bond stress of 65 kPa within the depth of frost penetration (2.4 m).
2. A load factor (α) of 1.2 may be used in the calculation of ad-freezing forces.
3. A reduction factor of 0.8 may be used in calculation of the geotechnical resistance for the ULS condition with an ultimate (nominal) resistance of 35 kPa. Structural dead loads should be added to the resistance.
4. The calculated geotechnical resistance plus the structural dead loads must be greater than the factored ad-freezing forces.
5. Piles subject to ad-freezing forces should be a minimum of 8.0 m or as calculated by the method above, whichever is greater.

Measures such as flat lying rigid polystyrene insulation could be considered to reduce frost penetration depths and thereby ad-freezing and uplift forces.

4.7 Foundation Concrete

The degree of exposure of concrete in contact with soils to sulphate attack is classified in CAN/CSA-A23.1-M94 (Concrete Materials and Methods of Concrete Construction) as moderate, severe or very severe. Based on one tested sample (G04), the water soluble sulfate content is <0.010%. According to Table 3, CSA A23.1-09 (Concrete Materials and Methods of Concrete Construction), this result falls below the defined exposure classes. However, based on experience gathered through previous work in Brandon, the degree of exposure for concrete subjected to sulphate attack can be quite variable and as such, we recommend that all concrete in contact with the native soil should be made with at least moderate sulphate-resistant cement (MS, MSb, LH, HS or HSb). Furthermore, the concrete should have a minimum specified 56-day compressive strength of 30 MPa and have a maximum water to cement ratio of 0.50 in accordance with Table 2, CSA A23.1-09 for concrete with moderate sulphate exposure (S3). Concrete which may be exposed to freezing and thawing should be adequately air entrained to improve freeze-thaw durability in accordance with Table 4, CSA A23.1-09.

4.8 Foundation Inspection Requirements

In accordance with Section 4.2.2.3 *Field Review* of the NBCC (2010), the designer or other suitably qualified person shall carry out a field review on:

1. a continuous basis during:
 - i. the construction of all deep foundation units,
 - ii. the installation and removal of retaining structures and related backfilling operations, and
 - iii. during the placement of engineered fills.
2. on an as-required basis for the construction of shallow foundation units and in excavating, dewatering and other related works.

In consideration of the above and relative to this particular project, we recommend that TREK, as the geotechnical engineer of record, be retained to inspect the installation of any foundation elements. TREK is familiar with the geotechnical conditions and the basis for the foundation recommendations and can provide any design modifications deemed to be necessary should altered sub-surface conditions be encountered.

5.0 Floor Slabs

Based on the sub-surface conditions and laboratory testing results, the sand and silt layers underlying the surficial topsoil are considered weak, compressible and highly frost susceptible, which refers to the propensity of the soil to grow ice lenses and heave during freezing. To minimize the risk of floor slab movements, TREK recommends use of structural floor slabs. However, if movement or cracking of the floor slabs is tolerable, design parameters and recommendations for grade supported slabs can be provided upon request.

5.1 Structural Floor Slabs

A minimum void of 100 mm is recommended beneath a structural floor slab to accommodate seasonal movements of underlying sub-grade soils. The void can consist of a compressible layer (*e.g.* low density polystyrene) or a crawlspace to permit sub-grade soil movements without engaging the floor slab. A vapour barrier below the slab is also recommended to minimize long-term moisture changes within the sub-grade soils.

6.0 Exterior Concrete Slabs

Exterior concrete slabs will be used to support mechanical equipment (*e.g.* air conditioners). Exterior slabs are subject to vertical movements due to the weak, compressible and frost susceptible sub-grade soils. Although difficult to predict these movements could be in the order of 50 mm or more, therefore slabs should be designed to accommodate these movements. If vertical movements of this magnitude are not tolerable, piles should be considered to support the slabs. It should be noted that these movements may occur independent of settlement associated with loading.

The sub-grade for the slabs should be free of fill, organics and any other deleterious material. The sub-grade should be proof-rolled to detect soft areas. Soft areas should be repaired as per directions provided by a qualified geotechnical engineer. This will likely consist of additional excavation and replacement with compacted granular fill. Compaction of repair areas or the sub-grade should be undertaken using static methods (*e.g.* vibratory equipment using self-weight, no vibrations) to avoid softening of the sub-grade due the presence of wet, liquefiable silts and sands. For better long-term performance of slabs, a non-woven geotextile should be placed on the sub-grade. Slabs should be placed on a 75 mm thick base layer consisting of MIT Class A granular base course underlain by a 250 mm thick sub-base layer consisting of MIT Class C granular base course. The granular fill should be placed in lifts no greater than 150 mm and compacted to 98% of the Standard Proctor Maximum Dry Density (SPMDD).

7.0 Pavement Design

Recommendations for asphalt pavements for car parking areas and areas subjected to heavier vehicular loads are provided in Table 3. If the parking area is to consist of a gravel surface rather than asphalt, the thickness of the sub-base layer should be increased by 75 mm. The (MIT) Standard Construction Specification No. 900 *Specifications for Aggregate for Granular Base Course* should be considered when designing pavements. Recommendations for sub-grade and base preparation are provided below.

Table 3. Recommended Sections for Asphalts Pavements

Material	Layer Thickness		Compaction Requirements
	Car Parking Areas	Heavy Vehicular Loads	
Asphalt	75 mm	75 mm	98% Marshall Density
MIT Class A Granular Base Course (base layer)	75 mm	100 mm	100 % of SPMDD
MIT Class C Granular Base Course (sub-base layer)	250 mm	350 mm	98% of SPMDD
Non-Woven Geotextile (Geotex 801 or equivalent)	Required	Required	Install as per manufacturer's recommendations

Parking Lot Pavement Design and Construction Recommendations

1. For best long-term performance, organics, fill materials and any other deleterious material should be stripped such that the sub-grade consists of native silty sand or sandy silt.
2. Stripping to the design sub-grade elevation should be completed with a backhoe equipped with a smooth bladed bucket and operating from the edge of the excavation in order to minimize disturbance to the exposed sub-grade. Care should be taken not to over-excavate and to minimize the sub-grade disturbance at all times.
3. After excavation, the sub-grade should be inspected by TREK personnel prior to placement of the sub-base and base materials. The sub-grade should be proof-rolled to detect soft areas. Soft areas should be repaired as per directions provided by a geotechnical engineer. This will likely consist of additional excavation and replacement with compacted granular fill. Compaction of repair areas or the sub-grade should be undertaken using static methods (e.g. vibratory equipment using self-weight, no vibrations) to avoid softening of the sub-grade due the presence of wet, liquefiable silts and sands.
4. The sub-grade should be protected from freezing, drying, inundation with water and disturbance. If any of these conditions occur the sub-grade should be moisture conditioned as appropriate, scarified and re-compacted to 95% of SPMDD.
5. The granular sub-base and base materials should be placed in lift thicknesses no greater than 150 mm and compacted as outlined in Table 3.

8.0 Fill Placement

Based on a design main floor elevation of 388.06 m, site grading requirements are estimated to result in cuts and fills ranging between approximately 0 to 1.6 m. Fill placement should be performed in accordance with the recommendations provided below to minimize the potential for long-term settlements that may result in changes to the designed grading and drainage characteristics of the site. An engineered fill is required in fill areas intended to support any structural elements or pavement structures as outlined in previous sections of this report.

At the time of this report, the design elevation of the parking lot and paving areas had not been defined. It is recommended that the thickness of the sub-base layer shown in Table 3 be increased in the required fill areas in order to achieve the final design grades. Alternatively, material from excavation areas may potentially be used depending on the material type and water content. TREK can assess and provide recommendations for use of local fill material during the construction phase, once material has been exposed.

General Site Fill Placement Recommendations

1. For best long-term performance, organics, fill materials and any other deleterious material should be stripped such that the sub-grade consists of native silty sand or sandy silt.
2. The sub-grade should be protected from freezing, drying, inundation with water and disturbance. If any of these conditions occur the sub-grade should be moisture conditioned as appropriate, scarified and re-compacted to 95% of SPMDD.
3. Fill material should be placed in lift thicknesses no greater than 150 mm and compacted to 95% of SPMDD.

9.0 Site Drainage

Drainage adjacent to structures and exterior slabs should promote runoff away from the structures. A minimum gradient of about 2% should be used for both landscaped and paved areas and maintained throughout the life of the structures. All paved areas should be provided with minimum slopes of 2% to improve long-term drainage. The water discharge from roof leaders and run-off from exposed slabs should be directed away from the structures.

10.0 Temporary Excavations

Excavations must be carried out in compliance with the appropriate regulations under the Manitoba Workplace Safety and Health Act. It is anticipated that short term stability can be maintained for open-cut excavations shallower than 1 m with side slopes no steeper than 2 horizontal to 1 vertical (2H:1V). Any open-cut excavations greater than 3 m deep must be designed and sealed by a professional engineer and should be reviewed by the geotechnical engineer of record (TREK). Furthermore, maintaining the stability of the excavation slopes for the duration of construction should be the responsibility of the Contractor. To prevent wetting or drying of the exposed excavation side slopes, they should be

protected with plastic covering or similar measures. Stockpiles of excavated material and heavy equipment should be kept away from the edge of the excavation by a distance equal to or greater than the depth of excavation.

Dewatering measures should be completed as necessary to maintain a dry excavation and permit proper completion of the work. If seepage is encountered, it should be directed to a sump pit and pumped out of the excavation. If saturated silts or sands are encountered, shoring or slope flattening may be required. To prevent wet silts and sands from entering the excavation, gravel buttressing could be used in conjunction with sump pits for dewatering. Surface water should be diverted away from the excavation and the excavation should be backfilled as soon as possible following construction.

11.0 Closure

The geotechnical information provided in this report is in accordance with current engineering principles and practices (Standard of Practice). The findings of this report were based on information provided (field investigation and laboratory testing). Soil conditions are natural deposits that can be highly variable across a site. If sub-surface conditions are different than the conditions previously encountered on-site or those presented here, we should be notified to adjust our findings if necessary.

All information provided in this report is subject to our standard terms and conditions for engineering services, a copy of which is provided to each of our clients with the original scope of work, or a mutually executed standard engineering services agreement. If these conditions are not attached, and you are not already in possession of such terms and conditions, contact our office and you will be promptly provided with a copy.

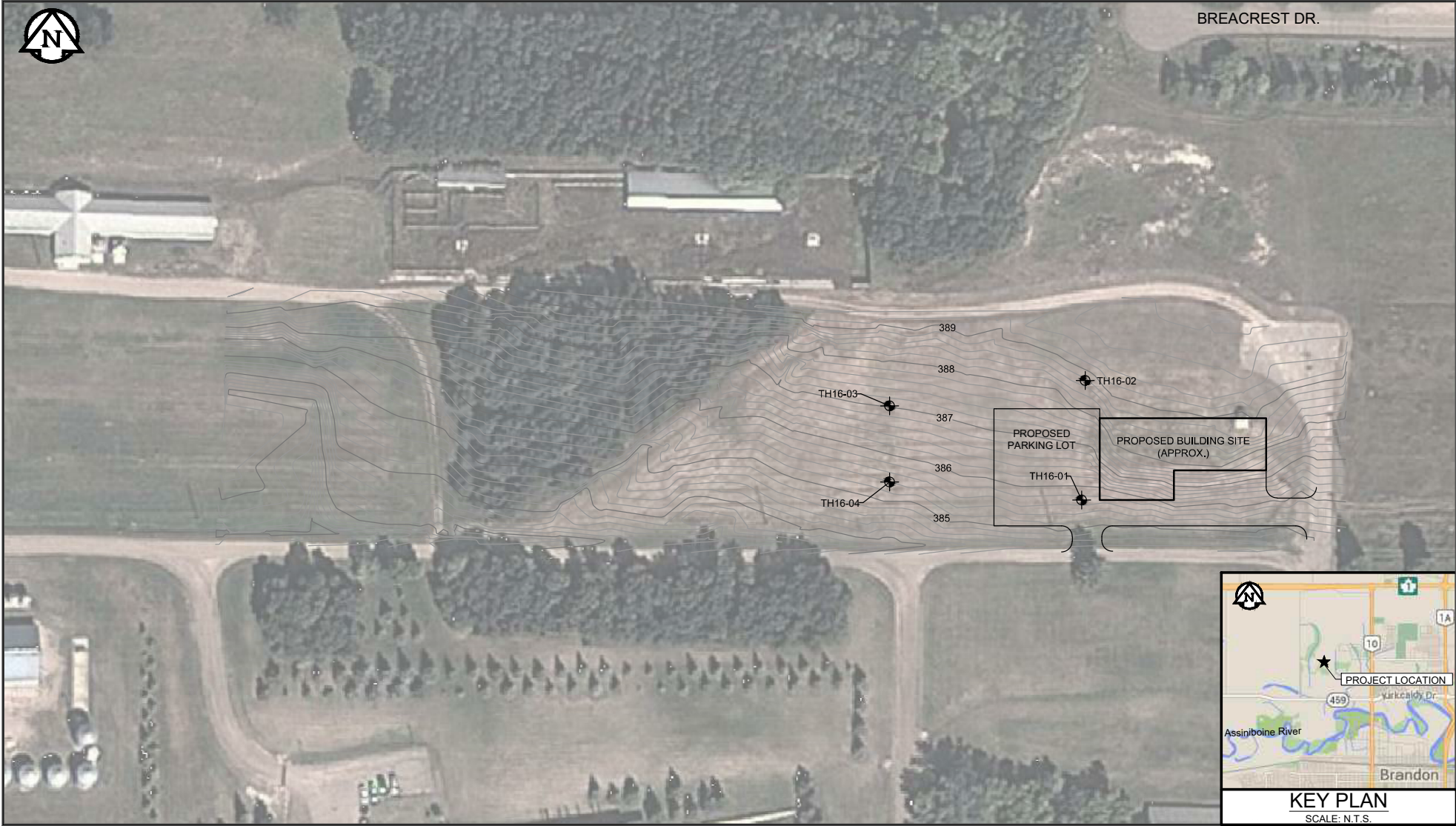
This report has been prepared by TREK Geotechnical Inc. (the Consultant) for the exclusive use of HDK Consulting Inc. (the Client) and their agents for the work product presented in the report. Any findings or recommendations provided in this report are not to be relied upon by any third parties, except as agreed to in writing by the Client and Consultant prior to use.

Figure

Tablet (279mm x 432mm)

PLOT: 4/6/2016 12:52:31 PM

FILE NAME: FIG 001 2016-04-06 Site Plan 0_C_HA 0169 006 00.dwg



0 10 20 30 40m
SCALE: 1:1000 (279mm x 432mm)

LEGEND :
 TEST HOLE (TREK, MARCH 7-8, 2016)










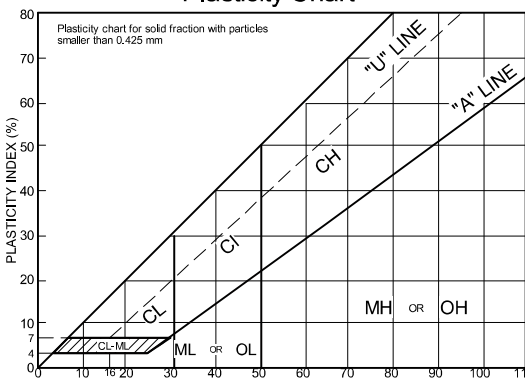






NOTES :
 1. AERIAL IMAGE FROM GOOGLE EARTH SEPTEMBER 14, 2013
 2. ELEVATION CONTOURS PROVIDED BY AGRICULTURE AND AGRI-FOODS CANADA (AAFC)

Figure 01
Test Hole Location Plan

Test Hole Logs












GENERAL NOTES

- Classifications are based on the United Soil Classification System and include consistency, moisture, and color. Field descriptions have been modified to reflect results of laboratory tests where deemed appropriate.
- Descriptions on these test hole logs apply only at the specific test hole locations and at the time the test holes were drilled. Variability of soil and groundwater conditions may exist between test hole locations.
- When the following classification terms are used in this report or test hole logs, the primary and secondary soil fractions may be visually estimated.

Major Divisions			USCS Classification	Symbols	Typical Names	Laboratory Classification Criteria			Particle Size	ASTM Sieve sizes	#10 to #4 #40 to #10 #200 to #40 < #200
Coarse-Grained soils (More than half the material is larger than No. 200 sieve size)						C _u = $\frac{D_{60}}{D_{10}}$ greater than 4; C _c = $\frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		Not meeting all gradation requirements for GW			
Gravels (More than half of coarse fraction is larger than 4.75 mm)	Clean gravel (Little or no fines)	GW					Well-graded gravels, gravel-sand mixtures, little or no fines				
		GP		Poorly-graded gravels, gravel-sand mixtures, little or no fines	Atterberg limits above "A" line or P.I. greater than 7						
Sands (More than half of coarse fraction is smaller than 4.75 mm)	Clean sands (Little or no fines)	GM		Silty gravels, gravel-sand-silt mixtures	C _u = $\frac{D_{60}}{D_{10}}$ greater than 6; C _c = $\frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		Not meeting all gradation requirements for SW				
		GC		Clayey gravels, gravel-sand-silt mixtures							
	Sands with fines (Appreciable amount of fines)	SW		Well-graded sands, gravelly sands, little or no fines	Atterberg limits below "A" line or P.I. less than 4		Above "A" line with P.I. between 4 and 7 are borderline cases requiring use of dual symbols				
		SP		Poorly-graded sands, gravelly sands, little or no fines							
		SM		Silty sands, sand-silt mixtures				Atterberg limits above "A" line or P.I. greater than 7			
		SC		Clayey sands, sand-clay mixtures							
Fine-Grained soils (More than half the material is smaller than No. 200 sieve size)						Plasticity Chart		Material	ASTM Sieve Sizes	#4 to #3/4 in.	
Silts and Clays (Liquid limit less than 50)	ML					Inorganic silts and very fine sands, rock floor, silty or clayey fine sands or clayey silts with slight plasticity					
	CL					Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays					
	OL					Organic silts and organic silty clays of low plasticity					
Silts and Clays (Liquid limit greater than 50)	MH					Inorganic silts, micaceous or distomaceous fine sandy or silty soils, organic silts	MH OR OH				
	CH					Inorganic clays of high plasticity, fat clays					
	OH					Organic clays of medium to high plasticity, organic silts					
Highly Organic Soils	Pt					Peat and other highly organic soils	Von Post Classification Limit				Strong colour or odour, and often fibrous texture

* Borderline classifications used for soils possessing characteristics of two groups are designated by combinations of groups symbols. For example; GW-GC, well-graded gravel-sand mixture with clay binder.

Other Symbol Types

	Asphalt		Bedrock (undifferentiated)		Cobbles
	Concrete		Limestone Bedrock		Boulders and Cobbles
	Fill		Cemented Shale		Silt Till
			Non-Cemented Shale		Clay Till

LEGEND OF ABBREVIATIONS AND SYMBOLS

LL - Liquid Limit (%)	▽ Water Level at Time of Drilling
PL - Plastic Limit (%)	▼ Water Level at End of Drilling
PI - Plasticity Index (%)	▽ Water Level After Drilling as Indicated on Test Hole Logs
MC - Moisture Content (%)	
SPT - Standard Penetration Test	
RQD- Rock Quality Designation	
Qu - Unconfined Compression	
Su - Undrained Shear Strength	
VW - Vibrating Wire Piezometer	
SI - Slope Inclinator	

FRACTION OF SECONDARY SOIL CONSTITUENTS ARE BASED ON THE FOLLOWING TERMINOLOGY

TERM	EXAMPLES	PERCENTAGE
and	and CLAY	35 to 50 percent
"y" or "ey"	clayey, silty	20 to 35 percent
some	some silt	10 to 20 percent
trace	trace gravel	1 to 10 percent

TERMS DESCRIBING CONSISTENCY OR COMPACTION CONDITION

The Standard Penetration Test blow count (N) of a non-cohesive soil can be related to compactness condition as follows:

<u>Descriptive Terms</u>	<u>SPT (N) (Blows/300 mm)</u>
Very loose	< 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very dense	> 50

The Standard Penetration Test blow count (N) of a cohesive soil can be related to its consistency as follows:

<u>Descriptive Terms</u>	<u>SPT (N) (Blows/300 mm)</u>
Very soft	< 2
Soft	2 to 4
Firm	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	> 30

The undrained shear strength (Su) of a cohesive soil can be related to its consistency as follows:

<u>Descriptive Terms</u>	<u>Undrained Shear Strength (kPa)</u>
Very soft	< 12
Soft	12 to 25
Firm	25 to 50
Stiff	50 to 100
Very stiff	100 to 200
Hard	> 200



Sub-Surface Log

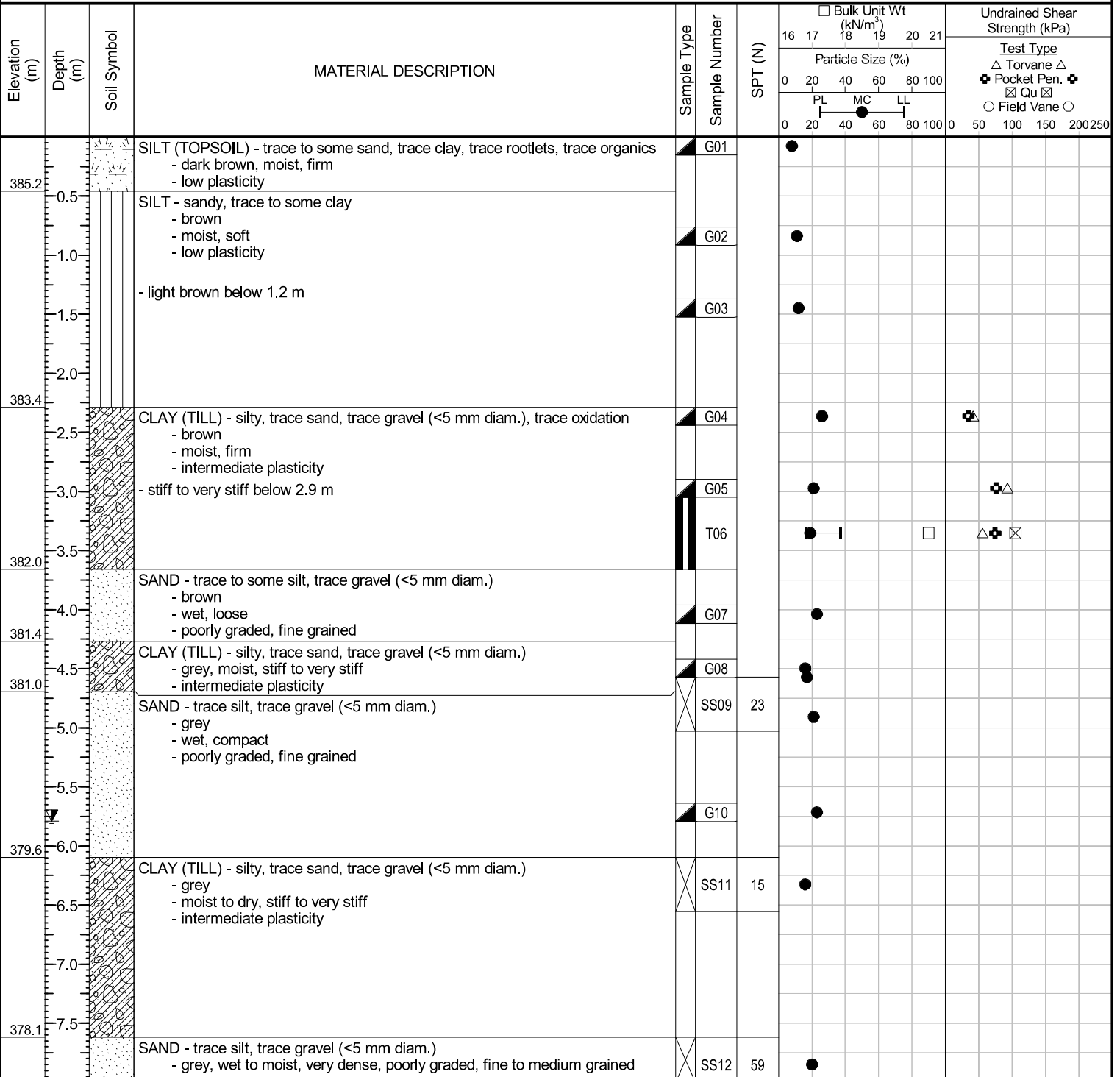
Test Hole TH16-01

1 of 2

Client: HDK Consulting Inc. Project Number: 0169 006 00
Project Name: Brandon Crop Services Bldg Location: UTM N-5524701, E-429844
Contractor: Paddock Drilling Ltd. Ground Elevation: 385.70 m
Method: 125 mm Solid Stem Auger, Canterra CT-250 Truck Mount Date Drilled: 7 March 2016

Sample Type: ☒ Grab (G) ☒ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ☒ Core (C)

Particle Size Legend: ☒ Fines ☒ Clay ☒ Silt ☒ Sand ☒ Gravel ☒ Cobbles ☒ Boulders



Logged By: Beta Taryana Reviewed By: Ryan Belbas Project Engineer: Shawn Beaudry

Sub-Surface Log

Test Hole TH16-01

2 of 2

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m ³)					Undrained Shear Strength (kPa)							
							Particle Size (%)					Test Type							
							16	17	18	19	20	21	0	50	100	150	200	250	
							0	20	40	60	80	100	0	50	100	150	200	250	
							PL	MC	LL										
							0	20	40	60	80	100	0	50	100	150	200	250	
377.5			- gravelly (<10 mm diam.) below 8.1 m																
	8.5		CLAY (TILL) - silty, trace sand, trace gravel (<5 mm diam.), trace cobbles - grey - moist to dry, very stiff - low plasticity		SS13	21													
376.9			SAND - trace silt, trace gravel (<10 mm diam.) - grey - wet, very dense - poorly graded, fine to medium grained		G14														
	9.0				SS15	69													
	9.5																		
375.9			CLAY (TILL) - silty, trace sand, trace gravel (<5 mm diam.) - grey - moist, very stiff - low plasticity																
	10.0																		
	10.5				G16														
375.0			SAND - trace silt, trace gravel (<5 mm diam.) - grey - wet, dense - poorly graded, fine to medium grained		SS17	31													
	11.0																		
374.4			CLAY (TILL) - silty, trace to some sand, trace gravel (<15 mm diam.) - grey - moist, hard - low plasticity																
	11.5																		
	12.0																		
	12.5				SS18	38													
	13.0																		
	13.5																		
	14.0				SS19	34													
	14.5																		
	15.0																		
	15.5				SS20	38													
370.0																			

END OF TEST HOLE AT 15.7 m IN CLAY (TILL)

Notes:

1. Seepage observed in SAND layer below 3.7 m depth.
2. Sloughing observed from SAND layer at 4.7 m depth.
3. Test Hole open to 7 m depth and water at 5.8 m depth thirty minutes after drilling.
4. Test Hole backfilled with auger cuttings.
5. Test Hole elevation was estimated from ground surface contours provided by Agriculture and Agri-foods Canada (AAFC).



Sub-Surface Log

Test Hole TH16-02

1 of 2

Client: HDK Consulting Inc. Project Number: 0169 006 00
Project Name: Brandon Crop Services Bldg Location: UTM N-5524734, E-429845
Contractor: Paddock Drilling Ltd. Ground Elevation: 388.70 m
Method: 125 mm Solid Stem Auger, Canterra CT-250 Truck Mount Date Drilled: 7 March 2016

Sample Type: ☒ Grab (G) ☒ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ☐ Core (C)

Particle Size Legend: ☒ Fines ☒ Clay ☒ Silt ☒ Sand ☒ Gravel ☒ Cobbles ☒ Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m ³)		Particle Size (%)		Undrained Shear Strength (kPa)	
							16	17	18	19	20	21
							0 20 40 60 80 100		0 20 40 60 80 100		0 50 100 150 200 250	
							PL MC LL				Test Type △ Torvane △ ✱ Pocket Pen. ✱ ☒ Qu ☒ ○ Field Vane ○	
388.1	0.5		SILT (TOPSOIL) - trace to some sand, trace clay, trace rootlets, trace organics - dark brown, moist, firm - low plasticity		G21							
	1.0		SAND - some silt, trace gravel (<5 mm diam.) - brown - moist, loose - poorly graded, fine grained		G22							
	1.5		- light brown, moist to dry below 1.5 m									
	2.0				SS23	9						
	2.5				G24							
	3.0		- compact below 3.0 m									
	3.5				SS25	11						
384.4	4.0											
384.1	4.5		CLAY (TILL) - silty, trace to some sand, trace gravel (<5 mm diam.), trace oxidation, brown, moist, very stiff, intermediate plasticity		G26							
	5.0		SAND - trace silt, trace clay - grey, moist, compact - poorly graded, fine grained		SS27	23						
383.5	5.5		- wet below 5.0 m									
	6.0		CLAY (TILL) - silty, trace to some sand, trace gravel (<5 mm diam.), trace oxidation - grey - moist, very stiff - intermediate plasticity									
	6.5				T28							
	7.0											
	7.5				SS29	17						

Logged By: Beta Taryana Reviewed By: Ryan Belbas Project Engineer: Shawn Beaudry

SUB-SURFACE LOG LOGS 2016-03-08 BRANDON CROP SERVICES BLDG 1_DRAFT 0169 006 00.GPJ TREK GEOTECHNICAL.GDT 6/4/16



Sub-Surface Log

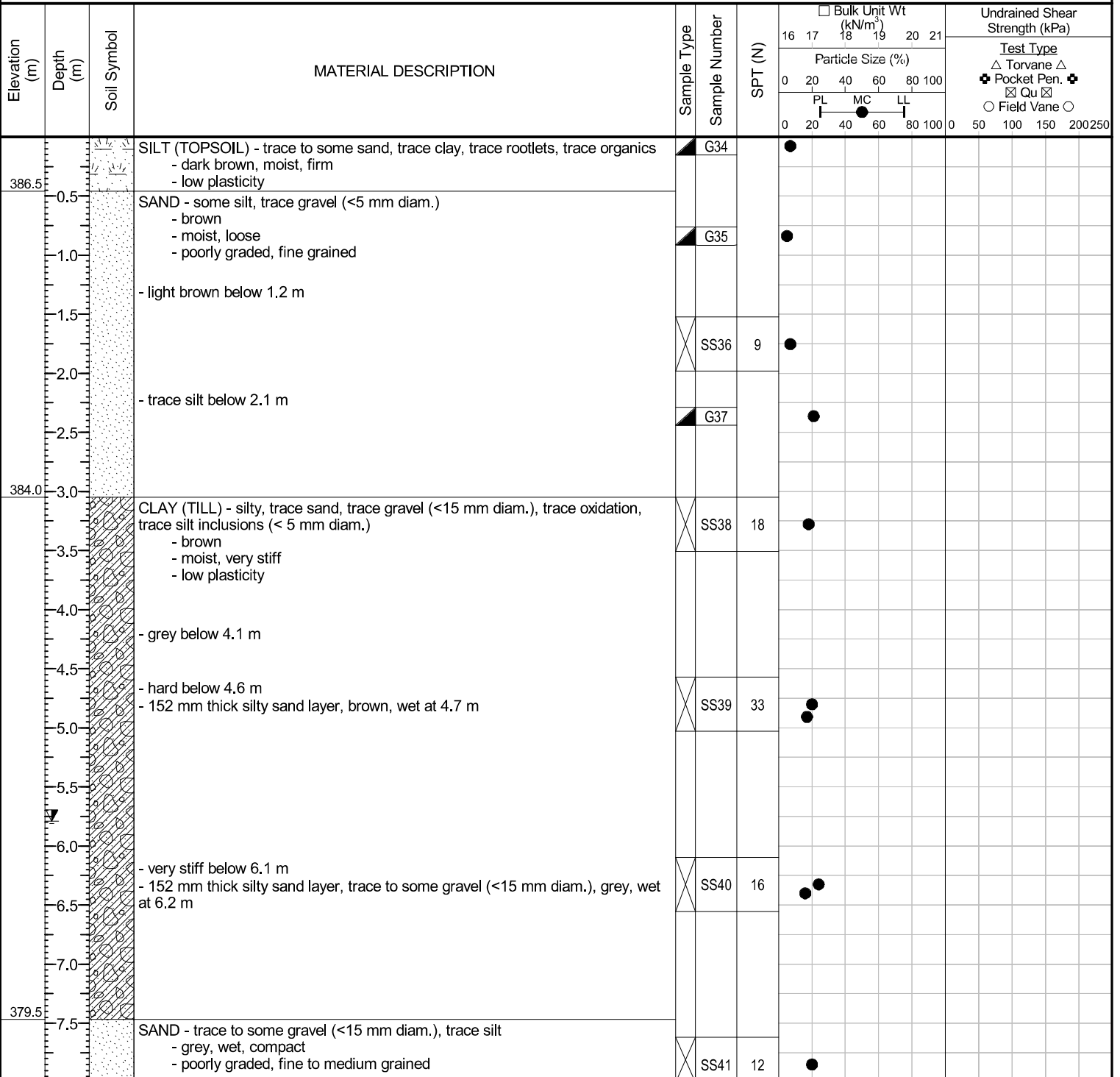
Test Hole TH16-03

1 of 2

Client: HDK Consulting Inc. Project Number: 0169 006 00
Project Name: Brandon Crop Services Bldg Location: UTM N-5524727, E-429791
Contractor: Paddock Drilling Ltd. Ground Elevation: 387.00 m
Method: 125 mm Solid Stem Auger, Canterra CT-250 Truck Mount Date Drilled: 8 March 2016

Sample Type: ☒ Grab (G) ☒ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ☒ Core (C)

Particle Size Legend: ☒ Fines ☒ Clay ☒ Silt ☒ Sand ☒ Gravel ☒ Cobbles ☒ Boulders



Logged By: Beta Taryana Reviewed By: Ryan Belbas Project Engineer: Shawn Beaudry

Sub-Surface Log

Test Hole TH16-03

2 of 2

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m ³)					Undrained Shear Strength (kPa)				
							Particle Size (%)					Test Type				
							0 20 40 60 80 100									
							PL MC LL									
							0 20 40 60 80 100					0 50 100 150 200 250				
378.6	8.5		- gravelly (<10 mm diam.) below 8.2 m													
	9.0		CLAY (TILL) - silty, trace to some sand, trace to some gravel (<5 mm diam.)													
			- grey, wet, hard													
			- low plasticity													
			- moist below 8.8 m													
	9.5			SS42	36											
	10.0															
	10.5															
376.3	11.0		SAND - trace silt, trace gravel (<5 mm diam.)													
			- grey													
			- wet to moist, very dense													
			- poorly graded, fine to medium grained													
			- wet to moist below 11 m													
	11.5															
	12.0															
	12.5			SS44	65											
	13.0															
373.6	13.5		CLAY (TILL) - silty, trace sand, trace gravel (<10 mm diam.)													
			- grey													
			- moist, very stiff													
			- low plasticity													
	14.0			SS45	28											
	14.5															
	15.0															
	15.5			SS46	25											

END OF TEST HOLE AT 15.7 m IN CLAY (TILL)

Notes:

1. Seepage observed in SAND layer at 7.5 m and 10.7 m depth, and in CLAY (TILL) layer at 8.8 m depth.
2. Sloughing observed from SAND layer at 7.5 m and 10.7 m depth, and from CLAY (TILL) layer at 8.8 m depth.
3. Drilling method switched to 170 mm hollow stem auger from 10.7 m to 15.7 m.
4. Test Hole open to 6.7 m depth and water at 5.8 m depth fifteen minutes after drilling.
5. Test Hole backfilled with auger cuttings.
6. Test Hole elevation was estimated from ground surface contours provided by Agriculture and Agri-foods Canada (AAFC).



Sub-Surface Log

Test Hole TH16-04

1 of 2

Client: HDK Consulting Inc. Project Number: 0169 006 00
Project Name: Brandon Crop Services Bldg Location: UTM N-5524706, E-429791
Contractor: Paddock Drilling Ltd. Ground Elevation: 385.40 m
Method: 125 mm Solid Stem Auger, Canterra CT-250 Truck Mount Date Drilled: 8 March 2016

Sample Type: ☒ Grab (G) ☒ Shelby Tube (T) ☒ Split Spoon (SS) ☒ Split Barrel (SB) ☐ Core (C)

Particle Size Legend: ☒ Fines ☒ Clay ☒ Silt ☒ Sand ☒ Gravel ☒ Cobbles ☒ Boulders

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)	Bulk Unit Wt (kN/m ³)		Particle Size (%)		Undrained Shear Strength (kPa)	
							16	17	18	19	20	21
							0 20 40 60 80 100		0 20 40 60 80 100		0 50 100 150 200 250	
							PL MC LL				Test Type △ Torvane △ ✱ Pocket Pen. ✱ ☒ Qu ☒ ○ Field Vane ○	
384.9	0.5		SILT (TOPSOIL) - trace to some sand, trace clay, trace rootlets, trace organics - dark brown, moist, firm - low plasticity		G47							
383.9	1.0		SAND - silty - brown - moist, loose - poorly graded, fine grained - light brown below 1.2 m		G48							
382.5	2.0		CLAY (TILL) - silty, trace sand, trace gravel (<5 mm diam.), trace oxidation - brown - moist, stiff - low plasticity		SS49	15						
381.7	3.0		SAND - silty, trace gravel (<5 mm diam.) - brown - moist, compact - poorly graded, fine grained		SS51	22						
381.1	4.0		SILT - clayey, sandy, trace gravel (<5 mm diam.), trace oxidation - brown - moist, firm - low plasticity		G52							
	4.5		CLAY (TILL) - silty, trace sand, trace gravel (<25 mm diam.), trace silt inclusions (<15 mm diam.) - grey - moist, very stiff - low plasticity		T53							
	5.0				G54							
	5.5				G55							
	6.0		- trace to some sand, trace to some gravel, wet from 5.8m to 6.1m		SS56	22						
	6.5				SS57	24						

Logged By: Beta Taryana Reviewed By: Ryan Belbas Project Engineer: Shawn Beaudry

Appendix A

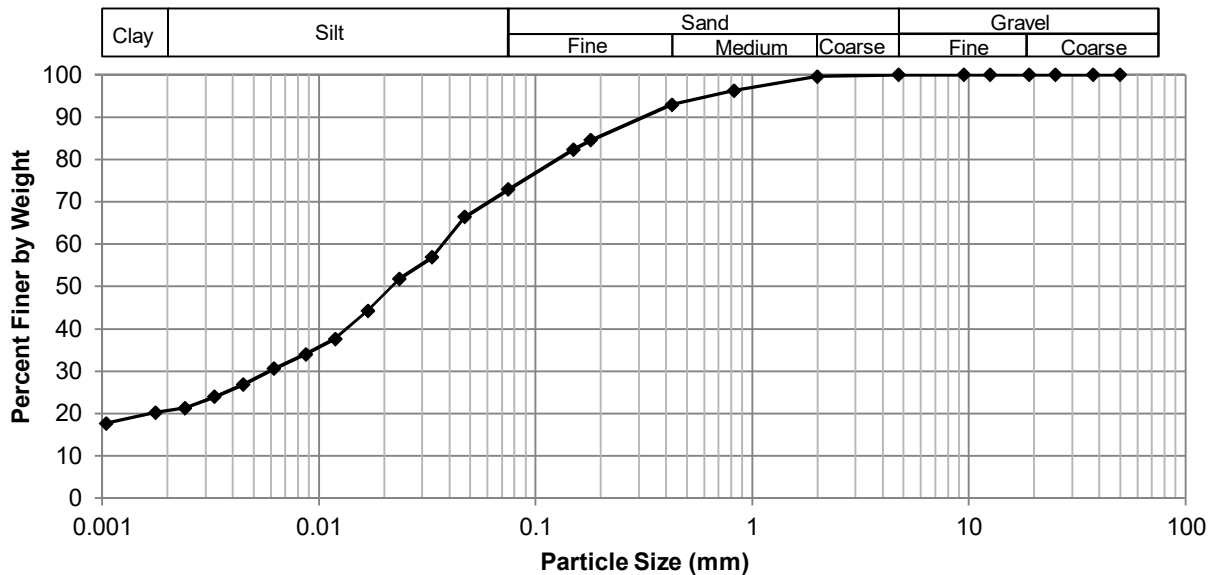
Laboratory Testing Results

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Corp Services Building

Test Hole TH16-04
Sample # G52
Depth (m) 3.8 - 4.0
Sample Date 7-Mar-16
Test Date 21-Mar-16
Technician LI

Gravel	0.0%
Sand	27.1%
Silt	52.3%
Clay	20.6%

Particle Size Distribution Curve



Gravel		Sand		Silt and Clay	
Particle Size (mm)	Percent Passing	Particle Size (mm)	Percent Passing	Particle Size (mm)	Percent Passing
50.0	100.00	4.75	100.00	0.0750	72.93
37.5	100.00	2.00	99.63	0.0471	66.41
25.0	100.00	0.825	96.25	0.0333	56.92
19.0	100.00	0.425	92.94	0.0236	51.86
12.5	100.00	0.180	84.59	0.0168	44.26
9.50	100.00	0.150	82.34	0.0119	37.62
4.75	100.00	0.075	72.93	0.0087	34.02
				0.0062	30.60
				0.0045	26.80
				0.0033	23.98
				0.0024	21.29
				0.0018	20.27
				0.0010	17.71

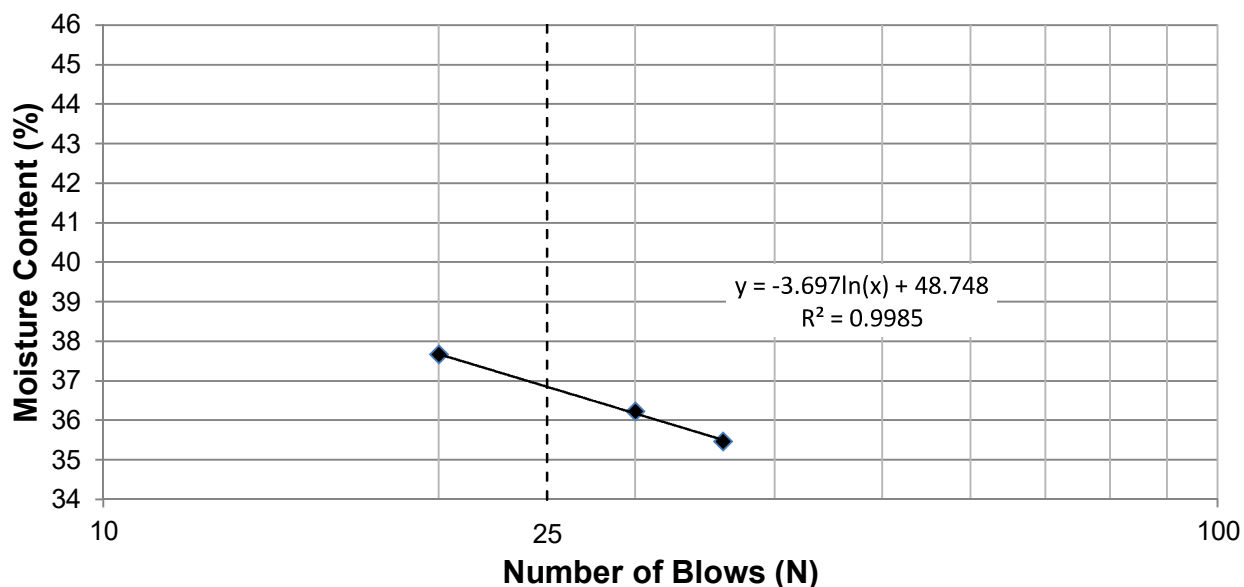
Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Corp Services Building

Test Hole TH16-01
Sample # T06
Depth (m) 3.0 - 3.7
Sample Date 07-Mar-16
Test Date 22-Mar-16
Technician LI

Liquid Limit	37
Plastic Limit	16
Plasticity Index	21

Liquid Limit

Trial #	1	2	3	4	5
Number of Blows (N)	36	30	20		
Mass Wet Soil + Tare (g)	27.450	27.056	27.479		
Mass Dry Soil + Tare (g)	23.983	23.626	23.782		
Mass Tare (g)	14.208	14.157	13.965		
Mass Water (g)	3.467	3.430	3.697		
Mass Dry Soil (g)	9.775	9.469	9.817		
Moisture Content (%)	35.468	36.223	37.659		



Plastic Limit

Trial #	1	2	3	4	5
Mass Wet Soil + Tare (g)	17.679	17.137			
Mass Dry Soil + Tare (g)	17.165	16.719			
Mass Tare (g)	13.999	14.028			
Mass Water (g)	0.514	0.418			
Mass Dry Soil (g)	3.166	2.691			
Moisture Content (%)	16.235	15.533			



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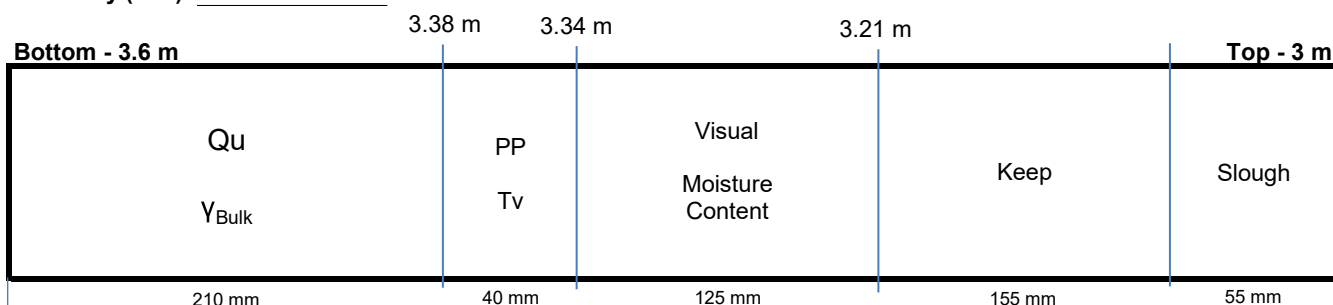
Shelby Tube Visual

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Test Hole TH16-01
Sample # T06
Depth (m) 3.0 - 3.6
Sample Date 07-Mar-16
Test Date 17-Mar-16
Technician LI

Tube Extraction

Recovery (mm) 585



Visual Classification

Material CLAY
Composition silty
some gravel (~<30mmØ)
trace sand
trace precipitates
trace oxidation

Color mottled grey and brown
Moisture moist
Consistency stiff to very stiff
Plasticity high plasticity
Structure fissures
Gradation

Torvane

Reading 0.25
Vane Size (s,m,l) s
Undrained Shear Strength (kPa) 61.3

Pocket Penetrometer

Reading 1 2.70
2 2.90
3 4.40
Average 3.33
Undrained Shear Strength (kPa) 163.5

Moisture Content

Tare ID AC07
Mass tare (g) 6.7
Mass wet + tare (g) 443.6
Mass dry + tare (g) 375.2
Moisture % 18.6%

Unit Weight

Bulk Weight (g) 1456.3
Length (mm) 1 175.00
2 175.00
3 177.00
4 175.00
Average Length (m) 0.176

Diam. (mm) 1 71.12
2 71.34
3 71.07
4 71.11
Average Diameter (m) 0.071

Volume (m³) 6.98E-04
Bulk Unit Weight (kN/m³) 20.5
Bulk Unit Weight (pcf) 130.3
Dry Unit Weight (kN/m³) 17.3
Dry Unit Weight (pcf) 109.9

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Test Hole TH16-01
Sample # T06
Depth (m) 3.0 - 3.6
Sample Date 7-Mar-16
Test Date 17-Mar-16
Technician LI

Unconfined Strength

	kPa	ksf
Max q_u	210.4	4.4
Max S_u	105.2	2.2

Specimen Data

Description CLAY - silty, some gravel ($\sim < 30\text{mm}\varnothing$), trace sand, trace precipitates, trace oxidation, mottled grey and brown, moist, stiff to very stiff, high plasticity, fissures,

Length 175.5 (mm)
Diameter 71.2 (mm)
L/D Ratio 2.5
Initial Area 0.00398 (m^2)
Load Rate 1.00 (%/min)

Moisture % 19%
Bulk Unit Wt. 20.5 (kN/m^3)
Dry Unit Wt. 17.3 (kN/m^3)
Liquid Limit -
Plastic Limit -
Plasticity Index -

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.25	61.3	1.28

Vane Size
s

Average

Pocket Penetrometer

Reading	Undrained Shear Strength	
tsf	kPa	ksf
2.70	132.4	2.77
2.90	142.2	2.97
4.40	215.8	4.51
Average	3.33	163.5
		3.41

Failure Geometry

Sketch:

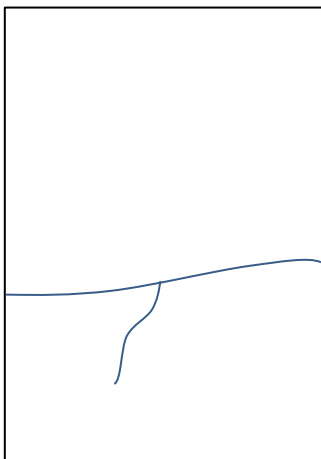
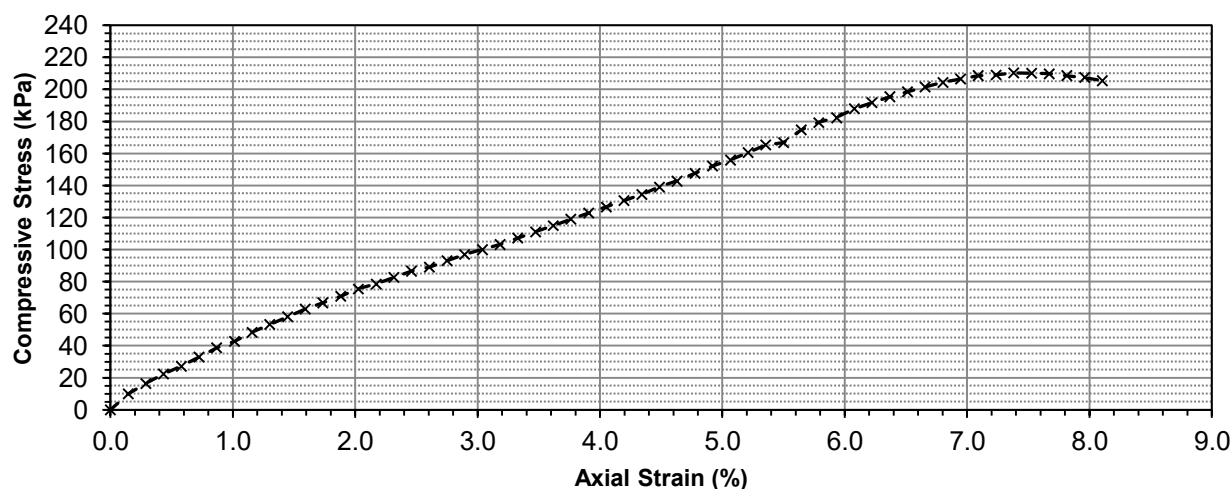


Photo:



Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m ²)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.003977	0.0	0.00	0.00
10	12	0.2540	0.14	0.003983	39.3	9.86	4.93
20	20	0.5080	0.29	0.003989	65.5	16.42	8.21
30	27	0.7620	0.43	0.003994	89.0	22.28	11.14
40	33	1.0160	0.58	0.004000	108.8	27.20	13.60
50	40	1.2700	0.72	0.004006	131.9	32.92	16.46
60	47	1.5240	0.87	0.004012	155.0	38.63	19.31
70	52	1.7780	1.01	0.004018	171.4	42.67	21.33
80	59	2.0320	1.16	0.004024	194.5	48.34	24.17
90	65	2.2860	1.30	0.004030	214.3	53.19	26.59
100	71	2.5400	1.45	0.004035	234.1	58.01	29.01
110	77	2.7940	1.59	0.004041	253.9	62.81	31.41
120	82	3.0480	1.74	0.004047	270.4	66.80	33.40
130	87	3.3020	1.88	0.004053	286.8	70.76	35.38
140	93	3.5560	2.03	0.004059	306.6	75.53	37.77
150	97	3.8100	2.17	0.004065	319.8	78.67	39.34
160	102	4.0640	2.32	0.004071	336.4	82.63	41.32
170	107	4.3180	2.46	0.004077	353.3	86.64	43.32
180	110	4.5720	2.61	0.004083	363.4	88.99	44.49
190	115	4.8260	2.75	0.004090	380.2	92.98	46.49
200	120	5.0800	2.89	0.004096	397.0	96.94	48.47
210	124	5.3340	3.04	0.004102	410.5	100.09	50.04
220	128	5.5880	3.18	0.004108	424.0	103.22	51.61
230	133	5.8420	3.33	0.004114	440.8	107.15	53.58

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m ²)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	138	6.0960	3.4735	0.004120	457.7	111.08	55.54
250	143	6.3500	3.62	0.004126	474.5	115.00	57.50
260	148	6.6040	3.76	0.004133	491.4	118.90	59.45
270	153	6.8580	3.91	0.004139	508.2	122.79	61.40
280	158	7.1120	4.05	0.004145	525.0	126.66	63.33
290	163	7.3660	4.20	0.004151	541.9	130.53	65.27
300	168	7.6200	4.34	0.004158	558.7	134.38	67.19
310	174	7.8740	4.49	0.004164	578.9	139.04	69.52
320	179	8.1280	4.63	0.004170	595.8	142.86	71.43
330	185	8.3820	4.78	0.004177	615.9	147.48	73.74
340	191	8.6360	4.92	0.004183	636.2	152.09	76.05
350	196	8.8900	5.07	0.004189	653.0	155.87	77.94
360	202	9.1440	5.21	0.004196	673.5	160.51	80.26
370	208	9.3980	5.35	0.004202	694.4	165.24	82.62
380	210	9.6520	5.50	0.004209	701.3	166.64	83.32
390	220	9.9060	5.64	0.004215	736.2	174.66	87.33
400	226	10.1600	5.79	0.004221	757.1	179.34	89.67
410	230	10.4140	5.93	0.004228	771.0	182.36	91.18
420	237	10.6680	6.08	0.004234	795.4	187.84	93.92
430	242	10.9220	6.22	0.004241	812.8	191.66	95.83
440	247	11.1760	6.37	0.004248	830.3	195.47	97.73
450	251	11.4300	6.51	0.004254	844.1	198.41	99.20
460	255	11.6840	6.66	0.004261	858.1	201.40	100.70
470	259	11.9380	6.80	0.004267	872.0	204.35	102.18
480	262	12.1920	6.95	0.004274	882.5	206.48	103.24
490	265	12.4460	7.09	0.004281	892.9	208.60	104.30
500	266	12.7000	7.24	0.004287	896.5	209.09	104.55
510	268	12.9540	7.38	0.004294	903.4	210.38	105.19
520	268	13.2080	7.53	0.004301	903.4	210.06	105.03
530	268	13.4620	7.67	0.004307	903.4	209.73	104.86
540	267	13.7160	7.82	0.004314	899.9	208.59	104.30
550	266	13.9700	7.96	0.004321	896.5	207.46	103.73
560	264	14.2240	8.10	0.004328	889.5	205.52	102.76

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Test Hole TH16-02
Sample # T28
Depth (m) 6.1 - 6.4
Sample Date 07-Mar-16
Test Date 16-Mar-16
Technician LI

Tube Extraction

Recovery (mm) 345

Bottom - 6.4 m		6.33 m	6.14 m	Top - 6.1 m
Visual	PP	Qu		
Moisture Content	Tv	Y _{Bulk}		
115 mm		190 mm	40 mm	

Visual Classification

Material CLAY (TILL)
Composition silty
some gravel (~<25mm Ø)
trace sand

Color grey
Moisture moist
Consistency very stiff
Plasticity high plasticity
Structure homogeneous
Gradation

Torvane

Reading 0.67
Vane Size (s,m,l) s
Undrained Shear Strength (kPa) 164.3

Pocket Penetrometer

Reading 1 4.40
2 4.50
3 4.25
Average 4.38
Undrained Shear Strength (kPa) 214.9

Moisture Content

Tare ID AB08
Mass tare (g) 6.7
Mass wet + tare (g) 359.4
Mass dry + tare (g) 309.4
Moisture % 16.5%

Unit Weight

Bulk Weight (g) 1041.6
Length (mm) 1 121.58
2 121.38
3 121.25
4 119.11
Average Length (m) 0.121

Diam. (mm) 1 72.15
2 71.91
3 71.87
4 72.08
Average Diameter (m) 0.072

Volume (m³) 4.92E-04
Bulk Unit Weight (kN/m³) 20.8
Bulk Unit Weight (pcf) 132.2
Dry Unit Weight (kN/m³) 17.8
Dry Unit Weight (pcf) 113.4

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Test Hole TH16-02
Sample # T28
Depth (m) 6.1 - 6.4
Sample Date 7-Mar-16
Test Date 16-Mar-16
Technician LI

Unconfined Strength

	kPa	ksf
Max q_u	279.5	5.8
Max S_u	139.8	2.9

Specimen Data

Description CLAY (TILL) - silty, some gravel ($\sim < 25\text{mm } \varnothing$), trace sand, grey, moist, very stiff, high plasticity, homogeneous,

Length 120.8 (mm)
Diameter 72.0 (mm)
L/D Ratio 1.7
Initial Area 0.00407 (m^2)
Load Rate 1.00 (%/min)

Moisture % 17%
Bulk Unit Wt. 20.8 (kN/m^3)
Dry Unit Wt. 17.8 (kN/m^3)
Liquid Limit -
Plastic Limit -
Plasticity Index -

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.67	164.3	3.43
Vane Size		
s		

Pocket Penetrometer

Reading	Undrained Shear Strength	
tsf	kPa	ksf
4.40	215.8	4.51
4.50	220.7	4.61
4.25	208.5	4.35
Average	4.38	215.0
		4.49

Failure Geometry

Sketch:

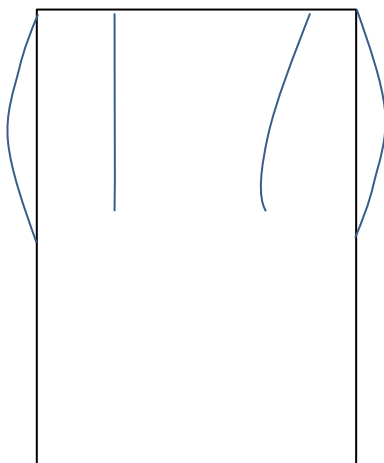
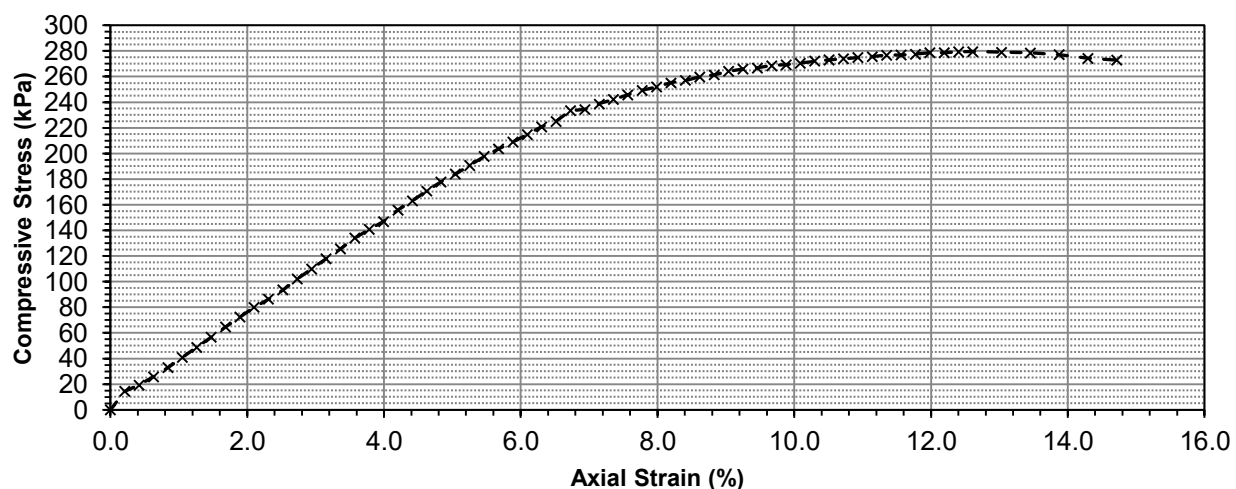


Photo:



Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m ²)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004072	0.0	0.00	0.00
10	18	0.2540	0.21	0.004080	58.9	14.44	7.22
20	24	0.5080	0.42	0.004089	78.6	19.23	9.62
30	32	0.7620	0.63	0.004098	105.5	25.75	12.87
40	41	1.0160	0.84	0.004106	135.2	32.92	16.46
50	51	1.2700	1.05	0.004115	168.1	40.86	20.43
60	61	1.5240	1.26	0.004124	201.1	48.77	24.38
70	71	1.7780	1.47	0.004133	234.1	56.65	28.32
80	81	2.0320	1.68	0.004141	267.1	64.49	32.24
90	91	2.2860	1.89	0.004150	300.0	72.29	36.15
100	101	2.5400	2.10	0.004159	333.1	80.08	40.04
110	109	2.7940	2.31	0.004168	360.0	86.37	43.18
120	118	3.0480	2.52	0.004177	390.3	93.44	46.72
130	129	3.3020	2.73	0.004186	427.4	102.09	51.05
140	139	3.5560	2.94	0.004195	461.1	109.90	54.95
150	149	3.8100	3.15	0.004204	494.7	117.67	58.84
160	159	4.0640	3.36	0.004214	528.4	125.41	62.70
170	170	4.3180	3.57	0.004223	565.5	133.91	66.95
180	179	4.5720	3.78	0.004232	595.8	140.78	70.39
190	187	4.8260	3.99	0.004241	622.7	146.82	73.41
200	199	5.0800	4.20	0.004250	663.1	156.00	78.00
210	208	5.3340	4.41	0.004260	694.4	163.00	81.50
220	218	5.5880	4.62	0.004269	729.2	170.80	85.40
230	227	5.8420	4.83	0.004279	760.6	177.76	88.88

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Building

Unconfined Compression Test Data (cont'd)

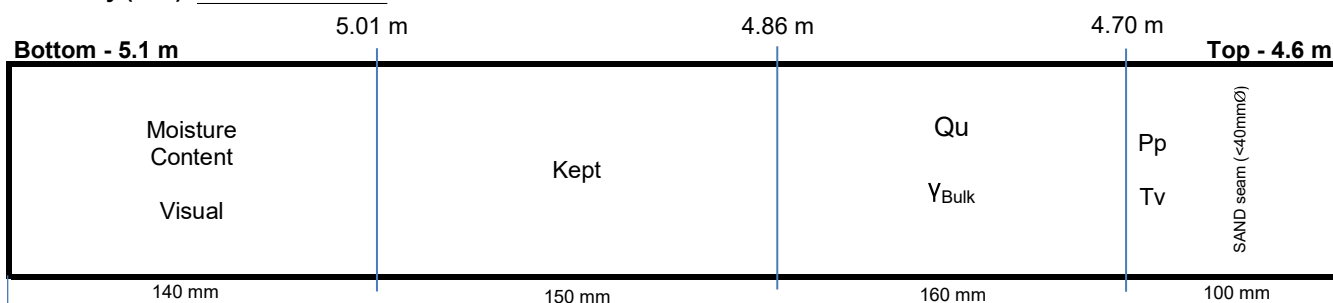
Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m ²)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	235	6.0960	5.0451	0.004288	788.4	183.87	91.93
250	244	6.3500	5.26	0.004298	819.8	190.76	95.38
260	253	6.6040	5.47	0.004307	851.1	197.60	98.80
270	261	6.8580	5.68	0.004317	879.0	203.63	101.81
280	268	7.1120	5.89	0.004326	903.4	208.81	104.40
290	276	7.3660	6.10	0.004336	931.3	214.77	107.39
300	284	7.6200	6.31	0.004346	959.2	220.71	110.35
310	290	7.8740	6.52	0.004356	980.1	225.01	112.51
320	301	8.1280	6.73	0.004365	1018.5	233.30	116.65
330	303	8.3820	6.94	0.004375	1025.5	234.39	117.20
340	309	8.6360	7.15	0.004385	1046.8	238.72	119.36
350	314	8.8900	7.36	0.004395	1064.6	242.22	121.11
360	319	9.1440	7.57	0.004405	1082.3	245.70	122.85
370	324	9.3980	7.78	0.004415	1100.1	249.16	124.58
380	328	9.6520	7.99	0.004425	1114.3	251.80	125.90
390	333	9.9060	8.20	0.004435	1132.0	255.22	127.61
400	336	10.1600	8.41	0.004446	1142.7	257.03	128.52
410	340	10.4140	8.62	0.004456	1156.9	259.64	129.82
420	343	10.6680	8.83	0.004466	1167.6	261.44	130.72
430	347	10.9220	9.04	0.004476	1181.7	263.99	131.99
440	350	11.1760	9.25	0.004487	1192.3	265.75	132.87
450	352	11.4300	9.46	0.004497	1199.5	266.71	133.36
460	355	11.6840	9.67	0.004508	1210.1	268.45	134.23
470	357	11.9380	9.88	0.004518	1217.2	269.40	134.70
480	359	12.1920	10.09	0.004529	1224.3	270.35	135.17
490	362	12.4460	10.30	0.004539	1235.0	272.06	136.03
500	364	12.7000	10.51	0.004550	1242.1	272.98	136.49
510	366	12.9540	10.72	0.004561	1249.1	273.89	136.95
520	368	13.2080	10.93	0.004572	1256.3	274.80	137.40
530	370	13.4620	11.14	0.004582	1263.3	275.70	137.85
540	372	13.7160	11.35	0.004593	1270.5	276.60	138.30
550	373	13.9700	11.56	0.004604	1274.0	276.71	138.36
560	375	14.2240	11.77	0.004615	1281.1	277.59	138.79
570	377	14.4780	11.98	0.004626	1288.2	278.47	139.23
580	378	14.7320	12.19	0.004637	1291.8	278.57	139.28
590	380	14.9860	12.40	0.004648	1298.8	279.42	139.71
600	381	15.2400	12.61	0.004659	1302.4	279.52	139.76
620	382	15.7480	13.03	0.004682	1306.0	278.93	139.47
640	383	16.2560	13.45	0.004705	1309.5	278.34	139.17
660	383	16.7640	13.87	0.004728	1309.5	276.99	138.49
680	381	17.2720	14.29	0.004751	1302.4	274.14	137.07
700	381	17.7800	14.71	0.004774	1302.4	272.79	136.40

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Bldg

Test Hole TH16 - 04
Sample # T53
Depth (m) 4.6 - 5.1
Sample Date 07-Mar-16
Test Date 17-Mar-16
Technician JB

Tube Extraction

Recovery (mm) 550



Visual Classification

Material CLAY
Composition silty
trace silt inclusions (~< 50 mm Ø)
trace gravel (~< 12 mm)

Color mottled grey and brown
Moisture moist
Consistency stiff to very stiff
Plasticity high plasticity
Structure homogeneous
Gradation

Torvane

Reading 0.58
Vane Size (s,m,l) m
Undrained Shear Strength (kPa) 56.9

Pocket Penetrometer

Reading
1 2.50
2 2.50
3 2.40
Average 2.47
Undrained Shear Strength (kPa) 121.0

Moisture Content

Tare ID N95
Mass tare (g) 8.4
Mass wet + tare (g) 575
Mass dry + tare (g) 499.7
Moisture % 15.3%

Unit Weight

Bulk Weight (g) 1343.7
Length (mm)
1 149.33
2 148.98
3 149.37
4 149.33
Average Length (m) 0.149

Diam. (mm)
1 72.81
2 72.99
3 72.53
4 73.93
Average Diameter (m) 0.073

Volume (m³) 6.26E-04
Bulk Unit Weight (kN/m³) 21.1
Bulk Unit Weight (pcf) 134.1
Dry Unit Weight (kN/m³) 18.3
Dry Unit Weight (pcf) 116.2

Project No. 0169-006-00
Client HDK Consulting Inc.
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Test Hole TH16 - 04
Sample # T53
Depth (m) 4.6 - 5.1
Sample Date 7-Mar-16
Test Date 17-Mar-16
Technician JB

Unconfined Strength

	kPa	ksf
Max q_u	257.8	5.4
Max S_u	128.9	2.7

Specimen Data

Description CLAY - silty, trace silt inclusions ($\sim < 50$ mm ϕ), trace gravel ($\sim < 12$ mm), mottled grey and brown, moist, stiff to very stiff, high plasticity, homogeneous,

Length 149.3 (mm)
Diameter 73.1 (mm)
L/D Ratio 2.0
Initial Area 0.00419 (m²)
Load Rate 1.00 (%/min)

Moisture % 15%
Bulk Unit Wt. 21.1 (kN/m³)
Dry Unit Wt. 18.3 (kN/m³)
Liquid Limit -
Plastic Limit -
Plasticity Index -

Undrained Shear Strength Tests

Torvane

Reading	Undrained Shear Strength	
tsf	kPa	ksf
0.58	56.9	1.19

Vane Size
m

Pocket Penetrometer

Reading	Undrained Shear Strength	
tsf	kPa	ksf
2.50	122.6	2.56
2.50	122.6	2.56
2.40	117.7	2.46
Average	2.47	121.0
		2.53

Failure Geometry

Sketch:

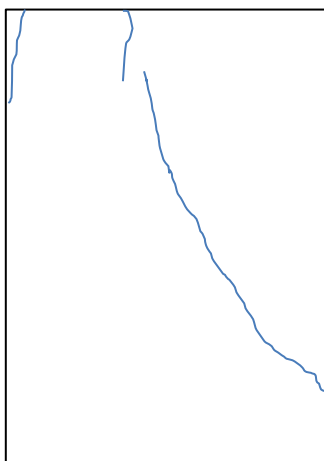
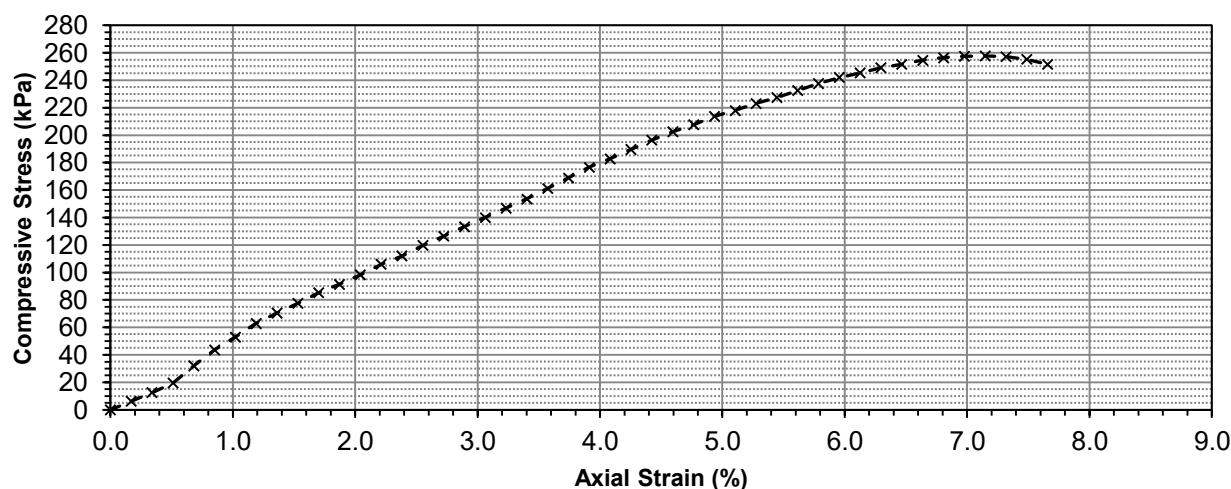


Photo:



Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Bldg

Unconfined Compression Test Graph



Unconfined Compression Test Data

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m ²)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
0	0	0.0000	0.00	0.004193	0.0	0.00	0.00
10	8	0.2540	0.17	0.004200	26.2	6.23	3.11
20	16	0.5080	0.34	0.004207	52.4	12.45	6.22
30	25	0.7620	0.51	0.004214	82.4	19.56	9.78
40	41	1.0160	0.68	0.004222	135.2	32.02	16.01
50	56	1.2700	0.85	0.004229	184.6	43.66	21.83
60	68	1.5240	1.02	0.004236	224.2	52.92	26.46
70	81	1.7780	1.19	0.004243	267.1	62.94	31.47
80	91	2.0320	1.36	0.004251	300.0	70.58	35.29
90	100	2.2860	1.53	0.004258	329.7	77.43	38.72
100	110	2.5400	1.70	0.004265	363.4	85.19	42.60
110	118	2.7940	1.87	0.004273	390.3	91.35	45.68
120	127	3.0480	2.04	0.004280	420.6	98.27	49.14
130	137	3.3020	2.21	0.004288	454.3	105.95	52.98
140	145	3.5560	2.38	0.004295	481.3	112.04	56.02
150	155	3.8100	2.55	0.004303	514.9	119.68	59.84
160	164	4.0640	2.72	0.004310	545.2	126.49	63.25
170	173	4.3180	2.89	0.004318	575.6	133.30	66.65
180	182	4.5720	3.06	0.004325	605.8	140.07	70.03
190	191	4.8260	3.23	0.004333	636.2	146.82	73.41
200	200	5.0800	3.40	0.004341	666.5	153.55	76.77
210	210	5.3340	3.57	0.004348	701.3	161.29	80.64
220	220	5.5880	3.74	0.004356	736.2	169.01	84.50
230	230	5.8420	3.91	0.004364	771.0	176.69	88.34




www.trekgeotechnical.ca
1712 St. James Street
Winnipeg, MB R3H 0L3
Tel: 204.975.9433 Fax: 204.975.9435

Unconfined Compressive Strength ASTM D2166

Project No. 0169-006-00
Client HDK Consulting Inc.
Project Brandon Crop Services Bldg

Unconfined Compression Test Data (cont'd)

Deformation Dial Reading	Load Ring Dial Reading	Deflection (mm)	Axial Strain (%)	Corrected Area (m ²)	Axial Load (N)	Compressive Stress, q_u (kPa)	Shear Stress, S_u (kPa)
240	238	6.0960	4.0844	0.004371	798.9	182.76	91.38
250	247	6.3500	4.25	0.004379	830.3	189.59	94.80
260	256	6.6040	4.42	0.004387	861.6	196.40	98.20
270	264	6.8580	4.59	0.004395	889.5	202.39	101.20
280	271	7.1120	4.77	0.004403	913.8	207.57	103.78
290	279	7.3660	4.94	0.004411	941.7	213.52	106.76
300	285	7.6200	5.11	0.004418	962.6	217.87	108.93
310	292	7.8740	5.28	0.004426	987.0	222.99	111.49
320	298	8.1280	5.45	0.004434	1007.9	227.30	113.65
330	305	8.3820	5.62	0.004442	1032.7	232.46	116.23
340	312	8.6360	5.79	0.004450	1057.5	237.62	118.81
350	318	8.8900	5.96	0.004458	1078.8	241.97	120.98
360	323	9.1440	6.13	0.004466	1096.5	245.50	122.75
370	328	9.3980	6.30	0.004475	1114.3	249.02	124.51
380	332	9.6520	6.47	0.004483	1128.5	251.74	125.87
390	336	9.9060	6.64	0.004491	1142.7	254.44	127.22
400	339	10.1600	6.81	0.004499	1153.3	256.35	128.17
410	341	10.4140	6.98	0.004507	1160.4	257.45	128.72
420	342	10.6680	7.15	0.004516	1164.0	257.77	128.88
430	342	10.9220	7.32	0.004524	1164.0	257.29	128.65
440	340	11.1760	7.49	0.004532	1156.9	255.26	127.63
450	336	11.4300	7.66	0.004541	1142.7	251.66	125.83



TREK Geotechnical Inc.
ATTN: RYAN BELBAS
1712 St. James Street
Winnipeg MB R3H 0L3

Date Received: 22- MAR- 16
Report Date: 28- MAR- 16 15:04 (MT)
Version: FINAL

Client Phone: 204- 282- 9957

Certificate of Analysis

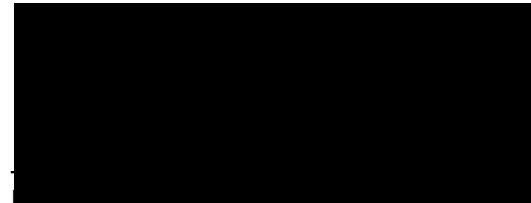
Lab Work Order #: L1747322

Project P.O. #: 0169- 006- 00

Job Reference: 2701 GRAND VALLEY RD, BRANDON MB

C of C Numbers:

Legal Site Desc:




David Bayer, B.Sc.

General Manager, Winnipeg

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ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2L 3T4, Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721



ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1747322-1	TH 16-01,G04,7.5'-8.0'							
Sampled By:	CLIENT on 17-MAR-16 @ 12:00							
Matrix:	Soil							
Miscellaneous Parameters								
Water Soluble Sulfate		<0.010		0.010	%	28-MAR-16	28-MAR-16	R3426512

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
SO4-WATER-SOL-SK	Soil	Water Soluble Sulfate (6 hour 1:10)	CSA A23.2-3B (CONCRETE)

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
----------------------------	---------------------

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg ww - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.