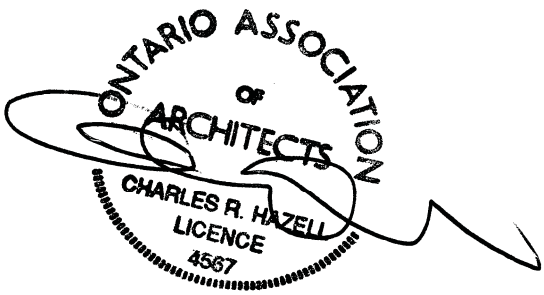
PROJECT TITLE Egbert, Ontario
6248 8th Line, L0L 1N0
New Hydrogen Generation (HOGEN)
and Balloon Launching Building

PROJECT NUMBER R.071909.001

PROJECT DATE 2016-01-29

END OF SECTION

Consultant for Building Code Review:




Building Code Designation Number (BCDN):

END OF SECTION

**DIVISION 07 – THERMAL AND MOISTURE PROTECTION**



**DIVISION 08 – OPENINGS**



**DIVISION 09 - FINISHES**



**DIVISION 10 - SPECIALTIES**



**DIVISION 22 - PLUMBING**



**DIVISION 23 – HEATING, VENTILATION AND AIR-CONDITIONING (HVAC)**

**DIVISION 25 – Integrated Automation**



**DIVISION 26 - ELECTRICAL**



**DIVISION 27 - COMMUNICATIONS**



**DIVISION 31 - EARTHWORK**

## DRAWINGS AND SCHEDULES

**Drawing List**



## APPENDICES

END OF SECTION

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

.1 Title and description of Work.

.2 Cost breakdown.

.3 Work sequence.

.4 Contractor use of premises.

### 1.2 PRECEDENCE

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

### 1.3 WORK COVERED BY CONTRACT DOCUMENTS

.1 Work of this Contract comprises construction of hydrogen generation (HOGEN) and balloon launching building located at 6248 8th Line, Egbert, Ontario; and further identified as HOGEN.

### 1.4 COST BREAKDOWN

.1 Within 48 hours of notification of acceptance of bid furnish a cost breakdown by Section aggregating contract Price.
.1 For Section 02 41 19, submit prices for each line item for the unit of measure specified.

.2 Show separately cost of equipment purchased exempt from Ontario Retail Sales Tax under your Ontario Sales Tax licence number.

.3 Within 48 hours of acceptance of bid submit a list of subcontractors.

### 1.5 WORK SEQUENCE

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

.2 Coordinate Progress Schedule and coordinate with Departmental Representative Occupancy during construction.

.3 Maintain fire access/control.

## 1.6 CONTRACTOR USE OF PREMISES

.1 Contractor shall limit use of premises for Work, for storage, and for access, to allow;
  .1 Work by other contractors.

.2 Coordinate 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.

# PART 2 - PRODUCTS

## 2.1 NOT USED

.1 Not used.

# PART 3 - EXECUTION

## 3.1 NOT USED

.1 Not used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 ACCESS AND EGRESS

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

### 1.2 USE OF SITE AND FACILITIES

.1 Execute work with least possible interference or disturbance to normal use of premises. Make arrangements with Departmental Representative to facilitate work as stated.

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

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

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

### 1.3 EXISTING SERVICES

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

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

.3 Provide for personnel and vehicular traffic.

.4 Construct barriers in accordance with Section 01 56 00.

### 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.

## 1.5 SECURITY

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

.2 Security clearances:
.1 Personnel will be required to sign in and sign out on a access sheet each day, which is to be turned over to the Site at the end of each day. No access passes will be issued.

## 1.6 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 2 weeks in advance of meeting date to Departmental Representative.

.4 Make arrangements for meetings.

.5 Preside at meetings.

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

.7 Reproduce and distribute copies of minutes within three days after meetings and transmit to Departmental Representative, meeting participants and affected parties not in attendance.

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

## 1.2 PRECONSTRUCTION MEETING

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

.2 Departmental Representative, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.

.3 Establish time and location of meeting and notify parties concerned minimum 2 weeks before meeting.

.4 Departmental representative to chair pre-construction meeting. Contractor to record and prepare minutes for Departmental Representative's review and approval 72 hours before meeting. Contractor shall circulate minutes of meeting upon Departmental Representative's approval.

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

.6 Agenda to include:
.1 Appointment of official representative of participants in the Work.
.2 Schedule of Work: in accordance with Section 01 32 16.
.3 Schedule of submission of shop drawings, samples, mock-ups, colour chips. Submit submittals in accordance with Section 01 33 00.
.4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00.
.5 Site security in accordance with Section 01 56 00.
.6 Health and safety in accordance with Section 01 35 29.
.7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
.8 Departmental Representative provided products.
.9 Record drawings and specifications in accordance with Sections 01 33 00 and 01 78 00.
.10 Maintenance manuals in accordance with Section 01 78 00.
.11 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00.
.12 Monthly progress claims, administrative procedures, photographs, hold backs.
.13 Appointment of inspection and testing agencies or firms.
.14 Insurances, transcript of policies.
.15 Bi-weekly meeting scheduling.

## 1.3 PROGRESS MEETINGS

.1 During course of Work and two weeks prior to project completion, schedule progress meetings biweekly.

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

.3 Notify parties minimum three days prior to meetings. Unexpected or urgent meetings require approval of Departmental Representative after which meeting will be scheduled with a minimium 48 hours notice.

.4 Record minutes of meetings and submit to Departmental Representative for approval within 72 hours of meeting. Circulate final meeting minutes to attending parties and affected parties not in attendance upon approval of Departmental Representative.

.5 Agenda to include the following:
.1 Review, approval of minutes of previous meeting.
.2 Review of Work progress since previous meeting.
.3 All items up for review by Departmental Representative.

.4 Field observations, problems, conflicts.
.5 Problems which impede construction schedule.
.6 Review of off-site fabrication delivery schedules.
.7 Corrective measures and procedures to regain projected schedule.
.8 Revision to construction schedule.
.9 Progress schedule, during succeeding work period.
.10 Review submittal schedules: expedite as required.
.11 Maintenance of quality standards.
.12 Review proposed changes for affect on construction schedule and on completion date.
.13 Other business.
.14 Prepare 2 week look ahead schedule showing work in progress, anticipated submittal dates, mock-ups and upcoming items of interest.

## PART 2 - PRODUCTS

### 2.1 NOT USED

.1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

.1 Not Used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

.1 Section 01 77 00 - Closeout Procedures.

### 1.2 PROGRESS PHOTOGRAPHS

.1 Viewpoints: interior and exterior locations in viewpoints determined by Departmental Representative.

.2 Frequency: weekly and submitted monthly with progress statement as directed by Departmental Representative. Submission of pohoto's and progress statements will be linked to progress draw approval.

.3 Submit all digital files of coloured prints before final acceptance of building.

.4 Insert C.D. of files in envelopes and identify with name and number of project.

### 1.3 ELECTRONIC COPY

.1 Submit electronic and hard copy of colour digital photography in jpg format, standard resolution.

.2 Identification: name and number of project and date of exposure indicated.

.3 Number of viewpoints: 4. Locations of viewpoints determined by Departmental Representative.

.4 Frequency: as directed by Departmental Representative.

## PART 2 - PRODUCTS

### 2.1 NOT USED

.1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

.1 Not Used.

END OF SECTION

# PART 1 - GENERAL

## 1.1 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, Certificate of Substantial Performance and Certificate of Completion as defined times of completion are of essence of this contract.

## 1.3 SUBMITTALS

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

.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 for each structure as follows but not limited to:
.1 Award.

.2 Shop Drawings, Samples.
.3 Permits.
.4 Mobilization.
.5 Site preparation, excavation and civil engineering.
.6 Foundations and low walls.
.7 Metal Structure.
.8 Insulation and sheathing.
.9 Cladding.
.10 HOGEN systems installation.
.11 Lighting.
.12 Lighting electrical system.
.13 Electrical.
.14 Piping.
.15 Controls.
.16 Heating and Ventilating.
.17 Testing and Commissioning.
.18 Departmental Representative 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 specified in Section 01 31 19, identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on baseline schedule.

.2 Weather related delays with their remedial measures will be discussed and negotiated.

# PART 2 - PRODUCTS

## 2.1 NOT USED

.1 Not used.

## PART 3 - EXECUTION

### 3.1 NOT USED

.1 Not used.

END OF SECTION

## PART 1 - GENERAL

### 1.1 ADMINISTRATIVE

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

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

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

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

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

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

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

.8 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative'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.

.11 Submit number of hard copies specified for each type and format of submittal and also submit in electronic format as pdf files. Forward pdf, NMSEdit Professional spp, MS Word, MS Excel, MS Project and Autocad dwg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

## 1.2 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 Province of Ontario of Canada.

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

.4 Allow 3 working days for Departmental Representative's review of each submission.

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

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

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

.8 Submissions shall 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 one electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.

.11 Submit three hard copies and one electronic copy 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 three hard copies and one electronic copy 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 three hard copies and one electronic copy 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 three hard copies and one electronic copy 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 three hard copies and one electronic copy 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 three hard copies and one electronic copy 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 address.

.3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.

.4 Where colour, pattern or texture is criterion, submit full range of samples.

.5 Adjustments made on samples by Departmental Representative are not intended to change Contract Price.If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

.6 Make changes in samples 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 Section 01 45 00.

## 1.5 PHOTOGRAPHIC DOCUMENTATION

.1 Refer to Section 01 32 00.

## 1.6 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Safety and Insurance Board Experience Report.

## 1.7 FEES, PERMITS AND CERTIFICATES

.1 Provide authorities having jurisdiction with information requested.

.2 Pay fees and obtain certificates and permits required.

.3 Furnish certificates and permits.

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

.2 National Building Code 2010 (NBC):
.1 NBC 2010, Division B, Part 8 Safety Measures at Construction and Demolition Sites.

.3 National Fire Code 2010 (NFC):
.1 NFC 2010, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.

.4 Province of Ontario:
.1 Occupational Health and Safety Act Revised Statutes of Ontario 1990, Chapter O.1 as amended, and Regulations for Construction Projects, O. Reg. 213/91 as amended.
.2 O. Reg. 490/09, Designated Substances.
.3 Workplace Safety and Insurance Act, 1997.
.4 Municipal statutes and authorities.

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

## 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
.1 Results of site specific safety hazard assessment.
.2 Results of safety and health risk or hazard analysis for site tasks and operation found in work plan.
.3 Measures and controls to be implemented to address identified safety hazards and risks.

.3 Provide a Fire Safety Plan, specific to the work location, in accordance with NBC, Division B, Article 8.1.1.3 prior to commencement of work. The plan shall be coordinated with, and integrated into, the existing Emergency Procedures and Evacuation Plan in place at the site. Departmental Representative will provide Emergency Procedures and Evacuation Plan. Deliver two copies of the Fire Safety Plan to the Departmental Representative not later than 14 days before commencing work.

.4 Contractor's and Sub-contractors' Safety Communication Plan.

.5 Contingency and Emergency Response Plan addressing standard operating procedures specific to the project site to be implemented during emergency situations. Coordinate plan with existing Emergency Response requirements and procedures provided by Departmental Representative.

.6 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 14 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 7 days after receipt of comments from Departmental Representative.

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

.8 Submit names of personnel and alternates responsible for site safety and health.

.9 Submit records of Contractor's Health and Safety meetings when requested.

.10 Submit 2 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative, weekly.

.11 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.

.12 Submit copies of incident and accident reports.

.13 Submit Material Safety Data Sheets (MSDS).

.14 Submit Workplace Safety and Insurance Board (WSIB)- Experience Rating Report.

## 1.3 FILING OF NOTICE

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

## 1.4 WORK PERMIT

.1 Obtain building permits related to project prior to commencement of Work.

.2 Obtain Hot Work Permit from Property Manager.

## 1.5 SAFETY ASSESSMENT

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

## 1.6 MEETINGS

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

## 1.7 REGULATORY REQUIREMENTS

.1 Comply with the Acts and regulations of the Province of Ontario.

.2 Comply with specified standards and regulations to ensure safe operations at site.

## 1.8 PROJECT/SITE CONDITIONS

.1 Work at site may involve contact with designated or hazardous substances. Contractor shall coordinate and take necessary precautions and/or measures in accordance with information on hazardous or designated substances provided by Departmental Representative.

## 1.9 GENERAL REQUIREMENTS

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

.2 Departmental Representative may respond in writing, where deficiencies or concerns are noted and may request re-submission with correction of deficiencies or concerns either accepting or requesting improvements.

.3 Relief from or substitution for any portion or provision of minimum Health and Safety standards specified herein or reviewed site-specific Health and Safety Plan shall be submitted to Departmental Representative in writing.

## 1.10 COMPLIANCE REQUIREMENTS

.1 Comply with Ontario Occupational Health and Safety Act, R.S.O. 1990 Chapter 0.1, as amended.

## 1.11 RESPONSIBILITY

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

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

.3 Where applicable the Contractor shall be designated "Constructor", as defined by Occupational Health and Safety Act and Regulations for Construction Projects for the Province of Ontario.

## 1.12 UNFORSEEN HAZARDS

.1 Should any unforeseen or peculiar safety-related factor, hazard, or condition become evident during performance of Work, immediately stop work and advise Departmental Representative verbally and in writing.

.2 Follow procedures in place for Employees Right to Refuse Work as specified in the Occupational Health and Safety Act for the Province of Ontario.

## 1.13 POSTING OF DOCUMENTS

.1 Ensure applicable items, articles, notices and orders are posted in conspicuous location on site in accordance with Acts and Regulations of Province of Ontario, and in consultation with Departmental Representative.
.1 Contractor's Safety Policy.
.2 Constructor's Name.
.3 Notice of Project.
.4 Name, trade, and employer of Health and Safety Representative or Joint Health and Safety Committee members (if applicable).
.5 Ministry of Labour Orders and reports.
.6 Occupational Health and Safety Act and Regulations for Construction Projects for Province of Ontario.
.7 Address and phone number of nearest Ministry of Labour office.
.8 Material Safety Data Sheets.
.9 Written Emeregency Response Plan.
.10 Site Specific Safety Plan.
.11 Valid certificate of first aider on duty.
.12 WSIB "In Case of Injury At Work" poster.
.13 Location of toilet and cleanup facilities.

## 1.14 CORRECTION OF NON-COMPLIANCE

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

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

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

## 1.15 POWDER ACTUATED DEVICES

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

## 1.16 WORK STOPPAGE

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

.2 Assign responsibility and obligation to Competent Supervisor to stop or start Work when, at Competent Supervisor's discretion, it is necessary or advisable for reasons of health or safety. Departmental Representative may also stop Work for health and safety considerations.

## 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 GENERAL

.1 This section specifies general requirements and procedures for fire safety. Additional requirements may be specified in individual sections elsewhere in specifications.

## 1.2 REPORTING FIRES

.1 The Departmental Representative will co-ordinate arrangements for the Contractor to be briefed at the pre-construction meeting concerning Building's fire safety protocol.

.2 Building Manager will supply a copy of "Fire Safety Emergency Evacuation Plan" in effect for this building. Contractor shall comply with outlined fire safety requirements.

.3 Know location of nearest fire alarm box and telephone, including emergency phone number.

.4 Report immediately all fire incidents to Fire Department as follows:
   .1 activate nearest fire alarm box; or
   .2 telephone.

.5 Person activating fire alarm box will remain at box to direct Fire Department to scene of fire.

.6 When reporting fire by telephone, give location of fire, name or number of building and be prepared to verify the location.

## 1.3 FIRE WATCH

.1 Appoint a Fire Watch at locations where welding and soldering, torching or roofing is to take place.

.2 A dedicated Fire Watch is not required. A competent person from the workforce on site may be assigned as Fire Watch for duration of work.

.3 Assign a person who is knowledgeable in the correct use of fire extinguishers on the project.

.4 Have work inspected by the Fire Watch up to 1.0 hours after work stoppage for each work period.

## 1.4 INTERIOR AND EXTERIOR FIRE PROTECTION AND ALARM SYSTEMS

.1 Fire hydrants, standpipes and hose systems will not be used for other than fire-fighting purposes unless authorized by Departmental Representative.

.2 Provide and maintain free access to fire extinguishing equipment. Maintain exit facilities. Keep means of egress free from materials, equipment and obstructing.

## 1.5 FIRE EXTINGUISHERS

.1 Supply fire extinguishers, as necessary to protect work in progress and contractor's physical plant on site.

## 1.6 BLOCKAGE OF ROADWAYS

.1 Advise Departmental Representative of any work that would impede fire apparatus response. This includes violation of minimum required overhead clearance.

## 1.7 SMOKING PRECAUTIONS

.1 Smoking is not permitted within areas of work or site storage.

## 1.8 RUBBISH AND WASTE MATERIALS

.1 Rubbish and waste materials are to be kept to a minimum.

.2 Burning of rubbish is prohibited.

.3 Remove all rubbish from work site at end of work day or shift or as directed.

.4 Storage:
.1 Store oily waste in approved receptacles to ensure maximum cleanliness and safety.
.2 Deposit greasy or oily rags and materials subject to spontaneous combustion in approved receptacles and remove from site daily or at the end of each shift.

## 1.9 FLAMMABLE AND COMBUSTIBLE LIQUIDS

.1 Handling, storage and use of flammable and combustible liquids are to be governed by the current National Fire Code of Canada.

.2 Flammable and combustible liquids such as gasoline, kerosene and naphtha will be kept for ready use in quantities not exceeding 45 litres provided they are stored in approved safety cans bearing Underwriters' Laboratory of Canada or Factory Mutual seal of approval. Storage of quantities of flammable and combustible liquids exceeding 45 litres for work purposes requires permission of local Building Manager.

.3 Transfer of flammable and combustible liquids is prohibited within buildings or jetties.

.4 Transfer of flammable and combustible liquids will not be carried out in vicinity of open flames or any type of heat-producing devices.

.5 Flammable liquids having a flash point below 38°C such as naphtha or gasoline will not be used as solvents or cleaning agents.

.6 Flammable and combustible waste liquids, for disposal, will be stored in approved containers located in a safe ventilated area. Quantities are to be kept to a minimum and Fire Department is to be notified when disposal is required.

## 1.10 HAZARDOUS SUBSTANCES

.1 Work entailing use of toxic or hazardous materials, chemicals and/or explosives, or otherwise creating hazard to life, safety or health, will be in accordance with National Fire Code of Canada.

.2 Obtain from local Building Manager a "Hot Work" permit for work involving welding, burning or use of blow torches and salamanders, in building or facility.

.3 When Work is carried out in dangerous or hazardous areas involving use of heat, provide fire watchers equipped with sufficient fire extinguishers. Determination of dangerous or hazardous areas along with level of protection necessary for Fire Watch is at discretion of the local Building Manager. Contractors are responsible for providing fire watch service for work on a scale established and in conjunction with Building Manager at pre-construction meeting.

.4 Where flammable liquids, such as lacquers or urethanes are to be used, proper ventilation will be assured and all sources of ignition are to be eliminated. Building Manager is to be informed prior to and at cessation of such work.

## 1.11 WELDING, BURNING AND CUTTING

.1 Contractor performing work of this section must notify Departmental Representative in advance of commencing work.

.2 Use non-combustible shields for electric and gas welding or cutting executed within 3 m of combustible material or in occupied spaces.

.3 Place cylinders supplying gases as close to work as possible. Secure cylinders in upright position, free from exposure to sun or high temperature.

.4 Locate fire extinguishing equipment near all welding, cutting and soldering operations.

.5 Contractor's mechanics shall be properly equipped with required protective clothing, including goggles or welding hood or face mask, gloves, etc.

.6 Contractor is responsible for the protection of his work and the Departmental Representative 's property.

.7 Provide Fire Watch on standby with approved fire extinguisher while burning or welding is in progress and for 1 hour after completion of hot work.

## 1.12 QUESTIONS AND/OR CLARIFICATIONS

.1 Direct any questions or clarification on Fire Safety in addition to above requirements to local Building Manager.

## 1.13 FIRE INSPECTION

.1 Site inspections by Building Manager will be coordinated through Departmental Representative.

.2 Allow local Building Manager unrestricted access to work site.

.3 Co-operate with Building Manager during routine fire safety inspection of work site.

.4 Immediately remedy all unsafe fire situations observed by Building Manager.

## 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 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.

## 1.2 REFERENCES

.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.

## 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for products 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 and or 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.

## 1.4 FIRES

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

## 1.5 SNOW REMOVAL

.1 Remove fallen or drifting snow and ice from Site, including access roads, building and parking lots and provide salt and/or sand as required.

## 1.6 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.

## 1.7 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.

## 1.8 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.
.1 Leave Work area clean at end of each day.

.2 Burial of rubbish and waste materials on site will not be permitted.

.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.

.5 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

.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) 2010, National Fire Code of Canada (NFC) 2010 and Ontario Building Code (OBC) 2012, including all amendments up to bid closing date and other codes of provincial or local application provided that in case of conflict or discrepancy, more stringent requirements apply as directed by the Departmental Representative.

.2 Meet or exceed requirements of:
- .1 Contract documents.
- .2 Specified standards, codes and referenced documents.

## 1.2 HAZARDOUS MATERIAL DISCOVERY

.1 Stop work immediately and notify Departmental Representative if materials which may contain designated substances or PCB's, other than those identified in Section 01 35 29 are discovered in course of work.

## 1.3 BUILDING SMOKING ENVIRONMENT

.1 Comply with smoking restrictions.

## 1.4 IAQ - INDOOR AIR QUALITY

.1 Comply with CSA-Z204-94(R1999), Guideline for Managing Indoor Air Quality in Office Buildings and CSA B651-12.

## 1.5 TAXES

.1 Pay applicable Federal, Provincial and Municipal taxes.

## 1.6 EXAMINATION

.1 Examine existing conditions and determine conditions affecting 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 SECTION INCLUDES

.1 Inspection and testing, administrative and enforcement requirements.

.2 Tests and mix designs.

.3 Mock-ups.

.4 Mill tests.

.5 Equipment and system adjust and balance.

## 1.2 RELATED SECTIONS

.1 Section 01 91 13 - Commissioning - General Requirements.

## 1.3 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 may order any part of Work to be examined if Work is suspected to be not in accordance with Contract Documents. If, upon examination such work is found not in accordance with Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract Documents, Departmental Representative shall pay cost of examination and replacement.

## 1.4 INDEPENDENT INSPECTION AGENCIES

.1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work, above and beyond those required of the Contractor. Cost of such services 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/or testing, appointed agency will request additional inspection and/or 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.

## 1.5 ACCESS TO WORK

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

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

## 1.6 PROCEDURES

.1 Notify appropriate agency and Departmental Representative minimum 48 hours in advance of requirement for tests, in order that attendance arrangements can be made.

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

## 1.7 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 may deduct from Contract Amount difference in value between Work performed and that called for by Contract Documents, amount of which shall be determined by Departmental Representative.

## 1.8 REPORTS

.1 Submit 4 copies of inspection and test reports to Departmental Representative.

.2 Provide copies to Subcontractor of work being inspected or tested, and manufacturer or fabricator of material being inspected or tested.

## 1.9 TESTS AND MIX DESIGNS

.1 Furnish test results and mix designs as may be requested.

.2 The cost of tests and mix designs beyond those called for in Contract Documents or beyond those required by law of Place of Work shall be appraised by Departmental Representative and may be authorized as recoverable.

## 1.10 MOCK-UPS

.1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of all Sections required to provide mock-ups.

.2 Construct in all locations acceptable to Departmental Representative.

.3 Prepare mock-ups for Departmental Representative's review with reasonable promptness and in an orderly sequence, so as not to cause any delay in Work.

.4 Failure to prepare mock-ups in ample time is not considered sufficient reason for an 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 a schedule fixing dates for preparation.

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

## 1.11 MILL TESTS

.1 Submit mill test certificates as requested.

## 1.12 EQUIPMENT AND SYSTEMS

.1 Submit testing, adjusting and balancing reports for mechanical, electrical systems.

.2 Submit Commissioning Documentation in accordance with Section 01 91 13.

# 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 SECTION INCLUDES

.1 Temporary utilities.

## 1.2 RELATED SECTIONS

.1 Section 01 52 00 - Construction Facilities.

.2 Section 01 56 00 - Temporary Barriers and Enclosures.

## 1.3 SUBMITTALS

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

## 1.4 INSTALLATION AND REMOVAL

.1 Provide temporary utilities controls in order to execute work expeditiously.

.2 Remove from site all such work after use.

## 1.5 WATER SUPPLY

.1 Arrange for connection with appropriate utility company and pay all costs for installation, maintenance and removal.

## 1.6 TEMPORARY HEATING AND VENTILIATION

.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 ventiliation 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°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 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
.1 Conform with applicable codes and standards.
.2 Enforce safe practices.
.3 Prevent abuse of services.
.4 Prevent damage to finishes.
.5 Vent direct-fired combustion units to outside.

.7 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

## 1.7 TEMPORARY POWER AND LIGHT

.1 Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance and removal.

.2 Temporary power for electric cranes and other equipment requiring in excess of above is responsibility of Contractor.

.3 Provide and maintain temporary lighting throughout project. Ensure level of illumination on all floors and stairs is not less than 162 lx.

.4 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, data hook up, lines and equipment necessary for own use and use of Departmental Representative.

## 1.9 FIRE PROTECTION

.1 Provide and maintain temporary fire protection equipment during performance of Work required by insurance companies having jurisdiction and governing codes, egulations 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 NOT USED

.1 Not Used.

END OF SECTION

# PART 1 - GENERAL

## 1.1 SECTION INCLUDES

.1 Construction aids.

.2 Office and sheds.

.3 Parking.

## 1.2 REFERENCES

.1 Canadian Standards Association (CSA International)
.1 CSA Z797-09(R2014), Code of practice for Access Scaffold.
.2 CAN/CSA-Z321-96(R2006), Signs and Symbols for the Occupational Environment, withdrawn but still available from CSA, CCOHS and Techstreet.

## 1.3 SUBMITTALS

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

## 1.4 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.

## 1.5 SCAFFOLDING

.1 Scaffolding in accordance with CSA Z797.

.2 Provide and maintain scaffolding, ramps, and ladders.

## 1.6 HOISTING

.1 Provide, operate and maintain hoists/cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof.

.2 Hoists/cranes shall be operated by qualified operator.

## 1.7 SITE STORAGE/LOADING

.1 Confine work and operations of employees to areas defined by Contract Documents. Do not unreasonably encumber premises with products.

.2 Do not load or permit to load any part of Work with a weight or force that will endanger the Work.

## 1.8 CONSTRUCTION PARKING

.1 Parking will be permitted on gravel parking lot on west side of Site.

.2 Provide and maintain adequate access to project site.

.3 Maintain existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractors' use of roads.

.4 Clean construction runways and taxi areas where used by Contractor's equipment.

## 1.9 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in a 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 a manner to cause least interference with work activities.

## 1.10 SANITARY FACILITIES

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

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

## 1.11 CONSTRUCTION SIGNAGE

.1 No other signs or advertisements, other than warning signs, are permitted on site.

.2 Signs and notices for safety and instruction shall be in both official languages. Graphic symbols shall conform to CAN/CSA-Z321.

.3 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.

## 1.12 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 necessary.

.8 Haul roads: constructed with suitable grades and widths; sharp curves, blind corners, and dangerous cross traffic shall be avoided.

.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.

## 1.13 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.

# 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 SECTION INCLUDES

.1 Barriers.

.2 Environmental Controls.

.3 Traffic Controls.

.4 Fire Routes.

## 1.2 RELATED SECTIONS

.1 Section 01 51 00 - Temporary Utilities.

.2 Section 01 52 00 - Construction Facilities.

## 1.3 REFERENCES

.1 Canadian General Standards Board (CGSB):
  .1 CAN/CGSB-1.189-2000, Exterior Alkyd Primer for Wood.
  .2 CAN/CGSB-1.59-97, Alkyd Exterior Gloss Enamel.

.2 Canadian Standards Association (CSA):
  .1 CSA O121-08(R2013), Douglas Fir Plywood.

## 1.4 INSTALLATION AND REMOVAL

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

.2 Remove from site all such work after use.

## 1.5 HOARDING

.1 Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.

.2 Define work area and erect temporary site enclosure using modular freestanding fencing: galvanized, minimum 1.8 m high, chain link or welded steel mesh, pipe rail. Provide one lockable truck entrance gate and at least one pedestrian door as directed and conforming to applicable traffic restrictions on adjacent streets. Equip gates with locks and keys. Maintain fence in good repair.

## 1.6 GUARD RAILS AND BARRICADES

.1 Provide secure, rigid guard rails and barricades around open shafts, and open edges of roofs.

.2 Provide as required by governing authorities.

## 1.7 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.

## 1.8 ACCESS TO SITE

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

## 1.9 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 the public.

## 1.10 FIRE ROUTES

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

## 1.11 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.

## 1.12 PROTECTION OF BUILDING FINISHES

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

.2 Provide necessary screens, covers, and hoardings.

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

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

# PART 2 - PRODUCTS

## 2.1 NOT USED

.1 Not Used.

# PART 3 - EXECUTION

## 3.1 NOT USED

.1 Not Used.

END OF SECTION

# PART 1 - GENERAL

## 1.1 SECTION INCLUDES

.1 Product quality, availability, storage, handling, protection, and transportation.

.2 Manufacturer's instructions.

.3 Quality of Work, coordination and fastenings.

.4 Existing facilities.

## 1.2 RELATED SECTIONS

.1 Section 01 45 00 - Quality Control.

## 1.3 REFERENCES

.1 Within text of specifications, reference may be made to reference standards.

.2 Conform to these standards, in whole or in part as specifically requested in specifications.

.3 If there is question as to whether any product or system is in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.

.4 The cost for such testing will be born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance.

.5 Conform to latest date of issue of referenced standards in effect on date of submission of Bids, except where specific date or issue is specifically noted.

.6 OPSS Ontario Provincial Standard Specifications and OPSD Ontario Provincial Standard Drawings quoted in these specifications are available online at http://www.raqsa.mto.gov.on.ca/ techpubs/ops.nsf/OPSHomepage.

## 1.4 QUALITY

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

.2 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.

.3 Should any dispute arise as to quality or fitness of products, decision rests strictly with Departmental Representative based upon requirements of Contract Documents.

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

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

## 1.5 AVAILABILITY

.1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for any 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.

## 1.6 METRIC SIZED MATERIALS

.1 SI metric units of measurement are used exclusively on the drawings and in the specifications for this project.

.2 The Contractor is required to provide metric products in the sizes called for in the Contract Documents except where a valid claim can be made that a particular product is not available on the Canadian market.

.3 Claims for exemptions from use of metric sized products shall be in writing and fully substantiated with supportive documentation. Promptly submit application to Departmental Representative for consideration and ruling. Non-metric sized products may not be used unless Contractor's application has been approved in writing by the Departmental Representative.

.4 Difficulties caused by the Contractor's lack of planning and effort to obtain modular metric sized products which are available on the Canadian market will not be considered sufficient reasons for claiming that they cannot be provided.

.5 Claims for additional costs due to provision of specified modular metric sized products will not be considered.

## 1.7 STORAGE, HANDLING AND PROTECTION

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

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

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

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

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

.6 Store sheet materials, lumber and metal panels 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.

## 1.8 TRANSPORTATION

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

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

## 1.9 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 may 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.

## 1.10 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.

## 1.11 CO-ORDINATION

.1 Ensure cooperation of workers in laying out Work. Maintain efficient and continuous supervision.

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

.3 Be responsible for coordination with trailer manufacturer and installer.

## 1.12 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.

## 1.13 REMEDIAL WORK

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

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

## 1.14 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.

## 1.15 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.

## 1.16 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.

## 1.17 PROTECTION OF WORK IN PROGRESS

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

## 1.18 EXISTING UTILITIES

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

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

## 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 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00.

.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 Departmental Representative 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 Departmental Representative or separate contractor.
- .7 Written permission of affected separate contractor.
- .8 Date and time work will be executed.

## 1.2 MATERIALS

.1 Required for original installation.

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

## 1.3 PREPARATION

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

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

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

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

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

## 1.4 EXECUTION

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

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

.3 Uncover Work to install ill-timed Work.

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

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

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

.7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.

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

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

.10 Submit proposed materials, finishes and installation method for patching to Departmental Representative for approval, prior to patching.

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

## 1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse, and recycling in accordance with Section 01 74 20.

## 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 SECTION INCLUDES

.1 Progressive cleaning.

.2 Final cleaning.

## 1.2 PROJECT CLEANLINESS

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

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

.3 Clear snow and ice from access to building, bank/pile snow in designated areas only.

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

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

.6 Provide and use clearly marked separate bins for recycling. Refer to Section 01 74 20.

.7 Remove waste material and debris from site and deposit in waste container at end of each working day.

.8 Dispose of waste materials and debris off site.

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

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

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

## 1.3 FINAL CLEANING

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

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

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

.4 Remove waste products and debris other than that caused by Departmental Representative 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 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.

.8 Remove dirt and other disfiguration from exterior surfaces.

.9 Clean and sweep roofs, gutters, areaways, and sunken wells.

.10 Sweep and wash clean paved areas.

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

.12 Clean roofs, downspouts, and drainage systems.

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

.14 Remove snow and ice from access to building.

# PART 2 - PRODUCTS

## 2.1 NOT USED

.1 Not Used.

## PART 3 - EXECUTION

### 3.1 NOT USED

.1 Not Used.

END OF SECTION

# PART 1 - GENERAL

## 1.1 CONSTRUCTION & DEMOLITION WASTE

.1 Carefully deconstruct and source separate materials/equipment and divert, from D&C waste destined for landfill to maximum extent possible. Target for this project is 50% diversion from landfill. Reuse, recycle, compost, anaerobic digest or sell material for reuse except where indicated otherwise. On site sales are not permitted.

.2 Source separate waste and maintain waste audits in accordance with the Environmental Protection Act, Ontario Regulation 102/94 and Ontario Regulation 103/94.
.1 Provide facilities for collection, handling and storage of source separated wastes.
.2 Source separate the following waste:
.1 Brick and portland cement concrete.
.2 Corrugated cardboard.
.3 Wood, not including painted or treated wood or laminated wood.
.4 Gypsum board, unpainted.
.5 Steel.
.6 Items indicated in Section 02 42 93, Deconstruction and Waste Products Workplan Summary.

.3 Submit a waste reduction workplan indicating the materials and quantities of material that will be recycled and diverted from landfill.
.1 Indicate how material being removed from the site will be reused, recycled, composted or anaerobically digested using Section 02 42 93, Deconstruction and Waste Products Workplan Summary.

.4 Submit proof that all waste is being disposed of at a licensed land fill site or waste transfer site. A copy of the disposal/waste transfer site's license and a letter verifying that said landfill site will accept the waste must be supplied to Departmental Representative prior to removal of waste from the demolition site.

## 1.2 WASTE PROCESSING SITES

.1 Province of: Ontario.
.1 Ministry of Environment and Energy, 135 St. Clair Avenue West, Toronto, ON, M4V 1P5.
.2 Telephone: 800-565-4923 or 416-323-4321.
.3 Fax: 416-323-4682.

.2 Recycling Council of Ontario: 215 Spadina Avenue, #225, Toronto, ON, M5T 2C7.
- .1 Telephone: 416-657-2797.
- .2 Fax: 416-960-8053.
- .3 Email: rco@rco.on.ca.
- .4 Internet: http://www.rco.on.ca/.

## PART 2 - PRODUCTS

### 2.1 NOT USED

.1 Not Used.

## PART 3 - EXECUTION

### 3.1 CANADIAN GOVERNMENTAL DEPARTMENTS CHIEF RESPONSIBILITY FOR THE ENVIRONMENT

.1 Government Chief Responsibility for the Environment.

| | | | |
|---|---|---|---|
| Ontario | Ministry of Environment and Energy<br>135 St Clair Avenue West<br>Toronto, ON<br>M4V 1P5 | (416) 323-4321<br>(800) 565-4923 | (416) 323-4682 |
| | Environment Canada<br>Toronto, ON | (416) 734-4494 | |

END OF SECTION

## PART 1 - GENERAL

### 1.1 INSPECTION AND DECLARATION

.1 Contractor's Inspection: Contractor and all Subcontractors shall conduct an 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 that corrections have been made.
.2 Request Departmental Representative's Inspection.

.2 Departmental Representative's Inspection: Departmental Representative and Contractor will perform inspection of Work to identify obvious defects or deficiencies. Contractor to correct Work accordingly.

.3 Completion: submit written certificate that following have been performed:
.1 Work has been completed and inspected for compliance with Contract Documents.
.2 Defects have been corrected and deficiencies have been completed.
.3 Equipment and systems have been tested, adjusted and balanced and are fully operational.
.4 Certificates required by PWGSC Fire Protection Engineer have been submitted.
.5 Operation of systems have been demonstrated to Departmental Representative's personnel.
.6 Work is complete and ready for final inspection.

.4 Final Inspection: when items noted above are completed, request final inspection of Work by Departmental Representative and Contractor. If Work is deemed incomplete by Departmental Representative, complete outstanding items and request reinspection.

### 1.2 CLEANING

.1 In accordance with Section 01 74 11.

.2 Remove waste and surplus materials, rubbish and construction facilities from the site in accordance with Section 01 74 20.

## 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 SECTION INCLUDES

.1 As-built, samples, and specifications.

.2 Equipment and systems.

.3 Product data, materials and finishes, and related information.

.4 Operation and maintenance data.

.5 Spare parts, special tools and maintenance materials.

.6 Warranties and bonds.

.7 Final site survey.

## 1.2 RELATED SECTIONS

.1 Section 01 91 13 - Commissioning - General Requirements.

.2 Section 01 79 00 - Demonstration and Training.

## 1.3 SUBMISSION

.1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.

.2 Copy will be returned after final inspection, with Departmental Representative's comments.

.3 Revise content of documents as required prior to final submittal.

.4 Two weeks prior to Substantial Performance of the Work, submit to the Departmental Representative, four final copies of maintenance manuals and commissioning documentation in English.

.5 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work.

.6 If requested, furnish evidence as to type, source and quality of products provided.

.7 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

.8 Pay costs of transportation.

## 1.4 FORMAT

.1 Organize data in the form of an 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. Identify contents of each binder on spine.

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

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

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

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

.8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

.9 Provide 1:1 scaled CAD files in dwg format. Forward pdf, NMSEdit Professional spp, MS Word, MS Excel, and Autocad dwg files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

## 1.5 CONTENTS - EACH VOLUME

.1 Table of Contents: 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 clearly 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. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00.

.6 Training: Refer to Section 01 79 00.

## 1.6 AS-BUILTS AND SAMPLES

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

.2 Store record documents and samples in field office apart from documents used for construction. Provide files, racks, and secure storage.

.3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.

.4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.

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

.6 Turn one set, paper copy and electronic copy, of AS-BUILT drawings and specifications over to Departmental Representative on completion of work. Submit files on USB compatible with PWGSC encryption requirements or through email or alternate electronic file sharing service such as ftp, as directed by Departmental Representative.

.7 If project is completed without significant deviations from Contract drawings and specifications submit to Departmental Representative one set of drawings and specifications marked "AS-BUILT".

## 1.7 RECORDING ACTUAL SITE CONDITIONS

.1 Record information on set of black line opaque drawings, and in copy of Project Manual, provided by Departmental Representative.

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

.3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.

.4 Contract Drawings and shop drawings: legibly 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: legibly 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 Amendments and change orders.

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

## 1.8 EQUIPMENT AND SYSTEMS

.1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.

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

.3 Include installed colour coded wiring diagrams.

.4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.

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

.6 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 coordination drawings, with installed colour coded piping diagrams.

.12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

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

.14 Include test and balancing reports as specified in Section 01 45 00 and 01 91 13.

.15 Additional requirements: As specified in individual specification sections.

## 1.9 MATERIALS AND FINISHES

.1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations.

.2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

.4 Additional Requirements: as specified in individual specifications sections.

## 1.10 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 location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

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

## 1.11 MAINTENANCE 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 location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

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

## 1.12 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 location as directed; place and store.

.4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

## 1.13 STORAGE, HANDLING AND PROTECTION

.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 to satisfaction of Departmental Representative.

## 1.14 WARRANTIES AND BONDS

.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 the applicable item of work.

.4 Except for items put into use with Departmental Representative's permission, leave date of beginning of time of warranty until the Date of Certificate of Substantial Performance is determined.

.5 Verify that documents are in proper form, contain full information, and are notarized.

.6 Co-execute submittals when required.

.7 Retain warranties and bonds until time specified for submittal.

## 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 SECTION INCLUDES

.1 Procedures for demonstration and instruction of equipment and systems to Departmental Representative's O&M personnel.

.2 O&M personnel includes property facility manager, building operators, maintenenace staff, security staff and technical specialists, as applicable.

## 1.2 DESCRIPTION

.1 Demonstrate operation and maintenance of equipment and systems to Departmental Representative's personnel two weeks prior to date of Substantial performance.

.2 Departmental Representative will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

## 1.3 QUALITY CONTROL

.1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Departmental Representative's personnel, and provide written report that demonstration and instructions have been completed.

.2 Submit training schedule of time and date for demonstration and training of each item of equipment and each system in accordance with the training plan four weeks prior to designated dates, for Departmental Representative's approval.

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

.4 Report shall give time and date of each demonstration and training, with list of persons present.

## 1.4 CONDITIONS FOR DEMONSTRATIONS

.1 Testing, adjusting, and balancing has been performed and equipment and systems are fully operational.

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

## 1.5 PREPARATION

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

.2 Verify that designated O&M personnel are present.

## 1.6 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 designatedlocation.

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

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

.4 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.

## 1.7 TIME ALLOCATED FOR INSTRUCTIONS

.1 Allow for amount of time required for instruction of each item of equipment or system as required and agreed upon with Departmental Representative.

# PART 2 - PRODUCTS

## 2.1 NOT USED

.1 Not Used.

# PART 3 - EXECUTION

## 3.1 NOT USED

.1 Not Used.

END OF SECTION

# PART 1 - GENERAL

## 1.1 SUMMARY

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

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

## 1.2 GENERAL

.1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
.1 Verify installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and intent.
.2 Ensure appropriate documentation is compiled into the BMM.
.3 Effectively train O&M staff.

.2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
.1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be interactively with each other as intended in accordance with Contract Documents and design criteria.
.2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.

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

.4 AFD managed projects the term Departmental Representative in Cx specifications to be interpreted as AFD Service Provider.

## 1.3 COMMISSIONING OVERVIEW

.1 Refer to Mechanical and Electrical.

.2 Cx to be a line item of Contractor's cost breakdown.

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

.4 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.

.5 Departmental Representative will issue Certificate of Substantial Performance 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 O&M 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 unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.

## 1.5 PRE-CX REVIEW

.1 Before Construction:
.1 Review contract documents, confirm by writing to Departmental Representative.
.1 Adequacy of provisions for Cx.
.2 Aspects of design and installation pertinent to success of Cx.

.2 During Construction:

.1 Co-ordinate provision, location and installation of provisions for Cx.

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

.4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

## 1.6 CONFLICTS

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

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

## 1.7 SUBMITTALS

.1 Submittals: in accordance with Section 01 33 00.
.1 Submit no later than 4 weeks after award of Contract:
.1 Name of Contractor's Cx agent.
.2 Draft Cx documentation.
.3 Preliminary Cx schedule.
.2 Request in writing to Departmental Representative for changes to submittals and obtain written approval at least 8 weeks prior to start of Cx.
.3 Submit proposed Cx procedures to Departmental Representative where not specified and obtain written approval at least 8 weeks prior to start of Cx.
.4 Provide additional documentation relating to Cx process required by Departmental Representative.

## 1.8 COMMISSIONING DOCUMENTATION

.1 Departmental Representative to review and approve Cx documentation.

.3 Provide completed and approved Cx documentation to Departmental Representative.

## 1.9 COMMISSIONING SCHEDULE

.1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.

.2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
.1 Approval of Cx reports.
.2 Verification of reported results.
.3 Repairs, retesting, re-commissioning, re-verification.
.4 Training.

## 1.10 COMMISSIONING MEETINGS

.1 Convene Cx meetings following project meetings: Section 01 32 16 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. Departmental Representative to call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
.1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
.2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.

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

.6 Meeting will be chaired by Departmental Representative, who will record and distribute minutes.

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

## 1.11 STARTING AND TESTING

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

## 1.12 WITNESSING OF STARTING AND TESTING

.1 Provide 14 days notice prior to commencement.

.2 Departmental Representative to witness start-up and testing.
startstartstart-uptesting.
and testing.

.3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers.

## 1.13 MANUFACTURER'S INVOLVEMENT

.1 Factory testing: manufacturer to:
.1 Coordinate time and location of testing.
.2 Provide testing documentation for approval by Departmental Representative.
.3 Arrange for Departmental Representative to witness tests.
.4 Obtain written approval of test results and documentation from Departmental Representative before delivery to site.

.2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Departmental Representative.
.1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
.2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.

.3 Integrity of warranties:
.1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
.2 Verify with manufacturer that testing as specified will not void warranties.

.4 Qualifications of manufacturer's personnel:
.1 Experienced in design, installation and operation of equipment and systems.
.2 Ability to interpret test results accurately.
.3 To report results in clear, concise, logical manner.

## 1.14 PROCEDURES

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

.2 Conduct start-up and testing in following distinct phases:
- .1 Included in delivery and installation:
  - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
  - .2 Visual inspection of quality of installation.
- .2 Start-up: follow accepted start-up procedures.
- .3 Operational testing: document equipment performance.
- .4 System PV: include repetition of tests after correcting deficiencies.
- .5 Post-substantial performance verification: to include fine-tuning.

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

.4 Document require tests on approved PV forms.

.5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
- .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative.
- .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative.
- .3 If evaluation report concludes that major damage has occurred, Departmental Representative shall reject equipment.
  - .1 Rejected equipment to be remove from site and replace with new.
  - .2 Subject new equipment/systems to specified start-up procedures.

## 1.15 START-UP DOCUMENTATION

.1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.

.2 Start-up documentation to include:
- .1 Factory and on-site test certificates for specified equipment.

.2 Pre-start-up inspection reports.
.3 Signed installation/start-up check lists.
.4 Start-up reports,
.5 Step-by-step description of complete start-up procedures, to permit Departmental Representative to repeat start-up at any time.

## 1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

.1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.

.2 With assistance of manufacturer develop written maintenance program and submit Departmental Representative for approval before implementation.

.3 Operate and maintain systems for length of time required for commissioning to be completed.

.4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

## 1.17 TEST RESULTS

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

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

## 1.18 START OF COMMISSIONING

.1 Notify Departmental Representative at least 21 days prior to start of Cx.

.2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.

## 1.19 INSTRUMENTS / EQUIPMENT

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

.2 Provide the following equipment as required:
.1 2-way radios.
.2 Ladders.
.3 Equipment as required to complete work.

## 1.20 COMMISSIONING PERFORMANCE VERIFICATION

.1 Carry out Cx:
.1 Under actual operating conditions, over entire operating range, in all modes.
.2 On independent systems and interacting systems.

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

.3 Follow equipment manufacturer's operating instructions.

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

## 1.21 WITNESSING COMMISSIONING

.1 Departmental Representative to witness activities and verify results.

## 1.22 AUTHORITIES HAVING JURISDICTION

.1 Where specified start-up, testing or commissioning procedures duplicate verification requirements of authority having jurisdiction, arrange for authority to witness procedures so as to avoid duplication of tests and to facilitate expedient acceptance of facility.

.2 Obtain certificates of approval, acceptance and compliance with rules and regulation of authority having jurisdiction.

.3 Provide copies to Departmental Representative within 5 days of test and with Cx report.

## 1.23 EXTRAPOLATION OF RESULTS

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

## 1.24 EXTENT OF VERIFICATION

.1 Elsewhere:
.1 Provide manpower and instrumentation to verify up to 30% of reported results, unless specified otherwise in other sections.

.2 Number and location to be at discretion of Departmental Representative.

.3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.

.4 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.

.5 Perform additional commissioning until results are acceptable to Departmental Representative.

## 1.25 REPEAT VERIFICATIONS

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

## 1.26 SUNDRY CHECKS AND ADJUSTMENTS

.1 Make adjustments and changes which become apparent as Cx proceeds.

.2 Perform static and operational checks as applicable and as required.

## 1.27 DEFICIENCIES, FAULTS, DEFECTS

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

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

## 1.28 COMPLETION OF COMMISSIONING

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

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

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

## 1.29 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

## 1.31 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

## 1.32 OCCUPANCY

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

## 1.33 INSTALLED INSTRUMENTATION

.1 Use instruments installed under Contract for TAB and PV if:
.1 Accuracy complies with these specifications.
.2 Calibration certificates have been deposited with Departmental Representative.

.2 Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

## 1.34 PERFORMANCE VERIFICATION TOLERANCES

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

.2 Instrument accuracy tolerances:
.1 To be of higher order of magnitude than equipment or system being tested.

.3 Measurement tolerances during verification:
.1 Unless otherwise specified actual values to be within +/-2% of recorded values.

## 1.35 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 This section is limited to portions of the Building Management Manual (BMM) provided to Departmental Representative by Contractor.

.2 Acronyms:
.1 BMM - Building Management Manual.
.2 Cx - Commissioning.
.3 HVAC - Heating, Ventilation and Air Conditioning.
.4 PI - Product Information.
.5 PV - Performance Verification.
.6 TAB - Testing, Adjusting and Balancing.
.7 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 BMM:
.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 BMM.
.2 Summary of architectural, structural, fire protection, mechanical and electrical systems installed and commissioned - as indicated in Section 1.4 of BMM.

.1 Including sequence of operation as finalized after commissioning is complete as indicated in Section 2.0 of BMM.

.3 Description of building operation under conditions of heightened security and emergencies as indicated in Section 2.0 of BMM.

.4 System, equipment and components Maintenance Management System (MMS) identification - Section 2.1 of BMM.

.5 Information on operation and maintenance of architectural systems and equipment installed and commissioned - Section 2.0 of BMM.

.6 Information on operation and maintenance of fire protection and life safety systems and equipment installed and commissioned - Section 2.0 of BMM.

.7 Information on operation and maintenance of mechanical systems and equipment installed and commissioned - Section 2.0 of BMM.

.8 Operating and maintenance manual - Section 3.2 of BMM.

.9 Final commissioning plan as actually implemented.

.10 Completed commissioning checklists.

.11 Commissioning test procedures employed.

.12 Completed Product Information (PI) 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.

.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 BMM.

.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, O&M, 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 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.

.2 Assist Departmental Representative with preparation of BMM.

## 1.7 LANGUAGE

.1 English and French Language to be in separate binders.

## 1.9 USE OF CURRENT TECHNOLOGY

.1 Use current technology for production of documentation. Emphasis on ease of accessibility at all times, maintain in up-to-date state, compatibility with user's requirements.

.2 Obtain Departmental Representative's approval before starting Work.

# PART 2 - PRODUCTS

## 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 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.2 Transport Canada (TC)
.1 Transportation of Dangerous Goods Act, 1992 (TDGA), c. 34.

.3 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS 490 November 2015, Construction Specification for Site Preparation for Pipelines, Utilities and Associates Structures.
.2 OPSS 491 November 2010, Construction Specification for Preservation, Protection and Reconstruction of Existing Facilities.
.3 OPSS.PROV 510 November 2014, Construction Specification for Removal.

### 1.2 DEFINITIONS

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

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

### 1.3 ADMINISTRATIVE REQUIREMENTS

.1 Site Meetings.
.1 Convene pre-demolition meeting one week prior to beginning work in accordance with Section 01 32 16.06 to:
.1 Verify project requirements.
.2 Review installation and substrate conditions.
.3 Co-ordination with other building subtrades.
.4 Review manufacturer's installation instructions and warranty requirements.
.2 Arrange for site visit with Departmental Representative to examine existing site conditions adjacent to demolition work, prior to start of Work.
.3 Hold project meetings every week.
.4 Ensure site supervisor and project manager attend.
.5 Departmental Representative will provide written notification of change of meeting schedule established upon contract award 24 hours prior to scheduled meeting.

## 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in of Ontario, Canada.
.2 Submit for approval drawings, diagrams or details showing sequence of demolition work and supporting structures and underpinning, where required by authorities having jurisdiction.

.3 Hazardous Materials:
.1 Provide description of Hazardous Materials and Notification of Filing with proper authorities prior to beginning of Work as required.

.4 Waste Management in accordance with appropriate regulations and best practices.

.5 Certificates:
.1 Submit copies of certified receipts from authorized disposal sites and reuse and recycling facilities for material removed from site upon request of Departmental Representative.

## 1.5 QUALITY ASSURANCE

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

## 1.6 DELIVERY, STORAGE AND HANDLING

.1 Storage and Protection.
.1 Protect in accordance with Section 31 23 33.01.
.2 Protect existing items designated to remain and items designated for salvage. In event of damage to such items, immediately replace or make repairs to approval of Departmental and at no cost to Departmental Representative.
.3 Remove and store materials to be salvaged, in manner to prevent damage.
.4 Store and protect in accordance with requirements for maximum preservation of material.
.5 Handle salvaged materials as new materials.

## 1.7 SITE CONDITIONS

.1 Site Environmental Requirements.
.1 Perform work in accordance with Section 01 35 43.
.2 Ensure that selective demolition work does not adversely affect adjacent watercourses, groundwater and wildlife, or contribute to excess air and noise pollution.
.3 Do not dispose of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum based lubricants, or toxic cleaning solutions into watercourses, storm or sanitary

sewers.

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

.4 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties.

.5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authorities.

.6 Protect trees, plants and foliage on site and adjacent properties where indicated.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT

.1 Leave machinery running only while in use, except where extreme temperatures prohibit shutting machinery down.

## PART 3 - EXECUTION

### 3.1 PREPARATION

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

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

.3 Notify and obtain approval of utility companies before starting demolition.

### 3.2 REMOVAL OPERATIONS

.1 Remove items as indicated.

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

.3 Removal of pavements, curbs and gutters:

.1 Square up adjacent surfaces to remain in place by saw cutting or other method approved by Departmental Representative.

.2 Protect adjacent joints and load transfer devices.

.3 Protect underlying and adjacent granular materials.

.4 Prevent contamination with base course aggregates, when removing asphalt pavement for subsequent incorporation into hot mix asphalt concrete paving,

.5 Excavate at least 300 mm below pipe invert, when removing pipes under existing or future pavement area.

.6 Decommission water wells and monitoring wells in accordance with Provincial regulations.

.7 Remove designated trees during demolition.
.1 Obtain written approval of Departmental Representative prior to removal of trees not designated.

.8 Stockpile topsoil for final grading and landscaping:
.1 Provide erosion control and seeding if not immediately used.

.9 Salvage:
.1 Dismantle items containing materials for salvage and stockpile salvaged materials at locations as indicated.

.10 Disposal of Material:
.1 Dispose of materials not designated for salvage or reuse on site as instructed by Departmental Representative.

.11 Backfill:
.1 Backfill in areas as indicated and in accordance with Section 31 23 33.01.

## 3.3 STOCKPILING

.1 Label stockpiles, indicating material type and quantity.

.2 Designate appropriate security resources/measures to prevent vandalism, damage and theft.

.3 Locate stockpiled materials convenient for use in new construction to eliminate double handling wherever possible.

.4 Stockpile materials designated for alternate disposal in location which facilitates removal from site and examination by potential end markets, and which does not impede disassembly, processing, or hauling procedures.

## 3.4 REMOVAL FROM SITE

.1 Remove stockpiled material as directed by Departmental Representative, when it interferes with operations of project.

.2 Remove stockpiles of like materials by alternate disposal option once collection of materials is complete.

.3 Dispose of materials not designated for alternate disposal in accordance with applicable regulations.

## 3.5 RESTORATION

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

.2 Use soil treatments and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

## 3.6 CLEANING

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

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

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

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

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

.3 Waste Management in accordance with appropriate regulations and best practices.

## 3.7 PROTECTION

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

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED REQUIREMENTS

.1 Section 03 20 00: Concrete Reinforcing.

.2 Section 03 30 00: Cast-in-Place Concrete.

## 1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .2 CSA O86-14, Engineering Design in Wood.
- .3 CSA O121-08 (R2013), Douglas Fir Plywood.
- .4 CSA O151-09 (R2014), Canadian Softwood Plywood.
- .5 CSA O437 Series-93 (R2011), Standards for OSB and Waferboard.
- .6 CSA S269.1-1975 (R2003), Falsework for Construction Purposes.
- .7 CSA S269.3-M92 (R2013), Concrete Formwork

.2 American Concrete Institute (ACI):
- .1 ACI 347, Guide to Formwork for Concrete.

## 1.3 QUALITY ASSURANCE

.1 Qualifications
- .1 Engage a Professional Engineer licensed in the place where the project is located to be responsible for design and installation of all formwork, falsework and re-shoring.

.2 Samples
- .1 Samples for Architectural Concrete: Submit one sample for each type of the following items to be used:
  - .1 Circular forms.
  - .2 Form liner.
  - .3 Material for sealing joints in formwork and between formwork and concrete.

## 1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Provide shop drawings for formwork and falsework stamped and signed

by the Professional Engineer responsible for their design.

.1 Show on drawings:

.1 Formwork design data: permissible rate of concrete placement and temperature of concrete in forms.

.2 Erection sequence.

.3 Stripping and re-shoring procedure.

.4 Locations of all construction joints in slabs and walls.

.5 For Architectural concrete, types of liners and ties, and tie layout.

.6 Shoring of existing construction where required to carry construction loads.

## PART 2 - PRODUCTS

### 2.1 DESIGN REQUIREMENTS

.1 Design in accordance with CAN/CSA S269.1 and CAN/CSA S269.3

.2 Structural design of formwork will not be reviewed by the departmental representative.

### 2.2 MATERIALS

.1 Formwork materials: to CSA S269.1.

.1 For concrete without special architectural features, use wood and wood product formwork materials to CSA O121, CSA 0141, CSA O437 or CSA-O153.

.2 For concrete with special architectural features, use formwork materials to CSA A23.1/A23.2.

.3 Rigid insulation board: to CAN/ULC-S701.

.4 Tubular column forms: round, spirally wound laminated fibre forms, internally treated with release material. Provide liner for smooth finish where indicated on drawings.

.5 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.

.3 Form ties to be designed to act as ties and spreaders and to have a minimum working strength of 13 kN (3000 pounds).

.4 Snap ties to snap cleanly at least 25mm (1") from concrete surface without damage to the concrete.

.5 Cone ties to be internal disconnecting type which snaps cleanly at least 38mm (1½") from concrete surface without damage to the concrete.

.6 Form liner: high density overlay plywood to CSA O121 or other special materials to achieve the required concrete finish.

.7 Form release agent: non-toxic, low VOC, chemically active agent containing compounds that react with free lime in concrete resulting in water insoluble soaps.

.8 Form stripping agent: colourless mineral oil, non-toxic, low VOC, free of kerosene, with viscosity between 15 to 24 $mm^2/s$ (70 and 110s Saybolt Universal) at 40°C, flashpoint minimum 150°C, open cup.

.9 Grooves, reglets and chamfers: White pine selected for straightness and accurately dressed to size.

## 2.3 ACCESSORIES

.1 PVC Waterstops: flexible, extruded, heat weldable, ribbed to CGSB 41-GP-35M and as follows:

.1 Tensile strength: to ASTM D412, method A, Die "C", minimum 13MPa.

.2 Elongation: to ASTM D412, method A, Die "C", minimum 275%.

.3 Tear resistance: to ASTM D624, method A, Die "B", minimum 50 kN/m.

.4 Low temperature brittleness: to ASTM D746, minimum -37°C.

.5 Width in construction joints: 100mm (4”).

.6 Width in expansion joints: 225mm (9”), with 31mm ( 1-1/4”) O.D. centre bulb.

.2 Bentonite Waterstops: rectangular, flexible, swellable.

.3 Weep hole tubes: plastic.

.4 Bentonite Geotextile Waterproofing: two interlocked polypropylene geotextile sheets encapsulating a layer of bentonite.

# PART 3 - EXECUTION

## 3.1 FABRICATION AND ERECTION

.1 Confirm to CSA A23.1/A23.2.

.1 Do not place shores and mud sills on frozen ground.

.2 Provide site drainage to prevent washout of soil supporting mud sills and shores.

.3 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.

.4 Make formwork tight and flush faced to prevent the leakage of mortar and the creation of unspecified fins or panel outlines.

.5 Form sides of footings unless otherwise noted on the Structural Drawings.

.6 Use internal form ties.

.7 Apply a form coating and release agent uniformly to the contact surface of formwork panels before reuse.
.8 Use 25 mm (1”) chamfer strips on external corners and 25 mm (1”) fillets at interior corners, unless specified otherwise.
.9 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
.10 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
.11 Anchors and inserts not to protrude beyond surfaces designated to receive applied finishes, including painting.
.12 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.
.13 Do not close wall forms before reinforcing steel has been reviewed.

## 3.2 JOINTS

.1 Refer to typical details and drawings notes for detailing and maximum spacing requirements.

.2 Construction joints:
.1 Walls: locate joints with PVC waterstops at least 300mm (12”) away from wall corners and wall intersections.

.3 Provide evenly spaced vertical control joints in walls.

.4 Refer to Section 03 30 00 for construction joints, sawcut joints and isolation joints in slab on grade and concrete toppings.

## 3.3 WATERSTOPS

.1 PVC Waterstops:
.1 Provide PVC waterstops for expansion, and control joints in exterior walls, basement walls, retaining walls, slabs supporting earth, and at other locations shown.
.2 Do not use surface mounted waterstops at control joints which will be protected by hot applied waterproofing.
.3 Use equipment to manufacturer’s requirements to field splice waterstops for continuity over the full length of runs.
.4 Use only straight heat sealed butt joints in the field.
.5 Use factory welded corners and intersections.
.6 Securely tie waterstops to reinforcing bars at 1m (3 feet) maximum centres to keep them in alignment when concrete is placed.

.2 Bentonite Waterstops:
.1 Provide bentonite waterstops for all construction and temporary joints in exterior walls, basement walls, retaining walls, slabs supporting earth, and at other locations shown. Use PVC waterstops for expansion joints.
.2 Locate bentonite waterstops 75 mm (3”) from outside face of

concrete to avoid spalling of concrete due to swelling pressure of bentonite.

.3 Butt strips together. Do not overlap.

.4 Fasten to concrete at 600mm (2’-0”) maximum.

## 3.4 CONCRETE EXPOSED TO VIEW

.1 Minimize formwork joints. Locate joints and ties in a uniform pattern with no ties within 300mm (12") of an edge or joint.

.2 Where grooves, reglets or chamfers are shown, locate panel form joints behind them.

.3 Seal all joints in formwork and between formwork and concrete.

.4 Place 16 mm (5/8") bevel strips at member corners to form chamfers unless architectural details show an alternative profile.

.5 Do not reuse formwork if there is any evidence of surface damage or wear, which could impair the visual quality of the concrete surface.

.6 Reuse forms only on identical sections, using the original tie holes. Clean forms and fill nail holes before reuse.

.7 Use only galvanized nails.

.8 Remove form tie plastic cones. Install concrete plugs where indicated. Recess 6mm (1/4") and bond to concrete using a cement slurry with a bonding agent conforming to Section 03 30 00.

## 3.5 ARCHITECTURAL CONCRETE

.1 Refer to architectural drawings for concrete members requiring architectural exposed finishes.

.2 Conform to CSA A23.1.

.3 Construct forms for architectural concrete, and place ties as indicated. Joint pattern may not be based on using standard size panels or maximum permissible spacing of ties.

.4 Use form liners as indicated.

.5 Ensure members have sharp and accurate definition of corners, reglets, etc. and are free from chips and spalls.

.6 Incorrect tie holes, spacers, reglets or formwork joints may be cause for rejection at the discretion of the departmental representative.

## 3.6 REMOVAL AND RESHORING

.1 Conform to CSA A23.1 and to ACI 347.

## 3.7 FIELD QUALITY CONTROL

.1 Refer to Section 01 45 00 Quality Control.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED REQUIREMENTS

.1 Section 03 10 00: Concrete Forming and Accessories.

.2 Section 03 30 00: Cast-in-Place Concrete.

## 1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
- .2 CSA A23.3-14, Design of Concrete Structures.
- .3 CSA G30.18-09 (R2014), Carbon Steel Bars for Concrete Reinforcement.
- .4 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .5 CSA W186-M1990 (R2012), Welding of Reinforcing Bars in Reinforced Concrete Construction.

.2 Reinforcing Steel Institute of Canada (RSIC):
- .1 RSIC- [2004], Reinforcing Steel Manual of Standard Practice.

.3 American Concrete Institute (ACI):
- .1 ACI SP-66 [04], ACI Detailing Manual 2004.

.4 ASTM International Inc.:
- .1 ASTM A1064/A1064M-15, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .2 ASTM A775/A775M-07b(2014), Standard Specification for Epoxy-Coated Reinforcing Steel.

## 1.3 QUALITY ASSURANCE

.1 Qualifications
- .1 Welding of reinforcing steel to be performed by welders certified under CSA W186.

.2 Samples
- .1 Samples for Architectural Concrete
  - .1 Submit one sample for bar supports and side form spacers to be used for exposed concrete.

## 1.4 QUALITY CONTROL

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

.2 Source Quality Control Submittals:
- .1 Upon request, provide Departmental representative with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis.
- .2 Upon request, inform Departmental representative of proposed source of reinforcement material to be supplied.
- .3 Upon request, provide the Departmental representative with a copy of plant certificate by the Concrete Reinforcing Steel Institute for epoxy coating of reinforcement.
- .4 Upon request, provide the Departmental representative with a copy of manufacturer’s instructions for patching factory applied epoxy coating.

## 1.5 ALLOWANCE

.1 Include an allowance of 1/2 tonne of additional reinforcing bars in the Contract, to be placed as directed by the Departmental representative.

.2 Allowance to include all costs including supply, detailing, fabricating and placement of rebars.

.3 Provide detailed records of use.

.4 Provide credit for unused portion of the allowance

## 1.6 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:
- .1 Submit manufacturer’s data sheets for mechanical rebar splices.

.3 Shop Drawings:
- .1 Prepare shop drawings in accordance with RSIC Manual of Standard Practice unless the Contract Documents contain a more stringent requirement. Conform to ACI SP-66 Detailing Manual whenever a detail condition is not covered by any of the above.
- .2 Submit plans, elevations, sections and details necessary to fabricate, place and review reinforcement without reference to structural drawings, including masonry wall reinforcement. Draw to scale not smaller than 1:50 (¼" = 1'-0").
- .3 Show on drawings:
  - .1 Sizes, spacings and locations of reinforcement, with identifying labels.
  - .2 Bar bending details.
  - .3 Lengths of all lap splices.
  - .4 Types and locations of mechanical splices.
  - .5 Bar lists.
  - .6 Quantities of reinforcement (including all rebars added to accommodate installation).

.7 Construction joint, control joint and pour gap locations.
.8 Strip dimensions for flat slab and flat plate.
.9 Concrete cover.

.4 Do not release for fabrication reinforcing bars whose length may be affected by field conditions, such as the final elevation of footings, until obtaining the required field measurements.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Reinforcing steel: carbon steel, deformed bars to CSA G30.18., unless indicated otherwise.

.2 Weldable Reinforcing steel: weldable low alloy steel deformed bars to CSA G30.18.

.3 Cold-drawn annealed steel wire ties: to ASTM A82/A82M.

.4 Welded steel wire fabric: to ASTM A185/A185M. Provide in flat sheets only.

.5 Epoxy Coating of reinforcement: to ASTM A775/A775M.

.6 Chairs, bolsters, bar supports, spacers: to CSA A23.1/A23.2.

.7 Mechanical splices: to develop 125% of specified rebar yield strength.

.8 Plain round bars: to CSA G40.20/G40.21.

.9 Shear stud reinforcing: per ASTM A1044. Min yield strength for studs – 350MPa, for rails – 300MPa.

## PART 3 - EXECUTION

### 3.1 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice.

.2 Fabricate epoxy coated reinforcing steel in accordance with ASTM D3963/D3963M. Plants to be certified by the CRSI for epoxy coated steel. Provide colour to contrast sharply with reinforcing steel and rust colour.

.3 Weld reinforcement in accordance with CSA W186 where indicated.

.4 Ship bundles of bar reinforcement, clearly identified in accordance with bar lists.

.5 Provide standard hooks at ends of all hooked bars.

.6 Substitute different size bars only if permitted in writing by the Departmental representative

## 3.2 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where indicated or authorized by Departmental representative.

.2 When field bending is authorized, bend without heat, applying slow and steady pressure.

.3 Replace bars which develop cracks or splits.

## 3.3 PLACING REINFORCEMENT

.1 Place reinforcing steel as indicated on reviewed placing drawings and in accordance with CSA A23.1/A23.2.

.2 Remove all loose scale, dirt, oil or other coatings which would reduce bond.

.3 Ensure cover to reinforcement is maintained during concrete pour.

.4 Turn ends of tie wire towards the interior of concrete.

.5 Use bar supports for beams and slabs.

.6 Use precast concrete chairs where supports rest on the ground. Where welded wire fabric is used in slabs-on- grade, place precast concrete chairs at 600 mm (2’-0”) on centre each way.

.7 Use side form spacers for walls and columns.

.8 Do not splice reinforcing at locations other than shown on placing drawings without Departmental representative’s written approval.

.9 Do not cut reinforcement without Departmental representative’s written approval.

.10 Exposed concrete surfaces:
.1 Use plastic or plastic tipped bar supports and spacer with colour to match concrete.

.11 Do not field weld reinforcement except where indicated or authorized by the Departmental representative.

## 3.4 FIELD QUALITY CONTROL

.1 Refer to Section 01 45 00 Quality Control.

.2 Bring to the attention of the Departmental representative any defects or deficiencies in the work together with a proposal for remedy. The Departmental representative will decide what corrective action may be taken, and will issue the necessary instructions.

.3 Construction Review:

.1 General review during construction by the Departmental representative will be carried out by examination of representative samples of the work.

.2 Do not close forms or pour concrete before reinforcing steel is reviewed.

.3 Construction review reports will outline any deficiencies found.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED REQUIREMENTS

.1 Section 03 10 00: Concrete Forming and Accessories.

.2 Section 03 20 00: Concrete Reinforcing.

.3 Section 05 12 23: Structural Steel for Buildings.

## 1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .2 CSA A283-06 (R2011), Qualification Code for Concrete Testing Laboratories.
- .3 CSA A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

.2 ASTM International Inc.:
- .1 ASTM C309-11, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- .2 ASTM D1751-04 (2013) e1, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

.3 Canadian General Standards Board (CGSB):
- .1 CAN/CGSB-51.34-[M86(R1988)], Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

## 1.3 QUALITY ASSURANCE

.1 Qualifications
- .1 Concrete supplier to have a valid “Certificate of Ready Mixed Concrete Production Facilities” issued by the relevant Ready Mixed Concrete Association.

## 1.4 QUALITY CONTROL

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

.2 Minimum two weeks prior to starting concrete work, provide valid certificate from plant delivering concrete.
- .1 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture will meet specified requirements.

.3 Minimum four weeks prior to starting concrete work, provide proposed quality control procedures on following items:
- .1 Hot weather concrete.
- .2 Cold weather concrete.
- .3 Curing.
- .4 Finishing.
- .5 Protection.

## 1.5 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meeting: convene pre-installation meeting one week prior to beginning concrete works. Ensure key personnel to attend.

.2 Batch Logs: keep record of each batch delivered to site.

.3 Concrete Delivery Slips: Keep all concrete delivery slips ("driver's tickets") on site until building is completed. Record on delivery slip where concrete was placed, including time and date.

.4 Record Drawings: Record on a set of Structural Drawings extent of each pour including pour date and falsework removal date. Also record all field changes, including footing elevations.

## 1.6 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Minimum 2 weeks prior to starting concrete work, submit all concrete mix designs, and indicate where each concrete mix is to be used.

.3 Minimum 2 weeks prior to placing concrete, submit drawings showing locations of all construction joints and slab on grade control joints.

.4 Minimum submission requirements for each concrete mix design shall include the following:
- .1 Minimum specified compressive strength at 28 day.
- .2 Maximum aggregate size.
- .3 Aggregate type (if not normal density).
- .4 Concrete density range, wet and dry (if not normal density).
- .5 CSA exposure class.
- .6 Cement type (if not type GU).
- .7 Percentage and type of supplemental cementing materials.
- .8 Maximum water/cemetitious ratio.
- .9 Assumed method of placement of concrete.
- .10 Corrosion inhibitor (name and quantity, if applicable).
- .11 Plastic or steel fibres (type, name and quantity, if applicable).
- .12 Alkali-aggregate resistance.
- .13 Architectural requirements (colour of cement and aggregate, if applicable).
- .14 Maximum time from batching to placing concrete (if retarding admixtures are used).

.5 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, concrete mix used, ambient air temperature and test samples taken.

.6 On completion of the works, provide written report to Departmental representative certifying that the concrete in place meets performance requirements established in PART 2 - PRODUCTS.

## PART 2 - PRODUCTS

### 2.1 DESIGN CRITERIA

.1 To CSA A23.1/A23.2, Alternative 1 – Performance, and as described under Mixes and on Structural Drawings.

### 2.2 PERFORMANCE CRITERIA

.1 Concrete supplier to meet the concrete performance criteria established by the Departmental representative and to provide verification of compliance.

### 2.3 MATERIALS

.1 Portland Cement: to CAN/CSA A3001, Type [GU] [HS].

.2 Cementitious hydraulic slag: to CSA A3000.

.3 Fly ash: to CSA A3001, Type CI.

.4 Water: to CSA A23.1.

.5 Aggregates: to CSA A23.1/A23.2.Do not use recycled concrete as aggregate.

.6 Admixtures: not to contain chlorides.

.7 Corrosion-inhibiting admixture: calcium nitrate solution.

.8 Plastic fibre additive: fibrillated polypropylene fibres at least 19mm (3/4”) in length.

.9 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA A23.1/A23.2. Minimum compressive strength: 40 MPa at 28 days.

.10 Non premixed dry pack grout: composition of non metallic aggregate and

Portland cement with sufficient water for mixture to retain its shape when made into ball by hand and capable of developing compressive strength of 40 MPa at 28 days.

.11 Curing/sealing compound: to CSA A23.1/A23.2 and ASTM C309, Type 1, Class B,water based acrylic, compatible with surface hardener where hardener is used.

.1 Floor surface hardener: Non-metallic, natural grey colour (unless other colour is requested by the Architect), premixed, Mohs Hardness 7 or better. For flatwork with air-entrainment, use liquid hardener applied after concrete has hardened.

.12 Pre-moulded joint fillers: Bituminous impregnated fiber board to ASTM D1751.

.13 Weep hole tubes: plastic.

.14 Evaporation reducer: water based polymer liquid forming continuous monomolecular temporary film on fresh concrete surface.

.15 Penetrating sealer: single component, water based clear water repellent with 40% active ingredient Alkylalkoxysilane.

.16 Bonding adhesive: Synthetic latex.

.17 Non slip nosing insert for concrete stairs: Fine aluminum oxide strips, 6mm (¼") wide x 10mm (3/8”) deep.

.18 Rigid insulation: Extruded polystyrene boards per ASTM C578, structural grade, compressive strength 100 psi (690 kPa).

.19 Control joint filler: semi-rigid filler to protect against slab edge breakdown:

.1 For sawcuts made with “Soff-Cut” saw: two component epoxy.

.2 For conventional sawcuts in interior slab: two component epoxy urethane.

.3 For conventional sawcuts in exterior slabs: two or multy component polyurethane based elastomeric.

.20 Prefabricated Seepage Protection System: polymer core with a geotextile laminated on one side.

.21 Bentonite Geotextile Waterproofing: two interlocked polypropylene geotextile sheets encapsulating a layer of bentonite.

.22 Crack Filler: low viscosity epoxy resin.

## 2.4 MIXES

.1 Use ready-mix concrete. Proportion concrete in accordance with CSA A23.1, Alternative 1 - Performance Method for Specifying Concrete.

.2 Set performance characteristics of concrete in plastic state in coordination with all trades involved.

.3 Meet performance criteria of concrete in hardened state as shown on Structural Drawings and provide verification of compliance.

.4 Use water-reducing agent in all concrete.

.5 Do not use admixtures containing chlorides.

.6 Supplementary cementing materials (SCM):
- .1 Confirm to CSA A23.1.
- .2 Follow slag and fly ash manufacturers' directions for proportioning and mixing of concrete.
- .3 Do not use SCM in architecturally exposed concrete or exposed concrete floors.
- .4 Do not use concrete with high SCM when ambient temperature is forecast to be below +10°C at the time of concrete pour and during the seven days after the pour, except for footings, walls and columns.
- .5 Reduce W/C ratio to 0.45 where using high SCM concrete for slabs and other horizontal finished surfaces, in order to reduce bleed water and to increase rate or strength gain.

## PART 3 - EXECUTION

### 3.1 PREPARATION

.1 Provide minimum 24 hours' notice prior to placing of concrete/closing of wall forms.

.2 Obtain written approval of each foundation bearing surface by the Geotechnical Departmental representative before placing concrete.

.3 Remove water and disturbed soil from excavations before placing concrete.

.4 Before placing slab-on-grade, confirm that subgrade and backfill meet specifications and are free of frost and surface water.

### 3.2 INSTALLATION/APPLICATION

.1 Set sleeves, conduits, pipe hangers, weep hole tubes, drains and other inserts and openings as indicated or specified elsewhere.

.2 Refer to Notes on Structural Drawings for maximum size and minimum spacing of conduits.

.3 Check locations and sizes of sleeves and openings shown on Structural Drawings with Architectural, Mechanical and Electrical Drawings. Notify Departmental representative of any discrepancies.

.4 Obtain Departmental representative's approval for any required sleeves and openings which are not shown on Structural Drawings.

.5 Do not carry sleeves, ducts, pipes or other openings through joists, beams, column capitals or columns, except where indicated on Structural Drawings or approved by Departmental representative.

.6 Set special inserts for strength testing as required for non destructive method of testing concrete

.7 Set anchor rods using templates under supervision of appropriate trade prior to placing concrete. Locate each anchor rod group to within 6mm (1/4”) of required location.

.8 Refer to Section 03 10 00 for construction joint requirements.

## 3.3 PLACING CONCRETE

.1 Place concrete in accordance with CSA A23.1.

.2 Delivery and place concrete with minimum re-handling.

.3 Do not overload forms.

.4 Use rubber tipped vibrators for concrete containing epoxy coated reinforcement

.5 Cast slabs with a top surface that is level or sloping as required by the Drawings.

.6 Concrete exposed to view:
- .1 Exposed surfaces to be dense, even, uniform in colour, texture and distribution of exposed aggregate.
- .2 Defects such as honeycombing, voids, loss of fines, visible flow lines, cold joints or excessive bug holes may be cause for rejection at the discretion of the Departmental representative.

.7 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.

## 3.4 FINISHING CONCRETE

.1 Finish concrete to CSA A23.1/A23.2.

.2 Cooperate with any trade applying finishes to concrete surfaces and provide surfaces which will ensure adequate bond. Provide chases and reglets where required.

.3 Finishing Flatwork:
- .1 Protect concrete during finishing process. Use evaporation reducer during severe drying conditions.
- .2 Provide final finish in accordance with proposed use and as follows:
  - .1 Screeded and bull floated for: mud slabs and footings/pile caps.

.2 Screeded and bull floated with scratch finish for: base slabs which receive mortar setting beds or bonded toppings.
.3 Wood float finish with brooming for: exterior exposed slabs.
.4 Magnesium float finish for: Interior exposed slabs with air entrainment.
.5 Powered steel trowel finish for: interior exposed slabs. Do not trowel slabs that contain air entrainment.
.6 Steel trowel exposed interior concrete floors at least twice. Provide final spin trowelling when non-slip finish is required.

.3 Surface hardeners:
.1 Provide where hardened concrete is required by Architectural Drawings or Specifications.
.2 Use only liquid hardeners on air entrained concrete; do not use dry-shake applied surface hardeners.
.3 Incorporate hardener into the surface of the concrete while concrete is still plastic.
.4 Follow manufacturer’s recommendations for dosage and application procedure.
.5 Hold pre-construction meeting with hardener technical representative and finisher to ensure proper application, curing and protection.

.4 Surface Tolerances:
.1 Concrete surface tolerance to CSA A23.1, Straightedge Method.
.2 Unless otherwise noted, conform to finish tolerance Class A.

.4 Finishing Formed Surfaces:
.1 Completely fill holes left by through-bolts with grout.
.2 Do not patch surfaces until instructed in writing by Departmental representative.
.3 Concrete exposed to view:
.1 Provide smooth-form finish.
.2 Rub exposed sharp edges with carborundum to produce 3 mm (1/8") radius edges unless otherwise indicated.

.4 Architectural Concrete:
.1 Refer to Architectural drawings for concrete elements which are considered Architectural Concrete.
.2 Final appearance of architectural concrete is as important a factor as the engineering properties of the concrete and failure of the as-cast concrete to meet the required standard of appearance may be cause for rejection at the discretion of the Departmental representative.
.3 Do not patch surfaces unless instructed in writing by Departmental representative. All patches must match colour and texture of adjacent concrete to approval of Departmental representative.
.4 Provide smooth-form finish. Do not rub surfaces unless agreed to by Departmental representative

## 3.5 CONCRETE CURING AND PROTECTION

.1 At a minimum cure and protect concrete in accordance with CSA A23.1

.2 Extend curing and protection period until concrete has reached following strength levels for structural safety:

.3 Framed slabs and beams: 75% of specified 28 day strength.
  .1 Columns, walls, piers and footings: 50% of specified 28 day strength

.4 For concrete containing supplementary cementing materials, curing and protection times may need to be extended beyond those outlined by CSA A23.1 to achieve the required structural properties.

.5 Cure slab surfaces immediately after finishing is completed. Unless otherwise noted, use a curing compound compatible with applied finishes.

.6 Slabs on grade and structural slabs receiving resilient floor or other moisture sensitive finishes:
  .1 Apply 24 hours of wet curing. Start curing immediately after finishing slab.
  .2 Cover slab for at least 72 hours using plastic sheets with joints taped and free edges covered.
  .3 Protect finished and cured slab from surface water (i.e. rain, snow).
  .4 Refer to Architectural Specifications for required testing methods prior to placing floor finishes.

.7 Concrete exposed to view:
  .1 Protect during construction period from wear, damage, marking, discolouration, staining and becoming coated with concrete leakage.
  .2 Unless rejected, repair damage and remove marks and stains to the approval of the Departmental representative.

## 3.6 SLABS ON GRADE

.1 Construction joints and sawcut joints:
  .1 Refer to drawing notes for maximum spacing requirements.
  .2 Saw cut depth to be equal to one quarter of the concrete thickness.
  .3 Locate joints on column lines wherever possible and on intermediate lines, which result in approximately square panels, without re-entrant corners.
  .4 Do not create “L” shaped panels nor “T” shaped joint intersections.
  .5 Protect edges of sawcuts from breakage.
  .6 Clean out sawcuts in exposed concrete and fill with control joint filler after concrete is at least 120 days old.
  .7 Sawcut top 25 mm (1") at construction joints in exposed concrete for a width of 5 mm (3/16") and fill with control joint filler after concrete is at least 120 days old.
  .8 Clean out sawcuts in other concrete and fill with a sand-cement paste one month prior to installing floor coverings.

.2 Isolation Joints:

.1 Unless otherwise shown on structural drawings, provide min. 10mm (3/8”) thick premoulded joint filler of the same depth as the thickness of the concrete wherever slabs-on-grade abut foundation walls, columns and piers. Omit if slab is chased or dowelled into structure.
.2 Furnish filler for each joint in single piece for depth and width required for joint,
.3 When more than one piece of filler is required for a joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.

.3 Cracks in Slabs-on-Grade:
.1 Extensive cracking of slabs-on-grade or cracks in excess of 3mm (1/8”) in width may be cause for rejection of slab or portion of slab at Departmental representative’s discretion.
.2 Protect edges of cracks in slabs-on-grade from breakage.
.3 Exposed slab on grade: Unless slab is rejected, repair cracks that are over 0.4 mm (0.016") wide:
.1 Fill cracks with a sand-cement grout after concrete is at least 120 days old.
.2 Seven days later, cut out top 20 mm (3/4") of crack for a width of 5 mm (3/16") and fill with control joint filler.
.4 Architectural slab on grade: Unless slab is rejected, repair cracks that are over 0.2 mm (0.008") wide:
.1 Fill cracks with epoxy after concrete is at least 180 days old.
.2 Take all measures necessary to prevent epoxy on surface of exposed slab.
.3 Have manufacturer’s technical representative present during initial repairs.

## 3.7 BONDED CONCRETE TOPPINGS

.1 Place bonded topping over hardened concrete base slab in accordance with CSA A23.1.

.2 Not less than 24 hours prior to applying concrete toppings, remove all laitance, dirt, dust, debris, grease, or other substances that would interfere with the bond between the base slab and the topping using one or more of the following methods:
.1 Wet or dry grit sand-blasting.
.2 High-pressure water-blasting.
.3 Mechanical removal by scarifiers, scabblers, or grinding wheels.

.3 Notify Departmental representative before placement of each topping.

.4 Bond topping to base slab using a cement/sand grout procedure.

.5 Provide joints in topping to match locations of those in base slab.

## 3.8 PENETRATING SEALER

.1 Concrete to receive penetrating sealer to be at least 28 days old.

.2 Surfaces to be treated with the sealer to be dry and free of dirt and other contaminants.

.3 Completely remove all curing compounds before the sealer application.

.4 Follow manufacturer’s recommendations for coverage rate and application procedure.

.5 Do not apply in inclement weather or if ambient air temperature or concrete surface temperature is less than 5°C or more than 38°C.

## 3.9 GROUTING UNDER BASE PLATES AND BEARING PLATES

.1 Grout under base plates and bearing plates using procedures in accordance with manufacturer's recommendations.

.2 Provide 100% contact over grouted area.

.3 Grout column base plates and beam bearing plates as soon as steelwork is completed.

.4 Do not add load on steelwork until grouting is completed and grout strength has reached at least 20 MPa.

## 3.10 FIELD QUALITY CONTROL

.1 Refer to Section 01 45 00 - Quality Control.

.2 Bring to the attention of the Departmental representative any defects or deficiencies in the work together with a proposal for remedy. The Departmental representative will decide what corrective action may be taken, and will issue the necessary instructions.

.3 Construction Review:
- .1 General review during construction by the Departmental representative will be carried out by examination of representative samples of the work.
- .2 Construction review reports will outline any deficiencies found.

.4 Inspection and Testing:
- .1 An independent Inspection and Testing Agency (certified under CSA A283 with category to suit testing provided) will be appointed to carry out inspection and testing of concrete and concrete materials.
- .2 Sampling and testing of concrete will be in accordance with CSA A23.1/A23.2.
- .3 The Agency will review all submittals pertaining to concrete mix designs and certification of plant, equipment and materials.

.4 The Agency will take additional test cylinders during cold weather concreting. Assist Agency by curing these cylinders for 7 days on site adjacent to the work which they represent and under the same conditions as the concrete which they represent.

.5 Samples will be taken prior to the addition of steel fibre reinforcement or superplasticizers to the mix on site.

.6 Inspection and testing by the Agency will not augment or replace the Contractor’s quality control nor relieve him of his contractual responsibility.

.7 Assist the Agency in its work. Notify the Agency as to the concreting schedule and before each pour. Provide concrete samples.

.8 The Agency will report to the Departmental representative, with copies to Departmental representative, Contractor, Concrete Supplier and Municipal Authorities. Reports will include the locations in structure to which tests relate comments on abnormal results and conditions, and the Supplier’s mix design numbers. Test reports shall be provided within five working days.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED REQUIREMENTS

.1 Section 03 30 00: Cast in Place Concrete.

## 1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 CSA S16-14, Limit States Design of Steel Structures.
- .3 CSA S136-12, North American Specifications for the Design of Cold Formed Steel Structural Members.
- .4 CSA W47.1-09, Certification of Companies for Fusion Welding of Steel.
- .5 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
- .6 CSA W55.3-08 (R2013), Certification of Companies for Resistance Welding of Steel and Aluminum.
- .7 CSA W59-13, Welded Steel Construction (Metal Arc Welding).

.2 ASTM International Inc.:
- .1 ASTM A123/A123M-13, Standard Specification for Zinc (Hot Dip Galvanized) coating on Iron and Steel Products.
- .2 ASTM A36/A36M-14, Standard Specification for Carbon Structural Steel.
- .3 ASTM A325-14, Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa (120/105 ksi) Minimum Tensile Strength.
- .4 ASTM A490M-14a, Standard Specification for High-Strength Steel Structural Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints.
- .5 ASTM A500-13, Specification for Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- .6 ASTM A1011/A1011M-15, Standard Specifications for Steel, Sheet and Strip, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability and Ultra High Strength.
- .7 ASTM A992-11(2015), Standard Specifications for Structural Steel Shapes.
- .8 ASTM F1554-15, Standard Specification for Anchor Bolts, Steel 36, 55 and 105 ksi Yield Strength.

.3 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturers Association (CPMA):
- .1 CISC Handbook of Steel Construction.
- .2 CISC/CPMA Standard 1-[73b], A Quick-drying One-coat Paint for Use on Structural Steel.
- .3 CISC/CPMA Standard 2-[75], Quick-drying Primer for Use on Structural Steel.
- .4 CISC Code of Standard Practice, Appendix I, Architecturally Exposed

Structural Steel (AESS).

.4 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International:
- .1 SSPC-SP 1, Solvent Cleaning.
- .2 SSPC SP 6/NACE No. 3-[00], Commercial Blast Cleaning.
- .3 SSPC-SP 7/NACE No.4 , Brush Off Blast Cleaning.
- .4 SSPC-SP 10/NACE No.2 , Near White Blast Cleaning.
- .5 SSPC Technology Guide No.14 – Guide for the Repair of Imperfections in Galvanized, Organic or Inorganic Zinc-Coated Steel Using Organic Zinc Rich Coating.
- .6 SSPC Paint Specification No. 20 – Zinc Rich Coating, Type I – Inorganic and Type II - Organic.

## 1.3 QUALITY ASSURANCE

.1 Qualifications
- .1 Structural steel fabricator to be certified by the Canadian Welding Bureau under the requirements of CSA W47.1, Division 1 or 2 for fusion welding and/or CSA W55.3 for resistance welding of structural steel components.
- .2 Welders to be CWB approved, working under supervision of a CWB approved firm.
- .3 Engage a Professional Engineer licensed in the place where the project is located to be responsible for design, detailing and installation of all connections related to structural steelwork.
- .4 The Professional Engineer designing connections to hold a Certificate of Authorization.

## 1.4 QUALITY CONTROL

.1 Submit in accordance with Section 01 45 00 – Quality Control.

.2 Source Quality Control Submittals:
- .1 Submit mill test reports 4 weeks prior to fabrication of structural steel.
  - .1 Mill test reports to show chemical and physical properties and other details of steel to be incorporated in project.
  - .2 The reports to be correlated to the materials or products to which they pertain

.3 Tolerances
- .1 Conform to the fabrication and erection tolerances of CAN/CSA S16.
- .2 If more stringent tolerances are specified elsewhere to suit interfacing materials or AESS members, the latter shall govern.

## 1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:
- .1 Provide drawings stamped and signed by the Professional Engineer responsible for steel connections.
- .2 Before submitting shop drawings, provide a letter signed and sealed by that Engineer stating that he has been engaged to undertake the responsibility for the above. Also submit a copy of that Engineer's Certificate of Authorization, and proof of his liability insurance.
- .3 If additional information is required from the Departmental representative, allow a minimum of five working days for the Structural Engineer to review and respond to the request for information.
- .4 It is advisable to submit erection diagrams for review before preparing shop details. Copies of plans and section details developed by Halsall will not be accepted as erection diagrams.

.3 Erection drawings:
- .1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including:
  - .1 Description of erection methods.
  - .2 Sequence of erection.
  - .3 Temporary bracings.
  - .4 Beam sizes (in addition to beam marks).
  - .5 Connections where threads must be excluded from shear plane.
  - .6 Members which are considered AESS and their category.
  - .7 Type and finish of bolts in AESS connections.
  - .8 Side where bolt heads should be placed in AESS connections.
  - .9 Weld grinding, finish and profile in AESS field connections.

.4 Fabrication drawings:
- .1 Submit fabrication drawings showing designed assemblies, member sizes, components and connections. Show on drawings:
  - .1 Material specifications.
  - .2 Surface preparation.
  - .3 Shop painting / galvanizing.
  - .4 Section splices.
  - .5 Types of shop and field connections.
  - .6 Net weld lengths.
  - .7 Precautions which will be taken to exclude threads from shear planes of bearing type bolted connections (where applicable).
  - .8 Vent holes required for galvanizing process.
- .2 Indicate members which are considered AESS, and their category. Refer to AESS Category Matrix as shown in Table 1 of the CISC Code of Standard Practice, Appendix I.
  - .1 For AESS bolted connections, indicate bolt type, finish and which side of the connection bolt heads should be placed.
  - .2 For AESS welded connections, show grinding, profile and weld finish.
- .3 Show details by which steel assemblies, which are set in concrete, are to be connected to the formwork.
- .4 Substitution of alternative sections will only be allowed provided the new members have equal or greater capacity and stiffness and their dimensions are approved by the Departmental representative.

.5 On completion of erection, submit a letter signed and sealed by the Professional Engineer responsible for structural steel connections certifying that the work has been completed in accordance with all contract documents.

## PART 2 - PRODUCTS

### 2.1 DESIGN REQUIREMENTS

.1 Design details and connections in accordance with requirements of CSA S16 and CSA S136 to resist forces and to allow for movements indicated. Consider load effects due to fabrication, erection and handling.

.2 When requested, submit sketches and design calculations stamped and signed by the Professional Engineer responsible for connection design.

.3 Beam end connections:
- .1 Select beam end connections from CISC "Handbook of Steel Construction" when connection for shear only (standard connection) is required.
- .2 When shears are not indicated, select or design non composite beam end connections to resist reaction due to maximum uniformly distributed load capacity of the beam in bending.

.4 Seated beam connections to have top clip angles.

.5 Provide all spandrel beams and all floor beams not fully braced by floor construction with top and bottom flange connections for torsional restraint.

.6 Assume that bolt threads are intercepted by shear plane, unless special measures are indicated on shop drawings to exclude threads from shear plane.

.7 Connection design to include consideration of all pass-through forces, including tension, compression, moment or shear. Provide local reinforcement at connection or joint as required.

.8 Where axial forces occur in beams framing to opposite sides of a supporting member, design connections for a pass-through force equal to the smaller axial force. If beam sizes differ, assume the axial force is centred in the smaller beam. Where beams frame into columns, connect each beam for the axial force shown.

.9 Follow conceptual connection details if shown on structural drawings. Do not change without the Departmental representative’s written approval. If welds are defined on drawings, the sizes shown are minimum requirements which might need to be increased to suit connection design.

.10 Pretension all high-strength bolts used in:
- .1 Connections where bolts are subject to tensile loads.

.2 Connections using oversized or slotted holes unless finger-tight bolts are required to accommodate movement.
.3 Connections required by CSA S16 to be pre-tensioned.

.11 Where moment connections are called for but values are not indicated, design for moment capacity of the smaller member in the connection.

.12 Install web and flange stiffener plates at moment connections as required by connection design and detail but in every case when indicated on the drawings. If the shear generated in column web exceeds its shear capacity, reinforce the web.

.13 For beams continuous over supports and for beams supporting columns, provide stiffener plates at each side of web at point of concentrated load, unless different details are shown on drawings.

.14 Shape and size gusset plates to accommodate required finishes and clearances, refer to Architectural and Mechanical drawings.

.15 Design gusset plates and bracing connections for members which are parts of seismic force resisting system to allow ductile rotation and to satisfy requirements of CSA S16. Design gusset plates for other compression members for the force equivalent to twice the specified compression member force, or provide stiffeners to prevent gusset plate buckling.

.16 Do not oversize anchor rod holes for site tolerances.

## 2.2 MATERIALS

.1 Structural steel:
.1 Rolled shapes: to CSA G40.20/G40.21.
.2 Hollow structural sections: to ASTM A500 or CSA G40.20/G40.21.

.2 Anchor rods: CSA G40.20/G40.21, Grade 300W, unless ASTM F1554 Grade 105 is indicated on drawings.

.3 Bolts, nuts and washers: to ASTM A325.

.4 Weldable reinforcing steel: to CSA G30.18, deformed bars.

.5 Shop paint: to CISC/CPMA 1-73a.

.6 Shop paint primer: to CISC/CPMA 2-75, solvent reducible alkyd, red oxide, compatible with specified topcoat.

.7 Zinc-rich coating: to SSPC Paint Specification No.20, compatible with top coat (where specified).

.8 Hot dip galvanizing: to ASTM A123/A123M, minimum zinc coating of 600 g/m², Coating Grade 85.

.9 Joint filler for exposed steelwork: Epoxy resin.

.10 Galvanizing vent hole plug: Grade 6061 Aluminum circular plug.

## 2.3 FABRICATION

.1 Fabricate structural steel in accordance with CSA S16 and with reviewed shop drawings.

.2 Install shear studs in accordance with CSA W59.

.3 Continuously seal members by intermittent welds and plastic filler unless continuous welds are indicated on drawings.

.4 Provide holes in beam flanges or weld threaded studs as required for attachment of nailers.

.5 Position beams having permissible mill camber so that the camber is up.

.6 Increase specified section thickness at no extra cost if required for fabrication (bending) or galvanizing, Alternatively, fabricate curved sections from plates.

.7 Reinforce holes through webs of beams and columns in accordance with Typical Detail. Alternatively, design reinforcing in accordance with the procedure set forth in the CISC Handbook of Steel Construction, and provide calculations for the Departmental representative’s review.

.8 Provide 16mm (5/8″) diameter weep holes in base plates of HSS columns which are not made watertight.

.9 HSS members which require galvanizing to either be per CSA G40.20/G40.21 grade 350W, Class H, or to be stress relieved prior to galvanizing.

.10 Provide vent holes in HSS sections where required for galvanizing process. Located so that any water inside HSS will drain away when HSS is in its final position. Maximum size – 16mm (5/8″) diameter. Fill holes with vent hole plugs after galvanizing.

.11 Provide 12 (1/2″) dia. holes in HSS columns to be filled with concrete. Locate at opposing column faces 150mm (6″) from each end.

.12 Provide closure plates for all exposed and for all exterior tubular members.

.13 Complete welded shop connections prior to galvanizing.

.14 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left unpainted, place marking at locations not visible from exterior.

.15 Match marking: shop mark bearing assemblies and splices for fit and match.

.16 Where shop inspection is required, do not ship material to the site before it has been inspected.

.17 Fabricate in stages complex members for which steel inspection is impossible or difficult once completed, and arrange for the Inspection and Testing Agency to do intermediate shop inspections.

.18 Fabricate AESS with tolerances and surface quality consistent with AESS category.

## 2.4 SHOP PAINTING

.1 Clean all members to SSPC-SP 1, Remove loose mill scale, rust, oil, dirt and foreign matter.

.2 Apply galvanizing in the shop to all structural steel

.3 If galvanized steel is to be painted, use only non passivated galvanizing process (without chromate coating).

.4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5°C.

.5 Maintain dry condition and 5°C minimum temperature until paint is thoroughly dry.

.6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

# PART 3 - EXECUTION

## 3.1 GENERAL

.1 Structural steel work: in accordance with CSA S16.

.2 Welding: in accordance with CSA W59.

## 3.2 ERECTION

.1 Erect structural steel in accordance with CSA S16 and reviewed erection drawings.

.2 Do not field cut or alter any members without the Departmental representative’s approval.

.3 Make adequate provision for all loads acting on the structure during erection. Provide erection bracing to keep the structure stable, plumb and in true alignment during construction. Bracing members or connections

shown on Structural Drawings are those required for the completed structure, and may not be sufficient for erection purposes. Do not remove erection bracings without written approval from the Engineer who designed it.

.4 Set column base plates on leveling screws or on steel shims to the required elevation ready for grouting. Alternatively, use leveling plates set with grout and level to within 1.5 mm (1/16") across the plate. Do not erect columns upon plates exceeding this tolerance. Lift base plates for inspection when directed.

.5 Grout under column base plates and beam bearing plates as soon as steelwork is completed. Do not add load on steelwork until grouting is completed and grout strength has reached at least 20 MPa.

.6 Do not make permanent connections until structure has been properly aligned.

.7 Report ill-fitting connections to the Departmental representative before taking corrective measures.

.8 When welding after galvanizing is in place, grind away galvanizing at areas to be welded.

.9 Do not weld in an ambient temperature below -17°C. Preheat material adjacent to welding areas when ambient temperature is between -17°C and +4°C.

.10 Remove slag from all completed welds so that they may be visually inspected.

.11 Seal members by continuous welds where indicated.

.12 AESS members:
- .1 Erect using softened slings or other methods to prevent damage.
- .2 Provide padding as required to protect while rigging and aligning.
- .3 Weld tabs for temporary bracings and safety cabling only at points concealed from view in the complete structure or where approved by the Departmental representative.
- .4 Remove all field connection aids added to allow alignment, fit up and welding.
- .5 Remove welds at run-out tabs to match adjacent surface.
- .6 Plug weld holes for erection bolts.

## 3.3 FIELD QUALITY CONTROL

.1 Bring to the attention of the Departmental representative any defects or deficiencies in the work together with a proposal for remedy. The Departmental representative will decide what corrective action may be taken, and will issue the necessary instructions.

.2 Construction Review:
- .1 General review during construction by the Departmental representative will be carried out by examination of representative

samples of the work.

.2 Construction review reports will outline any deficiencies found.

.3 Inspection and testing:

.1 An Inspection and Testing Agency (certified to CSA W178.1 & 2) will be appointed to carry inspection and testing of all structural steel.

.2 Do not commence fabrication until details of inspection have been worked out with the Agency.

.3 The Inspection Agency will submit reports to the Departmental representative, Structural Engineer, Contractor and Municipal Authorities covering the Work inspected and provide details of errors or deficiencies observed.

.4 Work will be inspected in the shop and when erected. Store fabricated members in the shop so that they are accessible for inspection. Items to be cast into concrete will be inspected on site before being installed.

.5 Inspection will include:

.1 Checking that the mill test certificates or producer’s certificates are properly correlated to materials and products supplied for the project or that legible markings were made on the material and products by the producers in accordance with the applicable standards. Where this is not possible, notify the Departmental representative and if requested carry out sample tests as described below.

.2 Confirming that all materials meet specifications.

.3 Sampling fabrication and erection procedures for general conformity with the requirements of the Contract.

.4 Checking welders' CWB Certification.

.5 Checking fabricated members against specified member shapes.

.6 Checking fabricated members against allowable mill sweep and camber.

.7 Checking fabricated members against specified camber.

.8 Visual inspection of all welded connections including spot checking of joint preparation and fit up.

.9 Sample checking bolted joints.

.10 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.

.11 Inspection of field cutting.

.12 Inspection of surface preparation, shop paint and field touch-up.

.13 Inspection of galvanizing and field touch-up.

.14 Inspection of grouting under base plates and bearing plates.

.6 Arrange for the Inspector to start field inspection as soon as each section of the Work is completed, plumbed, bolts tightened and field welding finished.

.7 The Inspector will visually check all bolts in bearing connections. Where erection drawings indicate bolts with threads excluded from the shear plane, he will remove nuts from 1% of all bearing bolts and check that thread is excluded from the shear planes.

.8 The Inspector will randomly select and pull test 5% of all types and sizes of post installed anchors installed on a weekly basis, but not less than one anchor of each type, size and orientation. Pull test to twice the allowable tensile load, or 1.5 times the factored resistance of the anchor given by the manufacturer. Chose anchor locations where proximity to concrete edge does not affect

anchor capacity, or use reduced anchor loads per manufacturer's recommendation. Submit reports to Departmental representative within one week of testing. Reports to indicate each anchor location, test load and mode of failure, if applicable. Notify Departmental representative immediately if any anchor fails the pull test.

## 3.4 FIELD PAINTING

.1 Paint in accordance with Section 09 91 00 Painting

.2 Touch up damaged surfaces with the same paint as the shop primer.

.3 Repair any galvanized or zinc rich painted surfaces which have been damaged or field welded in accordance with SSPC Technology Guide No.14.

.4 Clean and prepare surfaces of bolts, which will receive a finished coat of paint in the same manner as the connected steelwork.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED REQUIREMENTS

.1 Section 05 12 23: Structural Steel for Buildings.

.2 Section 07 20 00: Insulation.

.3 Section 09 22 16: Non - Structural Metal Framing.

.4 Section 09 21 16: Gypsum Board Assemblies.

## 1.2 REFERENCES

.1 Canadian Standards Association (CSA International):
- .1 CSA S136-12 package, North American Specifications for the Design of Cold Formed Steel Structural Members.
- .2 CSA W47.1-09 (R2014), Certification of Companies for Fusion Welding of Steel.
- .3 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
- .4 CSA W55.3-08 (R2013), Certification of Companies for Resistance Welding of Steel and Aluminum.
- .5 CSA W59-13, Welded Steel Construction (Metal Arc Welding).
- .6 CSA S304.1, Design of Masonry Structures.
- .7 CSA A370, Connectors for Masonry.
- .8 CSA A371, Masonry Construction for Buildings.

.2 ASTM International Inc.:
- .1 ASTM A307, Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod 60,000 PSI Tensile Strength
- .2 ASTM A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa (120/105 ksi) Minimum Tensile Strength.
- .3 ASTM A653/A653M-13 Standard Specification for Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .4 ASTM A792/A792M-10 Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .5 ASTM A1003/A1003M Standard Specification for Sheet Steel, Carbon, Metallic and Non-Metallic Coated for Cold-Formed Steel Framing Members.

.3 American Welding Society (AWS):
- .1 AWS D1.3/D1.3M, Structural Welding Code – Sheet Steel.

.4 Canadian Sheet Steel Building Institute (CSSBI):
- .1 CSSBI 50M-[06], Lightweight Steel Framing Design Manual.

.5 The Society for Protective Coatings (SSPC):
- .1 SSPC Technology Guide No.14 – Guide for the Repair of Imperfections in Galvanized, Organic or Inorganic Zinc-Coated Steel Using Organic Zinc Rich Coating.

.2 SSPC Paint Specification No. 15 – Steel Joist Shop Primer/ Metal Building Primer.

## 1.3 QUALITY ASSURANCE

.1 Qualifications:
- .1 Company performing the work to have minimum 3 years experience in installation of cold formed steel framing.
- .2 Cold formed steel fabricator to be certified by the Canadian Welding Bureau under the requirements of CSA W47.1.
- .3 Welders to be CWB approved, working under supervision of a CWB approved firm.
- .4 Engage a Professional Engineer licensed in the place where the project is located to be responsible for design, detailing and installation of all cold formed steel framing.
- .5 The Professional Engineer responsible for cold formed steel to hold a Certificate of Authorization, and to carry min. $1,000,000.00 in liability insurance (per occurrence).

## 1.4 QUALITY CONTROL

.1 In accordance with Section 01 45 00 – Quality Control.

.2 Source Quality Control Submittals:
- .1 If requested, submit mill test reports showing chemical and physical properties and other details of the cold formed steel to be incorporated in project.

.3 Tolerances:
- .1 Maximum out of plumbness and out of straightness (from both axis): member length / 1000.
- .2 Deviation in stud spacing: +/- 3mm.
- .3 Alignment of adjacent or abutting members in the same plane: +/- 0.5mm.
- .4 Maximum gap between stud web and top track: 3.2 mm.

## 1.5 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit product data for all framing components

.3 Submit product data for mechanical fasteners indicating sizes, load capacities and type of corrosion protection.

.4 Submit specifications for the coatings used.

.5 Shop Drawings:

.1 Provide drawings stamped and signed by a Professional Engineer responsible for cold formed metal framing.

.2 Before submitting shop drawings, provide a letter signed and sealed by that Engineer stating that he has been engaged to undertake the responsibility for the above. Also submit a copy of that Engineer's Certificate of Authorization, and proof of his liability insurance.

.3 Show on drawings:

.1 Design loads.

.2 Member sizes and layout.

.3 Member thickness (exclusive of coating).

.4 Coatings.

.5 Connection details (including weld and screw sizes and spacing).

.6 Bridging details.

.7 Splice details.

.8 Bracing details.

.9 Brick connectors.

.10 Temporary bracings.

.11 Installation procedure.

.6 On completion of erection, submit a letter signed and sealed by the Professional Engineer responsible for cold formed framing to certify that work has been completed in accordance with all contract documents.

## PART 2 - PRODUCTS

### 2.1 DESIGN REQUIREMENTS

.1 Design and detail members and connections in accordance with CSA S136 to resist forces and to allow for movements indicated. Consider load effects due to fabrication, erection and handling.

.2 Use Limit State Design, with loads and factors in accordance with the applicable Building Code.

.3 When requested, submit sketches and design calculations stamped and signed by the Professional Engineer responsible for cold formed metal framing.

.4 Conform to the requirements of fire rated assemblies specified on Architectural Drawings.

.5 Member depths and maximum spacing are shown on Contract Documents. Minimum thickness to be:

| Stud, Track or Joist Depth (mm) | Minimum Base Steel Thickness Exclusive of Coating (mm) | Design Thickness Exclusive of Coating (mm) |
|---|---|---|
| 152 or less | 0.836 | 0.879 |

| | | |
|---|---|---|
| 203 | 1.087 | 1.146 |
| 254 | 1.367 | 1.438 |
| 305 and 352 | 1.720 | 1.811 |

.6 Adjust material thickness and spacing as required by design. Do not increase spacing nor change stud and joists depth unless approved by the Departmental representative.

.7 All studs and joists to have lipped flange.

.8 Minimum member flange width when drywall is attached to the flange to be 31 mm.

.9 Maximum flexural deflections under specified live or wind loads to be:
- .1 Wall studs - L/360, maximum 25mm (1”).
- .2 Floor joist - L/360.
- .3 Roof joist supporting materials susceptible to cracking - L/360.
- .4 Roof joists supporting materials not susceptible to cracking, - L/300.
- .5 Building sway – 1/400 of building height or 1/500 of storey height.

.10 Allow for end eccentricities in design of axially loaded members.

.11 Design interior load bearing walls for a nominal wind load of 0.25 kPa, unless noted otherwise on Structural Drawings.

.12 Design wind bearing stud connections to accommodate structural deflections and tolerances without imposing axial loads onto the framing.

.13 Design for local loads due to anchorage of cladding and interior wall mounted fixtures and equipment.

.14 Design headers and trimmers to frame all openings. Note that all openings are not shown on Structural drawings, refer to Architectural and Mechanical drawings.

.15 Design joists and studs to accommodate the required cutouts. Reinforce where required.

.16 Design bridging to prevent member rotation and member translation perpendicular to minor axis. Consider secondary stress effects due to torsion between lines of bridging. Do not rely on collateral sheathing to help in the restraint. Locate bridging as to not interfere with required ventilation as identified in architectural drawings.

.17 Spacing for bridging lines not to exceed:
- .1 1524 mm o/c for wind bearing studs.
- .2 1219 mm o/c for axial load bearing studs.
- .3 2314 mm o/c for joists.

.18 Minimum thickness for bridging channels to be 1,087 mm for studs and 1.367 mm for joists. Use greater thickness if required by the design

.19 Minimum thickness for clip angles to be 1.367 mm for studs and 1.72 mm for joists. Use greater thickness if required by the design.

.20 Design anchorage and splice details for bridging. If these details are shown on Structural drawings, do not change unless approved by the Departmental representative.

.21 Design diagonally braced stud walls to act as shear walls for wind and seismic loading.

.22 Connection members by bolts, welds or sheet metal screws.

.23 Minimum fasteners:
- .1 Sheet steel screws - #10-16
- .2 Fasteners to structural steel - #12-24
- .3 Fasteners to concrete or masonry - 6.4 mm dia.

.24 For material less than 3mm thick, the effective throats of welds not to be less than the thickness of the thinnest connected part.

.25 Fastener penetration beyond joined materials not to be less than three exposed threads

.26 Design temporary bracings to ensure stability of wall structures until floor or roof structure providing lateral bracing are complete.

## 2.2 MATERIALS

.1 Cold formed metal: to CSA S136.

.2 Metallic coating: to ASTM A653/A653M, ASTM A792/A792M, or ASTM A1003/A1003M.

.3 Zinc rich coating: to SSPC Paint Specification No.15.

.4 Welding materials: to CSA W48 and CSA W59, certified by Canadian Welding Bureau.

.5 Bolts, nuts and washers: to ASTM A307 or ASTM A325, hot dip galvanized.

.6 Fasteners for sheet steel: as follows, with minimum 0.008mm zinc coating (or equivalent coating providing same or better corrosion protection).
- .1 Sheet steel screws: self drilling, self tapping, with low profile heads,
- .2 Fasteners to structural steel: self drilling, self tapping screws or powder actuated fasteners.
- .3 Fasteners to concrete: screwed or friction-fit fasteners installed into pre-drilled holes, drilled adhesive-set stud anchors or powder actuated fasteners.
- .4 Fasteners to masonry: threaded fasteners screwed into pre-drilled holes.

## 2.3 FABRICATION

.1 Fabricate cold formed steel in accordance with CSA S136 and with reviewed

shop drawings.

.2 Use stick built or panelized construction.

.3 Fabricate stud tracks, bridging and angle clips from the same material and with the same finish as steel studs.

.4 Mark minimum steel thickness (exclusive of coating) on each member by embossing, stamping in indelible ink, or by colour coding.

.5 Provide cut-outs centred in the webs of members as required to accommodate services and through-the-knockout style bridging. Unreinforced cut-outs to be limited to the dimensions listed below:

.6

| Member Depth mm | Maximum Across Member Depth mm | Maximum Along Member Length mm | Minimum Centre to Centre Spacing mm |
|---|---|---|---|
| 92 and 102 | 40 | 105 | 610 |
| 150 | 64 | 115 | 610 |

.7 Limit distance from centerline of last unreinforced cut out to end of member to less than 305mm (1’-0”).

.8 Ensure that parts to be welded or screwed together are in full contact. Provide clamping as required.

.9 Welding to be in accordance with CSA S136, CSA W59 and AWS D1.3, as applicable.

.10 Cold formed members forming part of the exterior building envelope to have minimum coating of Z180 galvanizing in accordance with ASTM A653/A653M. Other coatings (such as aluminum-zinc alloy to ASTM A792/A792M) providing equal or better corrosion protection may be used.

## PART 3 - EXECUTION

### 3.1 GENERAL

.1 Coordinate with work of other trades including structural steel, air and vapour barriers, exterior sheathings and insulation, stud space insulation, masonry, drywall, mechanical, electrical and plumbing, doors and windows, interior drywall partitions, concrete and concrete formwork and stairs.

## 3.2 EXAMINATION

.1 Verify conditions of substrates previously installed under other Sections or Contracts are acceptable for cold formed metal framing installation:
- .1 Visually inspect substrate.
- .2 Inform Departmental representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied

## 3.3 ERECTION

.1 Erect cold formed framing components and assemblies true and plumb, within the specified tolerances.

.2 Make all field measurements necessary to ensure proper fit of all members.

.3 Accommodate tolerances of the structure.

.4 Provide all temporary bracings required to ensure stability during construction.

.5 Handle and lift prefabricated panels not to cause permanent distortion to any member or collateral material.

.6 Align adjacent prefabricated panels to provide surface continuity at the interface.

.7 Cut all framing components squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Use saw or shear. Do not use torch cutting.

.8 Align all axially loaded members vertically down to foundation. Maintain alignment at roof/wall and floor/wall intersections

.9 Do not splice axially load bearing members.

.10 Provide uniform and level bearing for bottom tracks. Provide skim coat / grout bed if required.

.11 Unless otherwise shown on drawings, anchor top and bottom track for stud walls at max. 813 mm on center. Provide additional anchors within 102 mm of each end piece.

.12 Anchor all track butt joints and abutting pieces of track to a common structural element, or butt welded or spliced together.

.13 Studs to be fully seated in the track and angles, top and bottom.

.14 Align web cut-outs in studs and joists as required for the installation of through-the-knockout style bridging and services.

.15 Do not field cut any holes unless reviewed and approved by the

Departmental representative.

.16 Install additional studs at abutting walls, openings, terminations against other materials and on each side at all wall corners.

.17 Install bridging rows at equal spacings not to exceed maximum spacing noted.

.18 Place insulation equal to that specified in all jamb and header assemblies that will be inaccessible after their installation into the wall. Keep it dry and do not compress

.19 Locate joists (or their end stiffeners) directly over load bearing studs. Alternatively, provide a load distribution member to transfer loads. Do not use track as the load distribution member.

.20 Install all proprietary fasteners in accordance with the manufacturer's recommendations.

.21 Touch up welds and coatings damaged by welding with zinc rich paint. Prior to touching up, prepare surface in accordance with paint manufacturer's recommendations.

.22 Replace members with localized damage.

## 3.4 FIELD QUALITY CONTROL

.1 Refer to Section 01 45 00 Quality Control.

.2 Bring to the attention of the Departmental representative any defects or deficiencies in the work together with a proposal for remedy. The Departmental representative will decide what corrective action may be taken, and will issue the necessary instructions.

.3 Construction Review:
- .1 The Professional Engineer responsible for cold formed metal framing to provide periodic field review during construction and to submit reports to the Departmental representative.
- .2 General review during construction by the Departmental representative will be carried out by examination of representative samples of the work.
- .3 Construction review reports will outline any deficiencies found.

.4 Inspection and testing:
- .1 An Inspection and Testing Agency will be appointed to carry inspection and testing of all cold formed metal framing.
- .2 The Inspection Agency will submit reports to the Departmental representative, Structural Engineer, Contractor and Municipal Authorities covering the Work inspected and provide details of errors or deficiencies observed.
- .3 Inspection will include:
  - .1 Checking that mill test certificates or producer's certificates are satisfactorily correlated to materials and products supplied for the project and confirming that all

materials meet specifications.

.2 Sampling fabrication and erection procedures for general conformity with the requirements of the Contract.

.3 Checking welders' CWB Certification.

.4 Checking fabricated members against specified member shapes.

.5 Visual inspection of all welded connections including spot checking of joint preparation and fit up.

.6 Additional inspection and testing of welded connections as required by CSA W59

.7 Sample checking of screwed and bolted joints.

.8 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.

.9 Inspection of field cutting and alterations required by other trades..

END OF SECTION

# PART 1 - GENERAL

## 1.1 REFERENCES

.1 ASTM International
.1 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealled) by the Hot-Dip Process.

.2 American Wood Protection Association (AWPA):
.1 AWPA P8-14, Standard for Oil-Borne Preservatives.

.3 CSA International
.1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
.2 CSA O80 Series-15, Wood Preservation.
.2 CSA O112 Series-M1977(R2006), CSA Standards for Wood Adhesives.
.3 CSA O121-08 (R2013), Douglas Fir Plywood.
.4 CSA O141-05(R2014), Softwood Lumber.

.4 National Lumber Grades Authority (NLGA)
.1 Standard Grading Rules for Canadian Lumber December 1, 2014.

## 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for wood products and accessories and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

## 1.3 QUALITY ASSURANCE

.1 Lumber by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.

.2 Plywood, particleboard, OSB and wood based composite panels 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 and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
.1 Store materials in dry location 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 S-DRY graded and stamped in accordance with following standards:
.1 CSA O141.
.2 NLGA Standard Grading Rules for Canadian Lumber.

.2 Furring, blocking, nailing strips, strapping, grounds, rough bucks, bracing, bridging, curbs, fascia backing and sleepers: NLGA spruce, pine or fir (SPF), 121c. and pine, 113d.
.1 Natural finished trim: western red cedar, 202c. "C" CEDAR INDUSTRIAL CLEAR.

.3 Douglas fir plywood: to CSA 0121, urea formaldehyde free, alternative adhesive.
.1 Combined wall sheathing, siding: MDO 1S - Medium Density Overlay, G1S Good One Side Grade. Nominal thickness as indicated below, unsanded surfaces to Tables E-1 and E-2, square edge.
.2 Exterior side of walls: 7.5 mm thick.
.3 Interior side of walls: 19 mm thick.
.4 Underside of ceilings: 13 mm thick.
.5 Above ceilings: 19 mm thick.
.6 Ro f:
16 mm
thick.

.4 Field applied wood preservative: copper napthenate to AWPA P8, green colour.

## 2.2 ACCESSORIES

.1 Sealants: in accordance with Section 07 90 00.

.2 General purpose adhesive: to CSA O112 Series.

.3 Nails, spikes and staples: to CSA B111.

.4 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.

.5 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, recommended for purpose by manufacturer.

.6 Fastener Finishes:
.1 Galvanizing: to ASTM A653/A653M, use galvanized fasteners for exterior work, pressure-preservative treated lumber.

.7 Wood Preservative:
.1 Preservative Coating: to CSA-O80 Series, clear, odourless, in accordance with manufacturer's recommendations for surface conditions.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

.1 Verification of Conditions: 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 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 PREPARATION

.1 Treat surfaces of material with wood preservative, before installation.

.2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.

.3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.

.4 Treat material as indicated.

## 3.3 MATERIAL USAGE

.1 Exterior wall sheathing: in accordance with paragraph 2.1.3.
.1 Construction sheathing product: end use mark W24.

## 3.4 INSTALLATION

.1 Apply wood preservative to wood in contact with concrete.

.2 Treat surfaces of pressure treated wood and plywood which are cut or bored after pressure treatment with field applied wood preservative.

.3 Install members true to line, levels and elevations, square and plumb to a tolerance of 1:600 and rigidly secure in place.

.4 Construct continuous members from pieces of longest practical length.

.5 Install wall sheathing in accordance with manufacturer's printed instructions.

.6 Install furring and blocking as required to space-out and support wall and ceiling finishes, facings, fascia, soffit, siding as required.

.7 Install furring to support siding applied vertically where there is no blocking and where sheathing is not suitable for direct nailing.
.1 Align and plumb faces of furring and blocking to tolerance of 1:600.

.8 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.

.9 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized fasteners.

.10 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.

.11 Countersink bolts where necessary to provide clearance for other work.

.12 Secure exterior work with galvanized or non- ferrous fasteners.

## 3.5 CLEANING

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

.3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 20.
  .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 rough carpentry installation.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

.1 Section 03 30 11: Concrete.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Asphalt: chemical emulsifier type to CAN/CGSB- 37.1-M89, emulsified mineral colloid type unfilled to CAN/CGSB-37.2-M88, unfilled cutback to CGSB 37-GP-6Ma or filled cutback to CAN/CGSB-37.16-M89.

.2 Sealing compound: plastic cutback asphalt cement to CAN/CGSB-37.5-M89.

.3 Primer: unfilled asphalt to CGSB 37-GP-9Ma.

## PART 3 - EXECUTION

### 3.1 APPLICATION

.1 Apply continuously at minimum 5°C except material to CGSB 37-GP-6Ma, CAN/CGSB- 37.16-M89 may be used to 0°C.

.2 Asphalt to CAN/CGSB-37.1-M89 or CAN/CGSB-37.2 -M88 applied to CAN/CGSB-37.3-M89. Asphalt to 37-GP-6Ma applied to CGSB 37-GP-12Ma. Asphalt to CAN/CGSB-37.16-M89 applied to CGSB 37-GP-36M.

.3 Apply two additional coats of asphalt for 225 mm width on each side of vertical corners and 225 mm along pipes passing through walls.

.4 Apply sealing compound around items passing through dampproofed surfaces and at joint between foundation walls and footings.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED SECTIONS

.1 Section 07 26 00: Air and vapour retarders.

.2 Section 07 46 19: Preformed Steel Siding.

## 1.2 PRODUCT DATA

.1 Submit product data sheets for products in accordance with Section 01 33 00.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

.1 Rigid insulation: polystyrene to CAN/ULC- S701-11, Type 4, Ecologo certified.

.2 Polyisocyanurate insulation: CAN/ULC S704-11; Type 2, Rigid polyisocyanurate foam core board to meet specified requirements.

.3 Batt insulation: mineral fibre to CAN/ULC-S702-09, Type 1, preformed without membrane, Ecologo certified.

.4 Polystyrene Board Insulation (cement faced): CAN/ULC S701-11, Type 4; Extruded, closed-cell, foamed polystyrene with ship-lapped edges. Provide 8 mm thick latex modified concrete face.

.5 Drainage board panels: Three-dimensional dimpled core and geotextile fabric complete with adhesive or fasteners as required for installation.

.6 Adhesive: type recommended by insulation manufacturer, Ecologo certified.

.7 Foundation insulation fastening system: Purpose made galvanized steel clips and continuous galvanized steel flashing as recommended by insulation manufacturer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Perimeter insulation:
.1 Apply rigid insulation to exterior face of foundation wall below grade.
.2 Provide cement faced insulation with caulked joints extending down minimum 80 mm below top of concrete slab. Caulking of cement faced insulation to be grey to match concrete face colour.
.4 Butt boards tight together.
.5 Mechanically fasten in place to manufacturer's instruction.
.6 Install drainage board panels over insulation exposed to backfill. Position board with filter fabric side toward soil/drainage side and attach using manufacturer approved fastening system.

.2 Underslab insulation: Provide rigid insulation at underslab of floor slab. Protect from damage while placing concrete floor slab.

.3 Cavity wall rigid insulation:
.1 Apply 3 mm wet film thickness of adhesive to entire face of rigid insulation.
.2 Apply polyisocyanurate insulation to substrate with sliding motion to ensure adhesive contact.
.3 Butt joints with moderate contact.

.4 Between framing thermal batt insulation:
.1 Apply batt insulation between framing members to friction fit.
.2 Fit batt insulation tight to projections through insulation.
.3 Provide miscellaneous metal bracing or strapping as required to secure batt insulation in place within cavity.

END OF SECTION

# PART 1 - GENERAL

## 1.1 REFERENCES

.1 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.

## 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for air and vapour barriers and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 33 00.

.3 Certificates:
.1 Submit 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, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.

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

.3 Storage and Handling Requirements:
.1 Store materials in dry location 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 SHEET VAPOUR BARRIER

.1 Polyethylene film: to CAN/CGSB-51.34, 0.15 mm (6mil) thick.

## 2.2 AIR BARRIER

.1 Vapour permeable air barrier: 23 mils thick, single-ply, self adhering membrane consisting of engineered film and permeable adhesive with poly-release film.

## 2.3 ACCESSORIES

.1 Joint sealing tape: air resistant pressure sensitive adhesive tape, Type recommended by vapour barrier manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.

.2 Sealant: compatible with air and vapour barrier materials, recommended by barrier manufacturer.

.3 Staples: minimum 6 mm leg.

.4 Moulded box vapour barrier: factory-moulded polyethylene box for use with recessed electric switch and outlet device boxes.

.5 Air barrier primer: Low VOC quick setting rubber based adhesive.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for air and vapour barrier 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 Ensure services are installed and inspected prior to installation of barrier.

.2 Install sheet vapour barrier on warm side of exterior wall assemblies prior to installation of gypsum board to form continuous retarder.

.3 Use sheets of largest practical size to minimize joints.

.4 Attach sheet to substrate and apply continuous bead of sealant over solid backing at joint. Lap adjoining sheet minimum 150 mm and press into sealant bead. Instal fastener through lapped sheets into substrate.

.5 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.

## 3.3 EXTERIOR SURFACE OPENINGS

.1 Cut sheet vapour barrier to form openings and ensure material is lapped and sealed to frame.

## 3.4 PERIMETER SEALS

.1 Seal all around HOGEN room, walls and ceiling with vapour barrier. Seal around all penetrations including, but not limited to steel studs through ceiling assembly.

.2 llows:Seal perimeter of sheet vapour barrier as
.1 Apply continuous bead of sealant to substrate at perimeter of sheets.
.2 Lap sheet over sealant and press into sealant bead.
.3 Install staples through lapped sheets at sealant bead into wood substrate.
.4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

## 3.5 LAP JOINT SEALS

.1 Seal lap joints of sheet vapour barrier as follows:
.1 Attach first sheet to substrate.
.2 Apply continuous bead of sealant over solid backing at joint.
.3 Lap adjoining sheet minimum 150 mm and press into sealant bead.
.4 Install fasteners through lapped sheets at sealant bead into substrate.
.5 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

## 3.6 ELECTRICAL BOXES

.1 Seal electrical switch and outlet device boxes that penetrate vapour barrier as follows:

.1 Install moulded box vapour barrier.
.2 Apply sealant to seal edges of flange to main vapour barrier and seal wiring penetrations through box cover.

## 3.7 VAPOUR PERMEABLE AIR BARRIER

.1 Prime surfaces. Re-prime surfaces if not covered with air barrier within 4 hours.

.2 Lap air barrier ends and edges 50 mm minimum. Roll air barrier to ensure continuous adhesion over entire substrate area.

.3 Extend air barrier as requried to connect to other components of work comprising air barrier system.

.4 Seal around masonry reinforcing ot ties and all penetrations with termination mastic.

.5 Do not expose air barrier to sunlight for more than 30 days prior to enclosure.

## 3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.
.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.
.1 Remove insulation material spilled during installation and leave work area ready for application of wall board.

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED SECTIONS

.1 Section 07 20 00: Thermal insulation.

.2 Section 07 62 00: Flashings and sheet metal.

.3 Section 07 90 00: Joint sealing.

## 1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM):
.1 ASTM A653-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
.2 ASTM C920-14a, Standard Specification for Elastomeric Joint Sealants.

.2 CSA International (CSA):
.1 CAN/CSA-S136-12 Package, North American Specification for the Design of Cold-Formed Steel Structural Members.

## 1.3 SAMPLES

.1 Submit one 600 x 600 mm size samples of siding and soffit material, of colour and profile specified, in accordance with Section 01 33 00.

## 1.4 PRODUCT DATA

.1 Submit product data sheets in accordance with Section 01 33 00.

.2 Indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, soffits, fascia, and related work.

.3 Indicate conformance with CAN/CSA-S136-12 Package.

## 1.5 QUALITY ASSURANCE

.1 Mock-ups:
.1 Provide one full scale 1200 mm wide x 1800 mm long mock-up panel of preformed steel siding system showing custom made corner trims.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Prefinished siding: 0.76 mm thick ASTM A653/A653M, Z275 zinc coating designation prefinished with silicone modified polyester, two coat paint system, colour to be selected by Departmental Representative and profile 22 mm deep.

.2 Prefinished soffit: 0.76 mm thick ASTM A653/A653M, Z275 zinc coating designation prefinished with silicone modified polyester, two coat paint system, colour and profile to be selected by Departmental Representative.

.3 Z-bars or sub-girts, drip closures and notched steel closures: 1.26 mm thick galvanized steel to ASTM A653/A653M, Z275 zinc coating designation.

.4 Thermal clip: triangular, galvanized steel.

.5 Fascia, flashing and accessories: exposed trim, metal closures, cap pieces, etc. of same material and colour as siding. Allow for custom made corner trims as indicated on drawings.

.6 Fasteners: self tapping screws, colour to match siding, neoprene washers.

.7 Isolation coating: Bituminous coating, acid and alkali resistant material.

.8 Sealant: one component, elastomeric, chemical curing, to ASTM C920, Ecologo certified, SWRI validated, colour to match siding.

.9 Foam closers: PVC foam, 25 mm wide, shaped to match siding profile.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Attach Z-bars and sub-girts to structural supports through insulation, and plywood as indicated on drawings.

.2 Install starter strips, inside corners, continuous outside corners, edgings, soffits and drip, cap and sill flashings.

.3 Install siding and soffit with all attachments sequentially from starter strips up, to manufacturer's instructions.

.4 Install facing on soffit and fascia where indicated.

.5 Install exterior corners, fillers and closure strips with individually formed and profiled work using concealed fasteners.

.6 Maintain joints in exterior sheets, true to line, tight fitting. Ensure horizontal alignment of profile between high and low siding installations.

.7 Apply sealant where detailed, at junction with other materials, around door and window perimeters and at metal flashings.

.8 Wash down surfaces with mild detergent.

END OF SECTION

# PART 1 - GENERAL

## 1.1 SECTION INCLUDES

.1 Materials and installation for sheet metal roofing.

## 1.2 RELATED SECTIONS

.1 Section 07 62 00 - Sheet metal flashings.

.2 Section 07 90 00 - Joint Sealing.

## 1.3 REFERENCES

.1 American Society for Testing and Materials (ASTM).
.1 ASTM A653/A653M-15, 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-37.5-M89, Cutback Asphalt Plastic Cement.(Withdrawn)
.2 CAN/CGSB-37.29-M89, Rubber-Asphalt Sealing Compound.(Withdrawn)

## 1.4 SUBMITTALS

.1 Submit proof of manufacturer's CCMC Listing and listing number to Departmental Representative.

.2 Submit product data in accordance with Section 01 33 00.

.3 Submit shop drawings in accordance with Section 01 33 00.

.4 Indicate arrangements of sheets and joints, types and locations of fasteners and special shapes and relationship of panels to structural frame.

.5 Submit samples in accordance with Section 01 33 00.

.6 Submit duplicate 300 x 300 mm samples of each sheet metal material.

## 1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

# PART 2 - PRODUCTS

## 2.1 SHEET METAL MATERIALS

.1 Prefinished steel: 0.76 mm thick ASTM A653/A653M, Z275 zinc coating designation prefinished with silicone modified polyester, two coat paint system, colour to be selected by Departmental Representative and profile 22 mm deep.

## 2.2 ACCESSORIES

.1 Isolation coating: alkali resistant bituminous paint.

.2 Plastic cement: to CAN/CGSB-37.5.

.3 Waterproof membrane: 1.0 mm thick composite sheet comprised of SBS modified bitumen with woven polyethylene reinforcement. Primer recommended by membrane manufacturer.

.4 Sealant: Asbestos-free sealant, compatible with systems materials, recommended by system manufacturer.

.5 Rubber-asphalt sealing compound: to CAN/CGSB-37.29.

.6 Fasteners: Stainless steel, exposed, complete with coloured heads.

.7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

.8 Touch-up paint: as recommended by sheet metal roofing manufacturer.

.9 Ridge vent: Provide ridge vent as indicated on Architectural drawings.

.10 Snow guard: 150 mm high premanufactured three pipe snow guard, 4.8 mm thick aluminum bracket, and 25 mm diameter extruded aluminum tubing with 3 mm thick wall thickness.

## 2.3 FABRICATION

.1 Form individual pieces in 2400 mm maximum lengths. Make allowances for expansion at joints.

.2 Hem exposed edges on underside 12 mm, mitre and seal.

.3 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.4 Apply minimum 0.2 mm dry film thickness coat of plastic cement to both faces of dissimilar metals in contact.

.5 Protect disimilar metals against oxidization by backpainting with isolation coating where indicated.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Use concealed fastenings except where approved by Departmental Representative before installation.

.2 Provide waterproof membrane under sheet metal roofing. Secure in place and lap joints 100 mm minimum.

.3 Install sheet metal roof panels using cleats.

.4 Secure cleats with two fasteners each and cover with cleat tabs.

.5 Stagger transverse seams in adjacent panels.

.6 Flash roof penetrations with material matching roof panels, and make watertight.

.7 Form seams in direction of water-flow and make watertight.

.8 Install ridge vents ensuring opening are clear and air flow is not hindered.

.9 Install snow guards on metal roofing in accordance with manufacturers written instructions in locations as indicated on drawings.

END OF SECTION

# PART 1 - GENERAL

## 1.1 REFERENCES

.1 Aluminum Association (AA)
.1 AA DAF 45-03(R2009), Designation System for Aluminum Finishes - 9th Edition.

.2 American Society for Testing and Materials (ASTM)
.1 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.

.3 Canadian Roofing Contractors Association (CRCA)
.1 Roofing Specifications Manual 2012.

.4 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-37.5-M89, Cutback Asphalt Plastic Cement.(Withdrawn).

.5 Canadian Standards Association (CSA International)
.1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.

## 1.2 SUBMITTALS

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

.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.

.3 Shop Drawings:
.1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.4 Samples:
.1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colours.

## 1.3 QUALITY ASSURANCE

.1 Mock-ups:

.1 Provide full scale mock-up panel indicating all custom trims and flashings as selected by Departmental Representative.

## 1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 16 00.

.2 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

# PART 2 - PRODUCTS

## 2.1 SHEET METAL MATERIALS

.1 Plain aluminum sheet: Alloy AA 3102, Temper H14-H16, 1.0 mm thick unless indicated otherwise. Clear anodized finish in accordance with AA DAF-45.

.2 Prefinished steel: 0.76 mm thick ASTM A653/A653M, Z275 zinc coating designation prefinished Bulletin No. 7, October 1979, paint system, colour to be selected by Departmental Representative.

## 2.2 ACCESSORIES

.1 Plastic sleeve: Black plastic, unperforated sleeve for rain water leader in 25 mm diameter greater than rainwater leader.

.2 Isolation coating: alkali resistant bituminous coating.

.3 Plastic cement: to CAN/CGSB-37.5.

.4 Sealants: 07 90 00.

.5 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.

.6 Fasteners: Stainless steel, to CSA B111, ring thread flat head roofing nails of length and thickness suitable for metal flashing application.

.7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

.8 Concrete drain and drywell: Provide 915 mm diameter concrete drain with concrete cap below frost line.

.9 Dry well accessories: Provide clean out box, drain hub and concrete slab as indicated on drawings for dry well.

.9 Splash pad: CSA A231.1/A231.2, minimum 87 kg/m2 and maximum 107 kg/m2 with 5% air entrainment natural precast concrete pad with shotblast finish.

## 2.3 FABRICATION

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

.2 Form pieces in 2400 mm maximum lengths.
.1 Make allowance for expansion at joints.

.3 Hem exposed edges on underside 12 mm.
.1 Mitre and seal corners with sealant.

.4 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

.5 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

## 2.4 METAL TRIMS AND FLASHINGS

.1 Form flashings, copings and fascias to profiles indicated of prefinished aluminum.

## 2.5 GUTTER AND RAIN WATER LEADERS

.1 Form bent metal gutters from aluminum sheet metal in sections for assembly on Site.

.2 Fabricate rain water leaders as 100 mm diameter aluminum.

.3 Sizes and profiles as indicated.

.4 Provide goosenecks, outlets, strainer baskets and necessary fastenings.

## 2.6 LIGHTNING ROD PLATE

.1 Fabricate base plate for lightning rod of aluminum plate with allowance for electrical wiring.

# PART 3 - EXECUTION

## 3.1 MANUFACTURER'S INSTRUCTIONS

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

## 3.2 INSTALLATION

.1 Install sheet metal work in accordance with CRCA FL series details, as detailed.

.2 Use concealed fastenings except where approved before installation.

.3 Provide underlay under sheet metal.
.1 Secure in place and lap joints 100 mm.

.4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs.
.1 Flash joints using S-lock forming tight fit over hook strips, as detailed.

.5 Lock end joints and caulk with sealant.

.6 Install lightning rod plate in accordance with details and requirements.

## 3.3 GUTTERS AND RAIN WATER LEADERS

.1 Install gutter sections and secure to building at 750 mm on centre with gutter spikes through spacer ferrules.
.1 Slope gutters to rain water leaders as indicated.
.2 Seal joints watertight.

.2 Install rain water leaders and provide goosenecks back to wall.
.1 Secure rain water leaders to wall with straps at 1800 mm on centre; minimum two straps per rain water leader.

.3 Install plastic sleeves through sidewalk for rain water leaders as indicated on drawings.

.4 Install drywell as indicated on drawings and connect rain water leaders into system.

.5 Install splash pad angled away from building in locations indicated on drawings for areas where water is to be discharged at grade.

## 3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:
.1 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

## 3.5 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.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 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.2 Underwriter's Laboratories of Canada (ULC)
.1 CAN/ULC-S101-07, Standard Methods of for Fire Endurance Tests of Building Construction and Materials.
.2 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
.3 CAN/ULC-S115-11, Standard Method of 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 Continuity of Fire Separations: NBC 2010, Division B, Parts 3.1.8 and 3.1.9.1, 9.10.9):
.1 Wall, partition or floor assemblies required to be a fire separation shall be: constructed as a continuous element; have a fire resistance rating; have openings protected by a closure; and have penetrations sealed by a firestop.

## 1.3 SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00.

.3 Shop Drawings:
.1 Submit shop drawings to show location, proposed material, reinforcement, anchorage, fastenings, colours and method of installation.
.2 Construction details should accurately reflect actual job conditions.

.4 Samples:
.1 Submit duplicate 300 x 300 mm samples showing actual fire stop material proposed for project.

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00.
.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: 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.
.4 Manufacturer's Field Reports: submit to manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

## 1.4 QUALITY ASSURANCE

.1 Qualifications:
.1 Installer: company specializing in fire stopping installations with 5 years documented experience approved by manufacturer.
.2 All fire stopping material shall be from one manufacturer.
.3 All fire stopping installation work for entire project shall be by a single contractor experienced in firestopping. Individual disciplines shall NOT fire stop their own work.

.2 Pre-Installation Meetings: convene pre-installation meeting one week prior to beginning work of this Section, with Departmental Representative in accordance with Section 01 31 19 to:

.1 Verify project requirements.
.2 Review installation and substrate conditions.
.3 Co-ordination with other building subtrades.
.4 Review manufacturer's installation instructions and warranty requirements.

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

## 1.5 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:
.1 Deliver, store and handle materials in accordance with Section 01 61 00.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
.3 Deliver materials to the site in undamaged condition and in original unopened containers, marked to indicate brand name, manufacturer, ULC markings.

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

.3 Waste Management and Disposal:
.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

# 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 and conforming to specified special requirements described in PART 3.
.2 Fire stop system rating: F.
.3 Colours: As indicated on approved Shop Drawings.

.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 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.

.10 Sealants for vertical joints: non-sagging.

## 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 PREPARATION

.1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials.
.1 Ensure that substrates and surfaces are clean, dry and frost free.

.2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.

.3 Maintain insulation around pipes and ducts penetrating fire separation without interruption to vapour barrier.

.4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

## 3.3 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.

## 3.4 SEQUENCES OF OPERATION

.1 Proceed with installation only when submittals have been reviewed by Departmental Representative.

.2 Install floor fire stopping before interior partition erections.

.3 Metal deck bonding: fire stopping to precede spray applied fireproofing to ensure required bonding.

.4 Mechanical pipe insulation: certified fire stop system component.
.1 Ensure pipe insulation installation precedes fire stopping.

## 3.5 FIELD QUALITY CONTROL

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

.2 Manufacturer's Field Services:

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

## 3.6 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.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.

## 3.7 SCHEDULE

.1 Fire stop and smoke seal at:
.1 Around mechanical and electrical assemblies penetrating fire separations.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED SECTIONS

.1 Section 07 26 00: Sealing vapour barrier.

.2 Section 07 46 19: Sealing siding.

.3 Section 07 61 00: Sealing sheet metal roofing.

.4 Section 07 62 00: Sealing metal flashings.

.5 Section 08 51 13: Sealing windows.

## 1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM):
.1 ASTM C920-14a, Standard Specification for Elastomeric Joint Sealants.

## 1.3 QUALITY ASSURANCE

.1 Provide sealing of HOGEN room including ceiling, walls, and penetrations. All rooms within building to be sealed around concrete slab.

## 1.4 PRODUCT DATA

.1 Submit manufacturer's literature indicating recommended surface preparation, sealant selection and primer for each substrate in accordance with Section 01 33 00.

# PART 2 - PRODUCTS

## 2.1 SEALANT MATERIAL DESIGNATIONS

.1 Polyurethanes One Part.
.1 Non-sag polyurethane to ASTM C920, Type S, Grade NS, Class 50.

.2 Preformed compressible and non-compressible back-up materials, CFC free.
.1 Polyethylene, urethane, neoprene or vinyl foam. Extruded open cell foam backer rod. Size: oversize 30 to 50%.

.2 Bond breaker tape. Polyethylene bond breaker tape which will not bond to sealant.

## 2.2 SEALANT LOCATIONS

.1 Perimeters of exterior openings where frames meet exterior facade of building.

.2 Seal interior perimeters of exterior openings as detailed on drawings.

.3 Control and expansion joints on the interior of exterior poured-in place concrete walls.

.4 Interior control and expansion joints in floor surfaces.

.5 Perimeters of interior frames, as detailed and itemized.

.6 Exposed interior control joints in drywall.

## 2.3 JOINT CLEANER

.1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

# PART 3 - EXECUTION

## 3.1 PREPARATION OF JOINT SURFACES

.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 which 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.

## 3.2 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.

## 3.3 MIXING

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

## 3.4 APPLICATION

.1 Ventilate interior spaces during application and curing of sealants to maintain VOCs less than 50 g/l. Coordinate with building manager to ensure temporary ventilation supplies sufficient outside air.

.2 Sealant.
.1 Protect installed work of other trades from staining or contamination.
.2 Apply sealant in accordance with manufacturer's application manual and written instructions.
.3 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint. remove tape after sealant applied.
.4 Apply sealant in continuous beads.
.5 Apply sealant using gun with proper size nozzle.
.6 Use sufficient pressure to fill voids and joints solid.
.7 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
.8 Tool exposed surfaces before skinning begins to give slightly concave shape.

.3 Curing.
.1 Cure sealants in accordance with sealant manufacturer's instructions.
.2 Do not cover up sealants until proper curing has taken place.

.4 Cleanup.
.1 Clean adjacent surfaces immediately and leave work neat and clean.
.2 Remove excess and droppings, using recommended cleaners as work progresses.
.3 Remove masking tape after initial set of sealant.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED SECTIONS

.1 Section 07 90 00: Caulking of joints between frames and other building components.

.2 Section 08 51 13: Tempered glazing.

.3 Section 08 71 00: Door hardware.

.4 Section 09 21 16: Building-in frames into gypsum board assemblies.

## 1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
.1 ASTM A568/A568M-15, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
.2 ASTM A653/A653M-15, 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 CGSB 41-GP-19Ma-84, Rigid Vinyl Extrusions for Windows and Doors (Reaffirmation of September 1978).
.2 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
.3 CAN/CGSB-82.5-M88, Insulated Steel Doors.

.3 Canadian Steel Door Manufacturers Association (CSDMA) www.csdma.org/english/publications.html
.1 Recommended Dimensional Standards For Commercial Steel Doors and Frames 2000.
.2 Recommended Selection and Usage Guide for Commercial Steel Door and Frame Products 2009.

.4 Underwriters Laboratories Canada (ULC)
.1 CAN/ULC-S702-14, Standard for Mineral Fibre Thermal Insulation for Buildings.

## 1.3 PRODUCT DATA SHEETS

.1 Submit product data sheets in accordance with Section 01 33 00.

## 1.4 QUALIFICATIONS

.1 The manufacturer of steel doors and frames supplied under this section will be a member of the CSDMA - Canadian Steel Door Manufacturers Association.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

.1 Metal: tension levelled sheet steel to ASTM A568/A568M, Class 1, with ZF075 zinc coating on both sides designation to ASTM A653/A653M, minimum 30% total recycled content.

.2 Door cores:
.1 Continuous interlocking steel ribs: 0.9 mm thick continuous interlocking steel stiffeners at 150 mm O.C., securely welded to each face sheet 150 mm O.C. maximum.
.1 Voids between stiffeners Fibreglass: loose batt type, density: 24 kg/m$^3$ minimum, to CAN/ULC-S702, Type 1, Ecologo certified.

.3 Exterior top caps: PVC to CGSB 41-GP-19Ma.

.4 Frame thermal break: extruded, rigid polyvinyl chloride.

.5 Filler: polyester based.

.6 Primer: zinc rich, organic, ready mix to CAN/CGSB-1.181, Ecologo certified.

.7 Door bumpers: to ANSI/BHMA-A156.16, type L03011.

.8 Glazing: Tempered glass in accordance wtih Section 08 51 13.

.9 Gasket: self-adhering, closed cell foam of black vinyl copolymers.

## 2.2 FABRICATION

.1 To Canadian Steel Door Manufacturers Association (CSDMA), "Recommended Specifications for Commercial Steel Doors and Frames", "Recommended Dimensional Standards for Commercial Steel Doors and Frames".

.2 Exterior doors: comply with requirements of CAN/CGSB-82.5, Insulated Steel Doors.

.3 Doors: material thickness, opening classification and duty rating to CSDMA "Recommended Selection and Usage Guide For Commercial Steel Doors", hollow steel construction, filled with insulation, edges continuously welded or filled and sanded flush with no visible seams. Provide steel top cap filled and ground flush on exterior doors.

.4 Frames: 1.6 mm steel, welded type. Exterior frames with continuous thermal break. Anchors adjustable, type to suit each jamb condition.

.5 Glass mouldings: formed steel.

.6 Install 3 door bumpers on strike jamb of single doors.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install frames, doors and hardware plumb, square and level in accordance with manufacturer's instructions and templates.

.2 Install labelled steel fire rated doors and frames to NFPA 80.

.3 Provide even margins between doors and jambs and doors and flooring and thresholds as follows:
- .1 Hinge side: 1.0 mm.
- .2 Latch side and head: 1.5 mm.
- .3 Flooring and thresholds: 13 mm.

.4 Secure anchorages and connections to adjacent construction.

.5 Adhere continuous gaskets on each side of exterior frames at masonry jamb and at head.

.6 Fill in exterior frames with mineral fibre insulation.

.7 Touch-up with primer scratched or damaged zinc finish.

.8 Install hardware in accordance with manufacturer's instructions and templates.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 0 33 00.

.2 Indicate manufacturer's name, model number, size, thickness, material and finish, recycled content, component location and details of track, door construction and operating mechanism.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Acceptable Material:
.1 Hanover Doors, Weight Counterballance Doors, manufactured by Hanover Doors 1-800-667-3667 www.hanoverdoors.com, distributed by Richard Wilcox 1-800-667-1572 fax 905-625-0057 www.rwdoors.com.
.2 Alternative Materials: Approved by addendumin accordance with Instructions to Bidders.

.2 inPanels: flush, 50 mm thick, aluminum sheet face, flush back-up sheet, fibreglass or polyurethane to achieve RSI 1.5, finish to Aluminum Association Designation AA6063-T5 in finish designation AA-A31 clear anodized.

.3 Light: Dual pane sealed unit, mounted in hiimpact polystrene frame.

.4 Lock: built in deadlock.

.5 Latch: one point across door bar latch.

.6 Pull handle: provide pull handle on exterior of door.

.7 Weatherstripping: extruded neoprene at bottom and metal closure at jamb.

.8 Track: 75 x 2.75 mm galvanized steel.

.9 Brackets: 3.2 mm galvanized steel angle, adjustable, continuous.

.10 Hangers: perforated galvanized steel angle, 25 x 25 x 2.3 mm.

.11 Rollers: 75 mm diameter, ball bearing, solid tread, inner and outer ball races of hardened steel.

.12 Roller brackets: minimum 2.5 mm galvanized steel.

.13 Hinges: heavy duty, secure with rivets or self tapping screws.

.14 Shaft: 19 mm cold rolled steel, slotted and keyed.

.15 Counterbalance: counterweight system consisting of a series of weights mounted at manufacturer recommended locations. Weights to be attached to door panels by galvanized aircraft cable. Compression springs to be loaded into lift attachment. Weights to be joined by chain to weight box.

.16 Operation: steel chain pull rope.

.17 Track guard: 5 mm thick x 1500 mm high, formed steel, prime painted.

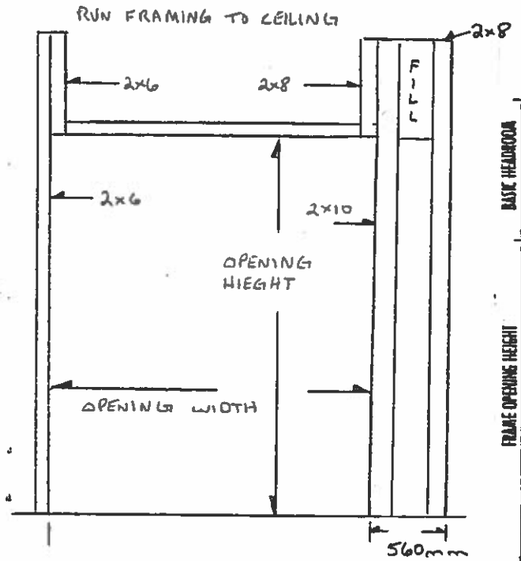
## PART 3 - EXECUTION

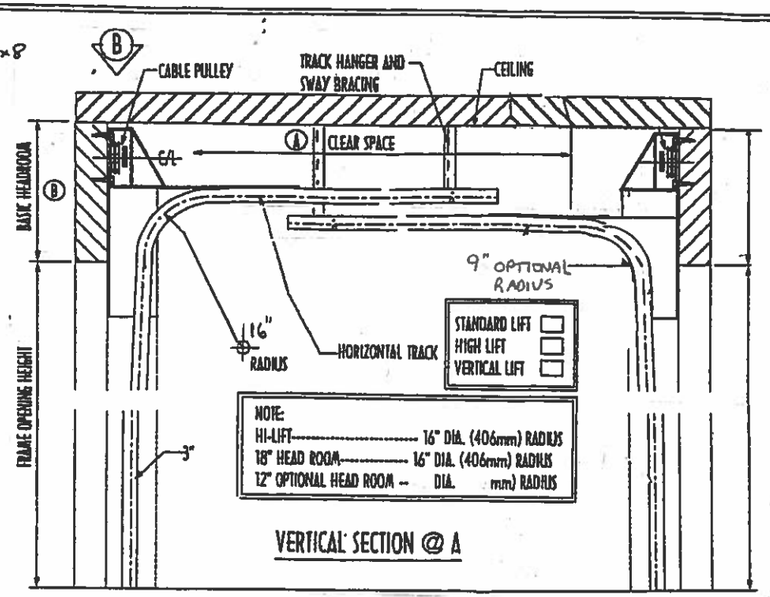
### 3.1 INSTALLATION

.1 Install door and hardware in accordance with manufacturer's instructions and templates.

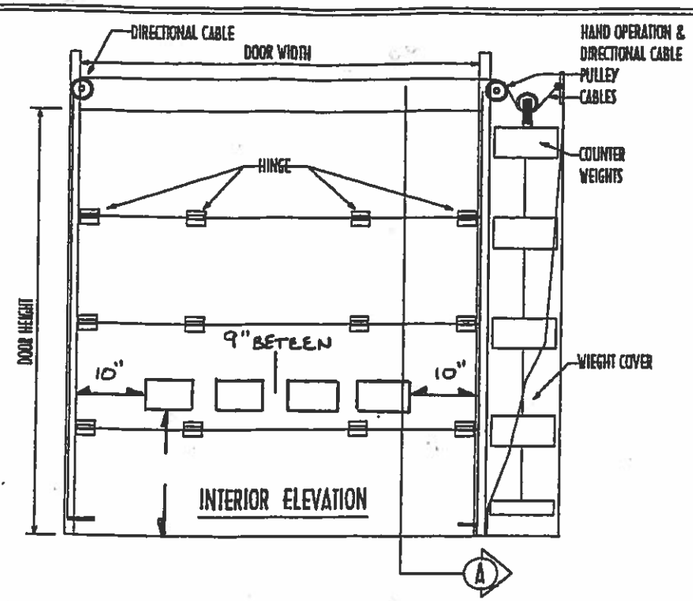
.2 Adjust and lubricate hardware.

END OF SECTION

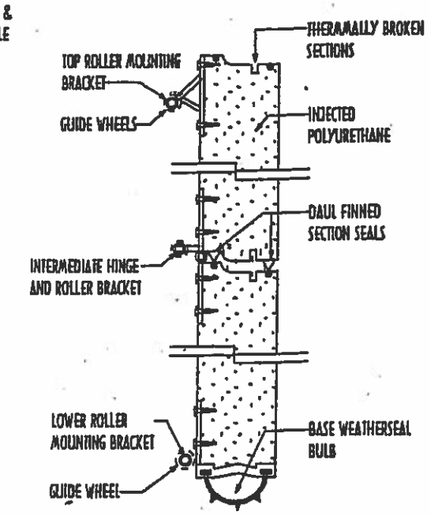



VERTICAL SECTION @ A




INTERIOR ELEVATION




SECTION @ A

## * AD.C.A. MOUNT DIMENSIONS

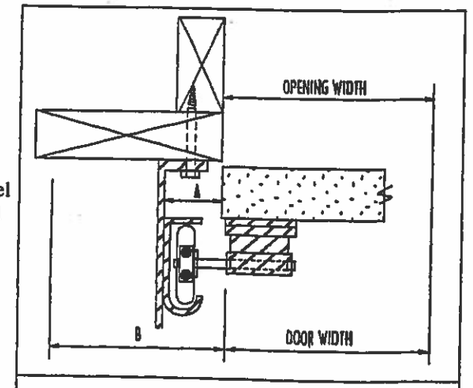
| DIMENSION @ | A | B | F |
|---|---|---|---|
| DOOR TYPE HARDWARE | 3" | 3" | 3" |
| STEEL FRAME | 2" 51mm | 4" 102mm | 2" 51mm |
| WOOD FRAME | 2" 51mm | 4" 102mm | 5" 127mm |
| ADJUSTABLE CONT. TRACK ANGLE | 2" 51mm | 5" 127mm | 3" 76mm |
| CONCRETE FRAME | 2" 51mm | 4" 102mm | 2" 51mm |
| WOOD FRAME | 2" 51mm | | 7" 178mm |
| | | | |

## DOOR SPECIFICATIONS

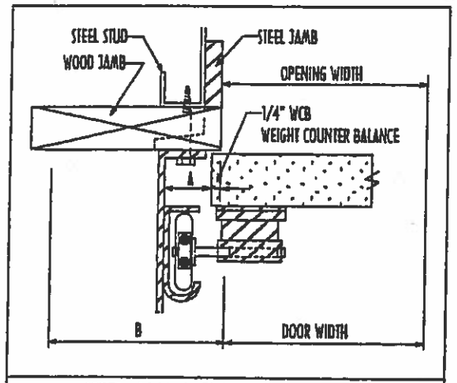
SIZE: 143.5" wide x 213" high
LIFTING MECHANISM: counter weight
GLAZING: placement as per drawing
Dual sealed pane lexan

ELECTRICAL: Not required
CLEARANCES: 18" headroom required
6" min left side room
21" min right side room
SERVICE RATING: counter weights not limited by cycle

PANELS: Richards-Wilcox ADV200-MR
2" thick R 18.28
face sheet thickness 0.016"
HARDWARE: Rollers are ¾"shaft with 3" steel wheel mounted on 6203 sealed bearing.
Hinges are custom made and powder coated.
Cable to be ¼" fibre core 6/18




WOOD FRAME MOUNT

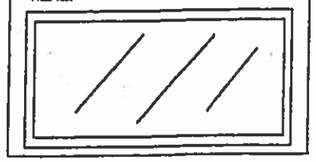



STEEL / WOOD FRAME MOUNT
VERTICAL LIFT

## GLAZING

NO GLAZING ☐
24"x12" STANDARD ☐
24"x6" OPT. (SECURITY) ☐

STANDARD 24" X 12" DUAL PANE SEALED UNIT, MOUNTED IN HIGH IMPACT, WHITE POLYSTYRENE FRAMES.



NOTE:
FRAME TO BE PLUMB AND SQUARE INSIDE FACE OF FRAMING TO BE FLUSH AND IN LINE FRAME MUST BE SECURELY ANCHORED TO BUILDING. SUPPLY AND INSTALLATION OF FRAME AND EXTENSIONS NOT IN R.W. CONTRACT.

## DOOR JAMB INSIDE DIMENSION SCHEDULE

| | INDICATE FEET / INCHES OR MILLIMETERS | SPECIAL CONDITIONS |
|---|---|---|
| A | | |
| B | | |
| C | | |
| D | | |
| E | | |
| F | | |
| G | MOUNT LEFT ☐ RIGHT ☐ | |
| H | MOUNT LEFT ☐ RIGHT ☐ | |
| I | MOUNT LEFT ☐ RIGHT ☐ | |
| | | |
| | | |

DOOR OPERATION : MANUAL ☐ ELECTRIC ☐

REVIEWED STAMP

HD HANOVER DOOR SYSTEMS
105 COMMERCE DRIVE STEINBACH, MANITOBA, CANADA 1-800-667-3667 1-204-326-3667

| | | |
|---|---|---|
| PROJECT: | | LOCATION: |
| CONTRACTOR: | | CONTACT PERSON: |
| ARCHITECT: | | PHONE # |
| SUBMITTIAL DATE: | | REVISED: |
| CONTRACT # | P.O. # | DWG. # |
| PRODUCED BY: | | CHECKED BY: |

* ADJUSTABLE CONTINUOUS ANGLE

# PART 1 - GENERAL

## 1.1 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00.

## 1.2 REFERENCES

.1 Canadian Standards Association (CSA) International
.1 AAMA/WDMA/CSA-101/I.S.2/A440-08, NAFS - North American Fenestration Standard/ Specification for Windows, Doors and Skylights.
.2 AAMA/WDMA/CSA-101/I.S.2/A440S1-09, Canadian Supplement to AAMA/WDMA/CSA-101/I.S.2/ A440-08, NAFS - North American Fenestration Standard/Specification for Windows, Doors and Skylights.
.3 CAN/CSA-A440.4-07(R2012), Window, Door, and Skylight Installation.

.2 Insulating Glass Manufacturers Association of Canada (IGMAC)
.1 North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use - 2004.

.3 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 CAN/CGSB-19.13-M87, Sealing Compound, One-Component, Elastomeric, Chemical Curing.
.4 CAN/CGSB-19.18-M87, Sealing Compound, One Component, Silicone Base, Solvent Curing.
.5 CAN/CGSB-19.24-M90, Multicomponent, Chemical-Curing Sealing Compound.

.4 American Society for Testing and Materials International, (ASTM)
.1 ASTM E1996-09, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
.2 ASTM F1233-08(2013), Standard Test Method for Security Glazing Materials and Systems.

.5 American Architectural Manufacturers Association (AAMA)
.1 AAMA 506-08, Voluntary Specifications for Impact and Cycle Testing of Fenestration Products.

.6 Underwriters Laboratories of Canada (ULC)
.1 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

## 1.3 TEST REPORT

.1 Submit test reports from approved independent testing laboratories, certifying compliance with specifications, for:
- .1 Windows classifications.
- .2 Anodized or Enamelled finish, weathering characteristics.
- .3 Air tightness level.
- .4 Specified DRWP.
- .5 Specified wind load-positive.
- .6 Specified snow load.
- .7 Design pressure-positive.
- .8 Design pressure-negative.
- .9 Specified wind load-negative.
- .10 Condensation resistance.
- .11 Insulating glass units.
- .12 Operating force.

## 1.4 STORAGE AND HANDLING

.1 Store and handle glazed units on site in accordance with IGMAC recommendations.

## 1.5 WARRANTY

.1 For the work of this Section 08 51 13 the 12 month warranty period prescribed in General Conditions GC3.13 is extended to three years.

.2 For insulating glass units the 12 month warranty period prescribed in General Conditions GC3.13 is extended to five years.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

.1 Aluminum alloy and finish: to AAMA/WDMA/CSA- 101/I.S.2/A440 and AAMA/WDMA/CSA-101/I.S.2/ A440S1, clear anodized, Class 2, minimum 50% recycled content.

.2 Fasteners: stainless steel, type 303.

.3 Thermal break: cork-neoprene composition or extruded or poured rigid polyvinyl chloride.

.4 Insulating glass unit: to CAN/CGSB-12.8, factory-sealed, double glazing units, outer and inner pane of clear, 6 mm tempered glass separated by 12.7 mm, low-E coating on the No. 3 surface, listed on Qualified Products List issued by the Interdepartmental Qualification Board for windows.
.1 Blast resistant film: ASTM F1233; 20 mil, 4 ply polyester film to withstand 3100 kPa (450 psi) breaking strength. Provide security sealant caulking bead around perimeter.

.5 Tempered glass: to CAN/CGSB-12.1, Type 2, Class B, Glazing Quality, 6 mm thick.

.6 Weatherstripping: to AAMA/WDMA/CSA-101/I.S.2/ A440 and AAMA/WDMA/CSA-101/I.S.2/A440S1.

.7 Sealant: multi-component, chemical curing to CAN/CGSB-19.24, Type 2; one component, elastomeric, chemical curing to CAN/CGSB- 19.13; or one component, silicone base, solvent curing to CAN/CGSB-19.18, Ecologo certified.
.1 Colour selected by Departmental Representative.
.2 Sealant primer: type recommended by sealant manufacturer.

.8 Joint filler: extruded, closed cell urethane, 20 Shore A hardness, 140 kPa, tensile strength, outsized 30 to 50%, CFC free.

.9 Glazing tape, blocks and splines: to AAMA/WDMA/ CSA-101/I.S.2/A440 and AAMA/WDMA/CSA-101/I.S.2/ A440S1.

.10 Insulation: expanded polystyrene to CAN/ULC- S701, Type 2, Ecologo certified.

## 2.2 FABRICATION

.1 Fixed windows (interior): to AAMA/WDMA/CSA-101/I.S.2/A440 and AAMA/WDMA/CSA-101/I.S.2/A440S1, Class LC, to the following performance levels.
.1 Air tightness level: fixed.
.2 Design pressure-positive: 1200 Pa.
.3 Design pressure-negative: 1200 Pa.
.4 Insulating glass units.

.2 Awning windows: to AAMA/ WDMA/CSA-101/I.S.2/A440 and AAMA/WDMA/CSA- 101/I.S.2/A440S1, Class LC, bottom projected, top hinged, opening out, heavy duty operators, to the following performance levels.
.1 Air tightness level: A3.
.2 Specified DRWP: 160 Pa.
.3 Design pressure-positive: 1200 Pa.
.4 Design pressure-negative: 1200 Pa.

.5 Condensation resistance: I58 to CSA A440.2/A440.3.
.6 Thermal transmittance: 0.29 (Imperial) to CSA A440.2/A440.3.
.7 Insulating glass units.
.8 Insect screens.
.9 Operating force:

.3 Face dimensions detailed are maximum permissible sizes.

.4 Units square and true with maximum tolerance of plus or minus 1.5 mm for units with a diagonal measurement of 1800 mm or less and plus or minus 3 mm for units with a diagonal measurement over 1800 mm.

.5 Form insulated aluminum panels to profiles indicated composed of 1.2 mm thick sheet aluminum faces laminated to 25 mm thick insulation.

.6 Extruded aluminum sills to profiles indicated.

.7 Form flashing to profiles indicated.

.8 Build in structural deflection allowance to prevent transfer of structural load to windows.

.9 Build thermal expansion allowance to withstand 85°C temperature difference without stressing sealants.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install in accordance with AAMA/WDMA/CSA-101/ I.S.2/A440, AAMA/WDMA/CSA-101/I.S.2/A440S1 and CAN/CSA-A440.4.

.2 Units plumb, square and level to 1:400; free of warp, twist and superimposed loads; weathertight.

.3 Arrange components to prevent abrupt variation in colour.

.4 Securely anchor units in place with concealed fasteners.

.5 Fix sills in place, level, with uniform wash to exterior. Install drip deflectors.

.6 Adjust opening sash and hardware to operate smoothly.

## 3.2 GLAZING

.1 Window: in accordance with AAMA/WDMA/CSA-101/ I.S.2/A440 and AAMA/WDMA/CSA-101/I.S.2/A440S1 and Glazing Recommendations for Sealed Insulating Glass Units.

.2 Provide security film on interior window in Control Room on the control room side.

## 3.3 SEALING

.1 Clean and dry joints.

.2 Mask adjoining surfaces.

.3 Insert joint filler 9.5 mm below joint surface.

.4 Prime joints when recommended by sealant manufacturer.

.5 Apply sealant to manufacturer's instructions.

.6 Form smooth concave surface.

.7 Remove masking tape and sealant smears from adjacent surfaces.

END OF SECTION

# PART 1 - GENERAL

## 1.1 REFERENCES

.1 Canadian Steel Door Manufacturers' Association (CSDMA)
.1 CSDMA Recommended Dimensional Standards for Commercial Steel Doors and Frames - 2009.

## 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for door hardware and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Samples:
.1 Submit for review and acceptance of each unit.
.2 Samples will be returned for inclusion into work.
.3 Identify each sample by label indicating applicable specification paragraph number, brand name and number, finish and hardware package number.
.4 After approval samples will be returned for incorporation in Work.

.4 Hardware List:
.1 Submit contract hardware list.
.2 Indicate specified hardware, including make, model, material, function, size, finish and other pertinent information.

.5 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.

.6 Manufacturer's Instructions: submit manufacturer's installation instructions.

## 1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for door hardware for incorporation into manual.

## 1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 16 00 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 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 in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Store and protect door hardware from nicks, scratches, and blemishes.
.3 Protect prefinished surfaces with wrapping.
.4 Replace defective or damaged materials with new.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

.1 Hinge: to ANSI/BHMA-A156.1-2013, Grade indicated, 626 satin chrome, use anti-friction (ball) bearing hinges with closers, one hinge for each 750 mm of door height, 101 mm hinges for 38 mm doors, 115 mm hinges on 45 mm doors, 125 mm hinges on 50 mm doors, button tips, non- rising removable pins unless indicated NRP on hardware schedule.
.1 Exterior:
.1 aring.Grade 1: A2111 - heavy weight, bronze, 4 ball

.2 Door closer: to ANSI/BHMA-A156.4-2013, Grade 1, C02041 top jamb mounting, and adaptor plates, surface closer, modern type with cover, sprayed enamel finish, metallic 689 aluminum, size to suit door width and mass, variable backcheck position valve as indicated.

.3 stop and shock absorber effective at all times.Overhead stop: to ANSI/BHMA- A156.8-2010, concealed slide type, Hold open and release by push and pull, except when exposed control is set in inactive position. Function C01511 Type 1 concealed.

.4 Exit device: to ANSI/BHMA-A156.3-2014, Grade 1, cross bar type design. All internal parts zinc dichromated to resist corrosion. Internal springs - compression type. Entrance by trim when latch bolt is released by key. Key removable only when locked.

.5 Exit Device Trim: to ANSI/BHMA-A156.6-2010, Type J401 - standard.

.6 Kick plate: to ANSI/BHMA-A156.6-2010, type stainless steel, 1.55 x 250 mm x door width, 3 bevelled edges.

.7 Threshold: to ANSI/BHMA-A156.21-2014, type J32190, 150 mm wide, aluminum serrated exposed surface, rigid PVC thermal break for exterior thresholds, square butt edges, finish 628.

.8 Sweep: densely compressed nylon filaments encased in clear anodized aluminum retainer, for mounting to door surface.
.1 5-315-9788 or 800-567-0123 www.kncrowder.com.Acceptable material: 'W-24S' manufactured by K.N. Crowder

.9 Weatherstrip: non-rigid, extruded vinyl chloride polymer or copolymer bulb or strip in aluminum strip at head and jamb, fixed:
.1 5-315-9788 or 800-567-0123 www.kncrowder.com.Acceptable material: 'W-14' manufactured by K.N. Crowder

## 2.2 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.

## 2.3 KEYING

.1 Doors to be keyed alike.

.2 Provide 3 keys for each door.

.3 Provide 6 master keys.

.4 Provide 2 grandmaster keys.

.5 Provide construction cores.

.6 Provide all permanent cores and keys to Departmental Representative.

## 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 metal 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 CSDMA Canadian Metric Guide for Steel Doors and Frames (Modular Construction).

.5 Where door stop contacts door pulls, mount stop to strike bottom of pull.

.6 Install key control cabinet.

.7 Use only manufacturer's supplied fasteners.
.1 Use of "quick" type fasteners, unless specifically supplied by manufacturer, is unacceptable.

.8 Remove construction cores when directed by Departmental Representative.
.1 Install permanent cores and ensure locks operate correctly.

## 3.2 ADJUSTING

.1 Adjust door hardware, 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: clean in accordance with Section 01 74 11.
.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.

## 3.4 PROTECTION

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

.2 Repair damage to adjacent materials caused by door hardware installation.

END OF SECTION

Heading 1

| | | | | |
|---|---|---|---|---|
| 1 | SGL | Door D101 | EXTERIOR / INFLATION ROOM | |
| 1 | SGL | Door D102 | EXTERIOR / INFLATION ROOM | |

4270 X 4270 X 25 X ALD X ALF
OVER-HEAD DOOR

Each Assembly to have:

| | | | | |
|---|---|---|---|---|
| 1 | EA | HARDWARE | BY DOOR & FRAME MANUFACTURE | UNK |

Heading 2

| | | | | |
|---|---|---|---|---|
| 1 | SGL | Door D103 | EXTERIOR / INFLATION ROOM | |

915 X 2135 X 45 X HMD X HMF X NONRTD

Each Assembly to have:

| | | | | |
|---|---|---|---|---|
| 3 | EA | HW HINGE | A156.1 A2111 114 X 114 NRP | 626 |
| 1 | EA | PANIC HARDWARE | A156.3 Type 1 Cross Bar | 626 |
| 1 | EA | RIM CYLINDER | IC Core c/w Temp Core | 626 |
| 1 | EA | FSIC CORE | Permanent Core | 626 |
| 1 | EA | OH STOP | A156.16 C01511 | 630 |
| 1 | EA | SURFACE CLOSER | A156.4 CO2041 - TOP JAMB | 689 |
| 1 | EA | TJ MOUNTING PLATE | A156.4 CO2041 | 689 |
| 1 | EA | KICK PLATE | A156.6 J102 200 X SIZE TO SUITE B4E | 630 |
| 1 | EA | WEATHER SEAL | A156.22 R3Y155 (2 H X 1 W) | AL |
| 1 | EA | DOOR SWEEP | A156.22 R3A155 X DR WIDTH | 628 |
| 1 | EA | THRESHOLD | A156.22 J32130 X OPENING WIDTH | AL |

Heading 3

| | | | | |
|---|---|---|---|---|
| 1 | SGL | Door D104 | EXTERIOR / CONTROL ROOM | |

915 X 2135 X 45 X HMD X UNK X NONRTD

Each Assembly to have:

| | | | | |
|---|---|---|---|---|
| 3 | EA | HW HINGE | A156.1 A2111 114 X 114 NRP | 626 |
| 1 | EA | PANIC HARDWARE | A156.3 Type 1 Cross Bar | 626 |
| 1 | EA | RIM CYLINDER | IC Core c/w Temp Core | 626 |
| 1 | EA | FSIC CORE | Permanent Core | 626 |
| 1 | EA | OH STOP | A156.16 C01511 | 630 |
| 1 | EA | SURFACE CLOSER | A156.4 CO2041 - TOP JAMB | 689 |
| 1 | EA | TJ MOUNTING PLATE | A156.4 CO2041 | 689 |
| 1 | EA | KICK PLATE | A156.6 J102 200 X SIZE TO SUITE B4E | 630 |
| 1 | EA | WEATHER SEAL | A156.22 R3Y155 (2 H X 1 W) | AL |
| 1 | EA | DOOR SWEEP | A156.22 R3A155 X DR WIDTH | 628 |
| 1 | EA | THRESHOLD | A156.22 J32130 X OPENING WIDTH | AL |

Heading 4

1 SGL Door D105 EXTERIOR / HOGEN ROOM
915 X 1352 X 45 X HMD X HMF X NONRTD

Each Assembly to have:

| | | | | |
|---|---|---|---|---|
| 3 | EA | HW HINGE | A156.1 A2111 114 X 114 NRP | 626 |
| 1 | EA | PANIC HARDWARE | A156.3 Type 1 Cross Bar | 626 |
| 1 | EA | RIM CYLINDER | IC Core c/w Temp Core | 626 |
| 1 | EA | FSIC CORE | Permanent Core | 626 |
| 1 | EA | OH STOP | A156.16 C01511 | 630 |
| 1 | EA | SURFACE CLOSER | A156.4 CO2041 - TOP JAMB | 689 |
| 1 | EA | TJ MOUNTING PLATE | A156.4 CO2041 | 689 |
| 1 | EA | KICK PLATE | A156.6 J102 200 X SIZE TO SUITE B4E | 630 |
| 1 | EA | WEATHER SEAL | A156.22 R3Y155 (2 H X 1 W) | AL |
| 1 | EA | DOOR SWEEP | A156.22 R3A155 X DR WIDTH | 628 |
| 1 | EA | THRESHOLD | A156.22 J32130 X OPENING WIDTH | AL |

END OF SECTION

# PART 1 - GENERAL

## 1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
.1 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
.2 ASTM B221-14, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

.2 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-93.1-M85, Sheet Aluminum Alloy, Prefinished, Residential.

## 1.2 SUBMITTALS

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

.2 Product Data:
.1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit WHMIS MSDS - Material Safety Data Sheets.

.3 Shop Drawings:
.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
.2 Indicate fabrication and erection details, including anchorage, accessories, and finishes.

.4 Samples:
.1 Submit duplicate samples of louvre showing colour and finish.
.2 Show frame detail, screening and finish.
.3 Where colour is not indicated, submit manufacturer's standard colours to Departmental Representative for selection.

.5 Quality Assurance Submittals: submit following in accordance with Section 01 33 00.
.1 Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

## 1.3 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 01 16 00.
.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
.3 Deliver materials to the site in undamaged condition.

.2 Storage and Protection:
.1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
.2 Protect louvres from nicks, scratches, and blemishes.
.3 Replace defective or damaged materials with new.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Aluminum sheet: to ASTM B209, with temper as required for forming utility sheet. Finish: clear anodized.

.2 Aluminum extrusions: to ASTM B221 alloy 6063- T5.

.3 Mullion louver:
.1 Description: Double drainable fixed extruded mullion louvre.
.2 Depth: 100 mm.
.3 Frame and mullion: 2 mm thick aluminum.
.4 Blade: 2 mm thick fixed blades.

.4 Soffit louvre:
.1 Description: Single drainable fixed extruded mullion louvre.
.2 Depth: 25 mm.
.3 Frame and mullion: 1.6 mm thick aluminum.
.4 Blade: 1.6 mm thick fixed blades.

.5 Screens:
.1 Birdscreens: expanded and flattened aluminum wire cloth secured to 1.4 mm thick extruded aluminum frame mitered at corners and secured with corner locks, 15.9 mm size mesh, 1.27 mm thick wire with.

## 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 louvres where indicated.

.2 Set adjustable louvre blades for uniform alignment in open and closed positions.

.3 Adjust louvres so moving parts operate smoothly.

.4 Attach bird screen to inside face of louvre or vent.

.5 Repair damage to louvres to match original finish.

### 3.3 CLEANING

.1 Proceed in accordance with Section 01 74 11.

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

### 3.4 PROTECTION

.1 Paint wood or other absorptive materials that may become repeatedly wet and in contact with metal with two coats of aluminum paint or coat of heavy-bodied bituminous paint.

END OF SECTION

# PART 1 - GENERAL

## 1.1 REFERENCES

.1 ASTM International
.1 ASTM C473-15, Standard Test Methods for Physical Testing of Gypsum Panel Products.
.2 ASTM C475/C475M-15, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
.3 ASTM C514-04(2014), Standard Specification for Nails for the Application of Gypsum Board.
.4 ASTM C840-13, Standard Specification for Application and Finishing of Gypsum Board.
.5 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.
.6 ASTM C1047-14a, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
.7 ASTM C1280-13a, Standard Specification for Application of Gypsum Sheathing.
.10 ASTM C1396/C1396M-14a, Standard Specification for Gypsum Board.
.11 ASTM D2394-05(2011), Standard Test Methods for Simulated Service Testing of Wood and Wood-Base Finish Flooring.

.2 Association of the Wall and Ceilings Industries International (AWCI)
.1 AWCI Levels of Gypsum Board Finish 101a-97.

## 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

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

.3 Samples:
.1 Submit for review and acceptance of each unit.
.2 Samples will be returned for inclusion into work.

## 1.3 DESIGN REQUIREMENTS

.1 Partition assembly to be non-combustible construction.

## 1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store and handle materials in accordance with Section 01 61 00 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 gypsum board assemblies materials level in dry location 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 degrees C minimum, 21 degrees C maximum for 48 hours prior to and during application of gypsum boards and joint treatment, and for 48 hours minimumafter completion of joint treatment.

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

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

# PART 2 - PRODUCTS

## 2.1 MATERIALS

.1 Standard board: to ASTM C1396/C1396M, abuse-resistant panels with water and mould-resistant core encased in paper faces, maximum practical length, ends square cut, edges squared, minimum 13 mm thick unless indicated otherwise.

.2 Resilient clips or drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.

.3 Nails: to ASTM C514.

.4 Steel drill screws: to ASTM C1002.

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

.6 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, metal, zinc-coated by electrolytic process, 0.5 mm base thickness, perforated flanges, one piece length per location.

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

.8 Joint compound: to ASTM C475/C475M, asbestos-free.

.9 Joint tape: to ASTM C475/C475M.
.1 Paper tape for standard gypsum board.

## 2.2 FINISHES

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

# PART 3 - EXECUTION

## 3.1 EXAMINATION

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

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

.2 Do application of gypsum sheathing to ASTM C1280.

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

.4 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.

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

.6 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers,and grilles.

.7 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.

.8 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.

.9 Furr openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.

.10 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

## 3.3 APPLICATION

.1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical 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 prior to application of walls to ASTM C840.
  - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.

.3 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.

.4 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes require vertical application.

.5 Install gypsum board with face side out.

.6 Do not install damaged or damp boards.

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

## 3.4 INSTALLATION

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

.2 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated.

.3 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.

.4 Construct control joints of two back-to-back casing beads set in gypsum board facing and supported independently on both sides of joint.

.5 Install control joints straight and true.

.6 Splice corners and intersections together and secure to each member with 3 screws.

.7 Install access doors to electrical and mechanical fixtures specified in respective sections.
   .1 Rigidly secure frames to furring or framing systems.

.8 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.

.9 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:
   .1 Levels of finish:
      .1 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges.

.10 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.

.11 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.

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

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

.14 Apply one coat of white primer sealer over surface to be textured. When dry apply textured finish in accordance with manufacturer's instructions.

## 3.5 CLEANING

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
.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 gypsum board assemblies installation.

END OF SECTION

# PART 1 - GENERAL

## 1.1 RELATED REQUIREMENTS

.1 Section 07 92 00 - Joint Sealants.

.2 Section 09 21 16 - Gypsum Board Assemblies.

## 1.2 REFERENCES

.1 ASTM International
.1 ASTM C645-14e1, Standard Specification for Nonstructural Steel Framing Members.

## 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for metal framing and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Samples:
.1 Submit duplicate 300 mm long samples of non-structural metal framing.

## 1.4 QUALITY ASSURANCE

.1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.

.2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

.3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

.4 Partition assembly to be fire resistance rated.

## 1.5 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:
.1 Store materials in dry location 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, roll formed from 0.91 mm thickness hot dipped galvanized steel sheet, for screw attachment of gypsum board.
.1 Knock-out service holes at 460 mm centres.

.2 Header supports: C-purlins in size to suit wall studs.

.3 Floor and ceiling tracks: to ASTM C645, in widths to suit stud sizes, 32 mm flange height.

.4 Metal channel stiffener: 1.4 mm thick cold rolled steel, coated with rust inhibitive coating.

.5 Insulating strip: rubberized, moisture resistant 3 mm thick cork strip, 12 mm wide, with self sticking adhesive on one face, lengths as required.

# 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 non-structural metal framing application 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 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 Provide header supprots above and below all openings including penetrations.

.9 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified.
.1 Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.

.10 Install heavy gauge single jamb studs at openings.

.11 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.

.12 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.

.13 Provide 40 mm stud or furring channel secured between studs for attachment of fixtures attached to steel stud partitions.

.14 Install steel studs or furring channel between studs for attaching electrical and other boxes.

.15 Extend partitions to ceiling height except where noted otherwise on drawings.

.16 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs.
.1 Use 50 mm leg ceiling tracks. Use double track slip joint as indicated.

.17 Install continuous insulating strips to isolate studs from uninsulated surfaces.

## 3.3 CLEANING

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

## 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 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for resilient base, adhesive, primer and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit 2 copies of WHMIS MSDS.

.3 Samples:
.1 Submit for review and acceptance of each unit.
.2 Samples will be returned for inclusion into work.
.3 Submit 300 mm long base.

## 1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00.

.2 Operation and Maintenance Data: submit operation and maintenance data for resilient base for incorporation into manual.

## 1.3 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:
.1 Store materials in dry location 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.

## 1.4 SITE CONDITIONS

.1 Ensure high ventilation rate, with maximum outside air, during installation.
.1 Vent directly to outside.

.2 Do not let contaminated air recirculate through a district or whole building air distribution system.
.3 Maintain extra ventilation for 1 month minimum after building occupation.

## PART 2 - PRODUCTS

### 2.1 ACCESSORIES

.1 Resilient base: to ASTM F1861-08(2012)e1, continuous, top set, complete with premoulded end stops and external corners:
.1 Type: vinyl, 2.0 mm thick.
.2 Style: Allow for coved and toe types.
.3 Height: 101.6 mm.
.4 Lengths: cut lengths minimum 2400 mm.
.5 Colour: as selected by Departmental Representative from manufacturer's standard colour range.

.2 Primers and adhesives: of types recommended by resilient flooring manufacturer for specific material on applicable substrate, above, on or below grade.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

.1 Examine conditions, substrates and work to receive work of this Section.

.2 Verification of Conditions: 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 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 PREPARATION

.1 Prepare for installation in accordance with manufacturer's written recommendations.

.2 Prime gypsum board wall as recommended by resilient flooring manufacturer's written instructions.

## 3.3 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 premoulded end pieces at flush door frames.

.7 Cope internal corners using premoulded corner units for right angle external corners and formed straight base material for external corners of other angles.

## 3.4 CLEANING

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

## 3.5 PROTECTION

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

.2 Repair damage to adjacent materials caused by resilient flooring installation.

END OF SECTION

# PART 1 - GENERAL

## 1.1 REFERENCES

.1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
.1 Material Safety Data Sheets (MSDS).

.2 The Master Painters Institute (MPI)
.1 Architectural Painting Specification Manual - current edition.
.2 Maintenance Repainting Manual - current edition.

## 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for paint and coating products and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit 2 copies of WHMIS MSDS.

.3 Samples:
.1 Submit for review and acceptance of each unit.
.2 Samples will be returned for inclusion into work.
.3 Submit duplicate 200 x 300 mm sample panels of each paint with specified paint or coating in colours, gloss/sheen and textures required to MPI Painting Specification Manual standards.

.4 Certificates: submit 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, store and handle materials in accordance with Section 01 16 00 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 Provide and maintain dry, temperature controlled, secure storage.
.2 Store painting materials and supplies away from heat generating devices.
.3 Store materials and equipment in well ventilated area within temperature as recommended by manufacturer.

.4 Fire Safety Requirements:
.1 Supply 1 9 kg Type ABC fire extinguisher adjacent to storage area.
.2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
.3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

## 1.4 SITE CONDITIONS

.1 Heating, Ventilation and Lighting:
.1 Ventilate enclosed spaces in accordance with Section 01 51 00.
.2 Co-ordinate use of temporary ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.
.3 Provide minimum lighting level of 323 Lux on surfaces to be painted.

.2 Temperature, Humidity and Substrate Moisture Content Levels:
.1 Apply paint finishes when ambient air and substrate temperatures at location of installation can be satisfactorily maintained during application and drying process, within MPI and paint manufacturer's prescribed limits.
.2 Test concrete, masonry and plaster surfaces for alkalinity as required.
.3 Apply paint to adequately prepared surfaces, when moisture content is below paint manufacturer's prescribed limits.

.3 Additional application requirements:
.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.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Supply paint materials for paint systems from single manufacturer.

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

.3 Materials in accordance with MPI - Architectural Painting Specification Manual and MPI - Maintenance Repainting Manual "Approved Product" listing.

.4 Colours:
.1 Submit proposed Colour Schedule to Departmental Representative for review.
.2 Base colour schedule on selection of 5 base colours and 3 accent colours.

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

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

| Gloss Level-Category | Gloss @ 60 degrees | Sheen @ 85 degrees |
|---|---|---|
| Gloss Level 1 - Matte Finish | Max. 5 | Max. 10 |
| Gloss Level 2 - Velvet | Max.10 | 10 to 35 |
| Gloss Level 3 - Eggshell | 10 to 25 | 10 to 35 |
| Gloss Level 4 | 20 to 35 | min. 35 |

- Satin
Gloss Level 5 35 to 70
- Semi-Gloss
Gloss Level 6 70 to 85
- Gloss
Gloss Level 7 More than 85
- High Gloss

.2 Gloss level ratings of painted surfaces to be determined.

.7 Exterior painting:
.1 Concrete Vertical Surfaces: (including horizontal soffits)
.1 EXT 3.1A - Latex finish.

.8 Interior painting:
.1 Plaster and gypsum board: gypsum wallboard, drywall, "sheet rock" type material, etc.
.1 INT 9.2A - Latex finish (over latex sealer).
.2 INT 9.2C - Alkyd finish (over latex sealer).
.3 INT 9.2M - Institutional low odour/low VOC finish.

## PART 3 - EXECUTION

### 3.1 GENERAL

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

.2 Perform preparation and operations for interior painting in accordance with MPI - Architectural Painting Specifications Manual and MPI - Maintenance Repainting Manual except where specified otherwise.

### 3.2 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.

## 3.3 PREPARATION

.1 Protection of in-place conditions:

.1 Protect 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.

.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.

.4 Clean and prepare surfaces in accordance with MPI - Architectural Painting Specification Manual and MPI - Maintenance Repainting Manual specific requirements and coating manufacturer's recommendations.

.5 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.

.6 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.

.1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.

.2 Apply wood filler to nail holes and cracks.

.3 Tint filler to match stains for stained woodwork.

.7 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.

.8 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.

.9 Touch up of shop primers with primer as specified.

## 3.4 APPLICATION

.1 Paint only after prepared surfaces have been accepted by Departmental Representative.

.2 Use method of application approved by Departmental Representative.
.1 Conform to manufacturer's application recommendations.

.3 Apply coats of paint in continuous film of uniform thickness.
.1 Repaint thin spots or bare areas before next coat of paint is applied.

.4 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.5 Sand and dust between coats to remove visible defects.

.6 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as projecting ledges.

.7 Touch-up: Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.

## 3.5 CLEANING

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

.3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

.4 Place paint defined as hazardous or toxic waste, including tubes and containers, in containers or areas designated for hazardous waste.

END OF SECTION

## PART 1 - GENERAL

### 1.1 PRODUCT DATA SHEETS

.1 Submit product data sheets of each item specified, in accordance with Section 01 33 00.

## PART 2 - PRODUCTS

### 2.1 MATERIAL

.1 Galvanized sheet steel: to ASTM A653/A653M-15, commercial grade CS type A, stretcher levelled, Z275 zinc coating designation, minimum 25% recycled content.

### 2.2 PORTABLE FIRE EXTINGUISHERS

.1 Extinguishers shall be ULC listed and labelled.

.2 Provide type 6A80BC rated multi-purpose dry chemical extinguishers of 4.53 kg capacity where indicated on drawings.

.3 Provide wall brackets and mount extinguishers 1 to 1.5 m above floor.

### 2.2 FABRICATION

.1 Metal wall cladding: Fabricate galvanized steel wall cladding minimum 0.455 mm unless indicated otherwise.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install items plumb, straight and level to a tolerance of 1:500.

.2 Securely fix items in place with concealed fasteners.

.3 Install galvanized steel wall cladding in inflation room around hydrogen storage tank from top of concrete slab to 600 mm above top of tank.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 74 11 - Cleaning

.3 Section 01 77 00 - Closeout Procedures

.4 Section 01 78 00 - Closeout Submittals

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop drawings; submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.3 Shop drawings to show:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.4 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

.5 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.

.6 Closeout Submittals:

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

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

.3 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.

.4 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.

.5 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.

.6 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Make changes as required and re-submit as directed by Departmental Representative.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.9 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.

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

## 1.3 QUALITY ASSURANCE

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

.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

## 1.4 MAINTENANCE

.1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals 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.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

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

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

PART 2 - EXECUTION

2.1 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 99 - Painting for Minor Works.

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

.3 Restore to new condition, finishes which have been damaged.

2.2 CLEANING

.1 Clean interior and exterior of all systems including strainers. Vacuum interior of ductwork and hvac systems.

2.3 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

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

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

2.4 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.

## 2.5 PROTECTION

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

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 01 35 29 - Health and Safety

.2 Section 01 33 00 - Submittal Procedures

.3 Section 01 74 11 - Cleaning

.4 Section 01 78 00 - Closeout Submittals

.5 Section 23 05 01 - Installation of Pipework

### 1.2 REFERENCES

.1 ASTM International Inc.

.1 ASTM D1784 (2011), Standard Specification for Rigid Poly (Vinyl Chloride) PVC Compounds and Chlorinated Poly (Vinyl Chloride) CPVC compounds

.2 ASTM D2467 (2015), Standard Specification for Poly (Vinyl Chloride) PVC Plastic Pipe Fittings, Schedule 80

.3 ASTM F437 (2015), Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe Fittings Schedule 80.

.4 ASTM F439 (2013), Standard Specification for Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe Fittings Schedule 80.

.5 ASTM F441/441M (2015), Standard Specification for Chlorinated Poly (Vinyl Chloride) CPVC Plastic Pipe Schedules 40 and 80.

.2 National Sanitation Foundation (NSF)

.1 NSF61 Potable Water Listing

.3 Canadian Standards Association (CSA International)

.1 CSA B137.6 CPVC Pipe, Tubing and Fittings for both Hot and Cold Water Distribution Systems

.4 Department of Justice Canada (Jus)

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

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

.1 Material Safety Data Sheets (MSDS).

.6 Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).

.1 MSS-SP-67-02a, Butterfly Valves.

.2 MSS-SP-70-06, Gray Iron Gate Valves, Flanged and Threaded Ends.

.3 MSS-SP-71-05, Gray Iron Swing Check Valves, Flanged and Threaded Ends.

.4 MSS-SP-80-03, Bronze Gate, Globe, Angle and Check Valves.

.7 National Research Council (NRC)/Institute for Research in Construction

.1 NRCC 38728, National Plumbing Code of Canada (NPC) - 2015.

.8 Transport Canada (TC)

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

## 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Closeout Submittals:

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

## 1.4 DELIVERY, STORAGE AND HANDLING

.1 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

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

.3 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal regulations.

## PART 2 - PRODUCTS

### 2.1 PIPING

.1 Non-potable water systems, within building.

.1 Above ground: NPS ½ to 3 CPVC to DR11 with IPS outside dimensions: CSA B 137.6 and ASTM D1784 cell class of 24447

### 2.2 FITTINGS

.1 CPVC Fittings: To CSA B137.6 and ASTM D1784 cell class of 24447

.2 CPVC Flanges: to ASTM F1970

.1 Flanged CPVC: 1034 kPa at 23C, 517 kPa at 60C not to be used above 60C

.2 Bolt hole patterns to ANSI B16.1 class 125

.3 Transition points: as recommended by manufacturer

.4 PEX compression fittings with PEX tubing

### 2.3 JOINTS

.1 Rubber gaskets, elastomeric, full face, hardness of 50 to 70 durometer

.2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.

.3 Teflon tape: for threaded joints.

.4 Solder: 95/5 tin copper alloy lead free for copper pipe

.5 Solvent weld with primer to ASTM F493

### 2.4 PVC SCHEDULE 40 BALL VALVES

.1 NPS 2 and under:

.1 Provide one-piece molded PVC body, threaded or socket ends

.2 In accordance with ASTM D2466, ASTM D1784 and UL Listed 94V-0

.3 Handle cap - ABS, Screw - Zinc plated steel, Handle - ABS, O Ring - EDPM, Seat Seal PTFE or EDPM, Ball - OVC, Body - PVC

.4 Maximum temperature 60C, do not test with compressed air

### 2.5 PVC SCHEDULE 40 IN-LINE CHECK VALVE

.1 NPS 2 and under:

.1 Provide one-piece molded PVC body, threaded or socket ends:

.2 EPDM Seat

.3 Stainless steel spring opens at 2 psi (55 Inch of water column)

.4 Maximum temperature 60C, do not test with compressed air

## 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 NPC, local authority having jurisdiction

.2 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.

.3 Assemble piping using fittings manufactured to ANSI standards.

.4 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.

### 3.3 VALVES

.1 Isolate equipment, fixtures and branches with ball valves, or as indicated.

### 3.4 PRESSURE TESTS

.1 Conform to requirements of Section 21 05 01 - Common Work Results for Mechanical.

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

### 3.5 FLUSHING AND CLEANING

.1 Flush entire system for 8 h. Ensure outlets flushed for 2 hours, and to requirements of Departmental Representative

### 3.6 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 air chambers, expansion compensators are installed properly.

## 3.7 START-UP

.1 Timing: start up after:

.1 Pressure tests have been completed.

.2 Flushing and Cleaning procedures have been completed.

.3 Certificate of static completion has been issued.

.2 Provide continuous supervision during start-up.

.3 Rectify start-up deficiencies.

## 3.8 PERFORMANCE VERIFICATION

.1 Scheduling:

.1 Verify system performance after pressure and leakage tests and cleaning are completed, as required per the Departmental Representative.

.2 Procedures:

.1 Verify that flow rate and pressure meet Design Criteria.

.3 Reports:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, using report forms as specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.

.2 Verify water flow and pressure tests conducted on water service, demonstrating adequacy of flow and pressure.

## 3.9 OPERATION REQUIREMENTS

.1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 05 - Installation of Pipework.

.2 Operation, include:

.1 Cleaning materials and schedules.

.2 Repair and maintenance materials and instructions.

## 3.10 CLEANING

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED SECTION

.1 Section 01 33 00- Submittal Procedures.

.2 Section 01 35 29 - Health and Safety.

.3 Section 01 74 11 -Cleaning.

.4 Section 01 91 13- General Commissioning.

### 1.2 REFERENCES

.1 American Society for Testing and Materials International, (ASTM).

.1 ASTM D638(2011), Standard Test for Tensile Properties of Plastics.

.2 ASTM D792 (2013), Standard Test Methods for Density and Gravity of Plastics by Displacement.

.3 ASTM D1238, Flow Rates of Thermoplastics by Extrusion Plastomer.

.4 ASTM D1598(2015), Standard Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.

.5 ASTM 01599, Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings.

.6 ASTM D1693(2015), Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.

.7 ASTM D2290(2012), Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe by Split Disk Method.

.8 ASTM 02837, Standard Test Method for Obtaining Hydrostatic Design Basis for thermoplastic Pipe Materials.

.9 ASTM 03350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

.10 ASTM F714, Standard Specifications for Polyethylene Plastic Pipe Based on Outside Diameter.

.11 ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.

.12 ASTM F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

.2 American Water Works Association, (AWWA).

.1 AWWA C906, Polyethylene Pressure Pipe and Fittings Joining Polyethylene Pipe and Fittings.

.3 Plastics Pipe Institute, (PPI)

.1 PPI Handbook of Polyethylene Pipe- 2009 (2nd Edition)

## 1.3 SUBMITTALS

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

## 1.4 HEALTH AND SAFETY

.1 Do construction occupational health and safety in accordance with Section 01 35 29 Health and Safety Requirements.

## 1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 11 Cleaning.

## 1.6 DELIVERY, STORAGE, AND HANDLING

.1 The customer shall Inspect all pipe and accessories for shortages, loss or damage upon receipt of the shipped material at the time of unloading, recording this information directly on the waybill received from the carrier.

.2 Acceptable limits for cuts, gouges or scratches are as follows:

.1 Pipe internal surface shall be free of all cuts, gouges or scratches.

.3 Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe.

.4 Stacked pipe shall be stored in accordance with manufacturer's recommendations.

.5 Pipe shall be handled using suitable slings or lifting equipment. Also, pipe shall not be dragged over sharp objects or surfaces.

# PART 2 - PRODUCTS

## 2.1 GENERAL

.1 The pipe shall be factory insulated complete with integral conduit for electric heat trace cable and black polyethylene jacket with UV inhibitor.

## 2.2 PIPE MATERIAL

.1 The resin compound shall be qualified to meet the following:

.1 The pipe shall be made from materials meeting the designations of PE3608 or PE4710 as assigned by the Plastic Pipe Institute.

.2 The pipe shall be made from a polyethylene resin compound with a minimum cell classification of 344464C for PE3608 and 445474C for PE4710 as defined in ASTM D3350.

.3 The Hydrostatic Design Stress (HDS) at 23"C(73.4"F) shall be 800 psi for resin designated by PE3608 and 1,000 psi for resin designated by PE4710 (PPI TR-4, Table 1.A.8 for PE3608, Table 1.A.13 for PE4710}.

.2 The pipe material shall contain 2%-2 Y.% well dispersed carbon black. Additives (which can be conclusively proven not to be detrimental to the pipe may also be used, provided the pipe produced meets the requirements of this specifications.

.3 The pipe shall contain no recycles compound except that which is generated in the manufacturer's own plant, from resin of the same specification and from the same raw material supplier.

## 2.3 PIPE DESIGN

.1 The pipe shall be designed in accordance with the relationships of the ISO modified formula as stated in ASTM F714.

.2 The design pressure rating shall be derived using an HDS of 800 psi at 23"C (73.4"F) for a PE3608 designation and an HDS of 1,000 psi at 23•c (73.4"F) for a PE 4710 designation, resulting in the following maximum continuous Working Pressure Rating (WPR, psi) for the respective pipe classes:

.3 Overpressure limits for pipe shall be allowed a specific magnitude greater than the maximum continuous working pressure of the pipe. Simple guidelines for frequent and frequent and infrequent surge conditions are as follows:

.1 Frequent surge pressures shall be permitted where the magnitude of the total pressure is not greater than 150% of the maximum allowable continuous working pressure of the pipe. Frequent surge pressures are typically generated by normal pump flow changes and valve operations.

.2 Infrequent surge pressures shall be permitted where the magnitude of the total pressure is not greater than 200% of the maximum allowable continuous working pressure of the pipe. Infrequent surge pressures are described as pump power-out shut down or quick emergency valve closures.

## 2.4 PIPE FITTINGS

.1 HDPE pipe flange assemblies shall meet the following requirements:

.1 Solid HDPE stub ends or flange adapters shall be made from the same resin grade (PE3608 or PE4710) and shall be formed using extrusion or molding methods.

.2 Flange rings shall be ductile iron (ASTM A536-2014) made to Class 150, ANSI 816.1/816.5 dimensional standards with exceptions.

.3 Methods for flange assembly, gasket selection and bolt torque application shall be as outlined in PPI Technical Note TN-38.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Installation of pre-insulated piping and fittings shall be as per manufacturer's recommendations.

.2 Buried HDPE pipe and fittings shall be installed in accordance with ASTM D2321 or ASTM D2774 for pressure systems and AWWA Manual of Practice M55 Chapter 7.

.3 Pipe embedment - Embedment material should be Class I, Class 11, or Class Ill, materials as defined by ASTM D2321 Section 6.

.4 Bedding: Pipe bedding shall be in conformance with ASTM D2321 Section 8. Compaction rates should be as specified in ASTM D2321.

.5 Backfilling to be completed as per Section 31 23 33 01 - Excavating, Trenching, And Backfilling.

## 3.2 JOINING METHODS

.1 Butt Fusion:

.1 The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42.

.2 Mechanical:

.1 Mechanical connection of HDPE to auxiliary equipment such as valves, and fittings shall use mechanical joint adapters and other devices in conformance with the PPI Handbook of Polyethylene Pipe, Chapter 9 and AWWA Manual of Practice M55, Chapter 6.

.2 Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or a fittings, or to a transition to another material. The use of slab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.

.3 Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.

.4 Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.

.5 Mechanical couplings shall be made by qualified technicians.

## 3.3 PRESSURE TESTING

.1 Precautions:

.1 The pipe system under test and any closures in the test section should be restrained against any unanticipated separation during pressurization. Refer to ASTM F2164.

.2 Test equipment should be examined before pressure is applied to ensure that it is tightly connected. All low pressure filling lines and other items not subject to the test pressure should be disconnected or isolated.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 01 35 29 - Health and Safety.

.3 Section 01 74 11 - Cleaning.

.4 Section 01 91 13 - General Commissioning.

### 1.2 REFERENCES

.1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME).

.1 ASME B31.3 (2014) - Process Piping.

.2 Bureau de normalisation du Quebec (BNQ)

.1 CAN/BNQ 1784-000/2007 Canadian Hydrogen Installation Code.

.3 National Fire Protection Association (NFPA)

.1 NFPA 2 (2016) - Hydrogen Technologies Code.

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

.1 Material Safety Data Sheets (MSDS).

### 1.3 SUBMITTALS

.1 Submit shop drawings, product data, and certifications including manufacturer's recommendations in accordance with Section 01 33 00.

.2 Product data:

.1 Hydrogen tubing & manufacturer's instructions.

.2 Hydrogen tubing mounts & manufacturer's recommendations.

.3 Hydrogen fittings & manufacturer's instructions.

.3 Certifications:

.1 Swagelok certificate(s) of completion for all installation technician(s).

### 1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 7411- Cleaning.

## PART 2 - PRODUCTS

### 2.1 HYDROGEN TUBING

.1 Type 316 seamless stainless steel tubing, fully annealed, to ASTM A269 or A213, hardness 90 HRB or less.

.2 Diameter as noted on drawings:

.1 1/4" (6mm) OD- Minimum tube wall thickness 0.035", working pressure 35,100 kPa (5100 psi).

.2 1/2" (12mm) OD- Minimum tube wall thickness 0.049", working pressure 25,500 kPa (3700 psi).

.3 3/4" (19mm) OD- Minimum tube wall thickness 0.065", working pressure 22,700 kPa (3300 psi).

.4 1" (25mm) OD- Minimum tube wall thickness 0.083", working pressure 23,300 kPa (3100 psi).

.5 Manufacturer: Swagelok. No equals will be accepted.

### 2.2 HYDROGEN TUBING MOUNTS

.1 Support body: Polypropylene.

.2 Cover plate: Type 304 stainless steel.

.3 Support bolts: Type 304 stainless steel, hex head.

.4 Mounting system: Type 304 stainless steel weld plate c/w weld nuts or type 303 stainless steel rail c/w steel rail nuts.

.5 Manufacturer: Swagelok. No equals will be accepted

### 2.3 HYDROGEN FITTINGS

.1 Type 316 stainless steel.

.2 All fittings sizes as noted on the drawings.

.3 5400 kPa (783 psi) working pressure.

.4 Manufacturer: Swagelok. No equals will be accepted.

## PART 3 - EXECUTION

### 3.1 HYDROGEN TUBING

.1 Installation to be completed by certified Swagelok technician in accordance with manufacturer's instructions.

.2 Minimum tube bend radius to be equal to or greater than five times the OD of the tubing.

.3 For all tubing installations, utilize Swagelok tubing mounts, installed as per manufacturer's recommendations.

## 3.2 HYDROGEN FITTINGS

.1 Installation to be completed by certified Swagelok technician in accordance with manufacturer's instructions

.2 All installed hydrogen fittings shall be visible and accessible.

## 3.3 HYDROGEN SYSTEM TESTING AND INSPECTION .

.1 Do all testing in accordance with Section 01 35 29 - Health and Safety.

.2 Contractor to perform pressure test on completely assembled and installed hydrogen system including Hydrogen Storage Tank Assembly, Vent Valve Assembly, and Dispensing Valve Assembly as supplied by Departmental Representative and installed by contractor.

.3 No pressure tests on individual pieces of equipment supplied by Departmental Representative are required.

.4 System pressure test to be completed as per below in accordance with ASME B31.3 (2014) - Process Piping.

.5 No mechanical controls system operation or testing shall be done during the duration of the hydrogen system pressure test, with the exception of measurement and recording of the temperatures and pressure as per below.

.6 Consultant to witness pressure test until beginning of 24 hour test period. Contractor to provide minimum 2 week notice of pressure test.

.7 Pressure test gas shall be dry, oil free Helium, supplied by contractor.

.8 Test pressure shall be 1724 kPa (250 psi).

.9 Pressure test procedure shall be as follows:

.1 Pressure test connection to be made at Vent Valve Assembly hydrogen inlet port. Refer to Vent Valve Assembly detail on drawings.

.2 The system gauge pressure shall be gradually increased in increments of 172 kPa (25 psi), and held for 5 minutes at each increment.

.3 If a drop in system pressure occurs at any increment, each joint and equipment connection shall be inspected and tested for leakage using.

.1 If leaks are discovered on government furnished equipment, notify Consultant and Departmental Representative. Leaks to be repaired only under direct authorization from Departmental Representative.

.4 After leaks have been located and repaired, the system shall be retested at the same pressure increment.

.5 Once the system test pressure of 1724 kPa (250 psi) is reached and all leaks have been located and repaired;

.1 The system shall be isolated and remain under pressure for a minimum of 24 consecutive hours.

.2 During this time period, the following shall be recorded simultaneously every 5 minutes;

.1 Hydrogen system pressure.

.2 Inflation Room air temperature.

.3 HOGEN Room air temperature.

.6 Once the minimum 24 hour test period is complete, the above recorded data shall be provided to the Mechanical Consultant for analysis, verification, and approval.

.7 Test Results;

.1 If a system pressure drop of 35 kPa (5 psi) or greater is recorded over the 24 hour time period, the test shall be considered a failure and shall be recompleted as per 3.3.8.

.2 If a system pressure drop greater than 7 kPa (1 psi) and less than 35 kPa (5 psi) is recorded, mechanical contractor shall repair leaks as per .3.8.3.

.3 If a pressure drop of less than 7 kPa (1 psi) is recorded, the test shall be considered a success.

.10 After completion of all testing, the system shall be left under pressure of 1380 kPa (200 psi).

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 29 - Health and Safety

.3 Section 01 74 11 - Cleaning

.4 Section 01 78 00 - Closeout Submittals

.5 Section 01 91 13 - General Commissioning

### 1.2 REFERENCES

.1 ASTM International

.1 ASTM A126-04(2014), Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.

.2 ASTM B62-15, Standard Specification for Composition Bronze or Ounce Metal Castings.

.2 American Water Works Association (AWWA)

.1 ANSI/AWWA C700-15, Standard for Cold Water Meters-Displacement Type, Bronze Main Case.

.2 ANSI/AWWA C701-14, Standard for Cold Water Meters-Turbine Type for Customer Service.

.3 ANSI/AWWA C702-15, Standard for Cold Water Meters-Compound Type.

.3 CSA International

.1 CSA-B64 Series-11, Backflow Preventers and Vacuum Breakers.

.4 Efficiency Valuation Organization (EVO)

.1 International Performance Measurement and Verification Protocol (IPMVP).

.1 IPMVP 2007 Version.

### 1.3 ADMINISTRATIVE REQUIREMENTS

.1 Pre-installation Meetings:

.1 Convene pre-installation meeting 1 week prior to beginning work of this Section with Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building construction sub-trades.

.4 Review manufacturer's written installation instructions and warranty requirements.

## 1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

.2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29 Health and Safety Requirements and 01 35 43 - Environmental Procedures. Indicate VOC's:

.3 Shop Drawings:

.1 Submit shop drawings for all plumbing materials and equipment in the documents, including drawings and specifications

.2 Indicate on drawings to indicate materials, finishes, method of anchorage, number of anchors, dimensions, construction and assembly details and accessories for the equipment, materials and installation of systems

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Instructions: submit manufacturer's installation instructions.

.6 Manufacturers' Field Reports: manufacturers' field reports specified.

## 1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.

.1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.

.2 Details of operation, servicing and maintenance.

.3 Recommended spare parts list.

## 1.6 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:

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

.2 Store and protect plumbing materials from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

.4 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 20 - Construction/Demolition Waste Management and Disposal.

# PART 2 - PRODUCTS

## 2.1 INDOOR POLYETHYLENE WATER STORAGE TANKS

.1 1476 L (325 gallons), 1549mm (w) x 762mm (l) x 1520mm (h), lid type 16 inch

.2 12 mm threaded PVC outlet at narrow side of tank at bottom

.3 Translucent Polyethylene, one piece seamless construction polyethylene lid cover

.4 Complete with float switch, high level audible alarm and visual alarms suitable for exterior mounting in extreme environments. Coordinate work, material and requirements to ensure that a complete and operational system is being provided.

## 2.2 WATER PUMP

.1 Capacity 7.5 L/min at 30 psi (207 kPa)

.2 3 chamber diaphragm pump, 30 psi (210 kPa) discharge pressure, polypro housing, EPDM valves

.3 120V/6Hz/1ph motor

.4 Pump c/w 8L stainless steel pre-charged accumulator tank

.5 Adjustable pressure switch factory set at 45 psi (310 kPa) off and 25 psi (175kPa) on.

## PART 3 - EXECUTION

### 3.1 MANUFACTURER'S INSTRUCTIONS

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

### 3.2 INSTALLATION

.1 Install in accordance with National Plumbing Code of Canada, provincial codes, local and authority having jurisdiction.

.2 Install in accordance with manufacturer's instructions and as specified.

### 3.3 START-UP

.1 General:

.1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.

.2 Timing: start-up only after:

.1 Pressure tests have been completed.

.2 Disinfection procedures have been completed.

.3 Certificate of static completion has been issued.

.4 Water treatment systems operational.

.3 Provide continuous supervision during start-up.

### 3.4 TESTING AND ADJUSTING

.1 General:

.1 Test and adjust plumbing specialties and accessories in accordance with Section 01 91 13- General Commissioning (Cx) Requirements: General Requirements, supplemented as specified.

.2 Timing:

.1 After start-up deficiencies rectified.

.2 After certificate of completion has been issued by authority having jurisdiction.

.3 Application tolerances:

.1 Pressure at fixtures: +/- 70 kPa.

.2 Flow rate at fixtures: +/- 20%.

.4 Adjustments:

.1 Verify that flow rate and pressure meet design criteria.

.2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.

## 3.5 CLOSEOUT ACTIVITIES

.1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.

.2 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

## 3.6 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 and recycling in accordance with Section 01 74 20 - 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 plumbing specialties and accessories installation.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 74 11 - Cleaning

.3 Section 01 77 00 - Closeout Procedures

.4 Section 01 78 00 - Closeout Submittals

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop drawings; submit drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada.

.3 Shop drawings to show:

.1 Mounting arrangements.

.2 Operating and maintenance clearances.

.4 Shop drawings and product data accompanied by:

.1 Detailed drawings of bases, supports, and anchor bolts.

.2 Acoustical sound power data, where applicable.

.3 Points of operation on performance curves.

.4 Manufacturer to certify current model production.

.5 Certification of compliance to applicable codes.

.5 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.

.6 Closeout Submittals:

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

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

.3 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.

.4 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.

.5 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.

.6 Approvals:

.1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.

.2 Make changes as required and re-submit as directed by Departmental Representative.

.7 Additional data:

.1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.

.8 Site records:

.1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.

.2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.

.3 Use different colour waterproof ink for each service.

.4 Make available for reference purposes and inspection.

.9 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.

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

## 1.3 QUALITY ASSURANCE

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

.2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

## 1.4 MAINTENANCE

.1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:

.1 One set of packing for each pump.

.2 One casing joint gasket for each size pump.

.3 One glass for each gauge glass.

.4 One filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers and in accordance with Section 01 78 00 - Closeout Submittals.

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

## 1.5 DELIVERY, STORAGE, AND HANDLING

.1 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

# PART 2 - EXECUTION

## 2.1 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 99 - Painting for Minor Works

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

.3 Restore to new condition, finishes which have been damaged.

## 2.2 CLEANING

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

## 2.3 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.

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

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

## 2.4 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.

## 2.5 PROTECTION

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

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Use of mechanical systems during construction.

.2 Related Requirements

.1 Section 23 34 00 - HVAC Fans

.2 Section 23 55 01 - Duct Heaters

.3 Section 23 82 20 - Forced Air Heaters

.4 Section 23 82 33 03 - Panel Convection Heaters

### 1.2 USE OF SYSTEMS

.1 Use of new heating and ventilating systems for supplying temporary heat and ventilation is permitted only under following conditions:

.1 Entire system is complete, pressure tested, cleaned, flushed out.

.2 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.

.3 There is no possibility of damage.

.4 Supply ventilation systems are protected by 30% filters, inspected daily, and changed every week or more frequently as required.

.5 Return systems have approved filters over openings, inlets, outlets.

.6 Systems will be:

.1 Operated as per manufacturer's recommendations and instructions.

.2 Operated by Contractor.

.3 Monitored continuously by Contractor.

.7 Warranties and guarantees are not relaxed.

.8 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.

.9 Refurbish entire system before static completion; clean internally and externally, restore to "as- new" condition, replace filters in air systems.

.2 Filters specified in this Section are over and above those specified in other Sections of this project.

.3 Exhaust systems are not included in approvals for temporary heating ventilation.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 01 74 11 - Cleaning

.2 Section 07 84 00 - Firestopping

.3 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment

### 1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

.2 Green Seal Environmental Standards (GSES)

.1 Standard GS-11-2008, 2nd Edition, Environmental Standard for Paints and Coatings.

.3 National Fire Code of Canada (NFCC 2015)

.4 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards

.1 SCAQMD Rule 1113-A2007, Architectural Coatings.

.2 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature, specifications and datasheets for piping and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

### 1.4 QUALITY ASSURANCE

.1 Sustainability Standards Certification:

.1 Low-Emitting Materials: provide listing of sealants and coatings used in building, comply with VOC and chemical component limits or restriction requirements.

## 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:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

# PART 2 - PRODUCTS

## 2.1 MATERIAL

.1 Paint: zinc-rich to CAN/CGSB-1.181.

.1 Primers, Paints, and Coating: provide in accordance with manufacturer's recommendations for surface conditions.

.2 Primer: maximum VOC limit 250 g/L to Standard GS-11 [to SCAQMD Rule 1113.

.3 Paints: maximum VOC limit 150 g/L to Standard GS-11 to SCAQMD Rule 1113.

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

.1 Sealants: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.

.3 Sealants: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.

.4 Adhesives: maximum VOC limit to SCAQMD Rule 1168 to GSES GS-36.

.5 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 National Fire Code of Canada and Canadian Electrical Code

.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 manual air vents to 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 Screwed fittings jointed with Teflon tape.

.2 Protect openings against entry of foreign material.

.3 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.4 Assemble piping using fittings manufactured to ANSI standards.

.5 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.

.6 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.7 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.8 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.9 Install, except where indicated, to permit separate thermal insulation of each pipe.

.10 Group piping wherever possible.

.11 Ream pipes, remove scale and other foreign material before assembly.

.12 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.

.13 Provide for thermal expansion as indicated.

.14 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 ball valves at branch take-offs for isolating purposes except where specified.

.15 Check Valves:

.1 Install silent check valves on discharge of pumps and in vertical pipes with downward flow.

.2 Install swing check valves in horizontal lines on discharge of pumps.

## 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 fires topping material or installation.

.4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

## 3.11 FLUSHING OUT OF PIPING SYSTEMS

.1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.

.2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.

.3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

## 3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

.1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.

.2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.

.3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.

.4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.

.5 Conduct tests in presence of Departmental Representative.

.6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative and Consultant 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 Clean in accordance with Section 01 74 11 - Cleaning.

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

.2 Waste Management: separate waste materials for reuse, recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 22 15 01 - Hydrogen Piping, Fittings and Valves

.2 Section 22 13 18.01 - High Density Polyethylene Piping

### 1.2 REFERENCES

.1 American Society of Mechanical Engineers (ASME)

.1 ASME B31.1-(2014), Power Piping.

.2 ASTM International

.1 ASTM A125- (2015), Standard Specification for Steel Springs, Helical, Heat-Treated.

.2 ASTM A307-(2014), Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.3 ASTM A563-(2014), 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 SP58-2014, Pipe Hangers and Supports - Materials, Design and Manufacture.

.2 MSS SP69-2014, Pipe Hangers and Supports - Selection and Application.

.3 MSS SP89-2014, Pipe Hangers and Supports - Fabrication and Installation Practices.

.5 Underwriter's 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 and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.2 Submit shop drawings for:

.1 Bases, hangers and supports.

.2 Connections to equipment and structure.

.3 Structural assemblies.

.4 Certificates:

.1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Manufacturers' Instructions:

.1 Provide manufacturer's installation instructions.

.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

## 1.4 CLOSEOUT SUBMITTALS

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

## 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:

.1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

# 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.

## 2.3 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized painted with zinc-rich paint after manufacture.

.2 Use electro-plating galvanizing process hot dipped galvanizing process.

.3 Ensure steel hangers in contact with copper piping are copper plated epoxy coated.

.2 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 carbon steel retaining clip.

.1 Rod: 9 mm UL listed

.3 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 Do not use 22 mm or 28 mm rod.

.4 Pipe attachments: material to MSS SP58:

.1 Attachments for steel piping: carbon steel black.

.2 Attachments for copper piping: copper plated black steel.

.3 Use insulation shields for hot pipework.

.4 Oversize pipe hangers and supports.

.5 Adjustable clevis: material to MSS SP69 UL listed and FM approved, 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.

.6 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.

.7 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.

.1 Finishes for steel pipework: black.

.2 Finishes for copper: black

.8 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

## 2.4 RISER CLAMPS

.1 Copper pipe: carbon steel copper plated to MSS SP58, type 42.

.2 Bolts: to ASTM A307.

.3 Nuts: to ASTM A563.

## 2.5 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.

## 2.6 VARIABLE SUPPORT SPRING HANGERS

.1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.

.2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with 2 springs in series in single casing.

.3 Variable spring hanger complete with factory calibrated travel stops. [Provide certificate of calibration for each hanger].

.4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5 % spring rate tolerance,

tested for free height, spring rate, loaded height and provided with CMTR.

## 2.7 EQUIPMENT ANCHOR BOLTS AND TEMPLATES

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

# PART 3 - EXECUTION

## 3.1 MANUFACTURER'S INSTRUCTIONS

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

## 3.2 INSTALLATION

.1 Install in accordance with:

.1 Manufacturer's instructions and recommendations.

.2 Vibration Control Devices:

.1 Install on piping systems at pumps, fans, and as required.

.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.

.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 Canadian Plumbing Code, unless otherwise recommended by the manufacturer's installation guidelines

.2 HDPE piping: up to NPS 1/2: every 1.5 m.

.3 Hydrogen piping: up to NPS 1/2: every 1.5 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 FIELD QUALITY CONTROL

.1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.2 Manufacturer's Field Services:

.1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

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

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

## 3.8 CLEANING

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

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal

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.

### 1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB-24.3-92, Identification of Piping 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 - Health and Safety Requirements.

### 1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

.2 Dispose of unused paint, coating material at official hazardous material collections site approved by Departmental Representative.

.3 Do not dispose of unused paint, coating material into sewer system, into streams, lakes, onto ground or in locations where it will pose health or environmental hazard.

## 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 Heaters, fans control panels: use size # 5.

.2 Equipment: use size # 9.

.5 Identification for PWGSC Preventive Maintenance Support System (PMSS):

.1 Use arrangement of Main identifier, Source identifier, Destination identifier.

.2 Equipment:

.1 Main identifier: size #9.

.2 Source and Destination identifiers: size #6.

.3 Terminal cabinets, fans, control panels: size #5.

.3 Equipment elsewhere: sizes as appropriate.

## 2.3 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 with protective over coating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.

.7 Colours and Legends:

.1 Where not listed, obtain direction from Departmental Representative.

.2 Colours for legends, arrows: to following table:

| Background colour: | Legend, arrows: |
|---|---|
| Yellow | BLACK |
| Green | WHITE |
| Red | WHITE |

.3 Background colour marking and legends for piping systems:

| Contents | Background colour marking | Legend |
|---|---|---|
| ** Add design temperature | | |
| ++ Add design temperature and pressure | | |
| Hydrogen | Blue | Hydrogen |
| RODI water | Green | RODI |
| Waste water | Green | Waste |
| Non-Potable | Green | Non-Potable |

## 2.4 IDENTIFICATION DUCTWORK SYSTEMS

.1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.

.2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

## 2.5 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.

## 2.6 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.

## 2.7 LANGUAGE

.1 Identification in English.

.2 Use one nameplate and label for English language.

# 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 99 - Painting for Minor Works has been completed.

## 3.3 INSTALLATION

.1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

.2 Provide ULC and/or 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 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.

.2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

### 1.2 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB to Departmental Representative within 90 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 for either:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2016.

.2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems-2015.

.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 specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.

.2 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

.3 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.

## 1.7 START-UP

.1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.

.2 Follow special start-up procedures specified elsewhere in Division 23.

## 1.8 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

## 1.9 START OF TAB

.1 Notify Departmental Representative 7 days prior to start of TAB.

.2 Start TAB when building is essentially completed, including:

.3 Installation of ceilings, doors, windows, other construction affecting TAB.

.4 Application of weather stripping, sealing, and caulking.

.5 Pressure, leakage, other tests specified elsewhere Division 23.

.6 Provisions for TAB installed and operational.

.7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 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 HVAC systems: plus 10 %, minus 10 %.

.2 Hydronic systems: plus or minus 10 %.

## 1.11 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2% of actual values.

## 1.12 INSTRUMENTS

.1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.

.2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.

.3 Calibrate within 3 months of TAB. Provide certificate of calibration to Departmental Representative.

## 1.13 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit, prior to commencement of TAB:

.2 Proposed methodology and procedures for performing TAB if different from referenced standard.

## 1.14 PRELIMINARY TAB REPORT

.1 Submit for checking and approval of Departmental Representative prior to submission of formal TAB report, sample of rough TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

## 1.15 TAB REPORT

.1 Format in accordance with referenced standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English and French 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, 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 TAB standards of AABC and SMACNA

.2 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls:

.1 Control Room Exhaust Fans

.2 HOGEN Room Supply Fan

.3 Qualifications: personnel performing TAB current member in good standing of AABC qualified to standards of AABC.

.4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.

.5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, fan, other equipment causing changes in conditions.

.2 At controllers, controlled device.

.7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.20 POST-OCCUPANCY TAB

.1 Measure DBT, WBT (or %RH), air velocity, air flow patterns, NC levels, in occupied zone of following areas: Control and Hogen room

.2 Participate in systems checks twice during Warranty Period - #1 approximately 3 months after acceptance and #2 within 1 month of termination of Warranty Period.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 33 - Health and Safety

.3 Section 01 74 11 - Cleaning

### 1.2 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 90.1-10, SI; Energy Standard for Buildings except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C335-05ae1, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.

.3 ASTM C411-11, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

.4 ASTM C449/C449M-2014, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.5 ASTM C547-15, Standard Specification for Mineral Fiber Pipe Insulation.

.6 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.7 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.8 ASTM C795-13, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

.9 ASTM C921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Green Seal Environmental Standards (GSES)

.1 Standard GS-36-00, Commercial Adhesives.

.5 South Coast Air Quality Management District (SCAQMD), California State

.1 SCAQMD Rule 1168-A2005, Adhesive and Sealant Applications.

.6 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).

.7 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-03, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

## 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for 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 Shop Drawings:

.1 Provide drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada.

.4 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.

.5 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence and cleaning procedures.

## 1.4 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 and member of TIAC.

## 1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.

.3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets crates, padding, packaging materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

# 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 cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.2 Lagging adhesive: compatible with insulation.

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

## 2.4 ACCESSORIES

.1 Vapour retarder lap adhesive:

.1 Water based, fire retardant type, compatible with insulation.

.1 Maximum VOC limit 200 g/L to SCAQMD Rule 1168

.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 ULC Listed Canvas Jacket:

.1 220 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.

.5 Outdoor Vapour Retarder Mastic:

.1 Vinyl emulsion type acrylic, compatible with insulation.

.2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

.6 Tape: self-adhesive, aluminum, plain and reinforced, 75 mm wide minimum.

.7 Contact adhesive: quick-setting

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

.8 Canvas adhesive: washable.

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

.9 Tie wire: 1.5 mm stainless steel.

.10 Banding: 19 mm wide, 0.5 mm thick stainless steel.

.11 Facing: 25 mm galvanized steel hexagonal wire mesh stitched on [one face of insulation with expanded metal lath on both faces of insulation.

.12 Fasteners: 2mm diameter pins with 35 mm diameter clips, 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 and 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 2rows 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 temperatire supply air ducts | C-2 | yes | 50 |
| Rectangular warm air ducts | C-1 | no | 25 |
| Round warm air ducts | C-1 | no | 25 |
| Supply, return and exhaust ducts exposed in space being served | none | | |
| Outside air ducts to mixing plenum | C-1 | yes | 25 |
| Mixing plenums | C-1 | yes | 25 |
| Exhaust duct between dampers and louvres | C-1 | no | 25 |
| Rectangular ducts outside | C-1 | special | 50 |
| Round ducts outside | C-1 | special | 50 |
| Acoustically lined ducts | none | | |

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

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

.2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation of low-pressure metallic ductwork, joints and accessories.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

### 1.2 REFERENCES

.1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

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

.1 ASTM A480/A480M (2013), Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.

.2 ASTM A635/A635M (2015), Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Hot Rolled.

.3 ASTM A653/A653M (2015), Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated by the Hot-Dip Process.

.3 Department of Justice Canada (Jus).

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

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

.1 Material Safety Data Sheets (MSDS).

.5 National Fire Protection Association (NFPA).

.1 NFPA 90A-2015, Standard for the Installation of Air-Conditioning and Ventilating Systems.

.2 NFPA 90B-2012, Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

.6 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA HVAC Duct Construction Standards - Metal and Flexible (2005)

.2 SMACNA HVAC Air Duct Leakage Test Manual (2012)

.3 IAQ Guideline for Occupied Buildings Under Construction 1995, 1st Edition.

.7 Transport Canada (TC).

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

## 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data: submit WHMIS MSDS - Material Safety Data Sheets - Sustainable Requirements: Construction - Hazardous Materials for the following:

.1 Sealants.

.2 Tape.

.3 Proprietary Joints.

## 1.4 QUALITY ASSURANCE

.1 Certification of Ratings:

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

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29- Health and Safety Requirements.

.3 Indoor Air Quality (IAQ) Management Plan.

.1 During construction meet or exceed the requirements of SMACNA IAQ Guideline for Occupied Buildings under Construction.

## 1.5 DELIVERY, STORAGE AND HANDLING

.1 Protect on site stored or installed absorptive material from moisture damage.

.2 Waste Management and Disposal:

.1 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.2 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.3 Separate for reuse and recycling and place in designated containers in accordance with Waste Management Plan.

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

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

.6 Fold up metal banding, flatten and place in designated area for recycling.

## PART 2 - PRODUCTS

### 2.1 SEAL CLASSIFICATION

.1 Classification as follows:

| Maximum Pressure Pa | SMACNA Seal Class |
|---|---|
| 500 | C |
| 250 | C |
| 125 | C |
| 125 | Unsealed |

.2 Seal classification:

.1 Class A: longitudinal seams, transverse joints, duct wall penetrations and connections made airtight with sealant and tape.

.2 Class B: longitudinal seams, transverse joints and connections made airtight with sealant and tape.

.3 Class C: transverse joints and connections made air tight with gaskets Longitudinal seams unsealed.

.4 Unsealed seams and joints.

### 2.2 SEALANT

.1 Sealant: oil resistant, water borne, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

### 2.3 TAPE

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

### 2.4 DUCT LEAKAGE

.1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

## 2.5 FITTINGS

.1 Fabrication: to SMACNA.

.2 Radiused elbows.

.1 Rectangular: standard radius and/or short radius with single thickness turning vanes, Centreline radius: 1.5 times width of duct.

.2 Round: smooth radius, five piece. Centreline radius: 1.5 times diameter.

.3 Mitred elbows, rectangular:

.1 To 400 mm: with single thickness turning vanes.

.2 Over 400 mm: with double thickness turning vanes.

.4 Branches:

.1 Rectangular main and branch: with 45 degrees entry on branch, radius on branch 1.5 times width of duct.

.2 Round main and branch: enter main duct at 45 degrees with conical connection.

.3 Provide volume control damper in branch duct near connection to main duct.

.4 Main duct branches: with splitter damper.

.5 Transitions:

.1 Diverging: 20 degrees maximum included angle.

.2 Converging: 30 degrees maximum included angle.

.6 Offsets:

.1 As indicated and/or short radiused elbows.

.7 Obstruction deflectors: maintain full cross-sectional area.

.1 Maximum included angles: as for transitions.

## 2.6 FIRE STOPPING

.1 Retaining angles around duct, on both sides of fire separation in accordance with Section 07 84 00 - Firestopping.

.2 Fire stopping material and installation must not distort duct.

## 2.7 GALVANIZED STEEL

.1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA

## 2.8 ALUMINUM

.1 To SMACNA. Aluminum type: 3003-H-14.

.2 Thickness, fabrication and reinforcement: to SMACNA.

.3 Joints: to SMACNA.

## 2.9 HANGERS AND SUPPORTS

.1 Hangers and Supports: in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment and SMACNA.

.1 Strap hangers: of same material as duct but next sheet metal thickness heavier than duct.

.1 Maximum size duct supported by strap hanger: 500.

.2 Hanger configuration: to SMACNA.

.3 Hangers: galvanized steel angle with galvanized steel rods to SMACNA [following table]:

| Duct Size | Angle Size | Rod Size |
|---|---|---|
| (mm) | (mm) | (mm) |
| up to 750 | 25 x 25 x 3 | 6 |
| 751 to 1050 | 40 x 40 x 3 | 6 |
| 1051 to 1500 | 40 x 40 x 3 | 10 |
| 1501 to 2100 | 50 x 50 x 3 | 10 |
| 2101 to 2400 | 50 x 50 x 5 | 10 |
| 2401 and over | 50 x 50 x 6 | 10 |

.4 Upper hanger attachments:

.1 For concrete: manufactured concrete inserts.

.2 For steel joist: manufactured joist clamp

.3 For steel beams: manufactured beam clamps:

# PART 3 - EXECUTION

## 3.1 GENERAL

.1 Do work in accordance with NFPA 90A, NFPA 90B, ASHRAE and SMACNA as required.

.2 Do not break continuity of insulation vapour barrier with hangers or rods.

.1 Insulate strap hangers 100 mm beyond insulated duct

.3 Support risers in accordance with SMACNA as required.

.4 Install breakaway joints in ductwork on sides of fire separation.

.5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.

## 3.2 HANGERS

.1 Strap hangers: install in accordance with SMACNA.

.2 Angle hangers: complete with locking nuts and washers.

.3 Hanger spacing: in accordance with SMACNA as follows:

| Duct Size | Spacing |
|---|---|
| (mm) | (mm) |
| to 1500 | 3000 |
| 1501 and over | 2500 |

## 3.3 WATERTIGHT DUCT

.1 Provide watertight duct for:

.1 Fresh air intake.

.2 Form bottom of horizontal duct without longitudinal seams.

.1 Solder or weld joints of bottom and side sheets.

.2 Seal other joints with duct sealer.

## 3.4 SEALING AND TAPING

.1 Apply sealant to outside of joint to manufacturer's recommendations.

.2 Bed tape in sealant and recoat with minimum of one coat of sealant to manufacturers recommendations.

## 3.5 LEAKAGE TESTS

.1 In accordance with SMACNA HVAC Duct Leakage Test Manual.

.2 Do leakage tests in sections.

.3 Make trial leakage tests as instructed to demonstrate workmanship.

.4 Do not install additional ductwork until trial test has been passed.

.5 Complete test before performance insulation or concealment Work.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for duct accessories including flexible connections, access doors, vanes and collars.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

### 1.2 REFERENCES

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

.1 Material Safety Data Sheets (MSDS).

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

.1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 95.

### 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 data sheet. Indicate the following:

.1 Flexible connections.

.2 Duct access doors.

.3 Turning vanes.

.4 Instrument test ports.

.3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.1 Certification of ratings: catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

.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: manufacturer's field reports specified.

.7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

## 1.4 QUALITY ASSURANCE

.1 Pre-Installation Meetings:

.1 Convene pre-installation meeting one week prior to beginning work-Construction Progress Schedule - Critical Path Method (CPM)

.1 Verify project requirements.

.2 Review installation and substrate conditions.

.3 Co-ordination with other building subtrades.

.4 Review manufacturer's installation instructions and warranty requirements.

.2 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

## 1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan (WMP).

.4 Separate for reuse and recycling and place in designated containers in accordance with Waste Management Plan (WMP).

.5 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

## PART 2 - PRODUCTS

### 2.1 GENERAL

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

### 2.2 FLEXIBLE CONNECTIONS

.1 Frame: galvanized sheet metal frame 0.5 mm thick with fabric clenched by means of double locked seams.

.2 Material:

.1 Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at minus 40 degrees C to plus 90 degrees C, density of 1.3 kg/m².

### 2.3 ACCESS DOORS IN DUCTS

.1 Non-Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame.

.2 Insulated Ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm thick complete with sheet metal angle frame and 25 mm thick rigid glass fibre insulation.

.3 Gaskets: neoprene.

.4 Hardware:

.1 Up to 300 x 300 mm: two sash locks complete with safety chain.

.2 301 to 450 mm: four sash locks complete with safety chain.

.3 451 to 1000 mm: piano hinge and minimum two sash locks.

### 2.4 TURNING VANES

.1 Factory or shop fabricated single thickness with trailing edge, to recommendations of SMACNA and as indicated.

### 2.5 INSTRUMENT TEST

.1 1.6 mm thick steel zinc plated after manufacture.

.2 Cam lock handles with neoprene expansion plug and handle chain.

.3 28 mm minimum inside diameter. Length to suit insulation thickness.

.4 Neoprene mounting gasket.

## 2.6 SPIN-IN COLLARS

.1 Conical galvanized sheet metal spin-in collars with lockable butterfly damper.

.2 Sheet metal thickness to co-responding round duct standards.

# PART 3 - EXECUTION

## 3.1 MANUFACTURER'S INSTRUCTIONS

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

## 3.2 INSTALLATION

.1 Flexible Connections:

.1 Install in following locations:

.1 Inlets and outlets to supply air units and fans.

.2 Inlets and outlets of exhaust and return air fans.

.3 As indicated.

.2 Length of connection: 100 mm.

.3 Minimum distance between metal parts when system in operation: 75 mm.

.4 Install in accordance with recommendations of SMACNA.

.5 When fan is running:

.1 Ducting on sides of flexible connection to be in alignment.

.2 Ensure slack material in flexible connection.

.2 Access Doors and Viewing Panels:

.1 Locations:

.1 Control dampers.

.2 Devices requiring maintenance.

.3 Required by code.

.4 Reheat coils.

.3 Instrument Test Ports:

.1 General:

.1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.

.2 Locate to permit easy manipulation of instruments.

.3 Install insulation port extensions as required.

.4 Locations:

.1 For traverse readings:

.1 Inlets and outlets of other fan systems.

.2 For temperature readings:

.1 At outside air intakes.

.2 At inlet and outlet of coils.

.4 Turning vanes:

.1 Install in accordance with recommendations of SMACNA and as required.

## 3.3 FIELD QUALITY CONTROL

.1 Manufacturer's Field Services:

.1 Have manufacturer of products, supplied under this Section, review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.

.2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

.3 Schedule site visits, to review Work, at stages listed:

.1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of the Work, after cleaning is carried out.

.4 Obtain reports, within 3 days of review, and submit, immediately, to Departmental Representative.

.5 Local/regional materials.

.6 Low-emitting materials.

## 3.4 CLEANING

.1 Perform cleaning operations as specified and in accordance with manufacturer's recommendations.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Operating dampers for mechanical forced air ventilation/exhaust and air conditioning systems.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 78 00 - Closeout Procedures

.3 Section 23 33 00 - Air Duct Accessories

.4 Section 25 30 02 - EMCS Field Control Devices

### 1.2 REFERENCES

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

.1 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated by Hot-Dip Process.

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

.1 Material Safety Data Sheets (MSDS).

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate the following:

.1 Performance data.

.2 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.

.3 Closeout Submittals

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

## 1.4 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

.2 Certificates:

.1 Catalogue or published ratings those obtained from tests carried out by manufacturer or those ordered by manufacturer from independent testing agency.

## 1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

# PART 2 - PRODUCTS

## 2.1 MULTI-LEAF DAMPERS

.1 Provide opposed blade type for motorized dampers.

.2 Extruded aluminum, interlocking blades, complete with extruded vinyl seals, spring stainless steel side seals, extruded aluminum frame.

.3 Pressure fit self-lubricated bronze bearings.

.4 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.

.5 Performance:

.1 Leakage: in closed position less than 2% of rated air flow at 100 Pa differential across damper.

.2 Pressure drop: at full open position less than 50 Pa differential across damper at 1.3 m/s.

.6 Insulated aluminum dampers:

.1 Frames: insulated with extruded polystyrene foam with RSI 0.88.

.2 Blades: constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, RSI 0.88.

## 2.2 BACK DRAFT DAMPERS

.1 Automatic gravity operated, multi leaf, aluminum construction with nylon bearings, centre pivoted as required.

## 2.3 RELIEF DAMPERS

.1 Automatic multi-leaf aluminum dampers with ball bearing centre pivoted and counter-weights set to open at static pressure as indicated.

# PART 3 - EXECUTION

## 3.1 MANUFACTURER'S INSTRUCTIONS

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

## 3.2 INSTALLATION

.1 Install where required.

.2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.

.3 Seal multiple damper modules with silicon sealant.

.4 Install access door adjacent to each damper. See Section 23 33 00 - Air Duct Accessories.

.5 Ensure dampers are observable and accessible.

## 3.3 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Fans, motors, accessories and hardware for commercial use.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 33 - Health and Safety

.3 Section 01 61 00 - Common Product Requirement

.4 Section 01 74 11 - Cleaning

.5 Section 01 78 00 - Closeout Submittals

.6 Section 23 33 00 - Air Duct Accessories

### 1.2 REFERENCES

.1 Air Conditioning and Mechanical Contractors (AMCA)

.1 AMCA 99-2013, Standards Handbook.

.2 AMCA 300-2014, Reverberant Room Method for Sound Testing of Fans.

.3 AMCA 301-1990, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

.2 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)

.1 ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.

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

.1 Material Safety Data Sheets (MSDS).

### 1.3 SYSTEM DESCRIPTION

.1 Performance Requirements:

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

.2 Capacity: flow rate, total static pressure, bhp, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.

.3 Fans: statically and dynamically balanced, constructed in conformity with AMCA 99.

.4 Sound ratings: comply with AMCA 301, tested to AMCA 300. Supply unit with AMCA certified sound rating seal.

.5 Performance ratings: based on tests performed in accordance with ANSI/AMCA 210. Supply unit with AMCA certified rating seal.

## 1.4 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.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings:

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

.1 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada.

.3 Provide:

.1 Fan performance curves showing point of operation, BHP, kW and efficiency.

.2 Sound rating data at point of operation.

.4 Indicate:

.1 Motors, sheaves, bearings

.2 Minimum performance achievable with variable speed controllers and ECM motors with adjustable speed range

.5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

.6 Closeout Submittals:

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

## 1.5 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

## 1.6 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.1 Spare parts to include:

.1 Matched sets of belts.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:

.1 Bearings and seals.

.2 Addresses of suppliers.

.3 List of specialized tools necessary for adjusting, repairing or replacing.

## 1.7 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 IN-LINE CENTRIFUGAL FANS

.1 Characteristics and construction: backward inclined fan wheels with axial flow construction and direct drive

.2 CSA certified for use in Class 1, Zone 2, Group IIC hazardous locations

.3 Plastic housing made of UV-protected thermoplastic resin

.4 Complete with bracket for indoor mounting and air flow switch

.5 120/1ph/60hz, refer to fan schedule on drawings

.6 Acceptable Product: Marc Climatic Controls Inc. ISFX inline fan

### 2.2 IN-LINE CABINET FANS

.1 Fan shall be duct mounted, direct driven centrifugal square inline

.2 Fan shall be manufactured at certified ISO 9001 certified facility and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings for seal for sound and air performance

.3 The fan shall be bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Housing shall be pre-drilled to accommodate universal mounting for installation. Nameplate shall indicate design CFM and static pressure

.4 Wheel shall be centrifugal backward inclined, constructed of 100% aluminum with a machined cast aluminum hub.

.5 Motor shall be electronically commutated motor rated for continuous duty and furnished with leads for connection to a 0-10 VDC external pressure controller to be controlled through BAS. Coordinate with controls contractor for integration.

## 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 FAN INSTALLATION

.1 Install fans as indicated, complete with resilient mountings provided by fan manufacturer, flexible electrical leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

.2 Bearings and extension tubes to be easily accessible.

.3 Access doors and access panels to be easily accessible.

.4 Install fans per manufacturer’s recommendations and in accordance with SMACNA

## 3.3 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Filters and filter gauges for various types of mechanical air handling equipment.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 29 - Health and Safety

.3 Section 01 61 00 - Common Product Requirement

.4 Section 01 74 11 - Cleaning

.5 Section 01 78 00 - Closeout Submittals

### 1.2 REFERENCES

.1 American National Standards Institute/National Fire Prevention Association (ANSI/NFPA)

.1 ANSI/NFPA 96-2014, Ventilation Control and Fire Protection of Commercial Cooking Operations.

.2 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 ASHRAE 52.1-1992, Gravimetric And Dust Spot for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter (ANSI Approved).

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-115.10-M90, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.

.2 CAN/CGSB-115.11-M85, Filters, Air, High Efficiency, Disposable, Bag Type.

.3 CAN/CGSB-115.18-M85, Filter, Air, Extended Area Panel Type.

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

.1 Material Safety Data Sheets (MSDS).

.5 Underwriters' Laboratories of Canada

.1 ULC -S111-13, Standard Method of Fire Tests for Air Filter Units.

## 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.

.1 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings:

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

.1 Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada.

.2 Indicate following: Filter size, thickness, efficiency, Merv rating, pressure drop chart

.3 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.

.4 Closeout Submittals

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

## 1.4 QUALITY ASSURANCE

.1 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29- Health and Safety Requirements.

## 1.5 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

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

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.2 Waste Management and Disposal:

.1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## 1.6 MAINTENANCE

.1 Extra Materials:

.1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.

.3 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 in accordance with section 01 78 00 - Closeout Submittals.

# PART 2 - PRODUCTS

## 2.1 GENERAL

.1 Media: suitable for air at 100% RH and air temperatures between minus 40 and 50 degrees C.

.2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as required

.3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

## 2.2 ACCESSORIES

.1 Holding frames: permanent "T" section or channel section construction of galvanized steel or extruded aluminum as required to suit application, 1.6 mm thick, except where specified.

.2 Seals: to ensure leakproof operation.

.3 Blank-off plates: as required, to fit all openings and of same material as holding frames.

.4 Access and servicing: through doors/panels on each side

## 2.3 FIBROUS GLASS PANEL FILTERS

.1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.

.2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diameter hinged wire mesh screen.

.3 Performance: to ASHRAE 52.1, minimum average synthetic dust weight arrestance 70 %.

.4 Fire rated: to ULC -S111.

.5 Nominal thickness: Refer to drawings and/or provide to suit application.

## 2.4 COTTON PANEL FILTERS

.1 Disposable pleated reinforced cotton dry media: to CAN/CGSB 115.18.

.2 Holding frame: galvanized steel, or slide in channel for side access.

.3 Performance:

.1 Average atmospheric dust spot efficiency 30 % to ASHRAE 52.1.

.2 Average synthetic dust weight arrestance 90 % to ASHRAE 52.1.

.4 Fire Rated: to ULC -S111.

.5 Nominal thickness: Refer to drawings and/or provide to suit application.

## 2.5 FILTER GAUGES - DIAL TYPE

.1 Diaphragm actuated, direct reading.

.2 Range: 0 to 2 times initial pressure]

## 2.6 FILTER GAUGES - MANOMETER TYPE

.1 Inclined acrylic tube.

.2 Complete with levelling screws.

.3 Range: 0 to 2 times initial pressure

# 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 GENERAL

.1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

## 3.3 FILTER GAUGES

.1 Install type as indicated across each filter bank in approved and easy readable location.

.2 Mark each filter gauge with value of pressure drop for clean condition and manufacturer's recommended replacement (dirty) value.

## 3.4 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Materials and application of electric duct heaters.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 33 - Health and Safety

.3 Section 01 61 00 - Common Product Requirement

.4 Section 01 74 11 - Cleaning

.5 Section 01 78 00 - Closeout Submittals

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA C22.2 No.46-2013, Electric Air-Heaters.

.2 Department of Justice Canada (Jus).

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

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

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit product data and include:

.1 Element support details.

.2 Heater: total kW rating, voltage, phase.

.3 Number of stages.

.4 Rating of stage: rating, voltage, phase.

.5 Heater element watt/density and maximum sheath temperature.

.6 Maximum discharge temperature.

.7 Physical size.

.8 Unit support.

.9 Performance limitations.

.10 Clearance from combustible materials.

.11 Internal components wiring diagrams.

.12 Minimum operating airflow.

.13 Pressure drop operating airflow.

## 1.4 QUALITY ASSURANCE

.1 Health and Safety.

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

## 1.5 DELIVERY, STORAGE AND HANDLING

.1 Waste Management and Disposal:

.1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Place materials defined as hazardous or toxic in designated containers in accordance with Section 01 35 43 - Environmental Procedures.

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

.6 Ensure emptied containers are sealed and stored safely.

.7 Fold up metal and plastic banding, flatten and place in designated area for recycling.

# PART 2 - PRODUCTS

## 2.1 SUSTAINABLE REQUIREMENTS

.1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.

## 2.2 DUCT HEATERS

.1 Duct heaters: flange type for installation in a horizontal duct.

.2 Elements:

.1 Helical coils of nickel chrome alloy resistance wire.

.2 Finned tubular.

.3 Incoloy sheathed.

.3 Controls:

.1 Factory mounted and wired in control box. Use terminal blocks for power and control wiring to thermostat and sail switch.

.2 Remote mounted as indicated with terminal strips in heater terminal box for power and control wiring.

.3 Controls mounted in a CSA approved enclosure and to include:

.1 Magnetic contactors.

.2 Control transformers.

.3 SCR controller with BACnet capability

.4 Where controls are mounted in heater, exercise care in mounting contactors to minimize switching noise transmission through ductwork.

.5 High temperature cut-out and air proving switch.

.4 Electrical: Refer to drawings

.1 Duct heater rating:

.1 240 voltage.

.2 1 phase.

.5 Terminal box shall contain integral disconnect switch, control circuit transformer, terminals for power connections and SCR controller to interface with the BAS.

.6 Supplier of duct heater shall provide the necessary integration SCR hardware to integrate and communicate with the BAS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Make power and control connections to CSA C22.2 No.46.

.2 Install per the manufacturer’s recommendations

.3 Install per the Canadian Electrical code

.4 Coordinate duct heater with duct size provided by contractor prior to procurement and installation

### 3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and Section 26 05 00 - Common Work Results for Electrical.

.2 Perform tests in presence of Departmental Representative.

.1 Provide test report and include copy with Operations and Maintenance Manuals.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Forced air heaters, controls and installation.

### 1.2 RELATED REQUIREMENTS

.1 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 29 - Health and Safety

.3 Section 01 61 00 - Common Product Requirement

.4 Section 01 74 11 - Cleaning

.5 Section 01 78 00 - Closeout Submittals

### 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 forced air heaters and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures

### 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 forced air heaters for incorporation into manual.

### 1.5 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:

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

.2 Store and protect forced air heaters 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 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 FORCED AIR HEATERS

.1 Forced air heaters, wall mounted commercial type: Tag FF-1 in drawings

.1 Performance:

.1 240 Volts, 1 Phase, 60 hz

.2 Refer to drawings for power

.2 Enclosure:

.1 Steel, surface mounted, provide manufacturers mounting box

.2 Knockouts for 12 mm diameter conduit left, right, bottom and rear.

.3 Grill and frame finished white

.3 Elements and Fan:

.1 Nickel chromium alloy.

.2 Motor: totally enclosed, shaded pole, impedance protected motor.

.3 Provide with manufacturer supplied disconnect switch

.2 Controls:

.1 Unit to be controlled by the room temperature sensor, refer to controls and sequences.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install heaters in accordance with manufacturer's written recommendations.

.2 Make power and control connections.

.3 Coordinate with electrical prior to procurement and installation

### 3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with 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.

.1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### 3.4 PROTECTION

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

.2 Repair damage to adjacent materials caused by forced air heaters installation.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Explosion proof panel convection heaters, controls and installation.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 35 29 - Health and Safety

.3 Section 01 61 00 - Common Product Requirement

.4 Section 01 74 11 - Cleaning

.5 Section 01 78 00 - Closeout Submittals

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.46-M1988 (R2013), Electric Air-Heaters.

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

.1 Material Safety Data Sheets (MSDS).

### 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 cabinet convector heaters and include product characteristics, performance criteria, physical size, weight, finish and limitations.

.2 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence and cleaning procedures

### 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 forced air heaters for incorporation into manual.

## 1.5 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:

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

.2 Store and protect cabinet convector heaters 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 20 - Construction/Demolition Waste Management and Disposal.

# PART 2 - PRODUCTS

## 2.1 PANEL CONVECTION HEATERS

.1 Refer to drawings for size of heaters: PH-1

.2 Wall mounted cabinet: to CSA C22.2 No. 46, pre-drilled back for securing to wall:

.1 Equipped with a wire guard and gull wing shaped aluminum rear baffles

.2 Uses copper free aluminum extruded convector

.3 Provide with patented X-max terminal housing

.4 Electrical 240 Volts, 1 Phase, 60 hz, 15 maximum circuit fuse, refer to drawings for power requirements

.5 Provide with manufacturer’s mounting brackets

.6 Unit shall be rated for Class 1, Zone 2, Group IIC hazardous classification

.7 Acceptable Manufacturers: CCI Thermal Technologies, model Norseman XB

## 2.2 CONTROLS

.1 Wall mounted temperature sensor: type low voltage rated for Class 1, Zone 2, Group IIC hazardous classification

.2 Provide each panel convection heater with contacts to be connected to room temperature sensor

.3 Coordinate installation and wiring with controls contractor to link all the heaters to the same temperature sensor

.4 Manufacturer to provide required hardware, including transformers to interface with the heaters and the BAS.

# 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.

.2 Prior to start-up and applying electrical power, refer to manufacturer’s recommendations for necessary steps, including but not limited to:

.1 Check all connections are secure

.2 All connections comply with applicable codes and wiring diagram requirements

.3 Confirm supply voltage is compatible with data plate specifications

.4 Remove any foreign objects from heater

.5 Ensure external fittings and enclosures are secured

## 3.2 INSTALLATION

.1 Install heaters as required, coordinate actual location with other equipment to maintain manufacturer’s recommended clearances and access in and around adjacent equipment and in accordance with the Canadian Electrical code.

.2 Install per the manufacturer’s placement requirements and field wiring requirements.

.3 Install wall mounted temperature sensor in location indicated.

.4 Make power and control connections.

.5 Coordinate mounting with surface to support heater’s weight. Secure mounting brackets to wall and install per manufacturer’s recommendations

## 3.3 FIELD QUALITY CONTROL

.1 Tests:

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

## 3.4 CLEANING

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

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:

.1 Start-up testing and verification of systems.

.2 Check out demonstration or proper operation of components.

.3 On-site operational tests.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 78 00 - Closeout Submittals

.3 Section 25 05 01 - EMCS: General Requirements

### 1.2 DEFINITIONS

.1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

.2 AEL: ratio between total test period less any system downtime accumulated within that period and test period.

.3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:

.1 Outage of main power supply in excess of back-up power sources, provided that:

.1 Automatic initiation of back-up was accomplished.

.2 Automatic shut-down and re-start of components was as specified.

.2 Failure of communications link, provided that:

.1 Controller automatically and correctly operated in stand-alone mode.

.2 Failure was not due to failure of any specified EMCS equipment.

.3 Functional failure resulting from individual sensor inputs or output devices, provided that:

.1 System recorded said fault.

.2 Equipment defaulted to fail-safe mode.

.3 AEL of total of all input sensors and output devices is at least 99 % during test period.

## 1.3 DESIGN REQUIREMENTS

.1 Confirm with Departmental Representative and Consultant that Design Criteria and Design Intents are still applicable.

.2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intents.

## 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01330 - Submittal Procedures.

.2 Final Report: submit report to Departmental Representative

.1 Include measurements, final settings and certified test results.

.2 Bear signature of commissioning technician and supervisor

.3 Report format to be approved by Departmental Representative before commissioning is started.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

## 1.5 CLOSEOUT SUBMITTALS

.1 Provide documentation, O M Manuals, and training of O M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals and Section 25 05 03 EMCS: Project Record Documents.

## 1.6 COMMISSIONING

.1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.

.2 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative.

.3 Inform, and obtain approval from, Departmental Representative in writing at least 14 days prior to commissioning or each test. Indicate:

.1 Location and part of system to be tested or commissioned.

.2 Testing/commissioning procedures, anticipated results.

.3 Names of testing/commissioning personnel.

.4 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.

.5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.

.6 Load system with project software.

.7 Perform tests as required.

## 1.7 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative and Consultant.

## 1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION

.1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

# PART 2 - PRODUCTS

## 2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.

.2 Instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 2 months prior to tests.

.4 Locations to be approved, readily accessible and readable.

.5 Application: to conform to normal industry standards.

## PART 3 - EXECUTION

### 3.1 PROCEDURES

.1 Test each system independently and then in unison with other related systems.

.2 Commission each system using procedures prescribed by the Departmental Representative

.3 Commission integrated systems using procedures prescribed by Departmental Representative

.4 Debug system software.

.5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.

.6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

### 3.2 FIELD QUALITY CONTROL

.1 Pre-Installation Testing.

.1 General: consists of field tests of equipment just prior to installation.

.2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.

.3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

.4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).

.5 Additional instruments to include:

.1 DP transmitters.

.2 VAV supply duct SP transmitters.

.3 DP switches used for dirty filter indication and fan status.

.6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between 0 and 500 Pa, to hold steady at any setting and with direct output to milli-amp meter at source and to BECC.

.7 After setting, test zero and span in 10 % increments through entire range while both increasing and decreasing pressure.

.8 Departmental Representative to mark instruments tracking within 0.5% in both directions as "approved for installation".

.9 Transmitters above 0.5% error will be rejected.

.10 DP switches to open and close within 10% of setpoint.

.2 Completion Testing.

.1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.

.2 Include following activities:

.1 Test and calibrate field hardware including stand-alone capability of each controller.

.2 Verify each A-to-D convertor.

.3 Test and calibrate each AI using calibrated digital instruments.

.4 Test each DI to ensure proper settings and switching contacts.

.5 Test each DO to ensure proper operation and lag time.

.6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.

.7 Test operating software.

.8 Test application software and provide samples of logs and commands.

.9 Verify each CDL including energy optimization programs.

.10 Debug software.

.11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.

.12 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. This document will be used in final startup testing.

.3 Final Start-up Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and provide:

.1 Provide technical personnel capable of re-calibrating field hardware and modifying software for minimum of 5 days (40 hours) on site.

.2 Detailed daily schedule showing items to be tested and personnel available.

.3 Departmental Representative's acceptance signature to be on executive and applications programs.

.4 Commissioning to commence during final startup testing.

.5 O & M personnel to assist in commissioning procedures as part of training.

.6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.

.7 Commission systems considered as life safety systems before affected parts of the facility are occupied.

.8 Operate systems as long as necessary to commission entire project.

.9 Monitor progress and keep detailed records of activities and results.

.4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.

.1 Prior to beginning of 30 day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.

.1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.

.2 Test to last at least 30 consecutive 24 hour days.

.3 Tests to include:

.1 Demonstration of correct operation of monitored and controlled points.

.2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.

.4 System will be accepted when:

.1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.

.2 Requirements of Contract have been met.

.5 In event of failure to attain specified AEL during test period, extend test period on day-to-

day basis until specified AEL is attained for test period.

.6 Correct defects when they occur and before resuming tests.

.5 Commissioning Manager, Departmental Representative to verify reported results.

## 3.3 ADJUSTING

.1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

## 3.4 DEMONSTRATION

.1 Demonstrate to Commissioning Manager, Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

### 1.2 DEFINITIONS

.1 CDL - Control Description Logic.

.2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures, supplemented and modified by requirements of this Section.

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipate date of beginning of training.

.1 List name of trainer, and type of visual and audio aids to be used.

.2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.

.3 Submit reports within one week after completion of training program that training has been satisfactorily completed.

### 1.4 QUALITY ASSURANCE

.1 Provide bilingual competent instructors thoroughly familiar with aspects of EMCS installed in facility.

.2 Departmental Representative reserves right to approve instructors.

### 1.5 INSTRUCTIONS

.1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.

.2 Training to be project-specific.

1.6 TIME FOR TRAINING

.1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

1.7 TRAINING MATERIALS

.1 Provide equipment, visual and audio aids, and materials for classroom training.

.2 Supply manual for each trainee, describing in detail data included in each training program.

.1 Review contents of manual in detail to explain aspects of operation and maintenance (O M).

1.8 TRAINING PROGRAM

.1 To be in 2 phases over 6 month period.

.2 Phase 1: 2 day program to begin before 30 day test period at time mutually agreeable to Contractor and Departmental Representative.

.1 Train O M personnel in functional operations and procedures to be employed for system operation.

.2 Supplement with on-the-job training during 30 day test period.

.3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.

.4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.

.3 Phase 2: 5 day program to begin 8 weeks after acceptance for operators, equipment maintenance personnel and programmers.

.1 Provide multiple instructors on pre-arranged schedule. Include at least following:

.1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.

.2 Equipment maintenance training: provide personnel with 2 days training within 5 day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.

.3 Programmers: provide personnel with 2 days training within 5 day period in following

subjects in approximate percentages of total course shown:

| |
|---|
| Software and architecture: 10% Logiciel et architecture : 10 % |
| Application programs: 15% Programmes d'application : 15 % |
| Controller programming: 50% Programmation du contrôleur : 50 % |
| Trouble shooting and debugging:10% Dépannage et mise au point : 10 % |
| Colour graphic generation: 15% Génération de graphiques en couleur : 15 % |

## 1.9 ADDITIONAL TRAINING

.1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

## 1.10 MONITORING OF TRAINING

.1 Departmental Representative to monitor training program and may modify schedule and content.

END OF SECTION

# PART 1 - GENERAL

## 1.1 SUMMARY

.1 Section Includes:

.1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

.2 Related Requirements

.1 Section 25 01 11- EMCS: Start-up, Verification and Commissioning

.2 Section 25 01 12 - EMCS: Training

.3 Section 25 05 01 - EMCS: General Requirements

.4 Section 25 05 02 - EMCS: Submittals and Review Process

.5 Section 25 05 03 - EMCS: Project Record Documents

.6 Section 25 05 54 - EMCS: Identification

.7 Section 25 08 20 - EMCS: Warranty and Maintenance

.8 Section 25 10 01 - EMCS: Local Area Network (LAN)

.9 Section 25 10 02 - EMCS: Operator Work Station (OWS)

.10 Section 25 30 01 - EMCS: Building Controllers

.11 Section 25 30 02 - EMCS: Field Control Devices

.12 Section 25 90 01 - EMCS: Site Requirements, Application and Systems, Sequence of Operations

## 1.2 REFERENCES

.1 American National Standards Institute (ANSI)/ The Instrumentation, Systems and Automation Society (ISA).

.1 ANSI/ISA 5.5-2014 Graphic Symbols for Process Displays.

.2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).

.1 ANSI/IEEE 260.1-2004, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).

.3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE STD 135-R2012, BACNET - Data Communication Protocol for Building Automation and Control Network.

.4 Canadian Standards Association (CSA International).

.1 CAN/CSA-Z234.1-89(R2011), Canadian Metric Practice Guide.

.5 Consumer Electronics Association (CEA).

.1 CEA-709.1-B-2014, Control Network Protocol Specification.

.6 Department of Justice Canada (Jus).

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

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

.7 Electrical and Electronic Manufacturers Association (EEMAC).

.1 EEMAC 2Y-1-2004, Light Gray Colour for Indoor Switch Gear.

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

.1 Material Safety Data Sheets (MSDS).

.9 Transport Canada (TC).

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

## 1.3 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in EMCS:

.1 AEL - Average Effectiveness Level.

.2 AI - Analog Input.

.3 AIT - Agreement on International Trade.

.4 AO - Analog Output.

.5 BACnet - Building Automation and Control Network.

.6 BC(s) - Building Controller(s).

.7 BECC - Building Environmental Control Center.

.8 CAD - Computer Aided Design.

.9 CDL - Control Description Logic.

.10 CDS - Control Design Schematic.

.11 COSV - Change of State or Value.

.12 CPU - Central Processing Unit.

.13 DI - Digital Input.

.14 DO - Digital Output.

.15 DP - Differential Pressure.

.16 ECU - Equipment Control Unit.

.17 EMCS - Energy Monitoring and Control System.

.18 HVAC - Heating, Ventilation, Air Conditioning.

.19 IDE - Interface Device Equipment.

.20 I/O - Input/Output.

.21 ISA - Industry Standard Architecture.

.22 LAN - Local Area Network.

.23 LCU - Local Control Unit.

.24 MCU - Master Control Unit.

.25 NAFTA - North American Free Trade Agreement.

.26 NC - Normally Closed.

.27 NO - Normally Open.

.28 OS - Operating System.

.29 O M - Operation and Maintenance.

.30 OWS - Operator Work Station.

.31 PC - Personal Computer.

.32 PCI - Peripheral Control Interface.

.33 PCMCIA - Personal Computer Micro-Card Interface Adapter.

.34 PID - Proportional, Integral and Derivative.

.35 RAM - Random Access Memory.

.36 SP - Static Pressure.

.37 ROM - Read Only Memory.

.38 TCU - Terminal Control Unit.

.39 USB - Universal Serial Bus.

.40 UPS - Uninterruptible Power Supply.

.41 VAV - Variable Air Volume.

## 1.4 DEFINITIONS

.1 Point: may be logical or physical.

.1 Logical points: values calculated by system such as set points, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.

.2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.

.2 Point Name: composed of two parts, point identifier and point expansion.

.1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide 25 character field for each point identifier. "System" is system that point is located on.

.1 Area descriptor: building or part of building where point is located.

.2 System descriptor: system that point is located on.

.3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be short forms or acronyms. Database must provide 25 character field for each point identifier.

.2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of short form or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide 32 character field for each point expansion.

.3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.

.1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.

.3 Point Object Type: points fall into following object types:

.1 AI (analog input).

.2 AO (analog output).

.3 DI (digital input).

.4 DO (digital output).

.5 Pulse inputs.

.4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.

.1 Printouts: to ANSI/IEEE 260.1.

.2 Refer also to Section 25 05 54- EMCS: Identification.

## 1.5 SYSTEM DESCRIPTION

.1 Refer to control schematics for system architecture.

.2 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:

.1 Building Controllers.

.2 Control devices as listed in I/O point summary tables.

.3 OWS(s).

.4 Data communications equipment necessary to effect EMCS data transmission system.

.5 Field control devices.

.6 Software/Hardware complete with full documentation.

.7 Complete operating and maintenance manuals.

.8 Training of personnel.

.9 Acceptance tests, technical support during commissioning, full documentation.

.10 Wiring interface co-ordination of equipment supplied by others.

.11 Miscellaneous work as specified in these sections and as indicated.

.3 Design Requirements:

.1 Design and provide conduit and wiring linking elements of system.

.2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.

.3 Location of controllers as reviewed by Departmental Representative prior to installation.

.4 Provide utility power to EMCS and emergency power to EMCS and Hogen as noted in the documents and drawings.

.5 Metric references: in accordance with CAN/CSA Z234.1.

.4 Language Operating Requirements:

.1 Provide English selectable access codes.

.2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English and French.

.3 Operating system executive: provide primary hardware-to-software interface specified as part of hardware purchase with associated documentation to be in English.

.4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.

.5 Include, in English:

.1 Input and output commands and messages from operator-initiated functions, field related changes, alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic refinements).

.2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English. Point name expansions in both languages.

.3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

## 1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures, 25 05 02 - EMCS: Submittals and Review Process.

.2 Submit for review:

.1 Provide equipment list, systems manufacturers after award of contract and prior to submission of submittals.

.2 List existing field control devices after award of contract and prior to submission of submittals.

.3 Quality Control:

.1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.

.2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.

.3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Submittals and Review Process, Label or listing of specified organization is acceptable evidence.

.4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.

.5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.

.6 Permits and fees: in accordance with general conditions of contract.

.7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.

.8 Existing devices intended for re-use: submit test report.

## 1.7 QUALITY ASSURANCE

.1 Be capable of providing instruction, routine maintenance and emergency service on systems within 48 hours.

.2 The EMCS Contractor must be Delta Controls and a Delta Partner

.3 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.

.4 Have access to essential parts and provide 7 year guarantee of availability of spare parts after obsolescence.

.5 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.

.6 Health and Safety:

.1 Do construction occupational health and safety in accordance with Section 01 35 29 - Health and Safety Requirements.

## 1.8 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative schedule within 2 weeks after award of Contract.

.2 Waste Management and Disposal:

.1 Separate waste materials for reuse, recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

.2 Remove from site and dispose of packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.

.4 Separate for reuse and recycling and place in designated containers Metal or Plastic waste in accordance with Waste Management Plan.

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

.6 Handle and dispose of hazardous materials in accordance with CEPA, TDGA, Regional and Municipal, regulations.

.7 Label location of salvaged material's storage areas and provide barriers and security devices.

.8 Ensure emptied containers are sealed and stored safely.

.9 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

.10 Fold up metal, plastic, banding, flatten and place in designated area for recycling.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT

.1 Control Network Protocol and Data Communication Protocol: to CEA 709.1 and ASHRAE STD 135.

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

### 2.2 ADAPTORS

.1 Provide adaptors between metric and imperial components.

## PART 3 - EXECUTION

### 3.1 MANUFACTURER'S RECOMMENDATIONS

.1 Installation: to manufacturer's recommendations.

### 3.2 PAINTING

.1 Painting: in accordance with Section 09 91 99 - Painting for Minor Works supplemented as follows:

.1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.

.2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

.3 Clean and prime exposed hangers, racks, fastenings, and other support components.

.4 Paint unfinished equipment installed indoors to EEMAC 2Y-1.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes.

.1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 25 05 01 - EMCS: General Requirements

### 1.2 DEFINITIONS

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

### 1.3 DESIGN REQUIREMENTS

.1 Preliminary Design Review: to contain following contractor and systems information.

.1 Location of local office.

.2 Description and location of installing and servicing technical staff.

.3 Location and qualifications of programming design and programming support staff.

.4 List of spare parts]

.5 Location of spare parts stock.

.6 Names of sub-contractors and site-specific key personnel.

.7 Sketch of site-specific system architecture.

.8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.

.9 Descriptive brochures.

.10 Sample CDL and graphics (systems schematics).

.11 Response time for each type of command and report.

.12 Item-by-item statement of compliance.

.13 Proof of demonstrated ability of system to communicate utilizing Proprietary Communications Protocol BACnet.

## 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.

.2 Submit preliminary design document within 5 working days after tender closing and before contract award, for review by Departmental Representative and Consultant.

.3 Shop Drawings to consist of 3 hard copies and 1 soft copy of design documents, shop drawings, product data and software.

.4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

.5 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

## 1.5 PRELIMINARY SHOP DRAWING REVIEW

.1 Submit preliminary shop drawings within 30 working days of award of contract and include following:

.1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.

.2 Detailed system architecture showing all points associated with each controller.

.3 Spare point capacity of each controller by number and type.

.4 Controller locations.

.5 Auxiliary control cabinet locations.

.6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.

.7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).

.8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.

.9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.

.10 Compressor schematic and sizing data.

.11 AC units and condensing units

.12 Exhaust and supply fans

.13 Electric heaters and convectors

## 1.6 DETAILED SHOP DRAWING REVIEW

.1 Submit detailed shop drawings within 60 working days after award of contract and before start of installation and include following:

.1 Corrected and updated versions (hard copy and PDF) of submissions made during preliminary review.

.2 Wiring diagrams.

.3 Piping diagrams and hook-ups.

.4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.

.5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:

.1 Sensing element type and location.

.2 Transmitter type and range.

.3 Associated field wiring schematics, schedules and terminations.

.4 Schematics and schedules.

.5 Complete Point Name Lists.

.6 Set points, curves or graphs and alarm limits high and low, 3 types critical, cautionary and maintenance), signal range.

.7 Software and programming details associated with each point.

.8 Manufacturer's recommended installation instructions and procedures.

.9 Input and output signal levels or pressures where new system ties into existing control equipment.

.6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure

required to achieve proper operation of project, including under complete failure of EMCS.

.7 Graphic system schematic displays of air and water systems with point identifiers and textual description of system, and typical floor plans as specified.

.8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.

.9 Listing and example of specified reports.

.10 Listing of time of day schedules.

.11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.

.12 Type and size of memory with statement of spare memory capacity.

.13 Full description of software programs provided.

.14 Sample of "Operating Instructions Manual" to be used for training purposes.

.15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

## 1.7 QUALITY ASSURANCE

.1 Preliminary Design Review Meeting: Convene meeting within 45 working days of award of contract to:

.1 Undertake functional review of preliminary design documents, resolve inconsistencies.

.2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).

.3 Review interface requirements of materials supplied by others.

.4 Review "Sequence of Operations".

.2 Contractor's programmer to attend meeting.

.3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for final control diagrams and operation and maintenance (O M) manual, for building Energy Monitoring and Control System (EMCS) Work.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 25 05 01 - EMCS: General Requirements

.3 Section 25 05 02 - EMCS: Submittals and Review Process

### 1.2 DEFINITIONS

.1 BECC - Building Environmental Control Centre.

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.

.2 Submit Record Documents, As-built drawings and Operation and Maintenance Manual to Departmental Representative and Consultant in English and French.

.3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.

.1 Binders to be 2/3 maximum full.

.2 Provide index to full volume in each binder.

.3 Identify contents of each manual on cover and spine.

.4 Provide Table of Contents in each manual.

.5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

### 1.4 AS-BUILTS

.1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:

.1 Changes to contract documents as well as addenda and contract extras.

.2 Changes to interface wiring.

.3 Routing of conduit, wiring and control air lines associated with EMCS installation.

.4 Locations of obscure devices to be indicated on drawings.

.5 Listing of alarm messages.

.6 Panel/circuit breaker number for sources of normal/emergency power.

.7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

.8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

.9 Basic system design and full documentation on system configuration.

.2 Submit for final review by Departmental Representative.

.3 Provide before acceptance 4 Hard and 1 soft copy incorporating changes made during final review.

## 1.5 O M MANUALS

.1 Custom design O M Manuals both hard and soft copy to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.

.2 Provide 2 complete sets of hard and soft copies prior to system or equipment tests

.3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.

.4 Functional description to include:

.1 Functional description of theory of operation.

.2 Design philosophy.

.3 Specific functions of design philosophy and system.

.4 Full details of data communications, including data types and formats, data processing and disposition

data link components, interfaces and operator tests or self-test of data link integrity.

.5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.

.6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented or planned for implementation in automatic mode.

.5 System operation to include:

.1 Complete step-by-step procedures for operation of system including required actions at each OWS.

.2 Operation of computer peripherals, input and output formats.

.3 Emergency, alarm and failure recovery.

.4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.

.6 Software to include:

.1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.

.2 Detailed descriptions of program requirements and capabilities.

.3 Data necessary to permit modification, relocation, reprogramming and to permit new software modules to respond to changing system functional requirements without disrupting normal operation.

.4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device

.5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, and program execution.

.6 Software for each Controller and single section referencing Controller common parameters and functions.

.7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault

diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.

.8 System configuration document:

.1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.

.2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.

.9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, and fully commented source listing of applicable driver/handler.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 25 05 01 - EMCS: General Requirements

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA C22.1-02, The Canadian Electrical Code, Part I (19th Edition), Safety Standard for Electrical Installations.

### 1.3 DEFINITIONS

.1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

### 1.4 SYSTEM DESCRIPTION

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

### 1.5 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.

.2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

## PART 2 - PRODUCTS

### 2.1 NAMEPLATES FOR PANELS

.1 Identify by Plastic laminate, 3 mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.

.2 Sizes: 25 x 67 mm minimum.

.3 Lettering: minimum 7 mm high, black.

.4 Inscriptions: machine engraved to identify function.

## 2.2 NAMEPLATES FOR FIELD DEVICES

.1 Identify by plastic encased cards attached by chain and plastic tie as applicable

.2 Sizes: 50 x 100 mm minimum.

.3 Lettering: minimum 5 mm high produced from laser printer in black.

.4 Data to include: point name and point address.

.5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

## 2.3 NAMEPLATES FOR ROOM SENSORS

.1 Identify by stick-on labels using point identifier.

.2 Location: as directed by Departmental Representative.

.3 Letter size: to suit and be clearly legible.

## 2.4 WARNING SIGNS

.1 Equipment including motors, starters under remote automatic control: supply and install orange coloured signs warning of automatic starting under control of EMCS.

.2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative's.

## 2.5 WIRING

.1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.

.2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.

.3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

## 2.6 CONDUIT

.1 Colour code EMCS conduit.

.2 Pre-paint box covers and conduit fittings.

.3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative during "Preliminary Design Review".

## PART 3 - EXECUTION

### 3.1 NAMEPLATES AND LABELS

.1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes.

.1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).

.2 Related Requirements

.1 Section 01 33 00 - Submittal Procedures

.2 Section 25 05 01 - EMCS: General Requirements

.3 Section 25 05 54 - EMCS: Identification

.4 Division 26 - Electrical

.5 Division 27 - Communications

.3 References.

.1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.

.2 Canadian Standards Association (CSA International).

.1 CSA Z204-94(R1999), Guidelines for Managing Indoor Air Quality in Office Buildings.

### 1.2 DEFINITIONS

.1 BC(s) - Building Controller(s).

.2 OWS - Operator Work Station.

.3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.

.3 Submit detailed inspection reports to Departmental Representative.

.4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:

.1 Point name and location.

.2 Device type and range.

.3 Measured value.

.4 System displayed value.

.5 Calibration detail

.6 Indication if adjustment required,

.7 Other action taken or recommended.

.5 Submit network analysis report showing results with detailed recommendations to correct problems found.

.6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.

.1 Maintain records and logs of each maintenance task on site.

.2 Organize cumulative records for each major component and for entire EMCS chronologically.

.3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.

.7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

## 1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD

.1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.

.2 Emergency Service Calls:

.1 Initiate service calls when EMCS is not functioning correctly.

.2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.

.3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.

.4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.

.5 Perform Work continuously until EMCS restored to reliable operating condition.

.3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.

.4 Work requests: record each service call request, when received separately on approved form and include:

.1 Serial number identifying component involved.

.2 Location, date and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.5 Provide system modifications in writing.

.1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative

## 1.5 SERVICE CONTRACTS

.1 Provide in-depth technical expertise and assistance to Departmental Representative in preparation and implementation of service contracts and in-house preventive maintenance procedures.

.2 Service Contracts to include:

.1 Annual verification of field points for operation and calibration.

.2 2 visits per year.

.3 4 responses to emergency calls per year.

.4 Complete inventory of installed system.

# PART 2 - EXECUTION

## 2.1 FIELD QUALITY CONTROL

.1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.

.2 Perform inspections during regular working hours, 0800 to 1700 h, Monday through Friday, excluding statutory holidays.

.3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:

.1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.

.2 Check and calibrate each field input/output device in accordance with Canada Labour Code - Part I CSA Z204

.3 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.

.4 Minor inspections to include, but not limited to:

.1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.

.2 Check equipment cooling fans as required.

.3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.

.4 Review system performance with Operations Supervisor and Departmental Representative to discuss suggested or required changes.

.5 Major inspections to include, but not limited to:

.1 Minor inspection.

.2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.

.3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.

.4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.

.5 Provide mechanical adjustments, and necessary maintenance on printers.

.6 Run system software diagnostics as required.

.7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.

.1 Perform network analysis and provide report as described in Submittal article.

.6 Rectify deficiencies revealed by maintenance inspections and environmental checks.

.7 Continue system debugging and optimization.

.8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.

.1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

.2 Related Requirements

.1 Section 25 01 11- EMCS: Start-up, Verification and Commissioning

.2 Section 25 01 12 - EMCS: Training

.3 Section 25 05 01 - EMCS: General Requirements

.4 Section 25 05 02 - EMCS: Submittals and Review Process

.5 Section 25 05 03 - EMCS: Project Record Documents

.6 Section 25 05 54 - EMCS: Identification

.7 Section 25 08 20 - EMCS: Warranty and Maintenance

.8 Section 25 10 02 - EMCS: Operator Work Station (OWS)

.9 Section 25 30 01 - EMCS: Building Controllers

.10 Section 25 30 02 - EMCS: Field Control Devices

.11 Section 25 90 01 - EMCS: Site Requirements, Application and Systems, Sequence of Operations

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA T529-95(R2000), Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).

.2 CSA T530-99(R2004), Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).

.2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.

.1 IEEE Std 802.3™-, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

.3 Telecommunications Industries Association (TIA)/Electronic Industries Alliance (EIA)

.1 TIA/EIA-568-March 2004, Commercial Building Telecommunications Cabling Standards Set, Part 1

General Requirements Part 2 Balanced Twisted-Pair Cabling Components Part 3 Optical Fiber Cabling Components Standard.

.2 TIA/EIA-569-A-December 2001, Commercial Building Standard for Telecommunications Pathways and Spaces.

.4 Treasury Board Information Technology Standard (TBITS).

.1 TBITS 6.9-2000, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

## 1.3 DEFINITIONS

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

## 1.4 SYSTEM DESCRIPTION

.1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with CSA T529, TIA/EIA-56, CSA T530, TIA/EIA-569-A, TBITS 6.9.

.1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.

.2 Allow for future expansion of network, with selection of networking technology and communication protocols.

.2 Data communication network to include, but not limited to:

.1 EMCS-LAN.

.2 Modems.

.3 Network interface cards.

.4 Network management hardware and software.

.5 Network components necessary for complete network.

## 1.5 DESIGN REQUIREMENTS

.1 EMCS Local Area Network (EMCS-LAN).

.1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with IEEE 802.3/Ethernet Standard.

.2 EMCS-LAN to: BACnet,

.3 Each EMCS-LAN to be capable of supporting at least 50 devices.

.4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.

.5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers,

upload/download information between network devices. Bit rate to be 10 Megabits per second minimum.

.6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.

.7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.

.2 Dynamic Data Access.

.1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.

.2 Access to data to be based upon logical identification of building equipment.

.3 Network Medium.

.1 Network medium: twisted cable, compatible with network protocol to be used within buildings. Fibre optic cable to be used between buildings, provided by electrical.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's.

.2 Related Requirements

.1 Section 01 33 00- Submittal Procedures

.2 Section 01 78 00 - Closeout Submittals

.3 Section 25 05 01 - EMCS: General Requirements

.4 Section 25 05 02 - EMCS: Submittals and Review Process

.5 Section 25 05 03 - EMCS: Project Record Documents

.6 Section 25 30 01 - EMCS: Building Controllers

.7 Section 25 90 01 - EMCS: Site Requirements, Application and Systems, Sequence of Operations

### 1.2 DEFINITIONS

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

.2 Secondary OWS: serves as backup to primary OWS, is storage and retrieval facility of soft copy of as-built contractor supplied data as described in Section 25 05 03 - EMCS: Project Record Documents.

.3 Portable OWS: used as remote dial-up OWS with same capabilities as primary OWS including graphic display.

.4 Remote Auxiliary OWS: performs identical user interface functions as primary OWS.

### 1.3 OWS SYSTEM DESCRIPTION

.1 Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.

.2 Primary OWS to include:

.1 Include two spare Delta License dongles with graphics editor privileges and delta software

.2 Colour graphics printer.

.3 Secondary OWS.

.4 Portable Laptop.

## 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

## 1.5 ENVIRONMENTAL CONDITIONS

.1 OWS to operate in conditions of 10 degrees C to 32degrees C and 10 % to 90 % non-condensing RH.

## 1.6 MAINTENANCE

.1 Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

# PART 2 - PRODUCTS

## 2.1 OWS HARDWARE

.1 PC system to include:

.1 Processor: Pentium IV micro-processor, MS windows OS, operating at minimum clock speed of 3.3 Gigahertz, capable of supporting software necessary to perform functions specified in this section. System backplane bus (350 Megahertz) to support PCI and ISA boards.

.2 Internal clock.

.1 Uninterruptible clock: accuracy of plus or minus 5 seconds/month, capable of deriving year / month / day / hour / minute / second.

.2 Rechargeable batteries: to provide minimum 48 h clock operation in event of power failure.

.3 Asynchronous interfaces for connection to listed peripheral devices including LAN and remote devices.

.2 Power supply unit to accept 120 V, 60 Hz source and include line surge and low voltage protection for processor and its peripherals.

.3 Include UPS to provide 5 minutes minimum operation of PC, CRT and communication and peripheral devices; applies to fixed (non portable) OWSs and peripherals.

## 2.2 OWS PC COMPONENTS

.1 Primary OWS: PC compatible with following as minimum:

.1 IDE Disk drive controller to support [4] drives.

.1 (1) 1.0 TB hard disk drive, 7200 rpm

.2 10/100/1000 Ethernet Ports

.3 Internal DVD/CD super-multi dual layer drive

.2 16 GB RAM minimum.

.3 Full size USB

.4 Optical USB

.5 Colour monitor: 24". LCD Flat panel display TFT, resolution 1920 X 1080, dot pitch 0.26 mm, colour support 24 bit, with anti-glare coating

.6 Video card with 4 GB video RAM.

.7 2 Parallel Ports to support printers.

.8 2 USB ports or 2 serial ports.

.9 Include two 2 spare expansion slots in system for PWGSC's use.

.10 Internal Modem - 56 k.

.11 PCI Ethernet LAN Adapter to connect to local Ethernet LAN network.

.12 200 W minimum power supply.

.2 Secondary OWS: PC compatible workstation as defined for primary OWS with following modifications:

.1 Include IDE controller interface.

.2 Drive will support ISO format.

.3 Provide necessary software to facilitate system backup and recovery from this device.

.3 Portable OWS: IBM compatible personal laptop computer, with following as minimum:

.1 Pentium processor 3 GHz.

.2 1 TB hard disk drive, 5 ms access time.

.3 Internal DVD super-multi dual layer drive

.4 Minimum 8 GB RAM.

.5 Enhanced 101-key keyboard.

.6 USB mouse device.

.7 29.5 cm Colour LCD (active matrix) display.

.8 Ethernet LAN adapter to connect to local Ethernet Network.

.9 PCMCIA or internal 56k bit/s auto-dial modem with Hayes-compatible command set.

.10 Protective case with serviceable carrying straps.

.11 CPU and peripherals: IBM compatible.

.12 Operating system: same as primary OWS and include licenced OWS software as installed on primary OWS.

## 2.3 PRINTERS

.1 Colour graphics printer include following features:

.1 Ink-jet technology capable of printing high quality colour images at speed of 4 pages per minute.

.2 Black cartridge to be separate cartridge from red green blue cartridge.

.3 Minimum colour resolution 2400 by 1200 dpi.

.4 Minimum black and white resolution 1200 by 1200 dpi.

.5 Minimum 8 MB RAM.

.2 Include one box of 8.5 X 11" and one box of 8.5 X 14" paper.

## 2.4 OPERATING SYSTEM (OS) OR EXECUTIVE

.1 OS to support complement of hardware terminals and software programs specified.

.2 OS to be true multitasking operating environment.

.1 MS DOS or PC DOS based software platforms not permitted.

.3 OWS software to operate in "Windows" based operating environment: Windows 7, 8 or 10 Windows based system.

## 2.5 OWS CONTROL SOFTWARE

.1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.

.2 Time Synchronization Module.

.1 System to provide Time Synchronization of real-time clocks in controllers.

.2 System to perform this feature on regular scheduled basis and on operator request.

.3 User Display Interface Module.

.1 OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.

.2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to 1 place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed 5 seconds from time of field change and system is to execute supervisory background scan every 20 seconds to verify point data value. For other systems

refresh rate not to exceed 5 seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed 8 seconds.

.4 General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:

.1 Operator Log-in from user interface device.

.2 Communication messages: errors, failures and recovery.

.3 Event notifications and alarms by category.

.4 Record of operator initiated commands.

.5 General Event Log:

.1 Hold minimum of 4 months information and be readily accessible to operator.

.2 Able to be archived as necessary to prevent loss of information.

.6 Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:

.1 Automatic logging of digital alarms and change of status messages.

.2 Automatic logging of analog alarms.

.3 System changes: alarm limits, set-points, alarm lockouts.

.4 Display specific point values, states as selected.

.5 Provide reports as requested and on scheduled basis when required.

.6 Display graphics as requested, and on alarm receptions (user's option).

.7 Display list of points within system.

.8 Display list of systems within building.

.9 Direct output of information to selected peripheral device.

.10 On-line changes:

.1 Alarm limits.

.2 Setpoints.

.3 Deadbands.

.4 Control and change of state changes.

.5 Time, day, month, year.

.6 Control loop configuration changes for controller-based CDLs.

.7 Control loop tuning changes.

.8 Schedule changes.

.9 Changes, additions, or deletions, of points, graphics, for installed and future systems.

.11 According to assigned user privileges (password definition) following functions are to be supported:

.1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.

.2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.

.12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.

.7 Dial-up host Module for off site OWSs.

.1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.

.2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.

.3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.

.8 Message Handling Module - and Error Messages: to provide message handling for following conditions:

.1 Message and alarm buffering to prevent loss of information.

.2 Error detection correction and retransmission to guarantee data integrity.

.3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of

equipment to respond to requests or commands and failure of communications between EMCS devices.

.4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.

.9 Access Control Module.

.1 Minimum 5 levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:

.1 Guest: no password data access and display only.

.2 Operator Level: full operational commands including automatic override.

.3 Technician: data base modifications.

.4 Programmer: data base generation.

.5 Highest Level: system administration - password assignment addition, modification.

.2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = 3 minutes.

.10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.

.1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate [30-480] minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least 6 month capacity.

.2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of 05 seconds to 3600 seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum 96 h basis in temporary storage

until removed from trend data list by operator. Option to archive data before overwriting to be available.

.3 Control loop plot utility: for AO Points provide for concurrent plotting of measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.

.4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of 6 historical points or 6 trend points concurrently or 1 Control Loop Plot. For display output of real time trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.

.5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.

.11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers.

.1 Reports to include time, day, month, year, report title, operator's initials.

.2 Software to provide capability to:

.1 Generate and format reports for graphical and numerical display from real time and stored data.

.2 Print and store reports as selected by operator.

.3 Select and assign points used in such reports.

.4 Sort output by area, system, as minimum.

.3 Periodic/automatic report:

.1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit

modifying periodic/automatic reporting profile at any time.

.2 Reports to include:

.1 Power demand and duty cycle summary: see application program for same.

.2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.

.3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.

.4 Summary of run time alarms: include point name, run time to date, alarm limit.

.5 Summary of start/stop schedules: include start/stop times and days, point name.

.6 Motor status summary.

.4 Report types:

.1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:

.2 Points in accessible from this OWS (total connected for this location), multiple "areas".

.3 Area (points and systems in Area).

.4 Area, system (points in system).

.5 System (points by system type).

.6 System point (points by system and point object type).

.7 Area point (points by system and point object type).

.8 Point (points by point object type).

.5 Summary report: printout or display of point objet data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.

.6 Include preformatted reports as listed in Event/Alarm Module.

.12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.

.1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlaid with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.

.2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.

.3 Library of pre-engineered screens and symbols depicting standard HVAC components (fans, coils, filters, dampers, etc), complete mechanical system components (air supply and exhaust systems, pumps), electrical symbols.

.4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:

.1 Modify portion of graphic picture/schematic background.

.2 Delete graphic picture.

.3 Call up and cancel display of graphic picture.

.4 Define symbols.

.5 Position and size symbols.

.6 Define background screens.

.7 Define connecting lines, curves.

.8 Locate, orient, size descriptive text.

.9 Define, display colours of elements.

.10 Establish co-relation between symbols or text and associated system points or other graphic displays.

.5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in

analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.

.6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.

.7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum 2 OWS's.

.8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by Departmental Representative and Consultant. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location.

.9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click” to activate selected graphic.

.10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain [English] [and/or] [French] language.

.13 Event/Alarm Module: displays in window alarms as received and stored in General Event Log.

.1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.

.2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.

.3 Alarm reports.

.1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.

.2 Analog alarm limit summary: include point name, alarm limits, deviation limits.

.3 Summary of alarm messages: include associated point name, alarm description.

.4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.

.5 EMCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:

.1 Critical - 5 seconds.

.2 Cautionary - 10 seconds.

.3 Maintenance - 10 seconds.

.6 Display alarm messages in English.

.7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.

.8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of other alarms.

.9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:

.1 Controller not responding - where possible delineate between controller and communication line failure.

.2 Controller responding - return to normal.

.3 Controller communications bad - high error rate or loss of communication.

.4 Controller communications normal - return to normal.

.10 Digital alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.

.14 Archiving and Restoration Module.

.1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.

.2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.

.3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.

.15 CDL Generator and Modifier Module.

.1 CDL Generator module to permit generation and modification of CDLs.

.2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.

.3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.

.4 Module to permit testing of code before downloading to building controllers.

## 2.6 ADDITIONAL UTILITY SOFTWARE

.1 Supply and install on primary OWS;

.1 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.

.2 Enter soft copy submissions, including "Record" drawings specified in Section 25 05 03 - EMCS: Project Record Documents in OWS.

## PART 3 - EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

.1 Provide necessary power as required from local 120 V emergency power branch circuit panels for OWS's and peripheral equipment.

.1 Install tamper locks on breakers of circuit panels.

.2 Refer to UPS requirements stated under OWS Hardware in PART 2.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation for building automation controllers including:

.1 Master Control Unit (MCU).

.2 Local Control Unit (LCU).

.3 Equipment Control Unit (ECU).

.2 Related Requirements

.1 Section 01 33 00- Submittal Procedures

.2 Section 01 78 00 - Closeout Submittals

.3 Section 25 05 01 - EMCS: General Requirements

.4 Section 25 05 02 - EMCS: Submittals and Review Process

.5 Section 25 05 03 - EMCS: Project Record Documents

.6 Section 25 10 01 - EMCS: Local Area Network (LAN)

.7 Section 25 30 01 - EMCS: Building Controllers

.8 Section 25 30 02 - EMCS: Field Control Devices

### 1.2 REFERENCES

.1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).

.1 ASHRAE (latest), Applications Handbook, SI Edition.

.2 Canadian Standards Association (CSA International).

.1 C22.2 No.205-M1983 (R1999), Signal Equipment.

.3 Institute of Electrical and Electronics Engineers (IEEE).

.1 IEEE C37.90.1-02, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.

.4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.

.1 MD13800-September 2000, Energy Management and Control Systems (EMCS) Design Manual. English: ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf

### 1.3 DEFINITIONS

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

## 1.4 DESCRIPTION

.1 General: Network of controllers comprising of MCU('s), LCU('s) or ECU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.

.1 Provide sufficient controllers to meet intents and requirements of this section.

.2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.

.2 Controllers: stand-alone intelligent Control Units.

.1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.

.2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

.3 Capable of interfacing with operator interface device.

.4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).

.3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.

.1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.

.2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

## 1.5 DESIGN REQUIREMENTS

.1 To include:

.1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.

.2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.

.3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.

.4 Control of systems as described in sequence of operations.

.5 Execution of optimization routines as listed in this section.

.2 Total spare capacity for MCUs and LCUs: at least 25 % of each point type distributed throughout the MCUs and LCUs.

.3 Field Termination and Interface Devices:

.1 To: CSA C22.2 No.205.

.2 Electronically interface sensors and control devices to processor unit.

.3 Include, but not be limited to, following:

.1 Programmed firmware or logic circuits to meet functional and technical requirements.

.2 Power supplies for operation of logics devices and associated field equipment.

.3 Lockable wall cabinet.

.4 Required communications equipment and wiring (if remote units).

.5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.

.6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.

.7 Wiring terminations: use conveniently located screw type or spade lug terminals.

.4 AI interface equipment to:

.1 Convert analog signals to digital format with 10 bit analog-to-digital resolution.

.2 Provide for following input signal types and ranges:

.1 4 - 20 mA;

.2 0 - 10 V DC;

.3 100/1000 ohm RTD input;

.3 Meet IEEE C37.90.1 surge withstand capability.

.4 Have common mode signal rejection greater than 60 dB to 60 Hz.

.5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.

.5 AO interface equipment:

.1 Convert digital data from controller processor to acceptable analog output signals using 8 bit digital-to-analog resolution.

.2 Provide for following output signal types and ranges:

.1 4 - 20 mA.

.2 0 - 10 V DC.

.3 Meet IEEE C37.90.1 surge withstand capability.

.6 DI interface equipment:

.1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.

.2 Meet IEEE C37.90.1 surge withstand capability.

.3 Accept pulsed inputs up to 2 kHz.

.7 DO interface equipment:

.1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to 0.5 amps at 2] V AC.

.2 Switch up to 5 amps at 220 V AC using optional interface relay.

.4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 10 % to 90 % non-condensing RH.

.5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.

.1 Provide for conduit entrance from top, bottom or sides of panel.

.2 ECUs to be mounted in equipment enclosures or separate enclosures.

.3 Mounting details as approved by Departmental Representative for ceiling mounting.

.6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.

.7 Provide surge and low voltage protection for interconnecting wiring connections.

## 1.6 ACTION AND INFORMATIONAL SUBMITTALS

.1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures Section 25 05 02 - EMCS: Submittals and Review Process.

.1 Submit product data sheets for each product item proposed for this project.

## 1.7 MAINTENANCE

.1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

# PART 2 - PRODUCTS

## 2.1 MASTER CONTROL UNIT (MCU)

.1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.

.2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.

.1 MCU must support BACnet.

.3 MCU local I/O capacity as follows:

.1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.

.2 LCUs may be added to support system functions.

.4 Central Processing Unit (CPU).

.1 Processor to consist of minimum 16 bit microprocessor capable of supporting software to meet specified requirements.

.2 CPU idle time to be more than 30 % when system configured to maximum input and output with worst case program use.

.3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:

.1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.

.2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, set points, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.

.4 Include uninterruptible clock accurate to plus or minus 5 secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum 72 hour operation in event of power failure.

.5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

.1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative and Consultant.

.2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.

.3 Display simultaneously minimum of 16 point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English and French.

.4 Functions to include, but not be limited to, following:

.1 Start and stop points.

.2 Modify setpoints.

.3 Modify PID loop parameters.

.4 Override PID control.

.5 Change time/date.

.6 Add/modify/start/stop weekly scheduling.

.7 Add/modify setpoint weekly scheduling.

.8 Enter temporary override schedules.

.9 Define holiday schedules.

.10 View analog limits.

.11 Enter/modify analog warning limits.

.12 Enter/modify analog alarm limits.

.13 Enter/modify analog differentials.

.5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.

.6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.

.7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to

be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.

.8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

## 2.2 LOCAL CONTROL UNIT (LCU)

.1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.

.2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.

.3 Points integral to one Building System to be resident on only one controller.

.4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:

.1 Include minimum 2 interface ports for connection of local computer terminal.

.2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.

.3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.

.4 Include power supplies for operation of LCU and associated field equipment.

.5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.

.6 Provide conveniently located screw type or spade lug terminals for field wiring.

## 2.3 EQUIPMENT (includes Terminals) CONTROL UNIT (ECU)

.1 Microprocessor capable of supporting necessary software and hardware to meet ECU functional specifications.

.1 ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.

.2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints,

and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.

2.4

SOFTWARE

.1 General.

.1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.

.2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.

.3 Include initial programming of Controllers, for entire system.

.2 Program and data storage.

.1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.

.2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.

.3 Programming languages.

.1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.

.2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.

.4 Operator Terminal interface.

.1 Operating and control functions include:

.1 Multi-level password access protection to allow user/manager to limit workstation control.

.2 Alarm management: processing and messages.

.3 Operator commands.

.4 Reports.

.5 Displays.

.6 Point identification.

.5 Pseudo or calculated points.

.1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.

.2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).

.6 Control Description Logic (CDL):

.1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.

.2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.

.3 Perform changes to CDL on-line.

.4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.

.5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.

.6 MCU to be able to perform following pre-tested control algorithms:

.1 Two position control.

.2 Proportional Integral and Derivative (PID) control.

.7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.

.8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

.9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its

appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.

.7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.

.8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.

.1 MCU in coordination with subordinate LCU and ECU to provide for the following energy management routines:

.1 Time of day scheduling.

.2 Calendar based scheduling.

.3 Holiday scheduling.

.4 Temporary schedule overrides.

.5 Optimal start stop.

.6 Night setback control.

.7 Fan speed/flow rate control.

.2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.

.3 Apply programs to equipment and systems as specified or requested by the Departmental Representative and Consultant.

.9 Function/Event Totalization: features to provide predefined reports which show daily, weekly, and monthly accumulating totals and which include high rate (time stamped) and low rate (time stamped) and accumulation to date for month.

.1 MCUs to accumulate and store automatically run-time for binary input and output points.

.2 MCU to automatically sample, calculate and store consumption totals on daily, weekly or monthly basis for user-selected analog or binary pulse input-type points.

.3 MCU to automatically count events (number of times fan is cycled off and on) daily, weekly or monthly basis.

.4 Totalization routine to have sampling resolution of 1 min or less for analog inputs.

.5 Totalization to provide calculations and storage of accumulations up to 99,999.9 units (eg. kWH, litres, tonnes, etc.).

.6 Store event totalization records with minimum of 9,999,999 events before reset.

.7 User to be able to define warning limit and generate user-specified messages when limit reached.

## 2.5 LEVELS OF ADDRESS

.1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

.1 Display analog values digitally to 1 place of decimals with negative sign as required.

.2 Update displayed analog values and status when new values received.

.3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.

.4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

## 2.6 POINT NAME SUPPORT

.1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

# PART 3 - EXECUTION

## 3.1 LOCATION

.1 Location of Controllers to be approved by Departmental Representative.

## 3.2 INSTALLATION

.1 Install Controllers in secure locking enclosures as directed by Departmental Representative.

.2 Provide necessary power from local 120 V branch circuit panel for equipment.

.3 Install tamper locks on breakers of circuit breaker panel.

.4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 Control devices integral to the Building Energy Monitoring and Control System (EMCS) including but not limited to: transmitters, sensors, controls, switches, transducers, dampers, damper operators, low voltage current transformers.

.2 Related Sections:

.1 Section 01 73 00 - Execution Requirements.

.2 Section 07 84 00 - Fire stopping.

.3 Section 23 33 15 - Dampers - Operating.

.4 Section 25 05 01 - EMCS: General Requirements.

.5 Section 25 05 02 - EMCS: Submittals and Review Process.

.6 Section 25 05 54 - EMCS: Identification.

.7 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.

.8 Section 26 05 00 - Common Work Results for Electrical.

.9 Section 26 27 10 - Modular Wiring System.

.10 Section 26 27 26 - Wiring Devices.

### 1.2 REFERENCES

.1 American National Standards Institute (ANSI).

.1 ANSI C12.7-2014, Requirements for Watthour Meter Sockets.

.2 ANSI/IEEE C57.13-2009, Standard Requirements for Instrument Transformers.

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

.1 ASTM B148(2014), Standard Specification for Aluminum-Bronze Sand Castings.

.3 National Electrical Manufacturer's Association (NEMA).

.1 NEMA 250-2014, Enclosures for Electrical Equipment (1000 Volts Maximum).

.4 Air Movement and Control Association, Inc. (AMCA).

.1 AMCA Standard 500-D-2012, Laboratory Method of Testing Dampers for Rating.

.5 Canadian Standards Association (CSA International).

.1 CSA-C22.1-2015, Canadian Electrical Code, (23 Edition) Safety Standard for Electrical Installations.

## 1.3 DEFINITIONS

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

## 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.

.2 Pre-Installation Tests.

.1 Submit samples at random from equipment shipped, as requested by Departmental Representative for testing before installation. Replace devices not meeting specified performance and accuracy.

.3 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions for specified equipment and devices.

# PART 2 - PRODUCTS

## 2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.

.3 Operating conditions: 0 - 32 degrees C with 10 - 90% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including two way radios.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

.7 Outdoor installations: use weatherproof construction in NEMA 4 enclosures.

.8 Devices installed in user occupied space not exceed Noise Criteria (NC) of 35. Noise generated by any device must not be detectable above space ambient conditions.

.9 Range: including temperature, humidity, and pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

.10 All devices used/installed in these rooms must meet the rating requirements of these classifications:

.1 HOGEN Room classified as class 1, zone 2 group IIC

.2 INFLATION room classified as class 1, zone 1, group IIC

## 2.2 TEMPERATURE SENSORS

.1 General: except for room sensors to be resistance or thermocouple type to following requirements:

.1 Thermocouples: limit to temperature range of 200 degrees C and over.

.2 RTD's: 100 or 1000 ohm at 0degrees C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3integral anchored lead wires. Coefficient of resistivity: 0.00385 ohms/ohm degrees C.

.3 Sensing element: hermetically sealed.

.4 Stem and tip construction: copper or type 304 stainless steel.

.5 Time constant response: less than 3 seconds to temperature change of 10 degrees C.

.6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length mm as required.

.2 Room temperature sensors and display wall modules.

.1 Temperature sensing and display wall module.

.1 LCD display to show space temperature and temperature setpoint.

.2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.

.3 Jack connection for plugging in contractor supplied palm compatible handheld device for access to zone bus.

.4 Integral thermistor sensing element 10,000 ohm at 24 degrees.

.5 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.

.6 Stability 0.02 degrees C drift per year.

.7 Separate mounting base for ease of installation.

.2 Room temperature sensors.

.1 Wall mounting, in slotted type covers having brushed aluminum finish, with guard.

.2 Element 10 to 50mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.

.3 Duct temperature sensors:

.1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length as required.

.2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.

.4 Outdoor air sensor:

.1 Shall be the RTD type with a 4-20mA transmitter mounted at the sensor. The RTD shall be mounted in a weather proof enclosure, the 4-20mA transmitter shall be mounted inside the building within an electrical box. The accuracy of the sensor shall be ± 0.3°C over a range of -18°C to 49°C. Where sensors are specified to be in outside air they are to be installed so as not to be affected by exhaust air or reverse warm air flow through air supply units should the supply fan be off. All outside sensors to be covered by a sun shield.

## 2.3 TEMPERATURE TRANSMITTERS

.1 Requirements:

.1 Input circuit: to accept 3-lead, 100 or 1000 ohm at 0 degrees C, platinum resistance detector type sensors.

.2 Power supply: 24 V DC into load of 575 ohms. Power supply effect less than 0.01 degrees C per volt change.

.3 Output signal: 4 - 20 mA into500 ohm maximum load.

.4 Input and output short circuit and open circuit protection.

.5 Output variation: less than 0.2 % of full scale for supply voltage variation of plus or minus 10 %.

.6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5 % of full scale output.

.7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed 25 mA.

.8 Integral zero and span adjustments.

.9 Temperature effects: not to exceed plus or minus 1.0 % of full scale/ 50 degrees C.

.10 Long term output drift: not to exceed 0.25 % of full scale/ 6 months.

.11 All Transmitters used/installed in these rooms must meet the rating requirements of these classifications:

.1 HOGEN Room classified as class 1, zone 2 group IIC

.2 INFLATION room classified as class 1, zone 1, group IIC

## 2.4 DIFFERENTIAL PRESSURE TRANSMITTERS

.1 Requirements:

.1 Internal materials: suitable for continuous contact with industrial standard instrument air.

.2 Output signal: 4 - 20 mA into 500 ohm maximum load.

.3 Output variations: less than 0.2 % full scale for supply voltage variations of plus or minus 10 %.

.4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5 % of full scale output over entire range.

.5 Integral zero and span adjustment.

.6 Temperature effects: not to exceed plus or minus 1.5 % full scale/ 50 degrees C.

.7 Over-pressure input protection to at least twice rated input pressure.

.8 Output short circuit and open circuit protection.

.9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

## 2.5 DIFFERENTIAL PRESSURE SENSORS/GAUGES

.1 CSA certified with indicating gauge, adjustable Hi-Lo limit switches/setpoint knobs, and 4-20 mA transmitter.

.2 Each complete with single pole, double throw contacts rated 10 amperes at 120 volts AC.

.3 Provide switch/gauge with a differential pressure range suitable to the application. Select materials suitable for

the measured variable, i.e. water and air, and to withstand a minimum of twice the normal pressure.

.4 The transmitter and sensor shall have a combined accuracy of <+/- 2.0% full scale.

## 2.6 STATIC PRESSURE SENSORS

.1 Requirements:

.1 Multipoint element with self-averaging manifold.

.1 Maximum pressure loss: 160 Pa at 10 m/s. (Air stream manifold).

.2 Accuracy: plus or minus 1 % of actual duct static pressure.

## 2.7 STATIC PRESSURE TRANSMITTERS

.1 Requirements:

.1 Output signal: 4 - 20 mA linear into 500 ohm maximum load.

.2 Calibrated span: not to exceed [150] % of duct static pressure at maximum flow.

.3 Accuracy: 0.4 % of span.

.4 Repeatability: within 0.5 % of output.

.5 Linearity: within 1.5 % of span.

.6 Deadband or hysteresis: 0.1% of span.

.7 External exposed zero and span adjustment.

.8 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit

## 2.8 TANK LEVEL SWITCHES

.1 Requirements:

.1 Indicate high/low water level and to alarm.

.2 Maximum operating temperature: 120 degrees C.

.3 Snap action contacts rated 15 amp at 120 V.

.4 Adjustable setpoint and differential.

.5 Complete with float, flexible cord, weight. Instrument casing to be suitable for immersion in measured liquid

## 2.9 SOLID STATE RELAYS

.1 General:

.1 Relays to be socket or rail mounted.

.2 Relays to have LED Indicator

.3 Input and output Barrier Strips to accept 14 to 28 AWG wire.

.4 Operating temperature range to be -20 degrees C to 70 degrees C.

.5 Relays to be CSA Certified.

.6 Input/output Isolation Voltage to be 4000 VAC at 25 degrees C for 1 second maximum duration.

.7 Operational frequency range, 45 to 65 HZ.

.2 Input:

.1 Control voltage, 3 to 32 VDC.

.2 Drop out voltage, 1.2 VDC.

.3 Maximum input current to match AO (Analog Output) board.

.3 Output.

.1 AC or DC Output Model to suit application.

## 2.10 CURRENT TRANSDUCERS

.1 Requirements:

.2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

.1 4-20 mA DC.

.2 0-1 volt DC.

.3 0-10 volts DC.

.4 0-20 volts DC.

.3 Frequency insensitive from 10 - 80 hz.

.4 Accuracy to 0.5% full scale.

.5 Zero and span adjustments. Field adjustable range to suit motor applications.

.6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

## 2.11 CURRENT SENSING RELAYS

.1 Requirements: Provide for the exhaust and supply fan motors. The sensor shall consist of a current transformer, a solid state current sensing circuit, and an LED indicating the power availability at the device.

.1 Suitable to detect belt loss or motor failure.

.2 Trip point adjustment, output status LED.

.3 Split core for easy mounting.

.4 Induced sensor power.

.5 Relay contacts: capable of handling 0.5 amps at 30 VAC / DC. Output to be NO solid state.

.6 Suitable for single or 3 phase monitoring. For 3-Phase applications: provide for discrimination between phases.

.7 Adjustable latch level.

## 2.12 CONTROL DAMPERS

.1 Refer to Section 23 33 15 Dampers-Control

## 2.13 CONTROL DAMPER ACTUATORS

.1 Requirements:

.1 Direct mount proportional type as indicated.

.2 Spring return for "fail-safe" in Normally Closed position.

.3 Operator: size to control dampers against maximum pressure and dynamic closing/opening pressure, whichever is greater.

.4 Power requirements: 5 VA maximum at 24 V AC, unless otherwise indicated on mechanical and electrical drawings as requiring 120 V power

.5 Operating range: 0 - 10 V DC or 4 - 20 mA DC.

.6 Damper actuator to drive damper from full open to full closed in less than 120 seconds.

.7 Acceptable Product for Control Room:

.1 Provide actuator suitable for application, 24V, spring return for fail-safe in normally closed position for outside and exhaust and spring return for fail-safe in normally open for return/recirculation, provide with end switch with lever operated, non-corrosive switches secured to damper frames, rated 5 amperes at 115 volts, CSA certified and activated by damper blade movement, provide with a set of aux. contacts for monitoring by the EMCS

.8 Acceptable Product for the HOGEN room:

.1 Explosion Proof Housing

.2 CSA: Class 1, Zone 2, Group IIC

## 2.14 PANELS

.1 Either Free-standing or wall mounted enamelled steel cabinets with hinged and key-locked front door.

.2 Multiple panels as required to handle requirements with additional space to accommodate 25% additional capacity as

required by Departmental Representative without adding additional cabinets.

.3 Panels to be lockable with same key.

## 2.15 HYDROGEN SENSOR AND TRANSMITTER

.1 $H_2$ Sensor

.1 Remote sensor mounting

.2 Lower detectable limit: 300 ppm

.3 Accuracy +/- 150 ppm

.4 Maximum 15 second response time

.5 -40°C minimum operating sensor

.2 Transmitter

.1 LMZ5 aluminum alloy construction 5 coat marine finish paint

.2 4 to 20 mA output, fault warning detection

.3 -40°C minimum operating temperature

.3 CSA: Class 1, Zone 1, Group IIC

.4 Acceptable Products:

.1 Honeywell XNX (transmitter)

.2 Honeywell MPD-CB1 (sensor)

.3 Honeywell 02000-A-1642 (collecting cone)

.4 Honeywell 1226A0354 (gassing point assembly)

## 2.16 FLAME SENSOR

.1 Powder coat with clear anodizing, copper free aluminum construction (less than 0.4%)

.2 Digitally stepped analog output 0 to 20 mA, c/w 120 degree field of view. External reflectors are not acceptable.

.3 -40°C minimum operating temperature

.4 CSA: Class 1, Zone 1, Group IIC

.5 Acceptable Product: no equals will be accepted

.1 Honeywell Fire Sentry SS4 Series

## 2.17 SMOKE DETECTOR (CONTROL ROOM)

.1 Photoelectric type

.2 UL268 Listed for fire protection signaling systems

.3 24V power, 130mA maximum alarm current

.4 Sensitivity: 2.5% per foot nominal

.5 Dual colour LED indicators

## 2.18 SMOKE DETECTOR (HOGEN ROOM)

.1 Photoelectric type

.2 UL 268 listed for fire protection signaling systems

.3 24 DC power Power, 10 mA standby, 35 mA alarm

.4 Sensitivity: 2.3% per foot nominal

.5 Visible alarm indicator LED

.6 CSA: class 1, zone 2, group IIC

## 2.19 STACK LIGHTS

.1 Socket-mount Multi-mode LED lamps c/w base

.2 24VDC

.3 Base unit to include a pulsating horn, 95dB at 1 meter

.4 Minimum lamp life 148,000 hours

.5 Provide two (2) stack light assemblies each complete with lens colors: Red, Green, Amber, Blue, Clear/White

.6 Minimum light diameter 50m

.7 Acceptable Product: Edwards Signaling 101XBRM

## 2.20 EXTERIOR ALARM (WARNING) LIGHTS

.1 Provide LED visual beacons with a UL listed type 4X enclosure

.2 24VDC, class 1, zone 2, group IIC

.3 Minimum lamp life 148,000 hours

.4 Provide two (2) stack light assemblies each complete with lens colors: Red, Green, Amber, Blue, Clear/White

.5 The base shall be made from glass-reinforced thermoplastic resin and the double Fresnel lens is made of shatter resistant polycarbonate

.6 Install per the manufacturer’s recommendations

.7 Provide each beacon with a spare replacement lens

.8 Acceptable Products: Edwards Signaling 105XBRM

## 2.21 EXTERIOR AUDIBLE ALARM

.1 24VDC, CSA certified, NEMA 4X enclosure

.2 18 gauge aluminum construction with neoprene gaskets between the trim ring and horn

.3 110 dBa at 1 meter output

.4 -54°C minimum operating temperature

.5 Acceptable Product: Edward Signaling 877-G1

## 2.22 CONTROL CONSOLE

.1 14 gauge steel body, door and lid

.2 Continuously hinged, sloped front instrument panel

.3 Continuously hinged front door with 3-point door latch

.4 Smooth continuously welded seams, solid sides and back

.5 Finish: beige powder coat

.6 CSA Type 12 certified, NEMA 12 enclosure

.7 Acceptable Product and Size: Hammond Enclosure Model 1471C36 (or equivalent)

## 2.23 EMERGENCY STOP BUTTON

.1 Foolproof twist release 22.5mm diameter, 24V

## 2.24 EMERGENCY DISCHARGE BUTTON

.1 Foolproof twist release 22.5 diameter, 24V

.2 Plastic cover to prevent accidental discharge

## 2.25 HYDROGEN DISPENSING BUTTOM

.1 Illuminated standby, flush shape, mounting type: level with bezel, green lens colour

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.

.3 Temperature transmitters, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.

.4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.

.5 Refer to drawings and specification 25 90 01 for sequences of operation and detailed operation of the control system.

.6 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.

.7 Electrical:

.1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Modify existing starters to provide for EMCS as indicated in I/O Summaries and as indicated.

.3 Refer to control schematics and sequences included as part of control design on drawings and specifications. Trace existing control wiring installation and provide updated wiring schematics including additions, deletions to control circuits for review by Departmental Representative and Consultant before beginning Work.

.4 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

.5 Install communication wiring in conduit.

.1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Maximum conduit fill not to exceed 40%.

.4 Design drawings do not show conduit layout.

.6 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative and Consultant to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

## 3.2 TEMPERATURE SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Outdoor installation:

.1 Protect from solar radiation and wind effects by non-corroding shields.

.2 Install in NEMA 4 enclosures.

.4 Duct installations:

.1 Do not mount in dead air space.

.2 Locate within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature.

.4 Thermally isolate elements from brackets and supports to respond to air temperature only.

.5 Support sensor element separately from coils, filter racks.

.5 Averaging duct type temperature sensors.

.1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.

.2 Wire multiple sensors in series for low temperature protection applications.

.3 Wire multiple sensors separately for temperature measurement.

.4 Use software averaging algorithm to derive overall average for control purposes.

.6 Thermowells: install for piping installations.

.1 Locate well in elbow where pipe diameter is less than well insertion length.

.2 Thermowell to restrict flow by less than 30%.

.3 Use thermal conducting paste inside wells.

## 3.3 PANELS

.1 Arrange for conduit and tubing entry from top, bottom or either side.

.2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.

.3 Identify wiring and conduit clearly.

## 3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS

.1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.

## 3.5 IDENTIFICATION

.1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

## 3.6 INDOOR AIR TEMPERATURE SENSOR

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.7 OUTDOOR AIR TEMPERATURE SENSOR

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.8 CONTROL DAMPER ACTUATORS

.1 Install per the manufacturer’s recommendations

3.9 HYDROGEN SENSOR

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for sensor location

3.10 FLAME SENSOR

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for sensor location

3.11 SMOKE DETECTOR (CONTROL ROOM)

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.12 SMOKE DETECTOR (HOGEN ROOM)

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.13 STACK LIGHTS

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.14 INTERIOR AUDIBLE ALARM

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.15 EXTERIOR ALARM LIGHTS

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.16 EXTERIOR AUDIBLE ALARM

.1 Install per the manufacturer’s recommendations

.2 Refer to drawings for location

3.17 CONTROL CONSOLE

.1 Install per the manufacturer's recommendations

.2 Refer to drawings for location

3.18 EMERGENCY STOP BUTTON

.1 Install per the manufacturer's recommendations

.2 Refer to drawings for location

3.19 EMERGENCY DISCHARGE BUTTON

.1 Install per the manufacturer's recommendations

.2 Refer to drawings for location

3.20 HYDROGEN DISPENSING BUTTON

.1 Install per the manufacturer's recommendations

.2 Refer to drawings for location

3.21 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

END OF SECTION

## PART 1 - GENERAL

### 1.1 SUMMARY

.1 Section Includes:

.1 At minimum detailed narrative description of Sequence of Operation of each system including;

.1 Sequence for each system.

.2 Input/Output Point Summary for HOGEN system, refer to drawing.

.3 System Diagrams consisting of the following; Control Design Schematic for systems indicated on drawings (as viewed on OWS)

### 1.2 REFERENCES

.1 Public Works and Government Services Canada (PWGSC) / Real Property Branch / Architectural and Engineering Services.

.2 Section 25 30 02 - EMCS: Field Control Devices

### 1.3 GENERAL

.1 All set points are to be operator adjustable from the graphics display interface in either the operations building or control room.

.2 Set points for the alarm lower flammability limit (LFL) levels will be password protected so they can only be adjusted by system administrators

.3 The date and time and description of all alarms occurrences as well as the date and time of the reset shall be logged by the DDC system, and shall be accessible from the operator workstation

.4 Under normal operating conditions, the green stack light located in the HOGEN building and Operations building shall be illuminated continuously.

.1 The green lights shall not be illuminated when there is an alarm condition or if HOGEN unit is in production mode. Refer to Alarm sequences for details

.5 Refer to Control Drawing for summary of HOGEN control points

.6 Refer to Control Diagrams for schematic of the HVAC systems

.7 Summer Operation - April 15 to Oct 1, adjustable

.8 Winter Operation - Oct 2 to April 14, adjustable

.9 Occupied Mode - 0500 (5am) to 2000 (8pm), Monday through Friday

.10 Unoccupied Mode - 2000 to 0500, Monday through Friday and all 24 hrs on Saturday, Sunday and Holidays

## 1.4 SEQUENCE OF OPERATION

.1 Control Room Ventilation:

.1 The Control Room is equipped with a single inline supply fan with an electric duct heater, pre-filter and an outside and return duct each with a motorized damper.

.1 The filter shall be equipped with differential pressure gauge to provide an alarm when the reading is 100 Pa (0.4” wg.) when it will require replacement.

.2 The current sensing relay shall alert the BAS upon a motor failure.

.3 The supply fan shall operate in a seasonal mode, summer and winter as programmed in the BAS (adjustable).

.1 Summer

.1 When the outside air temperature is less than the return air, the outside air damper shall be fully open and the recirculation air damper closed.

.2 When the outside air temperature is more than the return, the outside air and recirculation air damper shall be open and balanced to provide 50% of air from each air stream.

.3 The fan shall run continuously during the occupied and non-occupied hours (operator adjustable).

.2 Winter

.1 The outside air and recirculation air damper shall be open and balanced to provide 50% of air from each air stream.

.2 The electric duct heater shall operate to maintain the room temperature at 21°C (70°F) based on the room temperature sensor.

.3 The duct heater shall not operate upon detection of low air flow from the heaters internal air flow switch

.2 HOGEN Room Ventilation:

.1 The HOGEN room is equipped with two parallel dueled exhaust fans, fresh air intake duct, and motorized fresh air, exhaust air, and recirculation air dampers. When the control system detects the HOGEN (hydrogen generator) unit is in operation the control system shall:

.1 Start the lead exhaust fan and open the fresh air, exhaust air, and recirculation air dampers to provide 47 1/s of fresh air to the space (minimum position)

.2 If the lead exhaust fan does not start when commanded, the control system shall:

.1 Start the lag exhaust fan.

.3 If the lag exhaust fan does not start when commanded (as detected at the airflow sensor):

.1 Refer to Alarm Sequence #9 for HVAC Flow Restriction Detected.

.3 HOGEN Room Temperature Control:

.1 The HOGEN room is equipped with three electric space heaters. The lower and upper temperature set points are 18 degrees and 24 degrees Celsius.

.2 If the temperature in the HOGEN room drops to more than 6 degrees Celsius below set point:

.1 Electric heaters shall be engaged by the control system.

.2 When the room reaches set point temperature the heaters shall be shut off by the control system.

.3 If the temperature in the HOGEN room drops to more than 14 degrees Celsius below set point:

.1 Refer to Alarm Control Sequence #7 for HOGEN Room Low Temperature.

.4 If the temperature in the HOGEN room drops to more than 17 degrees Celsius below set point:

.1 An alarm message shall be sent to the operator work station (operations building) and the control panel (control room).

.5 If the temperature in the HOGEN room rises to more than 3 degrees Celsius above the upper set point and the HOGEN unit is not in operation:

.1 The lead exhaust fan shall be started.

.2 The fresh air, exhaust air, and recirculation air dampers shall be modulated to achieve space temperature set point.

.3 If the temperature In the HOGEN room rises to more than 5 degrees Celsius above the upper set

point for 15 minutes, the lag exhaust fan shall start.

.4 Once the space temperature drops to degree Celsius above set point, the lag exhaust fan shall stop.

.5 Once the space temperature set point is reached, the lead exhaust fan shall stop and the fresh air, exhaust air, and recirculation dampers shall close.

.6 If the temperature of the HOGEN room rises to more than 3 degrees Celsius above the upper set point and the HOGEN unit is in operation:

.1 The lag exhaust fan shall be started.

.2 The fresh air, exhaust air, and recirculation air dampers shall be modulated to achieve space temperature set point.

.3 If the HOGEN unit is still in operation and the space temperature set point is reached, the lag fan shall stop and the fresh air, exhaust air, and recirculation air dampers shall return to minimum position.

.7 If the space temperature exceeds the set point temperature by more than 3 degrees Celsius:

.1 An alarm message shall be sent to the operator work station (operations building) and the control panel (control room).

.4 Control Room Temperature Control - Heating:

.1 The Control Room is equipped with three electric space heaters.

.2 The space heaters shall operate in a summer and winter mode, as outlined in the control ventilation sequence. The BAS will reset the minimum space activation temperature.

.3 During the summer mode, the space heaters will engage when the space temperature drops below 15.6°C (60°F) in the occupied mode to reach room set point 21°C and in unoccupied mode to reach 18°C. When the room reaches set point, the heaters shall be shut off by the control system.

During the winter mode, the space heaters will engage when the space temperature in the Control room drops below 20°C (68°F) to reach set point of 21°C (70°F). When the room reaches set point temperature the heaters shall be shut off by the control system.

.4 If the space temperature falls more than 3 degrees Celsius below set point temperature:

.1 An alarm message shall be sent to the operator work station (operations building) and the control panel (control room).

.5 Hydrogen Dispensing:

.1 The hydrogen dispensing circuit shall be made active from the Control Room control panel graphic display. When the circuit is activated:

.1 The white segments of the stack warning alarm lights (located in the Control Room, building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.2 The green segments of the stack warning alarm lights shall be illuminated continuously.

.3 The hydrogen master dispensing valve shall open, the secondary hydrogen dispensing valve shall remain closed.

.4 The hydrogen dispensing button is made active and illuminated (this is to be indicated at the control panel graphic display).

.2 When the dispensing button is pressed:

.1 The secondary hydrogen dispensing valve shall open and hydrogen shall flow to the balloon.

.2 The white and green stack light segments shall be illuminated continuously.

.3 When the dispensing button is released:

.1 The secondary valve shall close.

.4 The dispensing circuit shall remain active for 60 seconds at any time following activation, if the secondary dispensing valve is not activated.

.5 The dispensing circuit shall remain active for a maximum of 10 minutes.

.6 Refer to Alarm Control Sequences for conditions that will override hydrogen dispensing valve operation.

.6 HOGEN Generator Producing Hydrogen:

.1 While the HOGEN is in hydrogen production mode:

.2 The green segments of the stack warning alarm lights (located at the building exterior, and the Operations Building shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.3 The ventilation system shall operate per HOGEN Room Ventilation sequence.

.7 Alarm Control Sequence #1 –Inflation Room Combustible Gas Detector

.1 When the Inflation Room combustible gas detector detects a hydrogen concentration greater than 20% of the lower flammability limit (LFL):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The yellow segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.3 The audible alarm, located at each of tile light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.4 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on 0.5 seconds off.

.5 The control system shall fully close both the main hydrogen dispensing valve and the secondary dispensing valve.

.6 The visual alarms shall remain on and the hydrogen-dispensing Valve shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 20%.

.7 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics Interface.

.2 When the Inflation Room combustible gas detector detects a hydrogen concentration greater than 50% of the lower flammability limit (LFL):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.4 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.5 The control system shall fully close the master and secondary hydrogen dispensing valves.

.6 The visual alarms shall remain on and the hydrogen-dispensing valves shall remain closed

until the alarm has been acknowledged at the operator graphics Interface, and the LFL level is below 50%.

.7 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.3 When the Inflation Room combustible gas detector detects a hydrogen concentration greater than 70% of the lower flammability limit (LFL):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel {control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 0.5 seconds on and 0.5 second off.

.3 The audible alarm, located at each of the light stacks shall produce a continuous tone.

.4 The audible alarm on the exterior of the building shall produce a continuous tone.

.5 The control system shall fully close the master and secondary hydrogen dispensing valves.

.6 The visual alarms shall remain on and the hydrogen-dispensing valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 70%.

.7 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.4 If the Inflation Room combustible gas detector detects a fault condition:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The yellow segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.3 The blue segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.4 The control system shall fully close the master and secondary hydrogen dispensing valves.

.5 The visual alarms shall remain on and the hydrogen-dispensing (valves shall remain closed

until the alarm has been acknowledged at the operator graphics interface and the gas sensor fault status is corrected.

.8 Alarm Control Sequence #2: HOGEN Room Combustible Gas Detector

.1 When the HOGEN Room combustible gas detector detects a hydrogen concentration greater than 20% of the lower flammability limit (LFL):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The yellow segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 second off.

.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.4 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.5 The control system shall fully close the master and secondary hydrogen dispensing valves.

.6 The HOGEN generator and Heated Wall Vent shall be powered down by the DDC.

.7 The visual alarms shall remain on, the master/secondary hydrogen dispensing valves shall remain closed and the heated wall vent shall remain off until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 20%.

.8 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.2 When the HOGEN Room combustible gas detector detects a hydrogen concentration greater than 50% of the lower flammability limit (LFL):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 second off.

.3 The audible alarm, located at each of the light stacks shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.4 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.5 The control system shall fully close the master and secondary hydrogen dispensing valves.

.6 The HOGEN generator and Heated Wall Vent shall be powered down by the DDC.

.7 The visual alarms shall remain on, the master/secondary hydrogen dispensing valves shall remain closed and the heated wall vent shall remain off until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 50%.

.8 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.3 When the HOGEN Room combustible gas detector detects a hydrogen concentration greater than 70% of the lower flammability limit (LFL):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 second off.

.3 The audible alarm, located at each of the light stacks shall produce a continuous tone.

.4 The audible alarm on the exterior of the building shall produce a continuous tone.

.5 The control system shall fully close the master and secondary hydrogen dispensing valves.

.6 The HOGEN generator and Heated Wall Vent shall be powered down by the DDC.

.7 The visual alarms shall remain on, the master/secondary hydrogen dispensing valves shall remain closed and the heated wall vent shall remain off until the alarm has been acknowledged at the operator graphics interface, and the LFL level is below 70%.

.8 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.4 If the HOGEN Room combustible gas detector detects a fault condition:

.1 An alarm warning shall be sent to the operator work station operations building) and the control panel (control room).

.2 The yellow segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.3 The blue segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.4 The control system shall fully close the master and secondary hydrogen dispensing valves.

.5 The HOGEN generator and Heated Wall Vent shall be powered down by the DDC.

.6 The visual alarms shall remain on and the hydrogen valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the gas sensor fault status is corrected.

.9 <u>Alarm Control Sequence #3: Inflation Room Flame Detector</u>

.1 When the infrared (IR) flame detector detects a fire in the Inflation Room:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall illuminate continuously.

.3 The audible alarm, locate at each of the light stacks shall produce a continuous tone.

.4 The audible alarm on the exterior of the building shall produce a continuous tone.

.5 The control system shall fully close the master hydrogen valve and the hydrogen dispensing valve.

.6 The visual alarms shall remain on, the hydrogen valves shall remain closed and the HOGEN unit off until the alarm has been acknowledged at the operator graphics interface, and the IR sensor no longer detects a fire.

.7 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.10 Alarm Control Sequence#4: HOGEN Room Flame Detector

.1 When the infrared (IR) flame detector detects a fire in the HOGEN Room:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall illuminate continuously.

.3 The audible alarm, locate at each of the light stacks shall produce a continuous tone.

.4 The audible alarm on the exterior of the building shall produce a continuous tone.

.5 The control system shall fully close the master hydrogen valve and the hydrogen dispensing valve.

.6 The HOGEN generator and Heated Wall Vent shall be powered down by the DDC.

.7 The visual alarms shall remain on, the hydrogen valves shall remain closed and the HOGEN unit off until the alarm has been acknowledged at the operator graphics interface, and the IR sensor no longer detects a fire.

.8 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.11 Alarm Control Sequence#5: HOGEN Room Smoke Detector

.1 When the smoke detector detects smoke in the HOGEN Room:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall illuminate continuously.

.3 The audible alarm, locate at each of the light stacks shall produce a continuous tone.

.4 The audible alarm on the exterior of the building shall produce a continuous tone.

.5 The control system shall fully close the master hydrogen valve and the hydrogen dispensing valve.

.6 The HOGEN generator and Heated Wall Vent shall be powered down by the DDC.

.7 The visual alarms shall remain on, and the hydrogen valves shall remain closed and the HOGEN unit off until the alarm has been acknowledged at the operator graphics interface, and smoke detector no longer detects smoke.

.8 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.12 Alarm Control Sequence #6: Control Room Smoke Detector

.1 When the smoke detector detects smoke in the Control Room:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red segments of the stack warning alarm lights (located at the building exterior, and the Operations Building shall illuminate continuously.

.3 The audible alarm, locate at each of the light stacks shall produce a continuous tone.

.4 The audible alarm on the exterior of the building shall produce a continuous tone.

.5 The control system shall fully close the master hydrogen valve and the hydrogen dispensing valve.

.6 The visual alarms shall remain on, and the hydrogen valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and the smoke detector no longer detects smoke.

.7 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.13 Alarm Control Sequence #7:HOGEN Room Low Temperature

.1 If the HOGEN room temperature sensor detects a room temperature more than 14 degrees Celsius below set point (4 degrees Celsius):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The blue segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall flash at a rate of 1.0 seconds on and 1.0 seconds off.

.3 The room heaters shall be turned on until the temperature in the room reaches the space temperature set point.

.4 The exhaust fans shall be disabled, and outdoor air, and exhaust air dampers closed.

.14 Alarm Control Sequence #8: Hydrogen Leak Detection

.1 If the hydrogen dispensing valves are deactivated, and the hydrogen flow switch detects a leak (flow):

.1 An alarm message shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The red and white color segments of the stack lights {located at the building exterior, and the Operations Building) shall be illuminated continuously. ·

.3 The audible alarm located at each stack light shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.4 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.5 The DDC system shall close the master and secondary hydrogen dispensing valves.

.6 The visual alarms shall remain on, and the hydrogen valves shall remain closed until the alarm has been acknowledged at the operator graphics interface, and a leak is no longer detected for a minimum test period of 60 seconds.

.7 The audible alarms shall stop once the alarm has been acknowledged at the operator graphics interface.

.2 The alarm condition shall not occur until 60 seconds after the dispensing circuit has been deactivated.

.15 Alarm Control Sequence #9: HOGEN Room Ventilation Flow Restriction:

.1 The HOGEN unit will go into Hydrogen production mode approximately 2 minutes after start-up. 90 seconds shall pass after the HOGEN unit goes into production mode before airflow monitoring begins. Following this, if the airflow sensor does not detect airflow above 451/s after the HOGEN unit has been in production mode for 120 seconds:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The blue and white segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall illuminate continuously.

.3 The DDC system shall power down the HOGEN unit.

.4 The visual alarms shall remain on, and the HOGEN unit off until the alarm has been acknowledged at the operator graphics interface, and airflow above 45 1/s has been detected for a minimum test period of 120 seconds.

.5 The audible alarm shall stop once the alarm has been acknowledged at the operator graphics interface.

.2 If the airflow sensor detects airflow below 45 l/s for 120 consecutive seconds at any time when the HOGEN unit is in production mode (following the 90 delay above):

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The blue and white segments of the stack warning alarm lights (located at the building exterior, and the Operations Building shall illuminate continuously.

.3 The DDC system shall power down the HOGEN unit.

.4 The visual alarms shall remain on, and the HOGEN unit off until the alarm has been acknowledged at the operator graphics interface, and airflow above 45 l/s has been detected for a minimum test period of 120 seconds.

.5 The audible alarm shall stop once the alarm has been acknowledged at the operator graphics interface.

.16 Alarm Control Sequence #10: HOGEN Generator Fault

.1 If a fault in the HOGEN generator is detected:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The yellow and white segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall illuminate continuously.

.17 Alarm Control Sequence #11: Heated Wall Vent Low Temperature

.1 If the sensor monitoring the heated wall vent temperature detects a temperature of less than 2 degrees Celsius:

.1 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.2 The yellow and blue segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall illuminate continuously.

.3 If the Heated Wall Vent has been commanded off by the DDC system then Alarm Control Sequence #11 shall be delayed for 5 minutes after restart of the Heated Wall Vent.

.18 Alarm Control Sequence#12: Emergency Shut Down Button

.1 When the emergency shut down button located at the operator work station (operations building) and the control panel (control room) is pressed:

.1 The DDC system shall power down the HOGEN Generator and Heated Wall Vent.

.2 The control system shall fully close the master hydrogen valve and the hydrogen dispensing valve

.3 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.4 All colour segments of the stack warning alarm lights (located at the building exterior, and the Operations Building shall illuminate continuously.

.5 The audible alarm, located at each of the stack lights shall produce a continuous tone.

.6 The audible alarm on the exterior of the building shall produce a continuous tone.

.7 The audible and visual alarms shall remain on, the hydrogen valves shall remain closed, and the HOGEN unit and Heated Wall Vent shall remain off until the stop button has been reset at the operator workstation.

.19 Alarm Control Sequence#13: Emergency Hydrogen Discharge

.1 When the emergency hydrogen discharge button located at the operator work station (operations building) is pressed:

.1 The DDC system shall open the emergency hydrogen discharge valve located at the hydrogen storage tank.

.2 The DDC system shall power down the HOGEN Generator.

.3 The DDC system shall fully close the master hydrogen valve and the hydrogen dispensing valve.

.4 An alarm warning shall be sent to the operator work station (operations building) and the control panel (control room).

.5 All colour segments of the stack warning alarm lights (located at the building exterior, and the Operations Building) shall illuminate continuously.

.6 The audible alarm, located at each of the stack lights shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.7 The audible alarm on the exterior of the building shall produce an intermittent tone of 0.5 seconds on and 0.5 seconds off.

.8 The audible and visual alarms shall remain on, the hydrogen dispensing valves shall remain closed, the hydrogen discharge valve shall remain open, and the HOGEN unit shall remain off until the discharge button has been reset at the operator workstation.

.20 Alarm Control Sequence #14: Alarm Test Button

.1 When the system state is normal (all green stack lights illuminated continuously), and the alarm test button located within the main control system panel in the Control Room is pressed:

.1 All colour segments of the stack warning alarm lights (located in the Control Room, building exterior, and the Operations Building shall illuminate continuously for 10 seconds.

.2 The Interior audible alarms, located at each of the stack lights and exterior audible alarm shall produce a continuous tone for 10 seconds.

.3 The test button will not be functional if any alarm conditions exist.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 Canadian Standards Association (CSA International)
- .1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.
- .2 CAN3-C235-83(R2015), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

.2 Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC)
- .1 IEEE SP1122-2000, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.

### 1.2 DEFINITIONS

.1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

### 1.3 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

- .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

.3 Language operating requirements: provide identification nameplates for control items in English/French.

.4 Use one nameplate for each language.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit for review single line electrical diagrams under plexiglass and locate in:

- .1 Electrical room.

.3 Shop drawings:

- .1 Submit shop drawings, manufacturers and product data and samples
  - .1 Submit for each item of equipment.

.2 Submit shop drawings in the same unit of measure as used on the drawings. Both metric and imperial measures may be included.

.3 Submit shop drawings by email to Departmental Represenative.

.2 Include a shop drawing cover sheet form prepared for this project, for each shop drawing or, include the same information on the contractors submittal cover sheet:

.1 Provide the following information on each submission;

.1 Client/Architect name

.2 Project Name

.3 Project number

.4 Date

.5 Contractor name

.6 Contractor reference No.

.7 Manufacturer’s name

.8 Product type

.9 Specification section number

.10 Contractor trade: mechanical, electrical, elevators, or general trades

.3 Submit shop drawings in PDF format;

.1 If submitted in hardcopy format, submit in 11 x 17, black and white originals of graphic quality suitable for photocopying. Allow one additional week for processing of shop drawings submitted in hardcopy format.

.4 Manufacturers’ printed product data sheets for standard items are acceptable in place of shop drawings provided that physical characteristics are identified and are related to specification references.

.5 Submit manufacturers’ data sheets with typed schedules listing manufacturers’ and suppliers’ name and catalogue model numbers for such items as fire alarm system components, etc.

.6 For luminaires, submit bound sets of luminaire cut sheets with manufacturers’ names and catalogue numbers for all luminaires to be used on the project. Identify and arrange the luminaire cut sheets and catalogue numbers in the same sequence as the Specification Luminaire List.

.7 Shop drawings and product data to show;

.1 CSA or equivalent approval,

.2 dimensioned outlines of equipment,

.3 dimensioned details showing service connection points.

.8 Indicate details of construction, dimensions, capacities, weights and electrical performance characteristics of equipment or material.

.9 Where applicable, include;

.1 wiring, single line and schematic diagrams,

.2 diagrams showing interconnection with work of other Sections,

.3 equipment elevations,

.4 component assemblies,

.5 trip settings,

.6 description of operation.

.10 Each shop drawing to be checked and stamped as being correct, by trade purchasing item, before drawing is submitted. If above requirements are not complied with, shop drawings will be rejected and returned forthwith.

.11 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.

.12 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.

.13 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.

.14 If changes are required, notify Departmental Representative of these changes before they are made.

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

.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.

.5 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.

## 1.5 QUALITY ASSURANCE

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

.2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

## 1.6 DELIVERY, STORAGE AND HANDLING

.1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.

.2 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## 1.7 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 will aspects of its care and operation.

## 1.8 OPERATING INSTRUCTIONS

.1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.

.2 Operating instructions to include following:

.1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.

.1 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

.2 Safety precautions.

.3 Procedures to be followed in event of equipment failure.

.4 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.

# PART 2 - PRODUCTS

## 2.1 MATERIALS AND EQUIPMENT

.1 Provide equipment in accordance with Section 01 61 00 - Common Product Requirements.

.2 Equipment to be CSA certified. Where CSA certified equipment is not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.

.3 Factory assemble control panels and component assemblies.

## 2.2 WARNING SIGNS

.1 Warning Signs: in accordance with requirements of authority having jurisdiction.

.2 decal signs, minimum size 175 x 250 mm.

## 2.3 WIRING TERMINATIONS

.1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper conductors.

## 2.4 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates as follows:

.1 Nameplates: lamicoid 3 mm thick melamine, black, matt white finish 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 6mm high letters unless specified otherwise.

.3 Wording on nameplates to be approved by Departmental Representative prior to manufacture.

.1 Labelling of equipment and distribution system should identify

.1 Source of Power (Where the location it’s fed from)

.2 What it is Feeding and Location

.3 Equipment Name or Inventory Number

.4 Allow for minimum of twenty-five (25) letters per nameplate.

.5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.6 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.7 Terminal cabinets and pull boxes: indicate system and voltage.

.8 Transformers: indicate capacity, primary and secondary voltages.

## 2.5 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings, numbered, on both ends of phase conductors of feeders and branch circuit wiring.

.2 Maintain phase sequence and colour coding throughout.

.3 Colour coding: to CSA C22.1.

.4 Use colour coded wires in communication cables, matched throughout system.

## 2.6 CONDUIT AND CABLE IDENTIFICATION

.1 Colour code conduits, boxes and metallic sheathed cables.

.2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

| 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 |

## 2.7 FINISHES

.1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.

.1 Paint indoor switchgear and distribution enclosures light gray.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

## 3.2 NAMEPLATES AND LABELS

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

## 3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.

.1 Sleeves through concrete: plastic, 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.

## 3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

.2 Do not install outlets back-to-back in wall; allow minimum 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.

## 3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.

.3 Install electrical equipment at following heights unless indicated otherwise (General/Barrier Free).

.1 Local switches: 1200/900-1100 mm.

.2 Wall receptacles:

.1 General: 300/450 mm.

.2 Above top of continuous baseboard heater: 200/200 mm.

.3 Above top of counters or counter splash backs: 175/175 mm.

.4 In mechanical rooms: 1200/1200 mm.

.3 Panelboards: as required by Code or as indicated.

.4 Telephone and interphone outlets: 300/450 mm.

.5 Wall mounted telephone and interphone outlets: 1500/1200 mm.

.6 Fire alarm stations: 1500/1200 mm (centre line).

.7 Fire alarm bells: 2100/2100 mm.

.8 Television outlets: 300/450 mm.

.9 Wall mounted speakers: 2100/2100 mm.

.10 Clocks: 2100/2100 mm.

.11 Door bell pushbuttons: 1200/900-1100 mm.

## 3.6 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings.

## 3.7 FIELD QUALITY CONTROL

.1 Load Balance:

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.

.2 Conduct 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 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 - SUBMITTALS.

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

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

## 3.8 CLEANING

.1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.

### 1.2 REFERENCES

.1 CSA International

.1 CSA C22.2 No.18.1-13, Metallic outlet boxes (Tri-national standard, with UL 514A and ANCE NMX- J-023/1).

.2 CAN/CSA-C22.2 No.18.2-06(R2011), Nonmetallic Outlet Boxes.

.3 CSA C22.2 No.18.3-12, Conduit, tubing, and cable fittings (Tri-national standard, with ANCE NMX-J-017 and UL 514B).

.4 CAN/CSA-C22.2 No.18.4-04(R2013), Hardware for the Support of Conduit, Tubing, and Cable (Bi-National standard, with UL 2239).

.5 CSA C22.2 No. 18.5-13, Positioning devices (Bi-national standard, with UL 1565).

.6 CSA C22.2 NO. 65-13, Wire connectors (Tri- national standard, with UL 486A-486B and NMX-J-543-ANCE).

.7 CSA C22.2 No. 188, Splicing Wire Connectors.

.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)

.4 Canadian Standards Association (CSA International)

.1 CSA C22.1-15, Canadian Electrical Code, Part 1, 23rd 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 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 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 Compression type pressure wire connectors:

.1 long barrel

.2 tin plated copper for copper conductors

.3 aluminum for aluminum conductors

.3 Twist on wire connectors:

.1 for copper wire up to and including #6 AWG,

.2 “live” spring construction,

.3 corrosion resistant spring,

.4 square wire spring construction,

.5 polypropylene cap rated for 105°C

.6 For damp, wet, outdoor and submersible locations: filled with silicone gel.

.4 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.

.1 current carrying parts of copper,

.2 sized to fit copper conductors 10 AWG or less,

.3 temperature rating of not less than 105°C

.5 Bushing stud connectors: to EEMAC 1Y-2 to consist of:

.1 Connector body and stud clamp for copper conductors.

.2 Clamp for copper conductors.

.3 Stud clamp bolts.

.4 Bolts for copper conductors or bars.

.5 Sized for conductors or bars 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 wire and box connectors 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 Provide connectors in accordance with the manufacturer’s recommendation for the size, quantity and type of wires.

.2 Install connectors in accordance with the manufacturer’s recommendations.

.3 Remove insulation carefully from ends of conductors and:

.1 where the conductor is damaged, remove the damaged portion and strip the insulation back further as necessary,

.2 where the conductor is too short, replace the conductor.

.4 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.

.5 Remove all traces of electrical joint compound after each connection has been made.

.6 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.

.7 Install bushing stud connectors in accordance with EEMAC 1Y-2.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

### 1.2 PRODUCT DATA

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

### 1.3 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## 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 or RWU90 XLPE.

.3 Copper conductors: size as indicated, with thermoplastic insulation type TWU or TWH rated at 600 V.

### 2.2 TECK 90 CABLE

.1 Cable: in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Conductors:

.1 Grounding conductor: copper.

.2 Circuit conductors: copper.

.3 Insulation:

.1 Cross-linked polyethylene XLPE.

.2 Rating: 600 V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: galvanized steel.

.6 Overall covering: thermoplastic polyvinyl chloride, compliant to applicable Building Code classification for this project.

.7 Fastenings:

.1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.

.2 Channel type supports for two or more cables at 3000 mm centers.

.3 Threaded rods: 6 mm diameter to support suspended channels.

.8 Connectors:

.1 Watertight or explosion-proof (as required) approved for TECK cable.

## 2.3 ARMOURED CABLES

.1 Conductors: insulated, copper, size as indicated.

.2 Type: AC90.

.3 Armour: interlocking type fabricated from galvanized steel strip.

.4 Connectors: anti short connectors.

## 2.4 ALUMINUM SHEATHED CABLE

.1 Conductors: copper, size as indicated.

.2 Insulation: cross linked polyethylene type RA90 rated 600V.

.3 Sheath: aluminum applied to form continuous corrugated sheath.

.4 Outer jacket: thermoplastic applied over sheath and to be compliant to applicable Building Code classification for direct burial and wet locations.

.5 Fastenings for aluminum sheathed cable:

.1 One hole steel straps to secure surface cables 25 mm and smaller. Two hole steel straps for cables larger than 25 mm. Use aluminum strap only with single conductor cable.

.2 Channel type supports for two or more cables at 3000 mm centers.

.3 Threaded rods: 6 mm diameter to support suspended channels.

## PART 3 - EXECUTION

### 3.1 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrica.

.2 Perform tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.

.3 Perform tests before energizing electrical system.

### 3.2 GENERAL CABLE INSTALLATION

.1 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0-1000 V.

.2 Cable Colour Coding: to Section 26 05 00 - Common Work Results for Electrical.

.3 Conductor length for parallel feeders to be identical.

.4 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.

.5 Wiring in walls: typically drop or loop vertically from above to better facilitate future renovations. Generally wiring from below and horizontal wiring in walls to be avoided unless indicated.

.6 Branch circuit wiring for surge suppression receptacles and permanently wired computer and electronic equipment to be 2-wire circuits only, i.e. common neutrals not permitted.

.7 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.

### 3.3 INSTALLATION OF BUILDING WIRES

.1 Install wiring as follows:

.1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Home runs, of 15 and 20 Ampere circuits to lighting and receptacle panels, which exceed:

.1 25 m (75’) in length: No. 10 AWG or larger,

.2 40 m (120’) in length: No. 8 AWG or larger,

.3 60 m (180’) in length: No. 6 AWG or larger.

.3 Increase the size of branch circuit conductors and home runs as required so that the total voltage drop, from panelboards to loads, does not exceed 3% under load.

.1 For branch circuit wiring [a common neutral conductor may be used with two or three phase conductors except where indicated otherwise.

.2 For branch wiring, common neutral conductors may be used in the following applications:

.3 lighting circuits, excluding dimming circuits,

.4 housekeeping receptacles,

.5 specific purpose receptacles for equipment that does not produce harmonic currents, such as resistance heating.

.6 Where wires are damaged or contaminated during installation, remove and dispose of wires, swab out conduits and pull in new, clean conductors.

## 3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)

.1 Group cables wherever possible on channels.

.2 Install cable exposed or concealed, as noted on drawings, securely supported by hangers.

## 3.5 INSTALLATION OF ARMOURED CABLES

.1 Group cables wherever possible on channels.

.2 May be used for drops to surface and recessed mounted fluorescent luminaires.

.3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

## 3.6 INSTALLATION OF ALUMINUM SHEATHED CABLE

.1 Group cables wherever possible on channels.

.2 Install and terminate cables in accordance with manufacturer's recommendations.

.3 Use non-magnetic connectors for single conductor cables.

.4 For single conductor cables in circuits rated up to and including 400Amperes:

.1 Space cables one cable diameter apart throughout the run,

.2 Cut an opening in the enclosure at each end of the run, opening to be large enough for all cables of the circuit to pass through with spacings maintained,

.3 Provide a 6mm thick aluminium termination plate at each end of the run,

.4 Size the termination plates to overlap the openings by at least 20mm on all sides,

.5 Seal the plates to the enclosures with silicone sealant and secure to the enclosures with nuts, bolts and lock washers every 150mm,

.6 Terminate all cables of the circuit on the same terminal plate,

.7 Bond each aluminium termination plate to its associated enclosure.

.5 For single conductor cables in direct buried circuits:

.1 Space cables apart per Diagram B4-1 of the electrical code,

.2 Maintain cable spacing throughout the run,

.3 Cut an opening in the enclosure at each end of the run, opening to be large enough for all cables of the circuit to pass through with spacings of not less than one cable diameter,

.4 At the supply end of the run:

.1 Provide a 6mm thick aluminium termination plate,

.2 Size the termination plate to overlap the opening by at least 20mm on all sides,

.3 Seal the plate to the enclosure with silicone sealant and secure to the enclosure with nuts, bolts and lock washers every 150mm,

.4 Terminate all cables of the circuit on the terminal plate,

.5 Bond the aluminium termination plate to the enclosure.

.5 At the load end of the run:

.1 Provide a 6mm thick non-conductive fire-resistant FRP (Glastic) termination panel,

.2 Size the termination panel to overlap the opening by at least 20mm on all sides,

.3 Seal the panel to the enclosure with silicone sealant and secure to the enclosure with nuts, bolts and lock washers every 150mm,

.4 Terminate all cables of the circuit on the terminal panel,

.5 Ensure that the cable connectors do not make electrical contact with the enclosure.

.6 Install a separate bonding conductor for the circuit:

.1 Insulated RWU90 copper,

.2 Sized per the Electrical Safety Code,

.3 Run from the bonding lug or bus in the supply end enclosure to the bonding lug or bus in the load end enclosure,

.4 Separated from the phase cables throughout the run, by a distance of not less than the spacing between the phase cables.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 American National Standards Institute /Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE 837-2014, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

.2 ANSI/IEEE Standard 142-2007, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

.2 CSA International

.1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

### 1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for grounding equipment for incorporation into manual.

### 1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## 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 Plate electrodes: copper, surface area 0.2 m², minimum 1.6 mm thick.

.5 Grounding conductors: bare stranded copper, tinned, soft annealed, size as indicated.

.6 Insulated grounding conductors: green, copper conductors, size as indicated.

.7 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

.8 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.

.9 Perimeter ground bus, 6 mm x 50 mm (¼” x 2") copper, mounted 150 mm (6") above floor on insulated spacers 600 mm (24") on centre.

.10 Ground bus mounting spacers

- .1 Standoff insulators to UL 891.
- .2 25 to 32 mm high waterproof glass fibre reinforced polyamide.
- .3 750V insulated.
- .4 UL 94VO self-extinguishing.
- .5 Bichromated zinc plated threaded steel inserts.

## PART 3 - EXECUTION

### 3.1 INSTALLATION GENERAL

.1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.

.2 Run ground wire in all conduits.

.3 Ground electrical equipment and wiring in accordance with Canadian Electrical Code and ANSI/IEEE Standard 142-2007.

.4 Install connectors in accordance with manufacturer’s instructions.

.5 Protect exposed grounding conductors from mechanical injury.

.6 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermit process.

.7 Use mechanical connectors for grounding connections to equipment provided with lugs.

.8 Soldered joints not permitted.

.9 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.

.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.

### 3.2 ELECTRODES

.1 Make ground connections to continuously conductive underground water pipe on street side of water meter.

.2 Install water meter shunt.

.3 Install rod electrodes and make grounding connections.

.4 Bond separate, multiple electrodes together.

.5 Use size 4/0 AWG copper conductors for connections to electrodes.

.6 Make special provision for installing electrodes that will give acceptable resistance to ground value where rock or sand terrain prevails. Ground as indicated.

## 3.3 SYSTEM AND CIRCUIT GROUNDING

.1 Install system and circuit grounding connections to neutral of secondary system and for common grounding conductors as per CSA C22.1 Table 17.

.2 Install insulated copper grounding conductor for service raceways and service equipment per CSA C22.1 Table 18.

.3 Install grounding conductors in conduit.

## 3.4 EQUIPMENT GROUNDING

.1 Install insulated copper bonding connections per CSA C22.1 Table 16 to typical equipment including, but not necessarily limited to following list: Service equipment, transformers, frames of motors, starters, control panels, building steel work and panels, outdoor lighting.

.2 Install bonding conductors in conduit.

## 3.5 GROUNDING BUS

.1 Install copper grounding bus mounted in rooms, as shown on the drawings.

.2 Ground electrical equipment.

## 3.6 PERMAFROST

.1 Bond non-current carrying metal parts together with size #3/0 AWG copper equipotential conductor. Run conductor from separate lug or service neutral bar to, but not necessarily limited to, following indoor systems and equipment:

.1 Hot water heating system.

.2 Main water pipe.

.3 Main building drain.

.4 Oil line.

.5 Telephone, radio/tv, emergency and fire alarm lead-in or service conduits, near panels.

.6 Make connections to pipes on building side of main valves and tanks. Connect jumpers across boilers to supply and return hot water heating pipes.

.2 Drive three -19 mm diameter x 3 m copper clad ground rods at least 1.8 m apart in original undisturbed ground. If rods will not penetrate permafrost, drive at angle not more than 60 degrees from vertical, and in same direction. Rods must be driven, not trenched.

.3 Install ground wire from service neutral bar to rods and where buried use bare copper not smaller than size 1 AWG strand or size 4 AWG solid, and at least [640] mm below

ground. Bond ground conductor, or short tap from it, to outside metal sheathing of building close to power service conduit. Use lug or cast clamp, with bronze or plated bolt, nut and washers (not sheet metal screw or wood screw). Remove paint from sheathing for good contact. Conduit is required only on outside wall of building. Indoors, run bare and fasten as specified for equipotential bonding wire.

.4 Install electrode interconnections where metal parts, circuits or grounding conductors and/or electrodes are in proximity to lightning rod conductors.

## 3.7 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.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

### 1.2 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management And Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

## PART 2 - PRODUCTS

### 2.1 SUPPORT CHANNELS

.1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted, suspended or set in poured concrete walls and ceilings.

### 2.2 Inserts

.1 Inserts for conduits and raceway hangers, for single, double and multiple runs shall be galvanized.

### 2.3 Hangers

.1 Hangers for electrical conduit shall be hot dipped galvanized after fabrication.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Supply and deliver inserts to site in ample time to be built into work of other trades. Provide necessary templates and adequate instructions to locate and install inserts.

.2 Secure equipment to masonry, tile and plaster surfaces with lead anchors.

.3 Secure equipment to poured concrete with expandable inserts.

.4 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.

.5 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.

.6 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.

.7 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.

.8 Suspended support systems.

.1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.

.2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.9 Provide galvanized after fabrication 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.

.14 Supply and erect special structural work required for the installation of electrical equipment. Provide anchor bolts and fastenings unless noted otherwise. Mount equipment

required to be suspended above floor level, where details are not shown, on a frame or platform bracketed from the wall or suspended from the ceiling. Carry supports to either the ceiling or the floor, or both as required, at locations where, because wall thickness is inadequate, it is not permitted to use such brackets.

.15 Electrical panels, switches or other electrical equipment shall be complete with suitable bases or mounting brackets. Install angle or channel iron supports to bear the equipment where it is shown in or on structural tile walls, or walls that are inadequate to bear the equipment.

.16 Provide channel iron or other metal supports where necessary to adequately support lighting fixtures. Do not use wood. Lighting fixtures shall be supported totally independent of ceiling and supported from structure above.

.17 Support hangers, in general, from inserts in concrete construction or from building structural steel beams, using beam clamps. Provide additional angle or channel steel members required between beams for supporting conduits.

.18 Do not use explosive drive pins in any section of work without obtaining prior written approval.

.19 Provide re-enforced concrete pads under switchboards, generators, and all other floor mounted electrical equipment. Pads are to formed with chamfered edges to prevent chipping. Pads are to be sealed and painted to prevent dust from entering and interfering with electrical equipment.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1-15, Canadian Electrical Code, Part 1, 23rd Edition.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.3 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 SPLITTERS

.1 Construction: sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.

.2 Terminations: main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.

.3 Spare Terminals: minimum three spare terminals or lugs on each connection

.4 Distribution riser splitters shall be of special construction with hinged access door, copper bus bars predrilled to accept two hole compression connectors for all incoming and outgoing cables.

### 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 flat covers.

## 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, and source power.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 20 - Wire and Box Connectors.

### 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 Submit samples for 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.

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 102 mm square or larger outlet boxes as required.

.3 Gang boxes where wiring devices are grouped.

.4 Blank cover plates for boxes without wiring devices.

.5 347 V outlet boxes for 347 V switching devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

### 2.2 GALVANIZED STEEL OUTLET BOXES

.1 One-piece electro-galvanized construction.

.2 Single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit

enters one side with extension and plaster rings as required.

.3 Utility boxes for outlets connected to surface-mounted EMT conduit, minimum size 102 x 54 x 48 mm.

.4 102 mm square or octagonal outlet boxes for lighting fixture outlets.

.5 Extension and plaster rings for flush mounting devices in finished plaster walls.

## 2.3 CONDUIT BOXES

.1 Cast FS boxes with factory-threaded hubs and mounting feet for surface wiring of devices.

.2 Explosion proof boxes in areas where indicated on drawings.

## 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 35mm and pull boxes for larger conduits.

.4 Double locknuts and insulated bushings on sheet metal boxes.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Support boxes independently of connecting conduits.

.2 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.3 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.

.4 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.

.5 Vacuum clean interior of outlet boxes before installation of wiring devices.

.6 Identify systems for outlet boxes as required.

.7 Provide a suitable outlet box for each light, switch, receptacle or other outlet, approved for the particular area in which it is to be installed.

.8 Offset outlet boxes, shown back to back in partitions, horizontally to minimize noise transmission between adjacent rooms.

.9 Use gang boxes at locations where more than one device is to be mounted. Use combination boxes with suitable barriers where outlets for more than one system are shown.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 NO. 18.1-13, Metallic Outlet Boxes.

.2 CAN/CSA-C22.2 NO. 18.2-06(R2011), Nonmetallic Outlet Boxes.

.3 CSA C22.2 No. 18.3-12, Conduit, Tubing, and Cable Fittings (Tri-National standard, with ANCE NMX-J-017 and UL 514B).

.4 CAN/CSA-C22.2 No. 18.4-04(R2013), Hardware for the Support of Conduit, Tubing, and Cable.

.5 CSA C22.2 No. 45.1-07(R2012), Electrical Rigid Metal Conduit - Steel (Tri-National standard, with UL 6 and NMX-J-534-ANCE-2007).

.6 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit

.7 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.

.8 CSA C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.

.9 CAN/CSA-C22.2 No. 227.3-05(R2010), 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.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management And Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

1.5 Location of Conduits

.1 Drawings do not indicate all conduit runs. Those indicated are in diagrammatic form only.

1.6 Wiring Methods

.1 Refer to drawings for notes and requirements related to conduits.

PART 2 - PRODUCTS

2.1 CONDUITS

.1 Rigid metal conduit: to CSA C22.2 No. 45, hot dipped galvanized steel threaded conduit.

.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 or with expanded ends, as required.

.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 Conduit shall be of sufficient size to allow easy removal of conductors at any time. Conduit sizes, where shown, are minimum and shall not be reduced.

2.2 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller. 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.

.4 Threaded rods, 6 mm diameter, to support suspended channels.

## 2.3 CONDUIT FITTINGS

.1 Fittings: 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.

## 2.4 EXPANSION FITTINGS FOR RIGID CONDUIT

.1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.

.2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.

.3 Weatherproof expansion fittings for linear expansion at entry to panel.

## 2.5 FISH CORD

.1 Polypropylene.

# PART 3 - EXECUTION

## 1.1 MANUFACTURER’S INSTRUCTIONS

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

## 1.2 INSTALLATION

.1 Refer to drawings regarding conduit installation.

.2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.3 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.

.4 Use electrical metallic tubing (EMT) except in cast concrete and above 2.4 m not subject to mechanical injury.

.5 Use rigid pvc conduit underground or in corrosive areas.

.6 Use flexible metal conduit for connection to motors in dry areas.

.7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.

.8 Use explosion proof flexible connection for connection to explosion proof motors.

.9 Install conduit sealing fittings in hazardous areas. Refer to drawings.

.1 Fill with compound after final inspection and sign off is given. If done prior to final inspection and sign-off, contractor will be responsible for removing compound and replacing it, once final review is complete.

.2 Ensure that all fittings meet room classifications.

.10 Minimum conduit size for lighting and power circuits: 21 mm.

.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 21 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.

.15 Dry conduits out before installing wire.

## 1.3 SURFACE CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.

.3 Run conduits in flanged portion of structural steel.

.4 Group conduits wherever possible on suspended or surface channels.

.5 Do not pass conduits through structural members except as indicated.

.6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

1.4 CONCEALED CONDUITS

.1 Run parallel or perpendicular to building lines.

.2 Do not install horizontal runs in masonry walls.

.3 Do not install conduits in terrazzo or concrete toppings.

1.5 CONDUITS UNDERGROUND

.1 Slope conduits to provide drainage.

.2 Waterproof joints (pvc excepted) with heavy coat of bituminous paint.

END OF SECTION

## PART 1 - GENERAL

### 1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

### 1.2 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters for incorporation into manual.

### 1.3 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 CABLE PROTECTION

.1 38 x 140mm planks pressure treated with clear or copper napthenate or 5% pentachlorophenol solution, water repellent preservative.

### 2.2 Markers

.1 Cedar post type markers: 89 x 89mm, 1.5m long, pressure treated with clear coloured or copper nathenate or 5% pentachlorophenol solution, water repellent preservative, with nameplates fastened near post top, on side facing

cable or conduit to indicated depth or direction of duct or cable runs.

## PART 3 - EXECUTION

### 3.1 DIRECT BURIAL OF CABLES

.1 After sand bed specified in section 31 23 10 - Excavating, Trenching and Backfilling, is in place, lay cables maintaining 75 mm clearance from each side of the trench to the nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining a minimum cable separation and bending radius requirements.

.3 Underground cable splices are not acceptable.

.4 Minimum permitted radius at cable bends for rubber, plastic or lead cover cables, 8 times diameter of cable, for metallic armoured cable, 12 times diameter of cable or in accordance with manufacturer’s instructions.

.5 Cable Separations:

.1 Maintain 75 mm minimum separations between cables of different circuits.

.2 Maintain 300 mm horizontal separation between low and high voltage cables.

.3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.

.4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

.5 Install treated planks on lower cables 0.6 m in each direction at crossing.

.6 After sand protective cover specified in Section 31 23 10 - Excavating, Trenching and Backfilling is in place, make good trench with top soil and sod. Trench and land around it, to be left in the same condition as the contractor found it.

### 3.2 MARKERS

.1 Mark cables every 150 m along cable runs and changes in directions.

.2 Where markers are removed to permit installation of additional cables, reinstall existing markers.

## 3.3 FIELD QUALITY CONTROL

.1 Preform tests in accordance with Section 26 05 00

.2 Preform tests using qualified personal. Provide necessary instruments and equipment.

.3 Check phase rotation and identify each phase conductor of each feeder.

.4 Check each feeder for continuity, short circuit and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.

.5 Pre-acceptance test:

.1 After installing cable but before splice and/or terminating, perform insulation resistance test with 1000V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.6 Acceptance Tests

.1 Ensure that terminations and accessory equipment are disconnected prior to test.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.3 High Potential (Hipot) Testing.

.1 Conduct hipot testing in accordance with equipment with equipment manufacturer’s recommendations.

.7 Provide Departmental Representative with list of test results showing location at which each test was made, circuit tested and results of each test.

.8 Remove and replace entire length of cable if cable fails test.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 CSA International

.1 CAN/CSA-C22.2 No.47 (R2013), Air-Cooled Transformers (Dry Type).
.2 CSA C9 (R2011), Dry-Type Transformers.
.3 CAN/CSA-C802.2 (R2013), Minimum Efficiency Values for Dry Type Transformers.

.2 National Electrical Manufacturers Association (NEMA)

### 1.2 REFERENCES

.1 CSA International

.1 CSA C22.1-15, Canadian Electrical Code, Part 1 (23rd Edition), Safety Standard for Electrical Installations.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer’s instructions, printed product literature and data sheets for transformers and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings:

.1 Indicate on drawings:

.1 Dimensions showing enclosure, mounting devices, terminals, taps, internal and external component layout.

.2 Technical data:

.1 kVA rating.
.2 Primary and secondary voltages.
.3 Frequency.
.4 Single or Three phase.
.5 Polarity or angular displacement.
.6 Full load efficiency.
.7 Regulation at unity pf.
.8 BIL.
.9 Insulation type.
.10 Sound rating.

.3 Factory Test Submittals: submit standard factory test certificates of each transformer and type test of each transformer in accordance with CSA C9.

## 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.

.3 Operation and maintenance instructions to include:

.1 Tap changing.

.2 Recommended environmental conditions.

.3 Recommended periodic inspection and maintenance.

.4 Bushing replacement.

## 1.5 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

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

.4 Storage and Handling Requirements:

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

.2 Store and protect transformers from nicks, scratches, and blemishes.

.3 Replace defective or damaged materials with new.

## 1.6 EXTRA MATERIALS

.1 Supply maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

.1 Dry-type transformers: to CSA C9.

## 2.2 TRANSFORMER CHARACTERISTICS

.1 Type: ANN.

.2 Rating: as per drawings kVA, 3 phase, 60 Hz.

.3 220 insulation system class, 150 degrees C temperature rise.

.4 Impedance: 3%.

.5 Primary winding: as per drawings.

.6 Secondary winding: as per drawings.

.7 No load and full load losses to exceed those indicated in CAN/CSA-C802.2.

.8 Efficiency to meet or exceed CAN/CSA C802.2

## 2.3 ENCLOSURE

.1 Enclosure Type 1 with drip shield.

.2 Finish:

.1 rust-inhibiting metal treatment process,

.2 powder coat finish to UL50 3R,

.3 colour: ANSI #61 grey.

.4 Provide a quart of matching paint to touch-up small areas marred during installation.

## 2.4 VOLTAGE TAPS

.1 4 taps at 2.5% intervals below nominal.

## 2.5 TAP CHANGER

.1 Bolted-link type.

## 2.6 WINDINGS

.1 Primary and secondary coils:

.1 Copper.

.1 Vacuum cast epoxy.

.2 Coil and core assembly:

.1 Taps located at front of coils for accessibility.

.3 Sound level: not to exceed CSA Standards.

## 2.7 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Equipment labels: nameplate size 7.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Locate, install and ground transformers in accordance with manufacturer's instructions.

.2 Set and secure transformers in place, rigid plumb and square.

.3 Energize transformers and check secondary no-load voltage.

.4 Mount transformers:

.1 ≤ 75 kVA suspended, on wall brackets or on floor as indicated,

.2 > 75 kVA on floor.

.5 Install transformers in level upright position.

.6 Provide suitable mounting hardware.

.7 Where specified, install the external vibration isolation mounts for both floor mounted (between enclosure and pad) and bracket (wall) mounted transformers (between enclosure and brackets)

.8 Position transformers to provide:

.1 adequate clearance for ventilation,

.1 adequate access to connections,

.1 adequate access to taps.

.9 Remove shipping supports only after transformer is installed and just before putting into service.

.10 Loosen isolation pad bolts until no compression is visible.

.11 Make final primary and secondary connections using flexible steel conduits.

.12 Make primary and secondary connections in accordance with wiring diagram.

.13 Provide a #6 AWG green insulated copper ground conductor in rigid PVC conduit from transformer secondary neutral to the building grounding system.

.14 Connect the bonding conductors from the primary and secondary feeders to the transformer bonding lugs.

.15 Provide a bonding conductor, sized not less than the secondary feeder bonding conductor, from the transformer bonding lugs to the transformer secondary neutral terminal.

.16 Provide nameplates in accordance with Article "Equipment Identification".

.17 Energize transformers after installation is complete.

.18 Adjust transformer taps as required to achieve suitable secondary voltage at loads, with the transformer operating under it’s typical load.

.19 Touch up small areas marred in transit or during installation with touch up paint.

.20 Repaint entire enclosure using electrostatic process where significant damage to factory finish has occurred.

## 3.2 PROTECTION

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

.2 Repair damage to adjacent materials caused by transformers installation.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 CSA International

.1 CSA C22.2 No.29-M2015, Panelboards and Enclosed Panelboards.

### 1.2 PLANT ASSEMBLY

.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.

## PART 2 - PRODUCTS

### 2.1 PANELBOARDS

.1 Panelboards to be product of one manufacturer.

.2 250 and 600V panelboards: bus and breakers rated for available (symmetrical) interrupting capacity or as indicated.

.3 Sequence phase bussing with breakers numbered as shown on drawings, with each breaker identified by permanent number identified as to circuit number.

.4 Panelboards: mains, number of circuits and number of size of branch circuit breakers as indicated.

.5 Two keys for each panelboard and key panelboards alike.

.6 Copper bus with full size neutral.

.7 Mains suitable for bolt-on breakers.

.8 Finish trim and door baked grey enamel.

.9 Sprinkler proof.

.10 Ensure system uses normal power supply mains and battery to provide continuous, regulated AC power to isolated load.

.11 Equipment: capable of operating continuously and unattended.

.12 Ensure that Uninterruptible Power Systems (UPS) is compatible with equipment that it feeds and with source from which it is fed.

### 2.2 BREAKERS

.1 Breakers to Section 26 28 21.

.2 Breakers with thermal magnetic tripping in panelboards except as indicated otherwise.

.3 Main breaker: separately mounted on top or bottom of panel to suit cable entry.

.4 Lock-on devices for receptacles, fire alarm, emergency, door supervisory, intercom, stairway, exit and night light circuits.

.5 Series rated to 22KA IC.

## 2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with 26 05 00.

.2 Nameplate for each panelboard size 4 engraved as indicated.

.3 Nameplate for each circuit in distribution paneslboards size 2 engraved as indicated.

.4 Complete circuit directory with typewritten legend showing locations and load of each circuit.

## 2.4 EQUIPMENT

.1 Panelboards and breaker types to match or be equivalent to existing site equipment.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.

.2 Install surface mounted panelboards on fireguard backboards. Where practical ground panelboards on common backboard.

.3 Mount panelboards to height given in section 26 05 00 or as indicated.

.4 Connect loads to circuits as indicated.

.5 Connect neutral conductors to common neutral bus with respective neutral identified.

END OF SECTION

## PART 1 - GENERAL

### 1.1 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).

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data:

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

### 1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for wiring devices for incorporation into manual.

### 1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 1.1 SWITCHES

.1 20A, 120 V single pole switches to CSA Listings.

.2 Manually-operated general purpose AC switches with following features:

.1 Terminal holes approved for No. 10 AWG wire.

.2 Silver alloy contacts.

.3 Urea or melamine moulding for parts subject to carbon tracking.

.4 Suitable for back and side wiring.

.5 Ivory toggle.

.3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.4 Switches of one manufacturer throughout project.

## 1.2 RECEPTACLES

.1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:

.1 Urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Break-off links for use as split receptacles.

.4 Eight back wired entrances, four side wiring screws.

.5 Triple wipe contacts and rivetted grounding contacts.

.6 Heavy duty specification grade type

.2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:

.1 Urea moulded housing.

.2 Suitable for No. 10 AWG for back and side wiring.

.3 Four back wired entrances, 2 side wiring screws.

.3 Other receptacles with ampacity and voltage as indicated.

.4 Receptacles of one manufacturer throughout project.

## 1.3 SOURCE QUALITY CONTROL

.1 Cover plates from one manufacturer throughout project.

.2 Stainless steel 18-8 chrome metal alloy, Type 302, vertically brushed, 1 mm (1/32") thick cover plates for wiring devices mounted in flush-mounted outlet box.

# PART 3 - EXECUTION

## 3.1 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.

## 3.2 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 REFERENCES

.1 CSA International

.1 CAN/CSA-C22.2 No.144-M91(R2011), 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.

### 1.2 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 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.

### 1.3 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for ground fault circuit interrupters 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.

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## 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, 120 or 208V, 1 phase circuit c/w test and reset facilities.

## 2.3 RECEPTACLE TYPE GROUND FAULT INTERRUPTER

.1 Unit shall include a 15A grounded duplex receptacle, a button to test operation of unit and current transformer and sensing mechanism. Unit to be complete with suitable outlet box.

.2 Units in Hospitals to be hospital grade.

.3 Unless noted otherwise, unit shall trip at 6 mA.

.4 Where shown in outdoor locations, units shall be enclosed in weatherproof surface-mounted enclosures. In other locations units shall be furnished with stainless steel coverplates.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Provide dedicated branch wiring neutral conductor for each individual breaker type ground fault interrupter.

.2 Do not ground neutral on load side of ground fault relay.

.3 Connect wiring to equipment in accordance with manufacturer's recommendations.

## 3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

.2 Arrange for field testing of ground fault equipment by Contractor.

.3 Demonstrate simulated ground fault tests.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 CSA International (CSA)

.1 CSA C22.2 No. 5-09(R2012), Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, and NMX-J-266-ANCE-2010).

### 1.2 PRODUCT DATA

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

.2 Provide short circuit fault study with shop drawings. Study shall bear seal of author.

## PART 2 - PRODUCTS

### 2.1 BREAKER GENERAL

.1 Bolt-on moulded case circuit breaker, quick-mate type, for manual and automatic operation.

.2 Common-trip breakers with single handle for multipole applications.

.3 Magnetic instantaneous trip elements in circuit breaker, to operate only when the value of the current reaches setting.

.4 Instantaneous interrupting capacity to be match existing breakers.

### 2.2 THERMAL MAGNETIC BREAKERS

.1 Moulded case circuit breakers to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping under overload conditions and instantaneous magnetic tripping for short circuit protection.

### 2.3 MANUFACTURERS

.1 To match existing switchboard.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install circuit breaker as indicated

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

### 1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CAN/CSA-C22.2 No.4-04 (R2013), Enclosed and Dead Front Switches.

.2 CSA C22.2 No.39, Fuseholder Assemblies.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.4 HEALTH AND SAFETY

.1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

### 1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials in accordance with Section 01 74 20 - Construction/Demolition Waste Management And Disposal.

.2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material for recycling in accordance with Waste Management Plan.

.4 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.

.5 Fold up metal banding, flatten and place in designated area for recycling.

## PART 2 - PRODUCTS

### 2.1 DISCONNECT SWITCHES

.1 Fusible and non-fusible disconnect switch in CSA Enclosure Type 1, Type 3R or Type 4, to CAN/CSA-C22.2 No.4-04 and size as indiated.

.2 2 pole or 3 pole as required for single phase or three phase circuits.

.3 2 pole with solid neutral for three wire circuits with neutral.

.4 3 pole with solid neutral for four wire circuits with neutral.

.5 Provision for padlocking in off switch position by locks.

.6 Mechanically interlocked door to prevent opening when handle in ON position.

.7 Fuses: size as indicated.

.8 Fuseholders: to CSA C22.2 No.39 suitable without adaptors, for type and size of fuse indicated.

.9 Quick-make, quick-break action.

.10 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 INSTALLATION

.1 Install disconnect switches complete with fuses if applicable.

.2 For CSA Type 3R and4x enclosures use watertight connectors complete with O rings for conduit connections.

.3 Provide fuses in disconnect switches, sizes as shown.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 CSA International

.1 CAN/CSA-C813.1-01(R2006), Performance Test Method for Uninterruptible Power Supplies.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product Data: include information as follows:

.1 Catalogue information.

.2 Shipping weight.

.3 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.

.4 Description of system operation, referenced to schematic diagram, for:

.1 Manual control during initial start-up and load transfer to bypass and back to inverter output.

.2 Inverter.

.3 Bypass.

.5 Estimate with supporting data for Mean Time to Repair factor (MTTR).

.6 Full load kVA output at 0.8% lagging power factor.

.7 Efficiency of system at 25%, 50%, 75% and 100% rated load.

.8 Type of ventilation: natural or forced.

.9 Bypass Switch

.10 Battery:

.1 Number of batteries/cells.

.2 Maximum and minimum voltages.

.3 Type of battery.

.4 Catalogue data with battery/cell trade name and type.

.5 Size and weight of each battery/cell.

.6 Batter/Cell charge and discharge curves of voltage, current, time and capacity.

.7 Derating factor for specified temperature range.

.8 Nominal ampere hour capacity of each battery/cell.

.9 Maximum charging current expected for fully discharged condition.

.10 Recommended low voltage limit for fully discharged condition.

.11 Expected life.

.11 Inverter:

.11 Type and catalogue number.

.12 DC current at minimum battery voltage to produce full load AC output.

.12 Rectifier:

.1 Type and capacity, with catalogue number.

.2 Battery charging sequence.

.3 Current-time data for Silicon Controlled Rectifier (SCR) protective devices.

.4 Guaranteed noise level.

.5 Estimated life.

.6 Metering.

.7 Alarms.

.13 Manufacturer's field experience with UPS of similar ratings including engineering expertise, manufacturing facilities and listing of UPS units manufactured and installed during last 5 years including model, customer, location and installation dates.

.14 Evaluation of Canadian content.

.15 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.

.16 Cooling air required in $m^3/s$.

.17 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.

.18 Typical operation and maintenance manual.

.19 Description of factory test facilities.

.19 Manufacturer's maintenance capabilities including:

.1 Willingness to undertake maintenance contract.

.2 Number of trained personnel available.

.3 Location of trained personnel and repair facilities.

.20 Manufacturer's written installation recommendations.

.21 Shop Drawings:

.1 Include outline schematics showing arrangement of cubicles, meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.

## 1.3 PROTECTION OF SYSTEMS

.1 Circuit breakers in system used to isolate it from load and from mains for safe working on equipment, and for manual blocking of bypass automatic control to prevent inadvertent operation of bypass during Work on inverter.

.2 Automatic circuit breakers and protection included in:

.1 AC input to rectifier.

.2 Battery input.

.3 Bypass circuit input.

.4 Inverter output.

.3 Surge suppressors:

.1 To protect system against supply voltage switching transients.

.2 To protect internal circuits where necessary against voltage transients.

.4 Current limiting devices, with panel front indication of device operation, to protect inverter SCR’s.

.5 Suitable devices, with panel front indication of device operation, to protect rectifier diodes.

.6 Failure of circuit or component not to cause equipment to operate in dangerous or uncontrolled mode.

## 1.4 QUALITY ASSURANCE

.1 Submit for approval records, indicating and recording instruments calibration certificates, including meters installed as part of system, in accordance with Section 01 33 00 - Submittal Procedures.

## 1.5 CLOSEOUT SUBMITTALS

.1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

.2 Operation and Maintenance Data: submit operation and maintenance data for uninterruptible power systems static (UPS) for incorporation into manual.

.3 Submit interim, draft final, and final Operation and Maintenance (OM) Manual. Final manual approved by Departmental Representative. Submit interim copies before notification of factory test date.

.4 Operation and Maintenance Manual to include:

.1 Operation and maintenance instructions concerning design elements, construction features, component

functions and maintenance requirements to permit effective operations maintenance and repair.

.2 Technical data:

.1 Approved shop drawings.

.2 Characteristic curves for automatic circuit breakers and protective devices.

.3 Project data.

.4 Technical description of components.

.5 Parts lists with names and addresses of suppliers.

## 1.6 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements: Crating:

.1 Adequately enclosed and protected from weather and shipping damage by use of minimum 12 mm plywood with vapour barrier inside.

.2 For rail or sea shipment use double layer of vapour barrier and 19 mm plywood covering.

.3 Subassemblies may be packed separately.

.4 Label crates:

.1 Shipping address.

.2 Weight and dimensions.

.3 Serial number of unit and brief description of contents.

.4 Stencilled with durable paint on at least two sides of each crate.

.5 List of contents:

.1 In weatherproof envelope stapled on outside of each crate.

.2 Copy placed inside each crate.

.3 Store materials off ground and protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.

## 1.7 WARRANTY

.1 Work of this Section 26 33 53 - Uninterruptible Power Systems Static, is warranted for 12 months warranty period.

.2 Contractor hereby warrants battery against defects in material and workmanship in accordance with GC 24, but for 1 years. This warranty is for 100% replacement for 1 year.

## 1.8 MAINTENANCE MATERIAL SUBMITTALS

.1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

.2 Include:

.1 4 sets of each type and size of fuses used.

.2 4 sets indicating lamps.

# PART 2 - PRODUCTS

## 2.1 SYSTEM DESCRIPTION

.1 System to consist of:

.1 Input/Output Cubicle.

.2 Rectifier/Invertor[/Battery Cubicle.

.3 Controls and meters.

.4 Bypass Switch

.2 Ensure system uses normal power supply mains and battery to provide continuous, regulated AC power to isolated load.

.3 Equipment: capable of operating continuously and unattended.

.4 Ensure that Uninterruptible Power Systems (UPS) is compatible with equipment that it feeds and with source from which it is fed.

## 2.2 PERFORMANCE

.1 Normal operation:

.1 System operates on mains power when mains voltage is within +/-10 % of nominal value and mains frequency is between 59.5 and 60.5 Hz.

.2 System performance and reliability:

.1 Consider any deviation from the required output power waveform as failure in UPS.

.2 Submit estimate, with supporting calculations, of Mean Time Between Failures (MTBF) expressed in hours.

.3 Noise Level to be less than 65dBA at full load capacity.

.2 Battery operation:

.1 System transfers automatically to battery operation.

.1 When manually selected at control panel.

.2 When mains power fails.

.3 When mains voltage varies more than 10 % from nominal or mains frequency varies more than 0.5 Hz from 60 Hz.

.4 When mains power is restored and mains voltage is within 10 % of nominal and mains frequency is within 0.3 Hz of 60 Hz, system automatically resynchronizes with mains;

.5 Slew rate of frequency during transition period of system output automatically synchronizing with mains and return to its internal frequency to be set between 0.5 to 1.0 Hz per second.

.3 Internal Static Bypass operation:

.1 Ensure system can be bypassed for maintenance purposes, automatically by manual selection at control panel to connect load directly to AC mains. Transfer without load interruption and leaving inverter energized.

.2 Load transfer from mains back to system automatically by manual selection at control panel when maintenance completed.

.3 Automatic transfer of load to mains in not more than ¼ cycle including sensing with inverter left energized but disconnected from load in case of:

.1 Inverter overloaded.

.2 Short circuit in load.

.4 Automatic retransfer of load to system without load interruption when above conditions disappear.

.5 Automatic transfer of load to mains in not more than ¼ cycle including sensing and shutdown of inverter in case of inverter internal malfunctions.

.6 Automatic transfer of load to mains without load interruption and inverter shutdown in case of:

.1 Over temperature harmful to system.

.2 Loss of forced ventilation.

.3 Low voltage of DC supply to inverter.

.4 Bypass capable of closing onto and withstanding momentary fault current of 800% of rating for 0.01 s.

## 2.3 UNINTERRUPTIBLE POWER SYSTEM

.1 Input power:

.1 Single phase, 120/240V, 3wire, grounded neutral, 60 Hz.

.2 Normal supply from AC mains.

.2 Output power:

.1 Single phase, 240V, 3wire, grounded neutral, 60 Hz.

.2 Full load output at unity power factor lagging 12 kVA.

.3 Overload capability: 125% of rated full load current at unity power factor and rated voltage for 10 minutes.

.4 Frequency - nominal 60 Hz:

.1 Adjustable from 58.5 to 61.5 Hz.

.2 Maximum variation from set value under load changes, including transients, [0.3] Hz maximum.

.3 Drift from set value - after two months normal operation within ambient temperature range of 0 degrees to 40 degrees C, not to exceed 0.6 Hz.

.5 Duration of full load output after mains failure not less than 10 minutes

.6 Output voltage control:

.1 Continuously adjustable on load at least 5% from rated value.

.2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.

.3 Transient voltage change not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of AC input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within 3 Hz.

.4 Harmonics over entire load range:

.1 Total RMS value not to exceed 5% RMS value of total output voltage.

.2 Single harmonic not to exceed 3% of total output voltage.

.5 Proper angular phase relation maintained within 4 electrical degrees at up to 20% load unbalance.

.7 Efficiency: Overall system efficiency at rated load with battery fully charged not less than 75 %.

.8 Interference suppression:

.1 If UPS equipment generates electromagnetic rf interference at levels which adversely affects other equipment in vicinity, install suppression circuits or shielding as required to eliminate such interference.

.2 If harmonics reflected back to mains from rectifier adversely affect other loads connected to same bus, install suppression circuits to prevent that condition.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Locate UPS cubicles, battery rack and battery as indicated.

.2 Locate and install remote mode lights and alarm cabinet[s] as indicated.

.3 Assemble and interconnect components to provide complete UPS as specified.

.4 Connect AC mains to main input terminal.

.5 Connect UPS output to load.

.6 Start-up UPS and make preliminary tests to ensure satisfactory performance.

### 3.2 PROTECTION

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

.2 Repair damage to adjacent materials caused by UPS installation.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

### 1.2 REFERENCES

.1 Institute of Electrical and Electronics Engineers, Inc. (IEEE)

.1 IEEE 837-2014, Standard for Qualifying Permanent Connections Used in Substation Grounding.

.2 CSA International

.1 CAN/CSA-B72-M87(R2008), Installation Code for Lightning Protection Systems.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Shop Drawings:

.1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.

.2 Indicate materials and methods of attachment of conductors to air terminals and electrodes.

### 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 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Lightning Rods: copper.

.2 Conductor: copper, size as per drawings.

.3 Fastenings and attachment straps: copper.

.4 Ground electrodes: 3 m x 20 mm diameter copper clad steel or copper alloy.

.5 Use copper conductors, terminals, connectors and fastenings for buildings sheathed in other than aluminum.

.6 Connections: copper connections formed by thermit process.

## 2.2 DESCRIPTION

.1 System to consist of metallic air terminals, lightning conductors connecting air terminals to ground and interconnected ground electrodes, and/or ground cables.

## 2.3 REGULATORY REQUIREMENTS

.1 System subject to: approval by authority having jurisdiction.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

.1 Install lightning protection to CAN/CSA-B72 and NFPA 780.

.2 Bond discharge conductors to service mast or other non-current-carrying electrical parts.

.3 Submit certificate of installation to Departmental Representative.

## 3.2 INSPECTION

.1 Obtain inspection certificate from Departmental Representative for discharge conductor passing through any fire supporting membrane.

## 3.3 PROTECTION

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

.2 Repair damage to adjacent materials caused by lightning protection installation.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 00 - Common Work Results for Electrical.

### 1.2 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI C82.1-2004, American National Standard for Lamp Ballasts - Line Frequency Fluorescent Lamp Ballasts.

.2 ANSI C82.4-2002, American National Standard for Ballasts for High-Intensity Discharge and Low-Pressure Sodium (LPS) Lamps (Multiple-Supply Type).

.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 review by Departmental Representative.

.3 Photometric data to include: VCP Table where applicable and spacing criterion.

.3 Quality assurance submittals: provide following.

.1 Manufacturer's instructions: provide manufacturer's written installation instructions and special handling

criteria, installation sequence, and cleaning procedures.

## 1.4 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

.3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.

.4 Divert unused metal materials from landfill to metal recycling facility.

.5 Disposal and recycling of fluorescent lamps as per local regulations.

# PART 2 - PRODUCTS

## 2.1 LAMPS

.1 Fluorescent lamps to be - T8, 32 Watt, medium bi-pin, rapid-start, 4100 K, 30,000 hour lamp life, 2950 initial lumens, CRI 80.

.2 Metal halide lamps to be - clear, BT37, Watt as indicated, base as indicated, horizontal burn, 4100 K, 15,000 hour lamp life, 36,000 initial lumens, CRI 65, open or enclosed type to suit the luminaire; or as indicated.

## 2.2 BALLASTS

.1 Fluorescent ballast: CBM and CSA certified, energy efficient type, IC electronic.

.1 Rating: voltage as indicated, 60 Hz, for use with 2-32W, rapid start lamps.

.2 Totally encased and designed for 40 degrees Celsius ambient temperature.

.3 Power factor: minimum 95 % with 95% of rated lamp lumens.

.4 Current crest factor: 1.7 maximum.

.5 Harmonics: 10 % maximum THD.

.6 Operating frequency of electronic ballast: 20 kHz minimum.

.7 Total circuit power: 62 Watts.

.8 Ballast factor: greater than 0.90.

.9 Sound rated: Class A.

.10 Mounting: integral with luminaire.

.2 Metal halide ballast:

.1 Rating: voltage as indicated, 60 Hz, for use with metal halide lamp. Provide circuitry for quartz re-strike standby light where indicated.

.2 Totally encased and designed for 40 degrees Celsius ambient temperature.

.3 Power factor: minimum 95 % with 95% of rated lamp lumens.

.4 Type: constant wattage autotransformer.

.5 Input voltage range: plus or minus 10% of nominal.

.6 Minimum starting temperature: minus 31 degrees Celsius at 90% line voltage.

.7 Mounting: integral with luminaire.

.8 Current crest factor: 1.8 maximum current.

## 2.3 FINISHES

.1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

## 2.4 OPTICAL CONTROL DEVICES

.1 As indicated in luminaire schedule.

## 2.5 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:

.2 Install flexible or rigid conduit for luminaires as indicated.

## 3.3 LUMINAIRE SUPPORTS

.1 For suspended ceiling installations support luminaires independently of ceiling.

3.4 LUMINAIRE ALIGNMENT

.1 Align luminaires mounted in continuous rows to form straight uninterrupted line.

.2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 00.

### 1.2 REFERENCES

.1 CSA-T529-95(R2000), Telecommunications Cabling System in Commercial Buildings (Adopted ANSI/EIA TIA 568a with modifications).

.2 CSA C22.2 No. 214-08(R2013), Communications Cables (Bi-national Standards, with UL 444).

.3 CAN/CSA-C22.2 No. 182.4-M90(R2015), Plugs, Receptacles and Connectors for Communication Systems.

.4 TIA/EIA-568-2001, Commercial Building Telecommunications Cable Standards Set.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product data: submit manufacturer's printed product literature, specifications and datasheets.

.1 Submit cable manufacturing data.

.3 Quality assurance submittals:

.1 Test reports: submit certified test reports.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Instructions: submit manufacturer's installation instructions.

### 1.4 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 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

.1 Structured system of telecommunications cables (copper) installed within building for distributing voice and data signals.

### 2.2 UNSHIELDED TWISTED PAIR (UTP)

.1 4-pair, 23 AWG, 100% FEP cable with insulated copper conductor in separate outer jacket: to C22.2 No. 214, FT-6 fire-rated jacket.

.2 Voice-grade electrical transmission requirements; to CSA-T529-95 and TIA-EIA-568.

.3 Data-grade electrical transmission requirements; to CSA-T529-95 and TIA-EIA-568.

.4 To meet category 6 requirements.

.5 All UTP cable to terminate in keystone jacks.

### 2.3 FIBRE OPTIC

.1 12 Strand Muli-mode Fibre Optic cables.

.2 Cable to be 62.5um.

.3 Cables to be terminated as per manufacturer’s recommendations and SC connectors.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF HORIZONTAL DISTRIBUTION CABLES

.1 Install UTP and Fibre Cables as indicated in conduits from termination points to outlet points.

.2 Refer to drawings for cable requirements per outlet.

### 3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 00.

.2 Test cable installation for:

.1 Continuity; including open/short, polarity and pair transpositions.

.2 DC Loop resistance.

.3 Length using TDR.

.4 Attenuation.

.5 NEXT, Return Loss, PS NEXT, F EXT.

.6 Propogation Delay.

.7 Delay Skew.

.3 Submit test results, soft and hard copies to the satisfaction of Department Representative.

.4 Provide minimum 2 year warranty for entire installed system. Cabling to have minimum 15 year warranty.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED REQUIREMENTS

.1 Section 26 05 00.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Product data: submit manufacturer's printed product literature, specifications and datasheets.

.1 Submit cable manufacturing data.

.3 Quality assurance submittals:

.1 Test reports: submit certified test reports.

.2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.3 Instructions: submit manufacturer's installation instructions.

### 1.3 DELIVERY, STORAGE AND HANDLING

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

.2 Waste Management and Disposal:

.1 Separate waste materials for recycling in accordance with Section 01 74 20 - Construction/Demolition Waste Management and Disposal.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

.1 Empty telecommunications raceways system consists of outlet boxes, cover plates, terminal distribution cabinets, conduits, cable trays, pull boxes, sleeves and caps, fish wires, service poles, service fittings, concrete encased ducts.

.2 Provide complete conduit system for Data system.

### 2.2 MATERIAL

.1 Conduits: EMT type, in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

.2 Junction boxes: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

.3 Outlet boxes, conduit boxes and fittings: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.

.4 Fish wire: polypropylene type.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

.1 Install empty raceway system, including distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cable tray, service poles, miscellaneous and positioning material to constitute complete system.

### 3.2 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.

### 3.3 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 WORK INCLUDED

.1 Excavation and backfilling for mechanical, electrical and site services work is included in this Section. This work to be laid out and supervised by trade concerned.

### 1.2 REFERENCES

.1 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS.PROV 206 November 2014, Construction Specification for Grading.
.2 OPSS.PROV 501 November 2014, Construction Specification for Compacting.
.3 OPSS 902 November 2010, Construction Specification for Excavating and Backfilling - Structures.

.2 CSA International
.1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
.2 CAN/CSA-A3000-13, Cementitious Materials Compendium.

### 1.3 ADMINISTRATIVE REQUIREMENTS

.1 Co-ordination: arrange with authority having jurisdiction for relocation of buried services that interfere with execution of work.
.1 Pay costs of relocating services.
.2 Before commencing work verify location of buried services on and adjacent to site.
.3 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
.4 Remove obsolete buried services within 2 m of foundations: cap cut-offs.

.2 Examine soil report found in Appendix.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Samples: submit to designated testing agency, 23 kg sample of backfill for fill material proposed for use, no later than 1 week before backfilling or filling work.

.3 Site Quality Control Submittals: submit in accordance with Section 01 45 00.
.1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article.

.2 Submit testing results and report as described in PART 3 - FIELD QUALITY CONTROL.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Granular material for bedding, cover and backfill to Section 31 05 16.

.2 Sand to Section 31 05 16.

.3 Drainage material to Section 31 05 16.

.4 Unshrinkable fill: proportioned and mixed to provide:
- .1 Maximum compressive strength of 0.4 MPa at 28 days.
- .2 Maximum Portland cement content of 25 kg/m3.
- .3 Minimum strength of 0.07 MPa at 24 hours.
- .4 Concrete aggregates: to CSA A23.1-14/A23.2-14.
- .5 Cement: to CAN/CSA-A3000-13, Type GU.
- .6 Slump: 160 to 200 mm.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

.1 Evaluation and Assessment:
- .1 Examine soil report found in Appendix.
- .2 Before commencing work verify locations of buried services on and adjacent to site.

### 3.2 PREPARATION

.1 Protection of in-place conditions:
- .1 Protect excavations from freezing.
- .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.

.2 Removal:
- .1 Remove trees, stumps, logs, brush, shrubs, bushes, vines, undergrowth, rotten wood, dead plant material, exposed boulders and debris within areas designated on drawings.

.2 Remove stumps and tree roots below footings, slabs, and paving, and to 600 mm below finished grade elsewhere.
.3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.

## 3.3 EXCAVATION

.1 Shore and brace excavations, protect slopes and banks and perform work in accordance with Provincial and Municipal regulations whichever is more stringent.

.3 Strip topsoil over areas to be covered by new construction, over areas where grade changes are required, and so that excavated material may be stockpiled without covering topsoil.
.1 Stockpile topsoil on site for later use.

.4 Excavate as required to carry out work.
.1 Do not disturb soil or rock below bearing surfaces.
.2 Notify Departmental Representative when excavations are complete.
.3 If bearings are unsatisfactory, additional excavation will be authorized in writing and paid for as additional work.
.4 Excavation taken below depths shown without Departmental Representative's written authorization to be filled with concrete of same strength as for footings at Contractor's expense.
.5 Excavation, backfilling and compacting for installation of storm pipe sewers, pipe culverts and end sections, pipe subdrains and other underground utilities in accordance with OPSS 401.

.5 Excavate trenches to provide uniform continuous bearing and support for 150 mm thickness of pipe bedding material on solid and undisturbed ground.
.1 Trench widths below point 150 mm above pipe not to exceed diameter of pipe plus 600 mm.

.6 Excavate for slabs and paving to subgrade levels.
.1 In addition, remove all topsoil, organic matter, debris and other loose and harmful matter encountered at subgrade level.

## 3.4 FIELD QUALITY CONTROL

.1 Testing of materials and compaction of backfill and fill will be carried out by testing laboratory designated by Departmental Representative.

.2 Not later than 1 week minimum before backfilling or filling, submit to designated testing agency, samples of backfill as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

.3 Do not begin backfilling or filling operations until material has been approved for use by Departmental Representative.

.4 Not later than 48 hours before backfilling or filling with approved

material, notify Departmental Representative to allow compaction tests to be carried out by designated testing agency.

## 3.5 BACKFILLING

.1 Inspection: do not commence backfilling until fill material and spaces to be filled have been inspected and approved by Departmental Representative.

.2 Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled.

.3 Lateral support: maintain even levels of backfill around structures as work progresses, to equalize earth pressures. Backfill simultaneously each side of walls and other structures greater than 1.3 m deep to equalize soil pressures.

.4 Compaction of subgrade: compact existing subgrade under walks, paving, and slabs on grade, to same compaction as fill.
.1 Fill excavated areas with selected subgrade material compacted as specified for fill.

.5 Placing:
.1 Place backfill, fill and base course material in 150 mm lifts: add water as required to achieve specified density.
.2 Place unshrinkable fill in areas as indicated: consolidate and level unshrinkable fill with internal vibrators.

.6 Compaction: compact each layer of material to following densities for material to SPMDD to ASTM D698:
.1 To underside of base courses: 95%.
.2 Base courses: 100%.
.3 Elsewhere: 90%.

.7 Backfill against foundations catch basin maintenance hole with excavated material.

.8 Place 150 mm compacted thickness of Granular A material below catch basin and maintenance holes.

.9 Place 150 mm sand bed in trench to support services through their length. Following approval of service installation handfill with sand to 300 mm compacted thickness over services. Backfill remainder of trench with excavated materials approved by Departmental Representative.

.10 Restore surface of excavation with material and finish to match existing adjoining surfaces.

.11 Under slabs and paving:
.2 Use selected subgrade material up to bottom of granular base courses.

.12 Under seeded and sodded areas: use site excavated material to bottom of topsoil except in trenches and within 600 mm of foundations.

.13 Against foundations (except as applicable to trenches and under slabs and paving): excavated material or imported material with no stones larger than 200 mm diameter within 600 mm of structures.

## 3.6 GRADING

.1 Grade so that water will drain away from buildings, walls and paved areas, to catch basins and other disposal areas approved by Departmental Representative.
.1 Grade to be gradual between finished spot elevations shown on drawings.

.2 Fill and grade site to achieve elevations indicated.

.3 Place excavated material in 300 mm lifts.

.4 Compact to 80% Standard Proctor maximum dry density.

.5 Grade to a uniform slope with a tolerance of 1:120.

## 3.7 SHORTAGE AND SURPLUS

.1 Supply necessary fill to meet backfilling and grading requirements and with minimum and maximum rough grade variance.

.2 Dispose of surplus material off site.

## 3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.
.1 Leave Work area clean at end of each day.
.2 Dispose of cleared and grubbed material off site daily.

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

.3 Waste Management in accordance with appropriate regulations and best practices.

END OF SECTION

## PART 1 - GENERAL

### 1.1 RELATED SECTIONS

.1 Section 31 23 10 - Excavating Trenching and Backfilling.

### 1.2 REFERENCES

.1 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS.PROV 314 November 2015, Construction Specification for Untreated Subbase, Base, Surface Shoulder, Selected Subgrade and Stockpiling.
.2 OPSS 1001 November 2013, Material Specification for Aggregates - General.
.3 OPSS.PROV 1004 November 2012, Material Specification for Aggregates - Miscellaneous.
.4 OPSS.PROV 1010 April 2013, Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.
.1 Submit sieve analysis for each type and source of granular material

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for aggregate materials 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 and with manufacturer's written instructions.

.2 Transportation and Handling: handle and transport aggregates to avoid segregation, contamination and degradation.

.3 Storage: store washed materials or materials excavated from underwater 24 hours minimum to allow free water to drain and for materials to attain uniform water content.

## 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, free from adherent coatings and injurious amounts of disintegrated pieces or other deleterious substances.

.2 Granular “A” to OPSS.PROV 1010 April 2013.

.3 Granular “B” Type I and II to OPSS.PROV 1010 April 2013.

.4 Clear Stone to OPSS 1004.PROV November 2012.

.5 Sand conforming to gradation requirements of mortar sand to OPSS 1004.PROV November 2012.

## 2.2 SOURCE QUALITY CONTROL

.1 Inform Departmental Representative of proposed source of aggregates and provide access for sampling 4 weeks minimum before starting production.

.2 If materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate alternative source.

.3 Advise Departmental Representative 4 weeks minimum 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 EXAMINATION

.1 Verification of Conditions: verify that conditions are acceptable for topsoil stripping.
.1 Visually inspect substrate in presence of Departmental Representative.
.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
.3 Proceed with topsoil stripping. only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

## 3.2 PREPARATION

.1 Topsoil stripping: in accordance with Section 31 14 13.

.2 Aggregate source preparation:
.1 Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as directed by Departmental Representative.
.2 Where clearing is required, leave screen of trees between cleared area and roadways as directed.

.3 Clear, grub and strip area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.

.4 When excavation is completed dress sides of excavation to nominal 1.5:1 slope, and provide drains or ditches as required to prevent surface standing water.

.5 Trim off and dress slopes of waste material piles and leave site in neat condition.

.6 Provide silt fence or other means to prevent contamination of existing watercourse or natural wetland features.

.3 Processing:

.1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.

.2 Blend aggregates, as required, including reclaimed materials that meet physical requirements of specification is permitted in order to satisfy gradation requirements for material and, percentage of crushed particles, or particle shapes specified.

.1 Use methods and equipment approved in writing by Departmental Representative.

.4 When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate gradation.

.5 Where necessary, screen, crush, wash, classify and process aggregates with suitable equipment to meet requirements.

.1 Use only equipment approved in writing by Departmental Representative.

.6 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 hours of rejection.

.7 Stockpile materials in uniform layers of thickness as follows:

.1 Maximum 1.5 m for coarse aggregate and base course materials.

.2 Maximum 1.5 m for fine aggregate and sub-base materials.

.3 Maximum 0.5 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.

## 3.3 CLEANING

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

.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.

.3 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.

.4 Leave any unused aggregates in neat compact stockpiles as directed by Departmental Representative.

.5 Waste Management in accordance with appropriate regulations and best practices.

END OF SECTION

## PART 1 – GENERAL

### 1.1 REFERENCES

.1 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS 201 November 2011, Construction Specification for Clearing, Close Cut Clearing, Grubbing and Removal of Surface and Piled Boulders.
.2 OPSS 802 November 2010, Construction Specification for Topsoil.

## PART 2 - PRODUCTS

### 2.1 NOT USED

.1 Not Used.

## PART 3 – EXECUTION

### 3.1 STRIPPING OF TOPSOIL

.1 Ensure that procedures are conducted in accordance with applicable Provincial and Municipal requirements.

.2 Remove topsoil before any construction procedures commence to avoid compaction of topsoil.

.3 Handle topsoil only when it is dry and warm.

.4 Remove vegetation from targeted areas by non-chemical means and dispose of stripped vegetation by alternative disposal.

.5 Remove brush from targeted area by non-chemical means and dispose of through alternative disposal.

.6 Strip topsoil to depths as directed by Departmental Representative. Avoid mixing topsoil with subsoil.

.7 Pile topsoil in berms in locations as directed by Departmental Representative. Stockpile height not to exceed 2.5 - 3 m.

.8 Dispose of unused topsoil in location as indicated by Departmental Representative.

.9 Protect stockpiles from contamination and compaction.

.10 Topsoil that has been piled for long term storage will be covered with trefoil or grass to maintain agricultural potential of soil.

## 3.2 PREPARATION OF GRADE

.1 Verify that grades are correct. If discrepancies occur, notify Departmental Representative and do not commence work until instructed by Departmental Representative.
.1 Grade area only when soil is dry to lessen soil compaction.
.2 Grade soil establishing natural contours and eliminating uneven areas and low spots, ensuring positive drainage.

## 3.3 PLACING OF TOPSOIL

.1 Comply with the requirements of OPSS 802 expect as amended herin.

.2 Place topsoil only after Departmental Representative has accepted subgrade.

.3 During dry conditions spread topsoil in uniform layers not exceeding 150 mm, over unfrozen subgrade free of standing water.

.4 Establish traffic patterns for equipment that will prevent driving on topsoil after it has been spread to avoid compaction.

.5 Cultivate the soil following spreading procedures.

## 3.4 SUB-SOILING

.1 Following the spreading and cultivating procedures sub-soil the area to improve drainage and agricultural potential of soil.

.2 With a vibrating sub-soiler work the area to a depth of 40 cm. Follow the contour lines of the natural grades of the area.

.3 Cross sub-soil the area following the first pass.

.4 Cultivate the soil with a chain harrow to de-clod the soil.

## 3.5 CLEANING

.1 Proceed in accordance with Section 01 74 11.

.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 REFERENCES

.1 ASTM International (ASTM)
.2 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

.1 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS.PROV 206 November 2014, Construction Specification for Grading.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

### 1.3 EXISTING CONDITIONS

.1 Examine subsurface investigation report found in Appendix.

.2 Known underground and surface utility lines and buried objects are as indicated on site plan.

.3 Before commencing work verify location of buried services on and adjacent to site.

.4 Refer to dewatering in Section 31 23 33.01.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Fill material: in accordance with of Section 31 23 33.01.

.2 Excavated or graded material existing on site suitable to use as fill for grading work if approved by Departmental Representative.

## 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 rough grading 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 STRIPPING OF TOPSOIL

.1 Proceed in accordance with Section 31 14 13.

## 3.3 GRADING

.1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.

.2 Slope rough grade away from building as indicated.

.3 Grade ditches to depth as indicated.

.4 Prior to placing fill over existing ground, scarify surface to depth of 150 mm minimum before placing fill over existing ground. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.

.5 Compact filled and disturbed areas to ASTM D698-12e2, as follows:

.1 90% SPMDD, under landscaped areas.
.2 95% SPMDD, under paved and walk areas.

.6 Do not disturb soil within branch spread of trees or shrubs to remain.

## 3.4 TESTING

.1 Inspection and testing of soil compaction will be carried out by testing laboratory designated by ULC. Costs of tests will be paid by Owner in accordance with Sections 01 29 83 and 01 45 00.

## 3.5 CLEANING

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

.3 Waste Management in accordance with appropriate regulations and best practices.

## 3.6 PROTECTION

.1 Protect or transplant existing fencing, trees, landscaping, surface or underground utility lines which are to remain as 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.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
.1 ASTM C136/C136M-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
.2 ASTM D422-63(2007)e2, Standard Test Method for Particle-Size Analysis of Soils.
.3 ASTM D4318-10e1, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

.2 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.3 Canadian Standards Association (CSA International)
.1 CAN/CSA-A3001-13, Cementitious Materials for Use in Concrete.
.2 CSA A23.1-14/A23.2-14, Concrete materials and methods of concrete construction/Test methods and standard practices for concrete.

.4 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS.PROV 206 November 2014, Construction Specification for Grading.
.2 OPSS.PROV 401 November 2015, Construction Specification for Trenching, Backfilling and Compacting.
.3 OPSS 492 November 2015, Construction Specification for Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures.
.4 OPSS.PROV 501 November 2014, Construction Specification for Compacting.
.5 OPSS 902 November 2010, Construction Specification for Excavating and Backfilling – Structures.

### 1.2 DEFINITIONS

.1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
.1 Rock : solid material in excess of 1.00 m3 and which cannot be removed by means of heavy duty mechanical excavating equipment. 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:
.1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.

.2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.

.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 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.

.7 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 D4318-10e1, and gradation within limits specified when tested to ASTM D422-63(2007)e2 and ASTM C136/C136M-14: Sieve sizes to CAN/CGSB-8.2-M88.
.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.

.8 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

## 1.3 SUBMITTALS

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

.2 Quality Control: in accordance with Section 01 45 00:
.1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
.2 Submit for review by Departmental Representative proposed dewatering and heave prevention methods as described in PART 3 of this Section.
.3 Submit to Departmental Representative written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
.4 Submit to Departmental Representative written notice when bottom of excavation is reached.
.5 Submit to Departmental Representative inspection results and report as described in PART 3 of this Section.

.3 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 location plan of relocated and abandoned services, as required.

.4 Samples:
.1 Submit samples in accordance with Section 01 33 00.
.2 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of fill materials and provide access for sampling.
.3 Submit 70 kg samples of type of fill specified including representative samples of excavated material.
.4 Ship samples prepaid to Departmental Representative, in tightly closed containers to prevent contamination and exposure to elements.
.5 At least 4 weeks prior to beginning Work, inform Departmental Representative source of fly ash and submit samples to Departmental Representative.
.1 Do not change source of Fly Ash without written approval of Departmental Representative.

## 1.4 QUALITY ASSURANCE

.1 Where Departmental Representative is employee of Contractor, submit proof that Work by Departmental Representative is included in Contractor's insurance coverage.

.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 Province of Ontario, Canada.

.4 Keep design and supporting data on site.

.5 Engage services of qualified professional Engineer who is registered or licensed in Province of Ontario, 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 by Departmental Representative.

.7 Health and Safety Requirements:
.1 Do construction occupational health and safety in accordance with Section 01 35 29.06.

## 1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Waste Management in accordance with appropriate regulations and best practices.

## 1.6 EXISTING CONDITIONS

.1 Examine soil report found in Appendix.

.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 applicable authorities having jurisdiction and establish location and state of use of buried utilities and structures. Departmental Representative and 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 Engineered 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.

.2 Granular material for bedding, cover and backfill to Section 31 05 16.

.3 Drainage material to Section 31 05 16.

.4 Sand to Section 31 05 16.

.5 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/m 3: to CSA A3001-13, Type GU.
- .3 Minimum strength of 0.07 MPa at 24 h.
- .4 Concrete aggregates: to CSA A23.1-14/A23.2-14.
- .5 Cement: Type GU.
- .6 Slump: 160 to 200 mm.

.6 Shearmat: honeycomb type bio-degradable cardboard 100 mm thick, treated to provide sufficient structural support for poured concrete until concrete cured.

## PART 3 - EXECUTION

### 3.1 GENERAL

.1 All work in this section shall comply with the requirements of OPSS 401 expect as amended herin.

### 3.2 SITE PREPARATION

.1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

.2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly in accordance with Section 02 41 13.

### 3.3 PREPARATION/ PROTECTION

.1 Protect existing features in accordance with Section 01 56 00 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.

## 3.4 STRIPPING OF TOPSOIL

.1 Topsoil stripping: in accordance with Section 31 14 13.

## 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 COFFERDAMS, SHORING, BRACING AND UNDERPINNING

.1 Maintain sides and slopes of excavations in safe condition by appropriate methods and in accordance with Section 01 35 29 Health and Safety Act for the Province of Ontario.
.1 Where conditions are unstable, Departmental Representative to verify and advise methods.

.2 Construct temporary Works to depths, heights and locations as approved by Departmental Representative.

.3 During backfill operation:
.1 Unless otherwise indicated or directed by Departmental Representative, remove sheeting and shoring from excavations.
.2 Do not remove bracing until backfilling has reached respective levels of such bracing.
.3 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation at least 500 mm above toe of sheeting.

.4 When sheeting is required to remain in place, cut off tops at elevations as indicated.

.5 Upon completion of substructure construction:
.1 Remove cofferdams, shoring and bracing.
.2 Remove excess materials from site and restore watercourses as directed by Departmental Representative.

## 3.7 DEWATERING AND HEAVE PREVENTION

.1 Keep excavations free of water while Work is in progress.

.2 Provide for Departmental Representative's review 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 manner not detrimental to public and private property, or portion of Work completed or under construction.
.1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.

## 3.8 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 directed by Departmental Representative.

.3 Remove concrete, masonry, paving, walks, demolished foundations and rubble and other obstructions encountered during excavation in accordance with Section 02 41 13.

.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 30 m of trench in advance of installation operations and do not leave open more than 15 m 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 as directed

by the 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 bearing surfaces and footings with Granular B Type 2 fill compacted to not less than 98% of Standard Proctor maximum dry density.
.2 Fill under other areas with Granular B Type 2 fill compacted to not less than 98% 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.
.2 Clean out rock seams and fill with concrete mortar or grout to approval of Departmental Representative.

## 3.9 BACKFILLING

.1 Backfilling in accordance with OPSS 401 except as modified herin.

.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.
.5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.

.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.

.3 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 0.3 m.

.4 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:

.1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Departmental Representative or:

.2 If approved by Departmental Representative, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Departmental Representative.

.7 Place unshrinkable fill in areas as indicated.

.8 Consolidate and level unshrinkable fill with internal vibrators.

.9 Install drainage system in backfill as directed by Departmental Representative.

## 3.10 RESTORATION

.1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 20, 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 Reinstate pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.

.5 Clean and reinstate areas affected by Work as directed by Departmental Representative.

.6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.

.7 Protect newly graded areas from traffic and erosion and maintain

free of trash or debris.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 ASTM International
.1 ASTM C88-13, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
.2 ASTM D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

.2 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS 302 November 2009, Construction Specification for Priming Granular Base.
.2 OPSS 310 November 2012, Construction Specification for Hot Mix Asphalt.
.3 OPSS.PROV 314 November 2015, Construction Specification for Untreated Subbase, Base, Surface Shoulder, Selected Subgrade and Stockpiling.
.4 OPSS 1103 November 2012, Material Specification for Emulsified Asphalt.
.5 OPSS.PROV 1010 April 2013, Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material.
.6 OPSS 1150 November 2010, Material Specification for Hot Mix Asphalt.

### 1.2 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00 and OPSS 1150.

### 1.3 DELIVERY, STORAGE AND HANDLING

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

.2 Deliver and stockpile aggregates in accordance with Section 31 05 16. Stockpile minimum 50% of total amount of aggregate required before beginning asphalt mixing operation.

.3 When necessary to blend aggregates from one or more sources to produce required gradation, do not blend in stockpiles.

.4 Stockpile fine aggregate separately from coarse aggregate, although separate stockpiles for more than two mix components are permitted.

.5 Provide approved storage, heating tanks and pumping facilities for asphalt cement.

.6 Submit to Departmental Representative copies of freight and waybills for asphalt cement as shipments are received.
.1 Departmental Representative reserves right to check weights as material is received.

.7 Waste Management in accordance with appropriate regulations and best practices.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

.1 Aggregates to: OPSS.PROV 1010 April 2013.
- .1 Granular A.
- .2 Granular B Type I and B Type II.
- .3 Select subgrade.

.2 Prime coat: SS-1 to OPSS 1103 November 2012.

.3 Tack coat: SS-1 to OPSS 1103 November 2012.

.4 Asphalt concrete: to 1150 November 2010.

## 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 asphalt paving 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 FOUNDATIONS

.1 Construction of granular foundations: OPSS.PROV 314 November 2015.

.2 Compaction: compact each lift of granular material to 100% maximum density to ASTM D698-12e2. Maximum lift thickness: 150 mm.

### 3.3 PAVEMENT THICKNESS

.1 Pavements for roadways:
- .1 Base course: 70 mm HL8.
- .2 Wear course: 50 mm HL3.

## 3.4 PAVEMENT CONSTRUCTION

.1 Construction of asphalt: OPSS 310 November 2012.

.2 Application of prime coat: OPSS 302 November 2009.

.3 Construction of asphalt concrete: OPSS 310 November 2012.

## 3.5 CLEANING

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

.3 Waste Management in accordance with appropriate regulations and best practices.

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS.PROV 206 November 2014, Construction Specification for Grading.
.2 OPSS 802 November 2010, Construction Specification for Topsoil.

### 1.2 SUBMITTALS

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

.2 Quality control submittals :
.1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 2 - SOURCE QUALITY CONTROL.
.2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

### 1.3 QUALITY ASSURANCE

.1 Pre-installation meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 32 16.06.

### 1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Waste management in accordance with appropriate regulations and best practices.

## PART 2 - PRODUCTS

### 2.1 TOPSOIL

.1 Topsoil: 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 N 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 Limestone:
.1 Ground agricultural limestone.
.2 Gradation requirements: percentage passing by weight, 90% passing 1.0 mm sieve, 50% passing 0.125 mm sieve.

.5 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 and manufactured 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 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 Avoid mixing topsoil with subsoil where textural quality will be moved outside acceptable range of intended application.

.3 Stockpile in locations as directed by Departmental Representative.
.1 Stockpile height not to exceed 2 m.

.4 Disposal of unused topsoil is to be in an environmentally responsible manner but not used as landfill as directed by Departmental Representative.

.5 Protect stockpiles from contamination and compaction.

## 3.2 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 100 mm.
.1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

## 3.3 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 sodded areas keep topsoil 15 mm below finished grade.

.4 Spread topsoil to following minimum depths after settlement.

.2 150 mm for sodded areas.

.5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

## 3.4 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 by Departmental Representative.

.1 Leave surfaces smooth, uniform and firm against deep footprinting.

## 3.5 ACCEPTANCE

.1 Departmental Representative will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

## 3.6 SURPLUS MATERIAL

.1 Dispose of materials except topsoil not required where directed by Departmental Representative.

## 3.7 CLEANING

.1 Proceed in accordance with Section 01 74 11.

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

END OF SECTION

## PART 1 - GENERAL

### 1.1 REFERENCES

.1 Ontario Provincial Standard Specifications (OPSS)
.1 OPSS 802 November 2010, Construction Specification for Topsoil.
.2 OPSS 803 November 2015, Construction Specification for Sodding.

### 1.2 ADMINISTRATIVE REQUIREMENTS

.1 Scheduling:
.1 Schedule sod laying to coincide with preparation of soil surface.
.2 Schedule sod installation when frost is not present in ground.
.3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 31 19.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

.1 Submit in accordance with Section 01 33 00.

.2 Product Data:
.1 Submit manufacturer's instructions, printed product literature and data sheets for sod, geotextile and fertilizer and include product characteristics, performance criteria, physical size, finish and limitations.
.2 Submit 2 copies of WHMIS MSDS.

.3 Samples.
.1 Submit:
.1 Sod for each type specified.
.1 Install approved samples in 1 square metre mock-ups and maintain in accordance with maintenance requirements during establishment period.
.2 Bio-degradable geotextile fabric.
.3 0.5 kg container of each type of fertilizer used.
.2 Obtain approval of samples by Departmental Representative.

.4 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements of seed mix, seed purity, and sod quality.

.5 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties of seed mix, seed purity, and sod quality.

## 1.4 QUALITY ASSURANCE

.1 Qualifications:
.1 Landscape Contractor: to be a Member in Good Standing of Landscape Ontario Horticultural Trades Association.
.2 Landscape Planting Supervisor: Landscape Industry Certified Technician with Softscape Installation designation.
.3 Landscape Maintenance Supervisor: Landscape Industry Certified Technician with Turf Maintenance designation.

## 1.5 DELIVERY, STORAGE AND HANDLING

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

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

.3 Storage and Handling Requirements:
.1 Store materials in accordance with supplier's recommendations.
.2 Replace defective or damaged materials with new.

.4 Waste Management in accordance with appropriate regulations and best practices.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

.1 Commercial Grade Turf Grass Nursery Sod: sod that has been especially sown and cultivated in nursery fields as turf grass crop.
.1 Kentucky Bluegrass Sod.

.2 Sod establishment support:
.1 Stakes for fastening sod to the earth shall be a minimum 150mm in length.

.3 Water:
.1 Supplied by Departmental Representative at designated source.

.4 Fertilizer:
.1 To conform to OPSS 803 November 2015.

## 2.2 SOURCE QUALITY CONTROL

.1 Obtain written 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 GENERAL

.1 All work in this section shall comply with the requirements of OPSS 803 expect as amended herin.

### 3.2 INSTALLERS

.1 Use installers who are Member in Good Standing of Landscape Ontario Horticultural Trades Association.

### 3.3 EXAMINATION

.1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for sod 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.

### 3.4 PREPARATION

.1 Verify that grades are correct and prepared in accordance with Section 32 91 19.13. If discrepancies occur, notify Departmental Representative and commence work when 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, 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 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; in location as directed by Departmental Representative in accordance with Section 01 74 20.

## 3.5 SOD PLACEMENT

.1 Ensure sod placement is done under supervision of certified Landscape Planting Supervisor.

.2 Lay sod within 24 hours of being lifted if air temperature exceeds 20 degrees C.

.3 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.

.4 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.

## 3.6 SOD PLACEMENT ON SLOPES AND PEGGING

.1 Start laying sod at bottom of slopes.

.2 Stake sod on slopes steeper than 3 horizontal to 1 vertical, within 1m of catch basins and within 1 m of drainage.
.1 Adjust pattern as directed by Departmental Representative.

## 3.7 FERTILIZING PROGRAM

.1 Fertilize during establishment and warranty periods to program agreed to by Departmental Representative.

## 3.8 CLEANING

.1 Progress Cleaning: clean in accordance with Section 01 74 11.
.1 Leave Work area clean at end of each day.
.2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.

.2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.
.1 Clean and reinstate areas affected by Work.

.3 Waste Management in accordance with appropriate regulations and best practices.

## 3.9 PROTECTION BARRIERS

.1 Protect newly sodded areas from deterioration with as directed by Departmental Representative.

.2 Remove protection 2 weeks after installation as directed by Departmental Representative.

## 3.10 MAINTENANCE DURING ESTABLISHMENT PERIOD

.1 Perform following operations from time of installation until acceptance.
.1 Water sodded areas in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 75 to 100 mm.
.2 Cut grass to 50 mm when or prior to it reaching height of 75 mm.
.3 Maintain sodded areas weed free 95%.
.4 Fertilize areas in accordance with fertilizing program. Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.
.5 Temporary barriers or signage to be maintained where required to protect newly established sod.

## 3.11 ACCEPTANCE

.1 Sodded 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 When environmental conditions allow, all sodded areas showing shrinkage cracks shall be top-dressed and seeded with a seed mix matching the original.

## 3.12 MAINTENANCE DURING WARRANTY PERIOD

.1 Perform following operations from time of acceptance until end of warranty period:

.1 Water sodded 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 as directed by Departmental Representative to height as follows:
.1 50 mm during normal growing conditions.
.2 Cut grass or as directed by Departmental Representative, but at intervals so that approximately one third of growth is removed in single cut.
.3 Fertilize areas in accordance with fertilizing program.

Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.

.4 Eliminate weeds by mechanical means to extent acceptable to Departmental Representative.

END OF SECTION