

Project Title CAMPBELLFORD, ONTARIO
 CORRECTIONAL SERVICE CANADA
 WARKWORTH INSTITUTION

HVAC UPGRADES

Project Number R.072852.001

Project Date 2015-03-16

END OF SECTION



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END OF SECTION

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END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Title and description of Work.
- .2 Contract method.
- .3 Cost Breakdown requirements
- .4 Work sequence.
- .5 Contractor use of premises.
- .6 Owner occupancy.
- .7 Alterations to existing building.

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 RELATED SECTIONS

- .1 Section 01 33 00.

1.4 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract comprises renovation of WW-18, WW-26 and WW-27 located at Warkworth Institution and further identified as PWGSC Ontario Region Project Number R.072852.001.

1.5 CONTRACT METHOD

- .1 Construct work under lump sum contract.
-

1.6 COST BREAKDOWN

- .1 Within 48 hours of notification of acceptance of bid furnish a cost breakdown by Section aggregating contract amount.
- .2 Within 48 hours of acceptance of bid submit a list of subcontractors.

1.7 WORK SEQUENCE

- .1 Construct Work in stages to accommodate Owner's continued use of premises during construction.
- .2 Coordinate Progress Schedule and coordinate with Owner Occupancy during construction.
- .3 Maintain fire access/control.

1.8 CONTRACTOR USE OF PREMISES

- .1 Contractor shall limit use of premises for Work to allow;
 - .1 Owner occupancy.
- .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.

1.9 OWNER OCCUPANCY

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

1.10 ALTERATIONS TO EXISTING BUILDING

- .1 Remove and recycle, compost, anaerobic digest, sell material for reuse or dispose of:
 - .1 Mechanical and electrical items as indicated.
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- .2 Architectural and structural elements as indicated.
- .2 Remove in good order, turn over to Department, and store within building where designated by Departmental Representative:
 - .1 Mechanical and electrical items as indicated
 - .2 Architectural and structural elements as indicated.
- .3 Remove, temporarily store, clean, alter to suit and reinstall:
 - .1 Mechanical and electrical items as indicated.
 - .2 Architectural and structural elements as indicated.
- .4 Remove, temporarily store and turn over to other sections for building in:
 - .1 Mechanical and electrical items as indicated.
 - .2 Architectural and structural elements as indicated.
- .5 Provide new openings required in existing construction.
- .6 Block in openings where items removed with material and finish to match existing adjoining construction.

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 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDING

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

1.4 EXISTING SERVICES

- .1 Notify Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative 48 hours of notice for necessary interruption of mechanical or electrical service throughout course of work. Keep duration of interruptions minimum. Carry out interruptions after normal working hours of occupants, preferably on weekends. Do not proceed with the work until written approval obtained from Departmental Representative.
 - .1 Work must be approved by Departmental Representative before proceeding and may not be approved.
- .3 Provide for personnel, pedestrian and vehicular traffic.
- .4 Construct barriers in accordance with Section 01 56 00.

1.5 SPECIAL REQUIREMENTS

- .1 Contractor will not be allowed to be within the Institution overnight.
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- .1 Contractor may obtain access to Institution overnight through special permission. Access needs to be approved by Departmental Representative and may not be granted.
- .2 Submit schedule in accordance with Section 01 32 16.07.
- .3 Ensure Contractor's personnel employed on site become familiar with and obey regulations including safety, fire, traffic and security regulations.
- .4 Keep within limits of work and avenues of ingress and egress.
- .5 Ingress and egress of Contractor vehicles at site is limited.
- .6 Delivery of materials shall be in accordance with section 01 35 13. Deliver materials during sally port hours of 8 am to 11 am or 12:30 to 15:00 pm.

1.6 SECURITY

- .1 Security to be in accordance with Section 01 35 13.

1.7 BUILDING SMOKING ENVIRONMENT

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 ADMINISTRATIVE

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

1.2 PRECONSTRUCTION MEETING

- .1 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
 - .2 Departmental Representative, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
 - .3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.
 - .4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
 - .5 Agenda to include:
 - .1 Appointment of official representative of participants in the Work.
 - .2 Schedule of Work: in accordance with Section 01 32 16.07.
 - .3 Schedule of submission of shop drawings, samples, 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 and Section 01 35 13.
 - .6 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
 - .7 Record drawings in accordance with Section 01 33 00.
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- .8 Maintenance manuals in accordance with Section 01 78 00.
- .9 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00.
- .10 Monthly progress claims, administrative procedures, photographs, hold backs.
- .11 Appointment of inspection and testing agencies or firms.
- .12 Insurances, transcript of policies.

1.3 PROGRESS MEETINGS

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.
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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.
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1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Submit to Departmental Representative within 5 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 award of contract.

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 minimum milestones and activity types as follows:
 - .1 Award.
 - .2 Shop Drawings, Samples.
 - .3 Permits.
 - .4 Mobilization.
 - .5 Housekeeping pad installation
 - .6 Structural Steel.
 - .7 Siding and Roofing.
 - .8 Interior Architecture (Walls, Floors and Ceiling).
 - .9 Plumbing.
 - .10 Electrical.
 - .11 Piping.
 - .12 Controls.
 - .13 Heating, Ventilating, and Air Conditioning.
 - .14 Testing and Commissioning.
 - .15 Supplied equipment long delivery items.

1.6 PROJECT SCHEDULE REPORTING

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

1.7 PROJECT MEETINGS

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

PART 2 - PRODUCTS

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.

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.
 - .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
 - .4 Allow 5 days for Departmental Representative's review of each submission.
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- .5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Amount. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.
 - .6 Make changes in shop drawings as Departmental Representative may require, consistent with Contract Documents. When resubmitting, notify Departmental Representative in writing of revisions other than those requested.
 - .7 Accompany submissions with transmittal letter, containing:
 - .1 Date.
 - .2 Project title and number.
 - .3 Contractor's name and address.
 - .4 Identification and quantity of each shop drawing, product data and sample.
 - .5 Other pertinent data.
 - .8 Submissions include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.
 - .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
 - .5 Details of appropriate portions of Work as applicable:
 - .1 Fabrication.
 - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.
 - .9 After Departmental Representative's review, distribute copies.
 - .10 Submit three hard copies and one electronic copy of shop drawings for each requirement requested in specification Sections and as Departmental Representative may reasonably request.
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- .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 manufacturer's 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,
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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 site office.
- .3 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .4 Where colour, pattern or texture is criterion, submit full range of samples.
- .5 Adjustments made on samples by Departmental Representative are not intended to change Contract Amount. 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 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic copy of colour digital photography in jpg format, fine resolution monthly with progress statement.
 - .1 Photographs must be taken using camera provided by Institution.
- .2 Project identification: name and number of project and date of exposure indicated.
- .3 Number of viewpoints: 2 locations.
 - .1 Viewpoints and their location as determined by Departmental Representative.
- .4 Frequency of photographic documentation: weekly.
 - .1 Upon completion of: of Work as directed by Departmental Representative.

1.5 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 PURPOSE

- .1 To ensure that both the construction project and the institutional operations may proceed without undue disruption or hindrance and that the security of the Institution is maintained at all times.

1.2 DEFINITIONS

- .1 "Contraband" means:
 - .1 An intoxicant, including alcoholic beverages, drugs and narcotics.
 - .2 Tobacco or associated tobacco products.
 - .3 An igniting device, lighter or matches.
 - .4 A weapon or a component thereof, ammunition for a weapon, and anything that is designed to kill, injure or disable a person or that is altered so as to be capable of killing, injuring or disabling a person, when possessed without prior authorization.
 - .5 An explosive or a bomb or a component thereof.
 - .6 Currency over any applicable prescribed limit, \$25.00 when possessed by an inmate, without prior authorization.
 - .7 Any item not described in paragraphs 1.2.1.1 to 1.2.1.6 that could jeopardize the security of a Penitentiary or the safety of persons, when that item is possessed without prior authorization.
 - .2 "Unauthorized Smoking and related Items" means all smoking items including, but not limited to, cigarettes, cigars, tobacco, chewing tobacco, cigarette making machines, matches and lighters.
 - .3 "Commercial Vehicle" means any motor vehicle used for the shipment of material, equipment and tools required for the construction project.
 - .4 "CSC" means Correctional Service Canada.
 - .5 "Director" means Director, Warden or Superintendent of the Institution as applicable.
 - .6 "Construction Employees" means persons working for the General Contractor, the sub-contractors, equipment operators, material suppliers, testing and inspection companies and regulatory agencies.
 - .7 "Departmental Representative" means the project manager from Public Works and Government Services Canada.
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- .8 "Perimeter" means the fenced or walled area of the Institution that restrains the movement of the inmates.
- .9 "Construction Limits" means the area as shown on the contract drawings that the Contractor will be allowed to work. This area may or may not be isolated from the security area of the Institution.

1.3 PRELIMINARY PROCEEDINGS

- .1 Prior to the commencement of work, the Contractor shall meet with the Director or his/her representative to:
 - .1 Discuss the nature and extent of all activities involved in the Project.
 - .2 Establish mutually acceptable security procedures in accordance with this instruction and the institution's particular requirements.
- .2 Contractor shall:
 - .1 Ensure that all Construction Employees are aware of the security requirements.
 - .2 Ensure that a copy of the security requirements is always prominently on display at the job site.
 - .3 Co-operate with institutional personnel in ensuring that security requirements are observed by all Construction Employees.

1.4 CONSTRUCTION EMPLOYEES

- .1 Submit to the Director a list of the names with date of birth of all Construction Employees to be employed on the construction site and a security clearance form for each employee.
 - .2 Allow two (2) weeks for processing of security clearances. Employees will not be admitted to the Institution without a valid security clearance in place and a recent picture identification such as a provincial driver's license. Security clearances obtained from other CSC Institutions are not valid at this Institution. CSC CPIC clearance is required for all construction employees.
 - .3 The Director may require that facial photographs may be taken of Construction Employees and these photographs may be displayed at appropriate locations in the Institution or in an electronic database for identification purposes. The Director may require that Photo ID cards be provided for all Construction Employees. ID cards will then be left at the designated entrance to be picked upon arrival at the institution and shall be displayed prominently on the Construction Employees' clothing at all time while Construction Employees are in the institution.
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- .4 Entry to Institutional Property will be refused to any person there may be reason to believe may be a security risk.
- .5 Any person employed on the construction site will be subject to immediate removal from Institutional Property if they:
 - .1 Appear to be under the influence of alcohol, drugs or narcotics.
 - .2 Behave in an unusual or disorderly manner.
 - .3 Are in possession of contraband.
- .6 Smoking is prohibited anywhere on CSC property.

1.5 VEHICLES

- .1 All unattended vehicles on CSC property shall have windows closed; doors and trunks shall be locked and keys removed. The keys shall be securely in the possession of the owner or an employee of the company that owns the vehicle.
- .2 The Director may limit at any time the number and type of vehicles allowed within the Institution.
- .3 Drivers of delivery vehicles for material required by the project will not require security clearances but must remain with their vehicle the entire time that the vehicle is in the Institution. The Director may require that these vehicles be escorted by Institutional Staff or Commissionaires while in the Institution.
- .4 If the Director permits trailers to be left inside the secure perimeter of the Institution, these trailer doors will be locked at all times. All windows will be securely locked when left unoccupied. All trailer windows shall be covered with expanded metal mesh. All storage trailers inside and outside the perimeter shall be locked when not in use.

1.6 PARKING

- .1 Parking area(s) to be used by Construction Employees will be designated by the Director. Parking in other locations will be prohibited and vehicles may be subject to removal.

1.7 SHIPMENTS

- .1 All shipments of project material, equipment and tools shall be addressed in the Contractor's name to avoid confusion with the Institution's own shipments. The Contractor must have his/her own employees on site to receive any deliveries or shipments. CSC staff will NOT accept receipt of deliveries or shipments of any material, equipment or tools.
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1.8 TELEPHONES

- .1 Telephones, Facsimile machines and computers with Internet connections are not permitted within the perimeter of the Institution unless prior approval of the Director is received.

1.9 WORK HOURS

- .1 Work hours within the Institution are: Monday to Friday 07:30 am to 4:00 p.m.
- .2 Work will not be permitted during weekends and statutory holidays without the permission of the Director. A minimum of seven days advance notice will be required to obtain the required permission. In case of emergencies or other special circumstances, this advance notice may be waived by the Director.

1.10 OVERTIME WORK

- .1 No overtime work will be allowed without permission of the Director. Give a minimum forty-eight (48) hours advance notice when overtime work on the construction project is necessary and approved. If overtime work is required because of an emergency such as the completion of a concrete pour or work to make the construction safe and secure, the Contractor shall advise the Director as soon as this condition is known and follow the directions given by the Director. Costs to the Crown for such events may be attributed to the Contractor.
- .2 When overtime work, weekend, or statutory holiday work is required and approved by the Director, extra staff members may be posted by the Director or his/her designate, to maintain the security surveillance. The Departmental Representative may post extra staff for inspection of construction activities. The actual cost of this extra staff may be subject to reclamation by the Crown.

1.11 TOOLS AND EQUIPMENT

- .1 Maintain a complete list of all tools and equipment to be used during the construction project. Make this inventory available for inspection when required.
 - .2 Throughout the construction project maintain up-to-date the list of tools and equipment specified above.
 - .3 Keep all tools and equipment under constant supervision, particularly power-driven and cartridge-driven tools, cartridges, files, saw blades, rod saws, wire, rope, ladders and any sort of jacking device.
 - .4 Store all tools and equipment in approved secure locations.
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- .5 Lock all tool boxes when not in use. Keys to remain in the possession of the employees of the Contractor. Scaffolding shall be secured and locked when not erected and when erected, will be secured in a manner agreed upon with the Institutional designate.
- .6 All missing or lost tools or equipment shall be reported immediately to the Director.
- .7 The Director will ensure that the security staff members carry out checks of the Contractor's tools and equipment against the list provided by the Contractor. These checks may be carried out at the following intervals:
 - .1 At the beginning and conclusion of every construction project.
 - .2 Tools must be accounted for at all times, and must be checked at least daily.
 - .3 The Contractor may be subject to random checks by security staff to ensure proper storage and security of tools throughout the project.
- .8 Certain tools/equipment such as cartridges and hacksaw blades are highly controlled items. The Contractor will be given at the beginning of the day, a quantity that will permit one day's work. Used blades/cartridges will be returned to the Director's representative at the end of each day.
- .9 If propane or natural gas is used for heating the construction, the Institution will require that an employee of the Contractor supervise the construction site during non-working hours.
- .10 If torches or grinders are required tools to perform Work, Contractor must complete a Hot Work Permit as supplied by CSC. Completed original form(s) are copied and posted on the work site in a conspicuous location. Original documents are to remain with the Institutional Fire Chief.

1.12 KEYS

- .1 Security Hardware Keys:
 - .1 The Contractor shall arrange with the security hardware supplier/installer to have the keys for the security hardware to be delivered directly to Institution, specifically the Security Maintenance Officer (SMO).
 - .2 The Security Maintenance Officer (SMO) will provide a receipt to the Contractor for security hardware keys.
 - .3 The Contractor will provide a copy of the above-mentioned receipt to the Departmental Representative.

- .2 Other Keys:
 - .1 The Contractor will use standard construction cylinders for locks for his/her use during the construction period.
 - .2 The Contractor will issue instructions to his/her employees and sub-trades, as necessary, to ensure safe custody of the construction set of keys.
 - .3 Upon completion of each phase of the construction, the CSC representative will, in conjunction with the lock manufacturer:
 - .1 Prepare an operational keying schedule.
 - .2 Accept the operational keys and cylinders directly from the lock manufacturer
 - .3 Arrange for removal and return of the construction cores and install the operational core in all locks.
- .3 Upon putting operational security keys into use, the CSC construction escort shall obtain these keys as they are required from the Security Maintenance Officer (SMO) and open doors as required by the Contractor. The Contractor shall issue instructions to his/her employees advising them that all security keys shall always remain with the CSC construction escort.

1.13 SECURITY HARDWARE

- .1 Turn over all removed security hardware to the Director of the Institution for disposal or for safekeeping until required for re-installation.

1.14 PRESCRIPTION DRUGS

- .1 Employees of the Contractor who are required to take prescription drugs during the workday shall obtain approval of the Director to bring a one day supply only into the Institution.

1.15 SMOKING RESTRICTIONS

- .1 Contractors and construction employees are not permitted to smoke inside correctional facilities or outdoors within the perimeter of a correctional facility and must not possess unauthorized smoking items within the perimeter of a correctional facility.
- .2 Contractors and construction employees who are in violation of this policy will be requested to immediately cease smoking or dispose of any unauthorized smoking items and, if they persist, will be directed to leave the institution.
- .3 Smoking is only permitted outside the perimeter of a correctional facility in an area to be designated by the Director.

1.16 CONTRABAND

- .1 Weapons, ammunition, explosives, alcoholic beverages, drugs and narcotics are prohibited on Institutional Property.
- .2 Discovery of Contraband on the construction site and the identification of the person(s) responsible for the Contraband shall be reported immediately to the Director.
- .3 Contractors shall be vigilant with both their staff and the staff of their sub-contractors and suppliers that the discovery of Contraband may result in cancellation of the security clearance of the affected employee. Serious infractions may result in the removal of the company from the Institution for the duration of the construction.
- .4 Presence of arms and ammunition in vehicles of Contractors, sub-contractors and suppliers or employees of these will result in the immediate cancellation of security clearances for the driver of the vehicle.

1.17 SEARCHES

- .1 All vehicles and persons entering Institutional property may be subject to search.
- .2 When the Director suspects, on reasonable grounds, that an employee of the Contractor is in possession of Contraband or unauthorized items, he/she may order that person to be searched.
- .3 All employees entering the Institution may be subject to screening of personal effects for traces of Contraband drug residue.

1.18 ACCESS TO AND REMOVAL FROM INSTITUTION PROPERTY

- .1 Construction personnel and commercial vehicles will not be admitted to the Institution after normal working hours, unless approved by the Director.

1.19 MOVEMENT OF VEHICLES

- .1 Escorted commercial vehicles will be allowed to enter or leave the Institution through the vehicle access gate during the following hours:
 - .1 07:45 a.m. to 11:00 a.m.
 - .2 1:00 p.m. to 3:30 p.m.
 - .2 Construction vehicles shall not leave the Institution until an inmate count is completed.
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- .3 The Contractor shall advise the Director twenty four (24) hours in advance to the arrival on the site of heavy equipment such as concrete trucks, cranes, etc.
- .4 Vehicles being loaded with soil or other debris, or any vehicle considered impossible to search must be under continuous supervision by CSC Staff or Commissionaires working under the authority of the Director.
- .5 Commercial Vehicles will only be allowed access to Institutional Property when their contents are certified by the Contractor or his/her representative as being strictly necessary to the execution of the construction project.
- .6 Vehicles shall be refused access to Institutional Property if, in the opinion of the Director, they contain any article which may jeopardize the security of the Institution.
- .7 Private vehicles of Construction Employees will not be allowed within the security wall or fence of medium or maximum security Institutions without the permission of the Director.
- .8 With the approval of the Director, certain equipment may be permitted to remain on the construction site overnight or over the weekend. This equipment must be securely locked, with the battery removed. The Director may require that the equipment be secured with a chain and padlock to another solid object.

1.20 MOVEMENT OF CONSTRUCTION EMPLOYEES ON INSTITUTIONAL PROPERTY

- .1 Subject to the requirements of good security, the Director will permit the Contractor and his/her employees as much freedom of action and movement as is possible.
 - .2 However, notwithstanding paragraph above, the Director may:
 - .1 Prohibit or restrict access to any part of the Institution.
 - .2 Require that in certain areas of the Institution, either during the entire construction project or at certain intervals, Construction Employees only be allowed access when accompanied by a member of the CSC security staff.
 - .3 During the lunch and coffee/health breaks, all employees will remain within the construction site. Employees are not permitted to eat in the officer's lounge and dining room.
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1.21 SURVEILLANCE AND INSPECTION

- .1 Construction activities and all related movement of personnel and vehicles will be subject to surveillance and inspection by CSC security staff members to ensure that established security requirements are met.
- .2 CSC staff members will ensure that an understanding of the need to carry out surveillance and inspections, as specified above, is established among Construction Employees and maintained throughout the construction project.

1.22 STOPPAGE OF WORK

- .1 The Director may request at any time that the Contractor, his/her employees, sub-contractors and their employees not enter or leave the work site immediately due to a security situation occurring within the Institution. The Contractor's site supervisor shall note the name of the staff member making the request and the time of the request and obey the order as quickly as possible.
- .2 The Contractor shall advise the Departmental Representative within 24 hours of this delay to the progress of the work.

1.23 CONTACT WITH INMATES

- .1 Unless specifically authorized, it is forbidden to come into contact with inmates, to talk with them, to receive objects from them or to give them objects. Any employee doing any of the above will be removed from the site and his/her security clearance revoked.
- .2 It is forbidden to take pictures of inmates, of CSC staff members or of any part of the Institution other than those required as part of this Contract.

1.24 COMPLETION OF CONSTRUCTION PROJECT

- .1 Upon completion of the construction project or, when applicable, the takeover of a facility, the Contractor shall remove all remaining construction material, tools and equipment that are not specified to remain in the Institution as part of the construction contract.
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PART 2 - PRODUCTS

2.1 NOT USED

.1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not used.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 National Building Code 2010 (NBC):
 - .1 NBC 2010, Division B, Part 8 Safety Measures at Construction and Demolition Sites.
- .2 National Fire Code 2010 (NFC):
 - .1 NFC 2010, Division B, Part 5 Hazardous Processes and Operations, subsection 5.6.1.3 Fire Safety Plan.
- .3 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.
- .4 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§ion=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 Facility Emergency Procedures and Evacuation Plan in place at the site. Departmental Representative will
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provide Facility 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 Facility 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 5 days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within 5 days after receipt of comments from Departmental Representative.
- .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 3 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative weekly.
- .11 Submit 3 copies of Contractor's authorized representative's work site health and safety inspection reports to Departmental Representative, weekly.
- .12 Submit copies of orders, directions or reports issued by health and safety inspectors of the authorities having jurisdiction.
- .13 Submit copies of incident and accident reports.
- .14 Submit Material Safety Data Sheets (MSDS).
- .15 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.
 - .2 Contractor shall agree to install proper site separation and identification in order to maintain time and space at all times throughout life of project.
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1.4 WORK PERMIT

- .1 Obtain building permits related to project prior to commencement of Work.
- .2 Obtain 'Permit to Work Form' from Departmental Representative.
- .3 Obtain Hot Work Permit from Departmental Representative.

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 will involve contact with:
 - .1 Silica in concrete block.

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.
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- .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 HEALTH AND SAFETY CO-ORDINATOR

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

1.14 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 Emergency 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.

1.15 CORRECTION OF NON-COMPLIANCE

- .1 Immediately address health and safety non-compliance issues identified by authority having jurisdiction or by Departmental Representative.
 - .2 Provide Departmental Representative with written report of action taken to correct non-compliance of health and safety issues identified.
 - .3 Departmental Representative may stop Work if non-compliance of health and safety regulations is not corrected.
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1.16 POWDER ACTUATED DEVICES

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

1.17 WORK STOPPAGE

- .1 Give precedence to safety and health of public and site personnel and protection of environment over cost and schedule considerations for Work.
- .2 Supervisor to stop or start Work when, at Health and Safety Coordinator's and/or 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.
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- .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 protection and alarm system will not be:
 - .1 obstructed;
 - .2 shut-off; or
 - .3 left inactive at end of working day or shift.
- .2 Fire hydrants, standpipes and hose systems will not be used for other than fire-fighting purposes unless authorized by Departmental Representative.
- .3 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 INSTALLATION AND/OR REPAIR OF ROOF TO INCLUDE CONTRACTORS PHYSICAL PLANT AT SITE

- .1 Ensure personnel use and take precautions as follows:
 - .1 Use kettles equipped with thermometers or gauges in good working order.
 - .2 Locate kettles in safe place outside of building. Locate to avoid danger of igniting combustible material.
 - .3 Maintain continuous supervision while kettles are in operation and provide metal covers for kettles to smother any flames in case of fire. Fire extinguishers shall be provided as required in 1.6.
 - .4 Prior to start of work, demonstrate container capacities to Departmental Representative.
 - .5 Use only glass fibre roofing mops.
 - .6 Used roofing mops will not be left unattended on roof and shall be stored away from building and combustible materials.
 - .7 All roofing materials will be stored in location no closer than 3 m to any structures.

1.7 BLOCKAGE OF ROADWAYS

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

1.8 SMOKING PRECAUTIONS

- .1 Smoking is not permitted anywhere on CSC property.

1.9 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.

1.10 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.
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- .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.

1.11 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.

1.12 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.
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- .7 Provide Fire Watch on standby with approved fire extinguisher while burning or welding is in progress.

1.13 QUESTIONS AND/OR CLARIFICATIONS

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

1.14 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 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 – General Commissioning (Cx) 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.
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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.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and/or testing, 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 re-inspection.

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 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
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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, 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 MILL TESTS

- .1 Submit mill test certificates as requested

1.11 EQUIPMENT AND SYSTEMS

- .1 Submit testing, adjusting and balancing reports for mechanical, electrical and building equipment 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 .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-Z797-09(2014), Code of practice for Access Scaffold.
- .2 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 833-R-06-004, May 2007, Developing your Stormwater Pollution Prevention Plan - A Guide for Construction Sites.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 INSTALLATION AND REMOVAL

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

1.4 SCAFFOLDING

- .1 Scaffolding in accordance with CSA Z797.
- .2 Provide and maintain scaffolding.

1.5 HOISTING

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

1.6 SITE STORAGE/LOADING

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

1.7 CONSTRUCTION PARKING

- .1 Parking will not be permitted on site.
- .2 Provide and maintain adequate access to project site.
- .3 Clean runways and taxi areas where used by Contractor's equipment.

1.8 SECURITY

- .1 Refer to Section 01 35 13.

1.9 OFFICES

- .1 Provide office heated to 22 degrees C, lighted 750 lx and ventilated, of sufficient size to accommodate site meetings and furnished with drawing laydown table.
- .2 Provide marked and fully stocked first-aid case in a readily available location.
- .3 Departmental Representative's Site office.
 - .1 Provide temporary office for Departmental Representative.
 - .2 Inside dimensions minimum 3.6 m long x 3 m wide x 2.4 m high, with floor 0.3 m above grade, complete with 4 50% opening windows and one lockable door.
 - .3 Insulate building and provide heating system to maintain 22 degrees C inside temperature at -20 degrees C outside temperature.
 - .4 Finish inside walls and ceiling with plywood, hardboard or wallboard and paint in selected colours. Finish floor with 19 mm thick plywood.
 - .5 Install electrical lighting system to provide min 750 lx using surface mounted, shielded commercial fixtures with 10 % upward light component.
 - .6 Provide private washroom facilities adjacent to office complete with flush or chemical type toilet, lavatory and mirror and maintain supply of paper towels and toilet tissue.
 - .7 Equip office with 1 x 2 m table, 4 chairs, 6 m of shelving 300 mm wide, one 3 drawer filing cabinet, one plan rack and one coat rack and shelf.
 - .8 Maintain in clean condition.

1.10 EQUIPMENT, TOOL AND MATERIALS STORAGE

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

1.11 SANITARY FACILITIES

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

1.12 CONSTRUCTION SIGNAGE

- .1 Signs and notices for safety and instruction in both official languages Graphic symbols.
- .2 Maintain approved signs and notices in good condition for duration of project, and dispose of offsite on completion of project or earlier if directed by Departmental Representative.

1.13 PROTECTION AND MAINTENANCE OF TRAFFIC

- .1 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
- .2 Protect travelling public from damage to person and property.
- .3 Contractor's traffic on roads selected for hauling material to and from site to interfere as little as possible with public traffic.
- .4 Verify adequacy of existing roads and allowable load limit on these roads. Contractor: responsible for repair of damage to roads caused by construction operations.
- .5 Provide necessary lighting, signs, barricades, and distinctive markings for safe movement of traffic.

1.14 CLEAN-UP

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.
-

PART 3 - EXECUTION

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 Barriers.
- .2 Environmental Controls.
- .3 Fire Routes.

1.2 REFERENCES

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

1.3 INSTALLATION AND REMOVAL

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

1.4 HOARDING

- .1 Erect temporary site enclosures using 38 x 89 mm construction grade lumber framing at 600 mm on center and 1200 x 2400 x 13 mm exterior grade fir plywood to CSA-O121.
 - .2 Apply plywood panels vertically flush and butt jointed. Screws must be used from the inside of the secure area to eliminate possible removal.
 - .3 Provide at least one pedestrian door as directed and conforming to applicable traffic restrictions on adjacent streets. Equip gates with locks and keys.
 - .4 Erect and maintain pedestrian walkways including roof and side covers, complete with signs and electrical lighting as required by law.
 - .5 Paint public side of site enclosure in selected colours with one coat primer and one coat exterior paint. Maintain public side of enclosure in clean condition.
 - .6 Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.
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- .7 All access points required through the temporary barrier will be complete with a locking system which uses a master key system. Refer to item 9 below.
- .8 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.
- .9 A master key system shall be used and a copy(s) of the key must be turned over the Departmental Representative who will give it to site security.

1.5 GUARD RAILS AND BARRICADES

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

1.6 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.

1.7 DUST TIGHT SCREENS

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

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 FIRE ROUTES

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

1.10 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.

1.11 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 REFERENCES

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

1.2 QUALITY

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

1.3 AVAILABILITY

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

1.4 STORAGE, HANDLING AND PROTECTION

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Store and mix paints in heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
- .8 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .9 Touch-up damaged factory finished surfaces to Departmental Representative's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

1.5 TRANSPORTATION

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

1.6 MANUFACTURER'S INSTRUCTIONS

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

1.7 QUALITY OF WORK

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

1.8 CO-ORDINATION

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

1.9 CONCEALMENT

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

1.10 REMEDIAL WORK

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

1.11 LOCATION OF FIXTURES

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

1.12 FASTENINGS

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

1.13 FASTENINGS - EQUIPMENT

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

1.14 PROTECTION OF WORK IN PROGRESS

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

1.15 EXISTING UTILITIES

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.
-

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

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

1.2 SURVEY REFERENCE POINTS

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

1.3 SURVEY REQUIREMENTS

- .1 Acceptable control points and bench marks are located on site. Coordinate with Departmental Representative and Geomatics.

1.4 EXISTING SERVICES

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

1.5 LOCATION OF EQUIPMENT AND FIXTURES

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

1.6 RECORDS

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

1.7 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit name and address of Surveyor to Departmental Representative.
- .2 On request of Departmental Representative, submit documentation to verify accuracy of field engineering work.
- .3 Submit certificate signed by surveyor certifying and noting those elevations and locations of completed Work that conform with Contract Documents.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

1.2 MATERIALS

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

1.3 PREPARATION

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

1.4 EXECUTION

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and/or 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 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, including that caused by Departmental Representative or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site.
- .3 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .4 Provide on-site 4 containers for collection of waste materials and debris.
- .5 Provide and use marked separate bins for recycling.
- .6 Dispose of waste materials and debris.
- .7 Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .8 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .9 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .10 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .11 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
 - .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
 - .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
 - .4 Remove waste products and debris including 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.
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- .6 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Clean and polish glass, hardware, wall tile, stainless steel, chrome, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
- .8 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, floors.
- .9 Clean lighting reflectors, lenses, and other lighting surfaces.
- .10 Vacuum clean and dust building interiors, behind grilles, louvres and screens.
- .11 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .12 Broom clean and wash exterior walks, steps and surfaces; rake clean other surfaces of grounds.
- .13 Remove dirt and other disfiguration from exterior surfaces.
- .14 Clean and sweep roofs.
- .15 Sweep and wash clean paved areas.
- .16 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .17 Clean roofs.
- .18 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and/or 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 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 60% 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.
 - .3 Submit a waste reduction workplan indicating the materials and quantities of material that will be recycled and diverted from landfill.
 - .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.
- Province: Ontario
Address: Ministry of Environment and Energy
135 St Clair Ave West
Toronto ON
M4V 1P5
Contact: (416) 323-4321
(800) 565-4923
Fax: (416) 323-4682
- Province: Ontario
Address: Environment Canada, Toronto ON
Contact: (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 Authorities having Jurisdiction have been submitted.
 - .5 Operation of systems have been demonstrated to Owner'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 – General Commissioning (Cx) 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, process flow, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: Manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format. Forward pdf, 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.

1.5 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project;
 - .2 Date of submission; names,
 - .3 Addresses, and telephone numbers of Contractor with name of responsible parties;
 - .4 Schedule of products and systems, indexed to content of volume.
-

- .5 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
- .6 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .7 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .8 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.
- .9 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 FINAL SURVEY

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

1.9 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.

1.10 MATERIALS AND FINISHES

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

1.11 SPARE PARTS

- .1 Provide spare parts, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to site place and store.
- .4 Receive and catalogue 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 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 site; 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.

1.13 SPECIAL TOOLS

- .1 Provide special tools, in quantities specified in individual specification section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to site; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.

1.14 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.

1.15 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 Owner'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 Owner's O&M personnel.
- .2 O&M personnel includes property facility manager, building operators, maintenance staff, security staff and technical specialists, as applicable.

1.2 DESCRIPTION

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to Departmental Representative's personnel two weeks prior to date of final inspection.
- .2 Departmental Representative will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

1.3 RELATED SECTIONS

- .1 Section 23 09 33 - Electric And Electronic Control System For HVAC
- .2 Section 23 73 11 - Air Handling Units – Packaged
- .3 Section 23 74 00 - Packaged Outdoor HVAC Equipment
- .4 Section 26 05 00 - Common Work Results For Electrical

1.4 QUALITY CONTROL

- .1 When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner'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.

1.5 CONDITIONS FOR DEMONSTRATIONS

- .1 Equipment has been inspected and put into operation in accordance with Sections 23 73 11 and 23 74 00.
- .2 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 13 and equipment and systems are fully operational.
- .3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

1.6 PREPARATION

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated O&M personnel are present.

1.7 DEMONSTRATION AND INSTRUCTIONS

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

1.8 TIME ALLOCATED FOR INSTRUCTIONS

- .1 Ensure amount of time required for instruction of each item of equipment or system as follows:
-

- .1 Sections 23 73 11 and 23 74 00 - Cooling and Ventilation System: 32 hours of instruction.
- .2 Section 23 09 33 - Control System: 8 hours of instruction.
- .3 Section 26 05 00 - Electrical System: 4 hours of instruction.

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

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

1.3 COMMISSIONING OVERVIEW

- .1 For Cx responsibilities refer to Section 01 91 31.
- .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 facility is constructed and proven to operate satisfactorily under weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities include transfer of critical knowledge to facility operational personnel.
- .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.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
-

- .1 Review contract documents, confirm by writing to Departmental Representative.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems, systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Departmental Representative.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.
 - .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
 - .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

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

1.7 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 Refer to Section 01 91 33.
- .2 Departmental Representative to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to Departmental Representative.

1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16.07.
- .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 16.07 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, 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.
- .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 required 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 Substantial Performance.

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 COMMISSIONING CONSTRAINTS

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

1.24 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.

1.25 EXTENT OF VERIFICATION

- .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.
-

1.26 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.

1.27 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.

1.28 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.

1.29 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 Certificate of Substantial Performance.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted to and accepted by Departmental Representative.

1.30 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 TRAINING

- .1 In accordance with Section 01 91 41.

1.32 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.33 OCCUPANCY

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

1.34 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.

1.35 PERFORMANCE VERIFICATION TOLERANCES

- .1 Application tolerances:
 - .2 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.
-

1.36 OWNER'S PERFORMANCE TESTING

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 REFERENCES

- .1 Public Works and Government Services Canada (PWGSC)
 - .1 PWGSC - Commissioning Guidelines CP.4 -3rd edition-03.
- .2 Underwriters' Laboratories of Canada (ULC)

1.3 GENERAL

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

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

1.4 DEVELOPMENT OF 100% CX PLAN

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

1.5 REFINEMENT OF CX PLAN

- .1 During construction phase, revise, refine and update Cx Plan to include:
 - .1 Changes resulting from Client program modifications.
 - .2 Approved design and construction changes.
 - .2 Revise, refine and update every 6 weeks during construction phase. At each revision, indicate revision number and date.
 - .3 Submit each revised Cx Plan to Departmental Representative for review and obtain written approval.
 - .4 Include testing parameters at full range of operating conditions and check responses of equipment and systems.
-

1.6 COMPOSITION, ROLES AND RESPONSIBILITIES OF CX TEAM

- .1 Departmental Representative to maintain overall responsibility for project and is sole point of contact between members of commissioning team.
- .2 Project Manager will select Cx Team consisting of following members:
 - .1 PWGSC Design Quality Review Team: during construction, will conduct periodic site reviews to observe general progress.
 - .2 Departmental Representative is responsible for:
 - .1 Monitoring operations and Cx activities.
 - .2 Witnessing, certifying accuracy of reported results.
 - .3 Witnessing and certifying TAB and other tests.
 - .4 Ensuring implementation of final Cx Plan.
 - .5 Performing verification of performance of installed systems and equipment.
 - .6 Implementation of Training Plan.
 - .7 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .8 Review of Cx documentation from operational perspective.
 - .9 Protection of health, safety and comfort of occupants and O M personnel.
 - .3 Construction Team: contractor, sub-contractors, suppliers and support disciplines, is responsible for construction/installation in accordance with contract documents, including:
 - .1 Organizing Cx.
 - .2 Testing.
 - .3 TAB.
 - .4 Performance of Cx activities.
 - .5 Delivery of training and Cx documentation.
 - .6 Assigning one person as point of contact with Departmental Representative and PWGSC Cx Manager for administrative and coordination purposes.
 - .7 Monitoring of Cx activities, training, development of Cx documentation.
 - .4 Contractor's Cx agent implements specified Cx activities including:
 - .1 Demonstrations.
 - .2 Training.
 - .3 Testing.
 - .4 Preparation, submission of test reports.
 - .5 Property Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving facility.

- .2 Day-To-Day operation and maintenance of facility.

1.7 CX PARTICIPANTS

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

1.8 EXTENT OF CX

- .1 Cx Structural and Architectural Systems:
 - .1 Architectural and structural:
 - .1 Exterior systems:
 - .1 Slab under AHU-WW26-01
 - .2 Accessibility and operational safety:
 - .1 Fence around AHU-WW26-1

- .2 Commission mechanical systems and associated equipment:
 - .1 HVAC and exhaust systems:
 - .1 HVAC systems AHU-WW26-1 and 2
 - .2 HVAC systems AHU-WW27-1 to 5
 - .3 HVAC systems AC-WW26-1
 - .2 Noise and vibration control systems for mechanical systems.
 - .1 HVAC systems AHU-WW27-1 to AHU-WW27-5
 - .2 HVAC systems AHU-WW26-1 and 2
 - .3 HVAC systems AC-WW26-1
 - .3 Seismic restraint and control measures.
 - .1 HVAC systems AHU-WW27-1 to AHU-WW27-5
 - .2 HVAC systems AHU-WW26-1 and 2
 - .3 HVAC systems AC-WW26-1
- .3 Commission electrical systems and equipment:
 - .1 Low voltage below 750 V:
 - .1 Low voltage equipment.
 - .2 Low voltage distribution systems.

1.9 DELIVERABLES RELATING TO O M PERSPECTIVES

- .1 General requirements:
 - .1 Compile English documentation.
 - .2 Documentation to be computer-compatible format ready for inputting for data management.
- .2 Provide deliverables:
 - .1 Warranties.
 - .2 Project record documentation.
 - .3 Inventory of spare parts, special tools and maintenance materials.
 - .4 Maintenance Management System (MMS) identification system used.
 - .5 WHMIS information.
 - .6 MSDS data sheets.
 - .7 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.10 DELIVERABLES RELATING TO THE CX PROCESS

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

- .2 Definitions:
 - .1 Cx as used in this section includes:
 - .1 Cx of components, equipment, systems, subsystems, and integrated systems.
 - .2 Factory inspections and performance verification tests.
 - .3 Deliverables: provide:
 - .1 Cx Specifications.
 - .2 Startup, pre-Cx activities and documentation for systems, and equipment.
 - .3 Completed installation checklists (ICL).
 - .4 Completed product information (PI) report forms.
 - .5 Completed performance verification (PV) report forms.
 - .6 Results of Performance Verification Tests and Inspections.
 - .7 Description of Cx activities and documentation.
 - .8 Description of Cx of integrated systems and documentation.
 - .9 Training Plans.
 - .10 Cx Reports.
 - .11 Prescribed activities during warranty period.
 - .4 Departmental Representative to witness and certify tests and reports of results provided to Departmental Representative.

1.11 PRE-CX ACTIVITIES AND RELATED DOCUMENTATION

- .1 Items listed in this Cx Plan include the following:
 - .1 Pre-Start-Up inspections: by Contractor prior to permission to start up and rectification of deficiencies to Departmental Representative's satisfaction.
 - .2 Contractor to use approved check lists.
 - .3 Departmental Representative will monitor all of these pre-start-up inspections.
 - .4 Include completed documentation with Cx report.
 - .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed by Departmental Representative and does not form part of Cx specifications.
 - .6 Departmental Representative will monitor some of these inspections and tests.
 - .7 Include completed documentation in Cx report.
- .2 Pre-Cx activities - ARCHITECTURAL AND STRUCTURAL:
 - .1 Slab and beam deflection test: test after removal of temporary supports and concrete has cured to ensure adequacy for raised floors.
- .3 Pre-Cx activities - MECHANICAL:

- .1 HVAC equipment and systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 At this time, complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
 - .4 Perform TAB on systems. TAB reports to be received by Departmental Representative.
- .2 EMCS:
 - .1 EMCS trending to be available as supporting documentation for performance verification.
 - .2 Perform point-by-point testing in parallel with start-up.
 - .3 Carry out point-by-point verification.
 - .4 Demonstrate performance of systems, to be witnessed by Departmental Representative prior to start of 30 day Final Acceptance Test period.
 - .5 Perform final Cx and operational tests during demonstration period and 30 day test period.
 - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
- 4 Pre-Cx activities - ELECTRICAL:
 - .1 Low voltage distribution systems under 750 V:
 - .1 Requires independent testing agency to perform pre- energization and post-energization tests.

1.12 START-UP

- .1 Start up components, equipment and systems.
- .2 Equipment manufacturer, supplier, installing specialist sub-contractor, as appropriate, to start-up, under Contractor's direction, following equipment, systems:
 - .1 HVAC systems AHU-WW27-1 to AHU-WW27-5
 - .2 HVAC systems AHU-WW26-1 and 2
 - .3 HVAC systems AC-WW26-1
- .3 Departmental Representative to monitor some of these start-up activities.
 - .1 Rectify start-up deficiencies to satisfaction of Departmental Representative.
- .4 Performance Verification (PV):
 - .1 Approved Cx Agent to perform.
 - .1 Repeat when necessary until results are acceptable to Departmental Representative.

- .2 Use procedures modified generic procedures to suit project requirements.
- .3 Departmental Representative to witness and review reported results using approved PI and PV forms.
- .4 Contractor to provide completed PV reports to Departmental Representative for review.
- .5 Departmental Representative reserves right to verify up to 30% of reported results at random.
- .6 Failure of randomly selected item shall result in rejection of PV report or report of system startup and testing.

1.13 CX ACTIVITIES AND RELATED DOCUMENTATION

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

1.14 CX OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION

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

1.15 INSTALLATION CHECK LISTS (ICL)

- .1 Refer to Section 01 91 33.

1.16 PRODUCT INFORMATION (PI) REPORT FORMS

- .1 Refer to Section 01 91 33.

1.17 PERFORMANCE VERIFICATION (PV) REPORT

- .1 Refer to Section 01 91 33.

1.18 DELIVERABLES RELATING TO ADMINISTRATION OF CX

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

1.19 CX SCHEDULES

- .1 Prepare detailed critical path Cx Schedule and submit to Departmental Representative for review and approval same time as project Construction Schedule. Include:
 - .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
 - .1 Design criteria, design intents.
 - .2 Pre-TAB review: 28 days after contract award, and before construction starts.
 - .3 Cx agents' credentials: 60 days before start of Cx.
 - .4 Cx procedures: 3 months after award of contract.
 - .5 Cx Report format: 3 months after contract award.
 - .6 Discussion of heating/cooling loads for Cx: 3 months before start-up.
 - .7 Submission of list of instrumentation with relevant certificates: 21 days before start of Cx.
 - .8 Notification of intention to start TAB: 21 days before start of TAB.
 - .9 TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
 - .10 Notification of intention to start Cx: 14 days before start of Cx.
 - .11 Notification of intention to start Cx of integrated systems: after Cx of related systems is completed 14 days before start of integrated system Cx.
 - .12 Identification of deferred Cx.

- .13 Implementation of training plans.
- .14 Cx reports: immediately upon successful completion of Cx.
- .2 Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over to Departmental Representative.
- .3 6 months in Cx schedule for verification of performance in all seasons and wear conditions.
- .2 After approval, incorporate Cx Schedule into Construction Schedule.
- .3 Contractor, Contractor's Cx agent, and Departmental Representative will monitor progress of Cx against this schedule.

1.20 CX REPORTS

- .1 Submit reports of tests, witnessed by Departmental Representative to Departmental Representative who will verify reported results.
- .2 Include completed and certified PV reports in properly formatted Cx Reports.
- .3 Before reports are accepted, reported results to be subject to verification by Departmental Representative.

1.21 ACTIVITIES DURING WARRANTY PERIOD

- .1 Cx activities must be completed before issuance of Certificate of Substantial Performance, it is anticipated that certain Cx activities may be necessary during Warranty Period, including:
 - .1 Fine tuning of HVAC systems.
 - .2 Adjustment of ventilation rates to promote good indoor air quality and reduce deleterious effects of VOCs generated by off-gassing from construction materials and furnishings.
 - .3 Full-scale emergency evacuation exercises.

1.22 TESTS TO BE PERFORMED BY OWNER/USER

- .1 None is anticipated on this project.

1.23 TRAINING PLANS

- .1 Refer to Section 01 91 41.

1.24 FINAL SETTINGS

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

PART 2 - PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.

1.2 INSTALLATION/START-UP CHECK LISTS

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

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

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

1.4 PERFORMANCE VERIFICATION (PV) FORMS

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

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

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

1.5 SAMPLES OF COMMISSIONING FORMS

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

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, develop appropriate verification forms and submit to Departmental Representative for approval prior to use.

1.7 COMMISSIONING FORMS

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

- .10 Reported results in true measured SI unit values.
- .11 Provide Departmental Representative with originals of completed forms.
- .12 Maintain copy on site during start-up, testing and commissioning period.

1.8 LANGUAGE

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 TRAINEES

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

1.3 INSTRUCTORS

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

1.4 TRAINING OBJECTIVES

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

1.5 TRAINING MATERIALS

- .1 Instructors to be responsible for content and quality.
- .2 Training materials to include:
 - .1 "As-Built" Contract Documents.
 - .2 Operating Manual.
 - .3 Maintenance Manual.
 - .4 Management Manual.
 - .5 TAB and PV Reports.
- .3 Project Manager, Commissioning Manager and Facility Manager will review training manuals.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.
- .5 Supplement training materials:
 - .1 Transparencies for overhead projectors.
 - .2 Multimedia presentations.
 - .3 Manufacturer's training videos.
 - .4 Equipment models.

1.6 SCHEDULING

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

1.7 RESPONSIBILITIES

- .1 Be responsible for:
 - .1 Implementation of training activities,
 - .2 Coordination among instructors,
 - .3 Quality of training, training materials,
- .2 Departmental Representative will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Departmental Representative.

1.8 TRAINING CONTENT

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

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

1.9 VIDEO-BASED TRAINING

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

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Before proceeding with demolition of load bearing walls or other walls and where required by authority having jurisdiction submit for review by Departmental Representative, shoring and underpinning drawings prepared by qualified professional registered or licensed in the Province of Ontario, showing proposed method.
- .3 Prior to beginning of Work on site submit detailed Waste Reduction Workplan in accordance with Section 01 74 20 and indicate:
 - .1 Schedule of selective demolition.
 - .2 Number and location of dumpsters.
 - .3 Anticipated frequency of tipping.
 - .4 Name and address of waste receiving organizations.

1.2 SITE CONDITIONS

- .1 Review "Designated Substance Report" and take precautions to protect environment.
- .2 If material resembling spray or trowel-applied asbestos or other designated substance listed as hazardous be encountered, stop work, take preventative measures, and notify Departmental Representative immediately.
 - .1 Proceed only after receipt of written instructions have been received from Departmental Representative.
- .3 Notify Departmental Representative before disrupting building access or services.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.
-

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Inspect building and 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.
- .4 Disconnect, cap, plug or divert, as required, existing public utilities within the property where they interfere with the execution of the work, in conformity with the requirements of the authorities having jurisdiction. Mark the location of these and previously capped or plugged services on the site and indicate location (horizontal and vertical) on the record drawings. Support, shore up and maintain pipes and conduits encountered.
 - .1 Immediately notify Departmental Representative and utility company concerned in case of damage to any utility or service, designated to remain in place.
 - .2 Immediately notify the Departmental Representative should uncharted utility or service be encountered, and await instruction in writing regarding remedial action.

3.2 PROTECTION

- .1 Prevent movement, settlement, or damage to adjacent structures, utilities, landscaping features and parts of building to remain in place. Provide bracing and shoring as required.
- .2 Keep noise, dust, and inconvenience to occupants to minimum.
- .3 Protect building systems, services and equipment.
- .4 Provide temporary dust screens, covers, railings, supports and other protection as required.

3.3 PREPARATION

- .1 Protection of In-Place Conditions:
 - .1 Prevent movement, settlement, or damage to adjacent structures, utilities, landscaping features and parts of building to remain in place. Provide bracing and shoring required.
 - .2 Keep noise, dust, and inconvenience to occupants to minimum.
 - .3 Protect building systems, services and equipment.
-

- .4 Provide temporary dust screens, covers, railings, supports and other protection as required.
- .5 Do Work in accordance with Section 01 35 29.
- .2 Demolition/Removal:
 - .1 Remove items as indicated.
 - .2 Remove parts of existing building to permit new construction.
 - .3 Trim edges of partially demolished building elements to tolerances as defined by Departmental Representative to suit future use.

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.
- .3 Refer to demolition drawings and specifications for items to be salvaged for reuse.
- .4 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 REQUIREMENTS

- .1 Section 03 35 00 – Concrete Finishing.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International), last edition.
 - .1 CSA A23.1-14/A23.2-14, Concrete materials and methods of concrete construction/Test methods 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 O153-13, Poplar Plywood.
 - .6 CSA O437 Series-93(R2011), Standards for OSB and Waferboard.
 - .7 CAN/CSA-S269.3-M92(R2013), Concrete Formwork.
- .2 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings for formwork and falsework.
 - .1 Provide submittals in accordance with Section 01 33 00
 - .2 Submit drawings stamped and signed by professional engineer licensed in Ontario.
 - .2 Design the falsework according to trade practices making sure not to exert abnormal stress on the structure under construction.
 - .3 For vertical components, vertical construction joints shall be a maximum of 18 m apart. Submit the location of construction joints to the Departmental Representative.
 - .4 The formworks are engineered to sustain the loads and lateral pressures described in Section 102 of the American publication "Recommended Practice for Concrete Formwork" (ACI 347). Wind loads are those recommended by the latest edition of the National Building Code of Canada NBCC.
 - .5 The specialized Contractor is entirely responsible for engineering, locating and building the formworks.
 - .6 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts.
-

- .7 Comply with CAN/CSA-S269.3 for formwork drawings.
- .8 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete in forms.
- .9 Indicate sequence of erection and removal of formwork/falsework as directed by Departmental Representative.
- .10 Submit WHMIS MSDS - Material Safety Data Sheets.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Store and manage hazardous materials.
- .2 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling.
 - .2 Place materials defined as hazardous or toxic in designated containers.
 - .3 Divert wood materials from landfill to a recycling, reuse or composting facility as approved by Departmental Representative.
 - .4 Divert plastic materials from landfill to a recycling or reuse facility as approved by Departmental Representative.
 - .5 Divert unused form release material from landfill to an official hazardous material collections site as approved by the Departmental Representative.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Do verification requirements in accordance with Sustainable Requirements: Contractor's Verification.
- .2 Formwork materials:
 - .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA O121, CAN/CSA O86, CSA O437 Series and CSA O153 standards.
 - .2 For concrete with special architectural features, use formwork materials to CSA A23.1/A23.2.
 - .3 Rigid insulation board: to CAN/ULC-S701.
- .3 Tubular column forms: round, spirally wound laminated fibre forms, internally treated with release material.
- .4 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.
- .5 Form liner:
 - .1 Plywood: Douglas Fir to CSA O121, Canadian Softwood Plywood to CSA O151, Poplar to CSA O153.

- .2 Waferboard: to CSA O437 Series-93(R2011).
- .6 Form release agent: non-toxic, biodegradable, and low VOC content of 350g/L.
- .7 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 15 to 24 mm²/s at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
- .8 Sleeves, fasteners, anchors and other parts embedded in concrete shall meet the requirements of the drawings and specifications, and comply with Sections 6.2 and 6.7 of the CSA A23.1/A23.2.
- .9 Sleeves embedded in concrete shall be equipped with a steel water barrier able to withstand a minimum of 60 kPa of hydrostatic pressure or the pressure in the line if it is greater.
- .10 Use mortar to fill all cone-shaped cavities left after removal of the plastic cones at the ends of the form ties.

PART 3 - EXECUTION

3.1 FABRICATION AND ERECTION

- .1 Verify lines, levels and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.
 - .2 Obtain Departmental Representative's approval for use of earth forms framing openings not indicated on drawings.
 - .3 Hand trim sides and bottoms and remove loose earth from earth forms before placing concrete.
 - .4 Fabricate and erect falsework in accordance with CSA S269.1.
 - .5 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
 - .6 Do not place shores and mud sills on frozen ground.
 - .7 Provide site drainage to prevent washout of soil supporting mud sills and shores.
 - .8 Fabricate and erect formwork in accordance with CAN/CSA-S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.
 - .9 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
 - .10 Use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners, joints, unless specified otherwise.
 - .11 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
 - .12 Construct forms for architectural concrete, and place ties as indicated.
 - .1 Joint pattern not necessarily based on using standard size panels or maximum permissible spacing of ties.
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- .13 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
 - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .14 Line forms for following surfaces:
 - .1 Secure lining taut to formwork to prevent folds.
 - .2 Pull down lining over edges of formwork panels.
 - .3 Ensure lining is new and not reused material.
 - .4 Ensure lining is dry and free of oil when concrete is poured.
 - .5 Application of form release agents on formwork surface is prohibited where drainage lining is used.
 - .6 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.
- .15 The footings and supports installed on the ground shall not be assembled on a frozen surface.
- .16 Design lot drainage to prevent the ground from being washed away from under the footings and the supports installed at ground level.
- .17 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.

3.2 ANCHORS, SLEEVES AND EMBEDDED PARTS

- .1 Provide and install the sleeves, fasteners, anchor plates and other embedded components required in the drawings and/or specifications, in compliance with Section 6.7 of the CSA A23.1/A23.2 standard. The work shall comply with Section 03 35 00.
- .2 Provide and install the anchor bolts for fasteners and machinery as shown and detailed in the drawings, in compliance with Section 6.7 of the CSA A23.1/A23.2 standard.
- .3 Install the sleeves, conduits and ducts provided by others at the levels and locations shown on the mechanical, electrical, procedural and architectural drawings.
- .4 In all cases, comply with the installation tolerances specified in CSA A23.1/A23.2 standard.
- .5 Install sleeves, conduits and ducts in compliance with the following requirements:
 - .1 The exterior diameter of the sleeves, conduits or ducts shall not exceed one third of the thickness of the beams, slabs or walls in which they are embedded;
 - .2 The centreline between adjacent components must be greater than or equal to three diameters;
 - .3 These parts shall not be positioned in a manner that reduces the strength of the structure;

- .4 These parts shall not be embedded in ground slabs exposed to the weather;
- .6 Make sure aluminum sleeves, conduits or ducts embedded in concrete are covered or adequately coated to protect them against aluminum corrosion.
- .7 Submit a sleeve location plan for approval by the Departmental Representative.

3.3 REMOVAL AND RESHORING

- .1 Remove the formwork and dismantle the falsework in compliance with Article 6.5.3.5 of the CSA-A23.1/A23.2 standard, unless otherwise indicated.
- .2 Leave formwork in place for following minimum periods of time after placing concrete.
 - .1 7 days for sides of beams.
 - .2 28 days for beam soffits, slabs, decks and other structural members, or 7 days when replaced immediately with adequate shoring to standard specified for falsework.
- .3 The periods of time specified above represent a cumulative number of hours, days or fractions of days, not necessarily consecutive, during which the ambient temperature is maintained above 10°C.
- .4 Remove formwork when concrete has reached 80% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .5 Depending on weather conditions, the placement of the concrete and curing conditions, the Departmental Representative may specify a minimum period of time that must elapse before the forms are removed from the various pours.
- .6 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .7 Space reshoring in each principal direction at not more than 2400 mm apart.
- .8 Re-use formwork and falsework subject to requirements of CSA A23.1/A23.2.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 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-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 ASTM A123/A123M-13, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
 - .6 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, most recent addition.
- .3 National Building Code of Canada 2010.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and SP-66.
- .2 Shop Drawings:
 - .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Submit drawings stamped and signed by professional engineer registered and licensed in Ontario, so the Departmental Representative has at least ten (10) working days to examine and comment on the shop drawings, which are submitted at each phase of the concrete work. Shop drawings to include the following:
 - .1 Bar bending details;
 - .2 Lists;
 - .3 Quantities of reinforcement;
 - .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by Departmental Representative, with identifying code marks to permit correct placement without reference to structural drawings.
 - .5 Indicate sizes, spacings and locations of chairs, spacers and hangers

- .6 Drawings should indicate type of tension lap splice. (Type A, B or C).
- .3 Detail lap lengths and bar development lengths to CAN/CSA-A23.3, unless otherwise indicated.
 - .1 Provide type C tension lap splices where indicated unless otherwise indicated.
- .3 Unless otherwise indicated in the drawings, the hooks required at the end of certain bars, including hangers, ties and spirals are all "standard hooks", which shall comply with the description provided in Articles 6.6.2 of the CAN/CSA A23.1/A23.2 standard.

1.3 QUALITY ASSURANCE

- .1 Submit in accordance with PART 2 - SOURCE QUALITY CONTROL.
 - .1 Mill Test Report: Upon request, provide Departmental Representative with certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .2 Upon request, submit in writing to Departmental Representative proposed source of reinforcement material to be supplied.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

Description	Standards
<ul style="list-style-type: none"> ▪ High adherence billet-steel reinforcement bars, regular category (R) 	CSA G30.18 Grade 400 unless indicated otherwise
<ul style="list-style-type: none"> ▪ Weldable high adherence steel reinforcement bars made of low alloy weldable steel, weldable category (W) 	CSA G30.18 Grade 400
<ul style="list-style-type: none"> ▪ Tie wire, Cold-drawn annealed steel wire ties, Deformed steel wire for concrete reinforcement 	CSA G30.3 and ASTM A82/A82M
<ul style="list-style-type: none"> ▪ High adherence steel wire for concrete reinforcement, 16 gauge 	CSA G30.14
<ul style="list-style-type: none"> ▪ Welded steel wire fabric provided in flat sheets only 	ASTM A185/A185M
<ul style="list-style-type: none"> ▪ Non-prestressed galvanized reinforcement 	ASTM A123/A123M-13 . Use Coating Grade 60
<ul style="list-style-type: none"> ▪ Chairs, bar chairs, bar supports, spacers (rustproof), bolster 	CSA A23.1/A23.2
<ul style="list-style-type: none"> ▪ Welded deformed steel wire fabric 	ASTM A82/A82M
<ul style="list-style-type: none"> ▪ GFRP Glass Fibre Reinforced Polymer 	CAN/CSA – S806-02
<ul style="list-style-type: none"> ▪ Mechanical Splices 	To Departmental Representative Approval
<ul style="list-style-type: none"> ▪ Plain round bars 	To CSA G40.20/G40.21

- .1 Substitute different size bars only if permitted in writing by Departmental Representative.
- .2 Galvanizing of non-prestressed reinforcement: to ASTM A123/A123M-13 , minimum zinc coating 610 g/m².
 - .1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.
 - .2 If chromate treatment is carried out immediately after galvanizing, soak steel in aqueous solution containing minimum 0.2% by weight sodium dichromate or 0.2% chromic acid.
 - .1 Temperature of solution equal to or greater than 32 degrees and galvanized steels immersed for minimum 20 seconds.

- .3 If galvanized steels are at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.
 - .1 In this case, no restriction applies to temperature of solution.
- .4 Chromate solution sold for this purpose may replace solution described above, provided it is of equivalent effectiveness.
 - .1 Provide product description as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with CSA A23.1/A23.2 and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada, SP-66 unless indicated otherwise.
- .2 Obtain Departmental Representative's written approval for locations of reinforcement splices other than those shown on structural drawings.
- .3 Upon approval of Departmental Representative, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement clearly identified, in accordance with bar bending details and lists. Ship epoxy coated bars in accordance with ASTM A775A/A775M

2.3 SOURCE QUALITY CONTROL

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

PART 3 - EXECUTION

3.1 PREPARATION

- .1 Galvanizing to include chromate treatment.
 - .1 Duration of treatment to be 1 hour per 25 mm of bar diameter.
 - .2 Conduct bending tests to verify galvanized bar fragility in accordance with ASTM A143/A143M.
 - .3 Manufacturing of the reinforcement shall not start until the Departmental Representative has reviewed and approved in writing the submitted shop drawings of this reinforcement.
 - .4 Cut and bend the bar in strict compliance with the details shown on the drawings and in accordance with the requirements of the CSA A23.1/A23.2 standard.
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- .5 No substitution of the bars shown on the reinforcement drawing shall be allowed without the Departmental Representative's authorization.
- .6 Take all precaution to avoid deforming or dirtying the reinforcement during transportation, handling and storage.

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 design drawings and in accordance with CSA A23.1/A23.2.
- .2 Prior to the placing of concrete, the condition of the reinforcement bars shall comply with Section 6.1.5 of the CAN/CSA A23.1/A23.2 standard.
- .3 If required, clean the reinforcement immediately before the concrete is poured.
- .4 Tie rebar with black annealed drawn steel wire. Use a pattern and number of supports that comply with Section 6.6.7 of the CAN/CSA A23.1/A23.2 standard.
- .5 Use an adequate number of support bars of the height and rigidity required to ensure all concrete coverage of the rebar complies with the thicknesses stipulated on the drawings and in the standards.
- .6 Use plain round bars as slip dowels in concrete.
 - .1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.
 - .2 When paint is dry, apply thick even film of mineral lubricating grease.
- .7 Prior to placing concrete, obtain Departmental Representative's approval of reinforcing material and placement. The Departmental Representative shall have minimum 48 hours to approve the steel reinforcement before the concrete is poured.
- .8 Ensure cover to reinforcement is maintained during concrete pour.

3.4 OVERLAP

- .1 Overlap the reinforcement as indicated on the drawings and typical details.
 - .2 Overlap lengths and extension lengths of bars beyond critical points shall comply with the CSA A23.3 standard. Unless otherwise indicated on the drawings, all overlaps shall be Class B (1.3 Lc), in compliance with Table 17b: overlapping
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requirements for upper reinforcement in the Reinforcing Steel Institute of Canada's manual of standard practice.

- .3 Obtain the Departmental Representative's approval for the locations of reinforcement overlaps other than those shown on the drawings.
- .4 Overlap at least 10% of the surface of the wire fabric sheets, but never less than one mesh width.

3.5 WELDING

- .1 Do not weld steel rebar without the Departmental Representative's written authorization.
- .2 Where permitted by the Departmental Representative, perform the welding work in compliance with Section 6.6.10 of the CAN/CSA A23.1/A23.2 standard and the requirements of the CSA W186 standard. When welding is performed, the use of category W weldable bars is mandatory.
- .3 All welding work shall be assigned to a company accredited by the Canadian Welding Bureau and shall be performed in compliance with the requirements of the most recent version of the CSA W186 standard. Prior to starting any welding work, submit to the Departmental Representative for verification, all details regarding the welds to be performed. In this case, the steel reinforcement to be welded shall comply with the requirements of the most recent version of the CSA G30.16 standard. Pre-heat all steel reinforcement as required by these standards.

3.6 FIELD TOUCH-UP

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

3.7 REINFORCEMENT DOWELING

- .1 The installation of reinforcement dowels in hardened concrete shall be performed using adhesive type anchors based system.

3.8 CLEANING

- .1 Progress Cleaning:
 - .1 Leave work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 03 10 00 – Concrete Forming and Accessories.

1.2 REFERENCES

- .1 Abbreviations and Acronyms:
 - .1 Portland Cement: hydraulic cement, blended hydraulic cement (XXb - b denotes blended) and Portland-limestone cement.
 - .1 Type GU, GUb and GUL - General use cement.
 - .2 Type MS and MSb - Moderate sulphate-resistant cement.
 - .3 Type MH, MHb and MHL - Moderate heat of hydration cement.
 - .4 Type HE, HEb and HEL - High early-strength cement.
 - .5 Type LH, LHb and LHL - Low heat of hydration cement.
 - .6 Type HS and HSb - High sulphate-resistant cement.
 - .2 Fly ash:
 - .1 Type F - with CaO content less than 15%.
 - .2 Type CI - with CaO content ranging from 15 to 20%.
 - .3 Type CH - with CaO greater than 20%.
 - .3 GGBFS - Ground, granulated blast-furnace slag.
- .2 Reference Standards:
 - .1 ASTM International
 - .1 ASTM C260/C260M-10a, Standard Specification for Air-Entraining Admixtures for Concrete.
 - .2 ASTM C494/C494M-13, Standard Specification for Chemical Admixtures for Concrete..
 - .3 ASTM C1017/C1017M-13e1, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - .4 ASTM D1751-04(2013)e1, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .5 ASTM D1752-04a(2013), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
 - .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34 - M86 (R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
 - .3 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.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 At least four (4) weeks prior to beginning Work, provide Departmental Representative with samples of materials proposed for use as follows: except otherwise mentioned
 - .1 5 L of curing compound.
 - .2 1 m length of each type of joint filler.
 - .3 1 m length of each type of waterstops.
 - .4 3 kg of each type of supplementary cementing material.
 - .5 10 kg of each type of blended hydraulic cement.
 - .6 5 kg of each admixture.
 - .7 10 kg of each fine and coarse aggregate.
- .3 Provide testing results and reports for review by Departmental Representative and do not proceed without written approval when deviations from mix design or parameters are found.
- .4 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.
- .5 Concrete hauling time: provide for review by Departmental Representative deviations exceeding maximum allowable time of 120 minutes for concrete to be prepared or delivered to site of Work and discharged after batching.

1.4 QUALITY ASSURANCE

- .1 Provide Departmental Representative, minimum 3 weeks prior to starting concrete work, with valid and recognized 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.
- .2 Minimum 4 weeks prior to starting concrete work, provide proposed quality control procedures for review by Departmental Representative on following items:
 - .1 Falsework erection.
 - .2 Hot weather concrete.

- .3 Cold weather concrete.
- .4 Curing.
- .5 Finishes.
- .6 Formwork removal
- .7 Joints.
- .3 Quality Control Plan: provide written report to Departmental Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
 - .1 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.
 - .1 Do not modify maximum time limit without receipt of prior written agreement from Departmental Representative, laboratory representative and concrete producer as described in CSA A23.1/A23.2.
 - .2 Deviations to be submitted for review by Departmental Representative.
 - .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
- .2 Packaging Waste Management: remove for reuse in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

- .1 Alternative 1 - Performance: to CSA A23.1/A23.2, and as described in MIXES of PART 2 - PRODUCTS.

2.2 PERFORMANCE CRITERIA AND MATERIALS

- .1 Quality Control Plan: ensure concrete supplied meets performance criteria of concrete as established by Departmental Representative and provide verification of compliance as described in PART 1 - QUALITY ASSURANCE.
 - .2 Portland Cement: to CSA A3001, Type GU or MS.
 - .3 Supplementary cementing materials: with minimum 20% Type F fly ash replacement, by mass of total cementitious materials to CSA A3001.
 - .4 Water: to CSA A23.1.
 - .5 Aggregates: to CSA A23.1/A23.2.
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- .6 Admixtures:
 - .1 Air entraining admixture: to ASTM C260.
 - .2 Chemical admixture: to ASTM C494 and ASTM C1017. Departmental Representative shall approve accelerating or set retarding admixtures during cold and hot weather placing.
- .7 Shrinkage compensating grout: premixed compound consisting of non-metallic aggregate, Portland cement, water reducing and plasticizing agents to CSA A23.1/A23.2.
 - .1 Compressive strength: 50 MPa at 28 days.
- .8 Non-premixed dry pack grout: composition of non metallic aggregate Portland cement with sufficient water for mixture to retain its shape when made into ball by hand and capable of developing compressive strength of 50MPa at 28 days.
- .9 Curing compound: to CSA A23.1/A23.2.
- .10 Mechanical waterstops: Polyvinyl Chloride manufactured from virgin PVC resin with the addition of only those plasticisers, stabilizers, and other materials necessary to ensure aging stability and in-place durability.
- .11 Pre-moulded joint fillers:
 - .1 Bituminous impregnated fiber board: to ASTM D1751.
 - .2 Sponge rubber: to ASTM D1752, Type I, flexible grade.
 - .3 Standard cork: to ASTM D1752, Type II.
- .12 Damp proof membrane:
 - .1 Kraft/polyethylene membrane:
 - .1 Plain: 0.75 mm thick polyethylene film bonded to asphalt treated creped kraft.
 - .2 Reinforced: two 0.75 mm thick polyethylene films bonded each side of asphalt treated creped kraft paper, reinforced with 13 x 13 mm fibreglass scrim.
 - .3 Membrane adhesive: as recommended by membrane manufacturer.
- .13 Damp proofing:
 - .1 Emulsified asphalt, mineral colloid type, unfilled.
- .14 Polyethylene film: Shall be clear and conform to CAN/CGSB 51.34 and ASTM C171.
- .15 Bonding adhesive: Epoxy resin conforming to the requirements of ASTM C881.

2.3 MIXES

- .1 Alternative 1 - Performance Method for specifying concrete: to meet Departmental Representative performance criteria to CSA A23.1/A23.2.
-

- .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as in Quality Control Plan.
- .2 Provide concrete mix to meet following plastic state requirements:

Intended application: Footings and Foundations

- .1 Uniformity:
 - .1 Shall be checked using slump test
 - .2 Temperature test to ASTM C1064
 - .3 Unit weight test (density test for fresh concrete)
 - .4 Air entrainment test
 - .2 Desired on site Slump: 80 mm (± 20 mm)
 - .3 Workability: free of surface blemishes, loss of mortar, colour variations and segregation.
 - .4 Set time: 2 hours maximum.
- .3 Provide concrete mix to meet the following hard state requirements:
 - .1 Durability and class of exposure (Table 1, CSA-A23.1/A23.2): C-XL
 - .2 Compressive strength at 28 days of age: 35 MPa minimum.
 - .3 Aggregate size: 20 mm maximum.

Intended application: Slab on Grade

- .1 Uniformity:
 - .1 Shall be checked using slump test
 - .2 Temperature test to conform with ASTM C1064
 - .3 Unit weight test (density test for fresh concrete)
 - .4 Air entrainment test
 - .2 On-site anticipated slump test: 80 mm (± 20 mm)
 - .3 Workability: free of surface blemishes, loss of mortar, colour variations and segregation.
 - .4 Set time: 2 hours maximum.
- .4 Concrete mix to meet the following hard state requirements:
 - .1 Durability and class of exposure (Table 1, CSA A23.1/A23.2):C-XL
 - .2 Compressive strength at 28 days of age: 35 MPa minimum.
 - .3 Aggregate size: 20 mm maximum.
 - .5 Provide quality management plan to ensure verification of concrete quality to the specified performance.
 - .6 Concrete supplier's certification: both batch plant and materials shall meet CSA A23.1 requirements.
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PART 3 - EXECUTION

3.1 PREPARATION

- .1 Obtain Departmental Representative's written approval before placing concrete. Provide 24 hours minimum notice prior placing of concrete.
- .2 Place the concrete reinforcing in accordance with CSA A23.1/A23.2.
- .3 During concreting operations:
 - .1 Development of cold joints is not allowed.
 - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Pumping of concrete is permitted only after approval of equipment and mix.
- .5 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .6 Prior to placing of concrete, obtain Departmental Representative's approval for proposed method for protection of concrete during placing and curing.
- .7 Protect previous Work from staining.
- .8 Clean and remove stains prior to application for concrete finishes.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .10 In locations where new concrete is dowelled to existing work, drill holes in existing concrete.
 - .1 Place steel dowels of deformed steel reinforcing bars and pack solidly with shrinkage compensating grout or epoxy grout to anchor and hold dowels in positions as indicated.
- .11 Do not place load upon new concrete until authorized by Departmental Representative.

3.2 INSTALLATION/APPLICATION

- .1 Do cast-in-place concrete work to CSA A23.1/A23.2.
- .2 Sleeves and inserts:
 - .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through joists, beams, column capitals or columns, except where indicated or approved by Departmental Representative.

- .2 Where approved by Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .3 Sleeves and openings greater than 100 x 100 mm not indicated must be reviewed by Departmental Representative.
 - .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Departmental Representative before placing of concrete.
 - .5 Confirm locations and sizes of sleeves and openings shown on drawings or as directed by Departmental Representative.
 - .6 Set special inserts for strength testing as indicated and as required by non destructive method of testing concrete.
- .3 Anchor bolts:
- .1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.
 - .2 Grout anchor bolts in preformed holes or holes drilled after concrete has set only after receipt of written approval from Departmental Representative.

Formed holes: 100 mm minimum diameter.
 - .1 Drilled holes: 25mm minimum diameter larger than bolts used, or to manufacturers' recommendations.
 - .3 Protect anchor bolt holes from water accumulations, snow and ice build ups.
 - .4 Set bolts and fill holes with shrinkage compensating grout or epoxy grout.
 - .5 Locate anchor bolts used in connection with expansion shoes, rollers and rockers with due regard to ambient temperature at time of erection.
- .4 Drainage holes and weeps holes:
- .1 Form weep holes and drainage holes in accordance with Section 03 10 00. If wood forms are used, remove them after concrete has set.
 - .2 Install weep hole tubes and drains as indicated.
- .5 Dovetail anchor slots:
- .1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
 - .2 Install continuous vertical anchor slots at 800mm on centre where concrete walls are masonry faced.
- .6 Grout under base plates using procedures in accordance with manufacturer's recommendations which result in 100 % contact over grouted area.
- .7 Finishing and curing:
- .1 Finish concrete to CSA A23.1/A23.2.
-

- .2 Use procedures as reviewed by Departmental Representative and those noted in CSA A23.1/A23.2 to remove excess bleed water. Ensure surface is not damaged.
 - .3 Use curing compounds compatible with applied finish on concrete surfaces.
Formed Surfaces shall undergo the following curing schedule:
 - .1 Formwork left in place for three days.
 - .2 Moist curing after removal of the formwork for 4 days. Curing compound shall not be used.
 - .4 Unformed surfaces such as slabs shall be kept moist for a period of at least 4 days using burlap and water (two layers shall be pre-soaked by immersing it in water at least 24 hours prior to placing on concrete), or moist vapour barrier (placed within the first 12 hours of the placement of concrete, and air flow between the moisture vapour barrier and the concrete surface shall be prevented), or 7 days when using curing compounds (shall be applied immediately after finishing of concrete surface and according to the instructions of the manufacturer).
 - .5 Rub exposed sharp edges of concrete with carborundum to produce 3 mm minimum radius edges unless otherwise indicated.
 - .8 Waterstops:
 - .1 Install waterstops to provide continuous water seal.
 - .2 Do not distort or pierce waterstop in way as to hamper performance.
 - .3 Do not displace reinforcement when installing waterstops.
 - .4 Use equipment to manufacturer's requirements to field splice waterstops.
 - .5 Tie waterstops rigidly in place.
 - .6 Use only straight heat sealed butt joints in field.
 - .7 Use factory welded corners and intersections unless otherwise approved by Departmental Representative.
 - .9 Joint fillers:
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Departmental Representative.
 - .2 When more than one piece is required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
 - .3 Locate and form construction and expansion joints as indicated. Install joint filler.
 - .4 Use 12 mm thick joint filler to separate slabs on grade from vertical surfaces and extend joint filler from bottom of slab to within 12 mm of finished slab surface unless indicated otherwise.
 - .10 Dampproof membrane:
 - .1 Install dampproof membrane under concrete slabs-on-grade inside building.
 - .2 Lap dampproof membrane minimum 150mm at joints and seal.
-

- .3 Seal punctures in dampproof membrane before placing concrete.
- .4 Use patching material at least 150 mm larger than puncture and seal.

3.3 SURFACE TOLERANCE

- .1 Concrete tolerance to CSA A23.1 Straightedge Method FF = 50: FL = 30 Waviness Index Method to tolerance schedule as indicated.
- .2 Ensure smooth, continuous and uniform surfaces.

3.4 FIELD QUALITY CONTROL

- .1 Site tests: conduct tests as follows and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
 - .1 Concrete pours;
 - .2 Slump;
 - .3 Air content;
 - .4 Compressive strength at 7 and 28 days;
 - .5 Air and concrete temperature.
 - .2 Inspection and testing of concrete and concrete materials will be carried out by a testing laboratory designated by Departmental Representative for review to CSA A23.1/A23.2.
 - .1 Ensure testing laboratory is certified to CSA A283.
 - .3 Ensure test results are distributed for discussion at pre-pouring concrete meeting between testing laboratory and Departmental Representative.
 - .4 In hot weather the concrete shall be protected according to article 7.7.3.4.1 of the CAN/CSA A23.1/A23.2 standard. When the air temperature exceeds 28°C and the concrete temperature exceeds 25°C, the concrete delivered by means of agitator or truck mixers shall be discharged within 1 hour after the introduction of the mixing water.
 - .5 In cold weather the concrete shall be protected according to article 7.7.3.4.2 of the CAN/CSA A23.1/A23.2 standard. Excavations prepared for concreting and any existing concrete, reinforcing steel, structural steel, forms or other surfaces against which concrete will be placed, shall be at a minimum temperature of 5°C for a period of 12 h prior to commencement of placing concrete.
 - .6 Departmental Representative will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
 - .7 Non-Destructive Methods for Testing Concrete: to CSA A23.1/A23.2.
-

- .8 Inspection or testing by Departmental Representative will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

3.5 CLEANING

- .1 Waste Management: separate waste materials for reuse and recycling.
- .2 Divert unused concrete materials from landfill to local quarry after receipt of written approval from Departmental Representative.
- .3 Provide appropriate area on job site where concrete trucks and be safely washed.
- .4 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site as approved by Departmental Representative.
- .5 Do not dispose of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.
- .6 Prevent admixtures and additive materials from entering drinking water supplies or streams.
- .7 Using appropriate safety precautions collect liquid or solidify liquid with inert, non-combustible material and remove for disposal. Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-25.20-95, Surface Sealer for Floors.
- .2 CSA International
 - .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
- .3 ASTM International
 - .1 ASTM C1602/1602M-12, Standard Specification for Mixing Water used in the Production of Hydraulic Cement concrete.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for concrete finishes and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Provide three copies of WHMIS MSDS in accordance with Section 01 35 29. WHMIS MSDS acceptable to Labour Canada and Health and Welfare Canada for concrete floor treatment materials. Indicate VOC content in g/L.

1.3 ENVIRONMENTAL REQUIREMENTS

- .1 Temporary lighting:
 - .1 Minimum 1200 W light source, placed 2.5 m above floor surface, for each 40 sq m of floor being treated.
- .2 Electrical power:
 - .1 Provide sufficient electrical power to operate equipment normally used during construction.
- .3 Work area:
 - .1 Make work area water tight protected against rain and detrimental weather conditions.
- .4 Temperature:

- .1 Maintain ambient temperature of not less than 10 degrees C from 7 days before installation to at least 48 hours after completion of work and maintain relative humidity not higher than 40% during same period.
- .5 Safety:
 - .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials.
- .6 Ventilation:
 - .1 Provide continuous ventilation during and after coating application.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- .1 Submit written declaration that components used are compatible and will not adversely affect finished flooring products and their installation adhesives.

2.2 CHEMICAL HARDENERS

- .1 Concrete densifier and chemical hardener: ready-to-use compound according to CSA A23.1/A23.2.
- .2 Water: potable to ASTM C1602.

2.3 SEALING COMPOUNDS

- .1 Surface sealer: to CAN/CGSB-25.20.

2.4 CURING COMPOUNDS

- .1 Select water-based free curing compounds.
-

2.5 CONCRETE STAINS

- .1 Select water-based concrete stains.

2.6 JOINT SEALER

- .1 Two-component, polysulphide-based product with a chemical cure.

2.7 AUXILLIARY BACKER ROD

- .1 Closed cell polyethylene foam. Required diameters are as directed by Departmental Representative.

2.8 MIXES

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

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verify that substrate surfaces are ready to receive work and elevations are as indicated on drawings recommended by manufacturer's written instructions.

3.2 PREPARATION OF EXISTING SLAB

- .1 Rub exposed sharp edges of concrete with carborundum to produce 3 mm radius edges unless otherwise indicated.
- .2 Saw cut control joints to CSA-A23.1, 24 hours maximum after placing of concrete.
- .3 The saw cut shall be 6mm wide and 40 mm deep. Saw cuts shall avoid damaging the slab rebar.
- .4 Use polysulphide caulking to seal sawed control joints.

3.3 APPLICATION

- .1 Apply concrete finishing floor hardener in accordance with manufacturer's written instructions.
 - .2 After floor treatment is dry, seal control joints and joints at junction with vertical surfaces with sealant.
-

- .3 Apply floor treatment in accordance with Sealer manufacturer's written instructions.
- .4 Clean over spray. Clean sealant from adjacent surfaces.

3.4 FINISHES

- .1 Unless otherwise specified, the upper surface of slabs-on-grade concrete pavement shall be finished with a steel finishing machine. The final trowelling shall leave the surface free from streaks, trowel marks or ripples.
- .2 Prior to final finishing, the surface grade of concrete slabs shall be checked to an accuracy of plus or minus 3mm, with a rounded shape 3.0 metre long metal straight edge. The straight edge shall be drawn across the pavement in a scrapping motion to identify deviations for immediate corrections.
- .3 Upon completion of finishing operations, and when excessive moisture has evaporated, the plastic surface of the entire concrete pavement shall be given a textured finish at right angles to the direction of traffic by means of steel or fibre broom of a type approved by the Departmental Representative. Surface depressions introduced by the brooms strands shall not be more than 3mm deep.
- .4 For the upper surface of concrete slabs, finish tolerance classes measured according to Articles 7.6.1.2 and 7.6.1.3 of the CSA-A23.1/A23.2 standard, Table 21 (Straightedge Method and F-Number Method).

3.5 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion, remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling.

3.6 PROTECTION

- .1 Protect finished installation in accordance with manufacturer's instructions.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 04 05 12 - Mortar and Masonry Grout.
- .2 Section 04 05 19 - Masonry Anchorage and Reinforcing.
- .3 Section 04 05 23 - Masonry Accessories.
- .4 Section 04 22 00 - Concrete Unit Masonry.
- .5 Section 07 21 13 - Board Insulation.
- .6 Section 07 92 10 - Joint Sealing.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A165 Series-14, Standards on Concrete Masonry Units.
 - .2 CAN/CSA-A371-14, Masonry Construction for Buildings.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation meetings: comply with Section 01 31 19. Conduct pre-installation meeting one week prior to commencing work of this Section to:
 - .1 Verify project requirements, including mock-up requirements.
 - .2 Verify substrate conditions.
 - .3 Co-ordinate products, installation methods and techniques.
 - .4 Sequence work of related sections.
 - .5 Co-ordinate with other building subtrades.
 - .6 Review manufacturer's installation instructions.
 - .7 Review masonry cutting operations, methods and tools and determine worker safety and protection from dust during cutting operations.
 - .8 Review warranty requirements.
- .2 Sequencing: sequence with other work in accordance with Section 01 32 16.07. Comply with manufacturer's written recommendations for sequencing construction operations.
- .3 Scheduling: schedule with other work in accordance with Section 01 32 16.07.

1.4 ACTION SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Product Data:
-

- .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, limitations and colours.
- .2 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS) in accordance with Section 01 35 29.
- .3 Samples:
 - .1 Provide samples as follows:
 - .1 One (1) of each type of concrete masonry unit specified.
 - .2 One (1) cured, and coloured samples of mortar and grout illustrating mortar colour and colour range, supplemented with specific requirements in Section 04 05 12.
 - .3 One (1) of each type of masonry accessory and flashing specified, supplemented by specific requirements in Section 04 05 23.
 - .4 One (1) of each type of masonry anchorage, reinforcement and connector proposed for use, supplemented by specific requirements in Section 04 05 19.
 - .2 Samples: used for testing and when accepted become standard for material used.
 - .3 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .4 Provide shop drawings detailing temporary bracing as required, designed to resist wind pressure and lateral forces during installation.

1.5 INFORMATION SUBMITTALS

- .1 Certificates: provide manufacturer's product certificates certifying materials comply with specified performance characteristics and criteria and physical requirements
- .2 Test and Evaluation Reports:
 - .1 Provide certified test reports in accordance with Section 01 33 00.
 - .2 Test reports to certify compliance of masonry units and mortar ingredients with specified performance characteristics and physical properties.
 - .3 Provide data for masonry units, in addition to requirements set out in referenced CSA and ASTM Standards, indicating initial rates of absorption.

1.6 CLOSEOUT SUBMITTALS

- .1 Provide manufacturer's instructions for care, cleaning and maintenance of prefaced masonry units for incorporation into manual specified in Section 01 78 00.
-

1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Provide manufacturer's instructions in accordance with Section 01 78 00 covering maintenance requirements and parts catalogue, with cuts and identifying numbers.

1.8 QUALITY ASSURANCE

- .1 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 00.
 - .2 Construct mock-up panel of exterior masonry wall construction 1200 x 1800 mm showing masonry colours and textures, use of reinforcement, ties, through-wall flashing, weep holes, jointing, coursing, mortar and workmanship.
 - .3 Mock-up used:
 - .1 To judge workmanship, substrate preparation, operation of equipment and material application.
 - .2 For testing to determine compliance with performance requirements.
 - .4 Construct mock-up where directed by Departmental Representative.
 - .5 Allow 48 hours for inspection of mock-up by Departmental Representative before proceeding with work.
 - .6 When accepted by Departmental Representative, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of finished work.
 - .7 Start work only upon receipt of written acceptance of mock-up by Departmental Representative.

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver materials in accordance with Section 01 61 00.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .3 Storage and Handling Protection:
 - .1 Keep materials dry until use.
 - .2 Store under waterproof cover on pallets or plank platforms held off ground by means of plank or timber skids.
 - .3 Packaging Waste Management:
 - .1 Remove for reuse and return by manufacturer of pallets and packaging materials in accordance with Section 01 74 20.

1.10 SITE CONDITIONS

- .1 Ambient Conditions: assemble and erect components when temperatures are above 4°C.
- .2 Weather Requirements: to CAN/CSA-A371.
- .3 Cold weather requirements:
 - .1 To CAN/CSA-A371 with following requirements.
 - .1 Maintain temperature of mortar between 5°C and 50°C until batch is used or becomes stable.
 - .2 Maintain ambient temperature of masonry work and its constituent materials between 5°C and 50°C and protect site from wind-chill.
 - .2 Hot weather requirements:
 - .1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
 - .2 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.
 - .3 Spray mortar surface at intervals and keep moist for maximum of three days after installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- .1 Ensure manufacturer has minimum 5 years of experience in manufacturing components similar to or exceeding requirements of project.

2.2 MATERIALS

- .1 Masonry materials are to match existing conditions.

PART 3 - EXECUTION

3.1 INSTALLERS

- .1 Experienced and qualified masons to carry out erection, assembly and installation of masonry work.
-

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 EXAMINATION

- .1 Examine conditions, substrates and work to receive work of this Section.
 - .1 Co-ordinate with Section 01 71 00.
- .2 Examine openings to receive masonry units. Verify opening size, location, and that opening is square and plumb, and ready to receive work of this Section.
 - .1 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation after unacceptable conditions have been remedied and after receipt of written approval from Departmental Representative.
- .3 Verification of Conditions:
 - .1 Verify that:
 - .1 Substrate conditions which have been previously installed under other sections or contracts are acceptable for product installation in accordance with manufacturer's instructions prior to installation of concrete block.
 - .2 Field conditions are acceptable and are ready to receive work.
 - .3 Built-in items are in proper location, and ready for roughing into masonry work.
 - .2 Commencing installation means acceptance of existing substrates.

3.4 PREPARATION

- .1 Surface Preparation: prepare surface in accordance with manufacturer's written recommendations and co-ordinate with Section 01 71 00.
- .2 Establish and protect lines, levels, and coursing.
- .3 Protect adjacent materials from damage and disfiguration.

3.5 INSTALLATION

- .1 Do masonry work in accordance with CAN/CSA-A371 except where specified otherwise.
 - .2 Build masonry plumb, level, and true to line, with vertical joints in alignment, respecting construction tolerances permitted by CAN/CSA-A371.
-

- .3 Layout coursing and bond to achieve correct coursing heights, and continuity of bond above and below openings, with minimum of cutting.

3.6 CONSTRUCTION

- .1 Exposed masonry:
 - .1 Remove chipped, cracked, and otherwise damaged units, in accordance with CAN/CSA-A165 in exposed masonry and replace with undamaged units.
 - .2 Jointing:
 - .1 Match existing conditions.
 - .3 Cutting:
 - .1 Cut out for electrical switches, outlet boxes, and other recessed or built-in objects.
 - .2 Make cuts straight, clean, and free from uneven edges.
- .4 Building-In:
 - .1 Build in items required to be built into masonry.
 - .2 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
 - .3 Brace door jambs to maintain plumb. Fill spaces between jambs and masonry with mortar.
- .5 Loose steel lintels:
 - .1 Install loose steel lintels. Centre over opening width.
- .6 Interface with other work:
 - .1 Cut openings in existing work as indicated.
 - .2 Openings in walls: reviewed by Departmental Representative.
 - .3 Make good existing work. Use materials to match existing.

3.7 SITE TOLERANCES

- .1 Tolerances in notes to CAN/CSA-A371 apply.

3.8 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection:
 - .1 Perform field inspection and testing in accordance with Section 01 45 00.
 - .2 Notify inspection agency minimum of 24 hours in advance of requirement for tests.
-

3.9 CLEANING

- .1 Clean in accordance with Section 01 74 11.
- .2 Progress Cleaning: in accordance with related masonry sections.
- .3 Final Cleaning:
 - .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
 - .2 Upon completion of installation and verification of performance of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
 - .1 Divert unused or damaged masonry units and glass block from landfill as specified in Section 01 74 20.

3.10 PROTECTION

- .1 Temporary Bracing:
 - .1 Provide temporary bracing of masonry work during and after erection until permanent lateral support is in place.
 - .2 Bracing approved by Departmental Representative.
 - .3 Brace masonry walls as necessary to resist wind pressure and lateral forces during construction.
- .2 Moisture Protection:
 - .1 Keep masonry dry using waterproof, nonstaining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until completed and protected by flashing or other permanent construction.
 - .2 Cover completed and partially completed work not enclosed or sheltered with waterproof covering at end of each work day. Anchor securely in position.
 - .3 Air Temperature Protection: protect completed masonry as recommended in 1.10 SITE CONDITIONS.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 04 05 10 – Common Work Results for Masonry.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A179-14, Mortar and Grout for Unit Masonry.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Provide manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
 - .3 Provide two copies of Workplace Hazardous Materials Information System (WHMIS) - Material Safety Data Sheets (MSDS) in accordance with Section 01 35 29. Indicate VOC's mortar, grout, parging, colour additives and admixtures. Expressed as grams per litre (g/L).
- .2 Samples:
 - .1 Samples: provide unit samples in accordance with Section 01 33 00, supplemented as follows:
 - .1 Provide One (1) size sample of mortar.
- .3 Manufacturer's Instructions:
 - .1 Provide manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties, and in accordance with Section 04 05 10.
 - .2 Certificates: 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. Comply with Section 01 31 19.
 - .4 Mock-ups:
-

- .1 Construct mock-ups in accordance with Section 01 45 00 and requirements of Section 04 05 10.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handles masonry mortar and grout materials in accordance with Section 01 61 00, supplemented as follows:
 - .1 Deliver prepackaged, dry-blended mortar mix to project site in labelled plastic-lined bags each bearing name and address of manufacturer, production codes or batch numbers, and colour or formula numbers.
 - .2 Maintain mortar, grout and packaged materials clean, dry, and protected against dampness, freezing, traffic and contamination by foreign materials.
- .2 Packaging Waste Management: remove for reuse and return by manufacturer of pallets and packaging materials in accordance with Section 01 74 20.

1.6 SITE CONDITIONS

- .1 Ambient Conditions: maintain materials and surrounding air temperature to:
 - .1 Minimum 5 degrees C prior to, during, and 48 hours after completion of masonry work.
 - .2 Maximum 32 degrees C prior to, during, and 48 hours after completion of masonry work.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Use same brands of materials and source of aggregate for entire project.
- .2 Mortar and grout: CSA A179.
- .3 Use aggregate passing 1.18 mm sieve where 6 mm thick joints are indicated.
- .4 Colour: To match existing conditions.
- .5 Water shall be potable, clean and free of deleterious amounts of acids, alkalis or organic materials.
- .6 Mortar should be used within two and a half hours or batching
- .7 Mortar for exterior masonry above grade:
 - .1 Loadbearing: type N based on Proportion specifications.
 - .2 Non-Loadbearing: type N based on Proportion specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Request inspection of spaces to be grouted.

3.2 PREPARATION

- .1 Apply bonding agent to existing concrete surfaces.
- .2 Plug clean-out holes with block masonry units. Brace masonry for wet grout pressure.

3.3 MANUFACTURER'S INSTRUCTIONS

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

3.4 CONSTRUCTION

- .1 Do masonry mortar and grout work in accordance with CAN/CSA-A179 except where specified otherwise.

3.5 3.5 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection: in accordance with Section 01 91 13 supplemented as follows:
 - .1 Test and evaluate mortar prior to construction and during construction in accordance with CAN/CSA-A179.
- .2 Manufacturer's Field Services: in accordance with Section 01 77 00.

3.6 CLEANING

- .1 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .2 Remove droppings and splashings using clean sponge and water.
- .3 Clean masonry with low pressure clean water and soft natural bristle brush.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

3.7 PROTECTION OF COMPLETED WORK

- .1 Cover completed and partially completed work not enclosed or sheltered with waterproof covering at end of each work day. Anchor securely in position.
 - .1 Mortar:
-

- .1 Concrete Masonry Units.

3.8 SCHEDULE

- .1 Match existing mortar conditions as best as possible.
.2 Use non-staining mortar for exposed concrete unit masonry.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A371-14, Masonry Construction for Buildings.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.
- .3 Shop Drawings:
 - .1 Provide shop drawings in accordance with Section 01 33 00.
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in the Province of Ontario, Canada.
 - .2 Shop drawings consist of flashing and installation details. Indicate sizes, spacing, location and quantities of fasteners.
- .4 Samples:
 - .1 Provide masonry accessory samples in accordance with Section 01 33 00, supplemented as follows:
 - .1 Two flashing material samples, illustrating colour, size, shape, and profile. Include as specified:
 - .1 Sheet metal flashings to match existing..
- .5 Quality Assurance Submittals:
 - .1 Test reports: submit certified test reports in accordance with Section 01 45 00.
 - .2 Certificates: submit in accordance with Section 01 33 00.
 - .3 Pre-installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Section 01 31 19.

1.3 FIELD MEASUREMENTS

- .1 Make field measurements necessary to ensure proper fit of members.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle masonry accessories in accordance with, Section 01 61 00 supplemented as follows:
 - .1 Keep fillers and adhesives dry, protected against dampness, and freezing.
 - .2 Store packaged materials off ground and in accordance with manufacturer's written instructions.
- .2 Packaging Waste Management:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 FLASHINGS

- .1 Sheet metal:
 - .1 To match existing conditions (colour, profile)

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: FLASHINGS

- .1 Build in flashings in masonry in accordance with CAN/CSA-A371.
 - .1 Install flashings under exterior masonry bearing on foundation walls, slabs, shelf angles, and steel angles over openings, and at base of cavity wall and where cavity is interrupted by horizontal members or supports and as shown on drawings. Install flashings under weephole courses and as indicated.
 - .2 In cavity walls and veneered walls, carry flashings from front edge of exterior masonry, under outer wythe, then up backing not less than 150 mm, and as follows:
 - .1 For masonry backing embed or bond flashing 25 mm in joint.
 - .2 For concrete backing, insert or bond flashing into reglets.
 - .3 For wood frame backing, staple flashing to walls behind water resistive paper, and lap joints.

- .4 For gypsum board and glass fibre faced sheathing backing, bond to wall using manufacturer's recommended adhesive.
- .3 Lap joints 150 mm and seal with adhesive.
- .2 Form flashing (end dams) at lintels, sills and wall ends to prevent water from travelling horizontally past flashing ends.
- .3 Install vertical flashing where outer veneer returns at window or door jambs, to prevent contact of veneer with inner wall.

3.3 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 04 05 10 – Common Work Results for Masonry.
- .2 Section 04 05 12 - Mortar and Masonry Grout.
- .3 Section 04 05 23 - Masonry Accessories.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A165 Series-14, CSA Standards on Concrete Masonry Units (covers: A165.1, A165.2, A165.3).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Product Data: provide product data, including manufacturer's printed data sheets and catalog pages illustrating products to be incorporated into project for specified products.
- .3 Samples:
 - .1 Provide unit samples in accordance with Section 04 05 10.
- .4 Manufacturer's Written Instructions: provide in accordance with Section 04 05 10.

1.4 QUALITY ASSURANCE SUBMITTALS

- .1 Certificates: provide in accordance with Section 04 05 10.
 - .2 Test and Evaluation Reports: provide certified test reports in accordance with Section 04 05 10.
 - .3 Pre-Installation Meetings: conduct pre-installation meeting in accordance with Section 04 05 10 to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.
 - .4 Mock-ups:
 - .1 Construct mock-ups in accordance with Section 01 45 10, supplemented as follows:
 - .1 Construct mock-up panel of exterior concrete unit masonry construction 1200 x 1800mm.
-

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, store and handle concrete unit masonry in accordance with Section 04 05 10.
- .2 Packaging Waste Management:
 - .1 Separate and recycle waste materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Standard concrete block units to match existing conditions and to CAN/CSA-A165 Series (CAN/CSA-A165.1).
- .2 Face design shall be split face as manufactured.
 - .1 All units will conform to CAN/CSA-A165.1.
 - .1 Weight Classification: Normal Weight.
 - .2 Minimum Net Compressive Strength 1900 PSI.
 - .3 Sizes: Manufacturer's Standard Nominal Sizes.

2.2 FLASHING

- .1 Flashing: in accordance with Section 04 05 23.

2.3 MORTAR MIXES

- .1 Mortar and mortar mixes in accordance with Section 04 05 12.

2.4 CLEANING COMPOUNDS

- .1 Compatible with substrate and acceptable to masonry manufacturer for use on products.
- .2 Cleaning compounds compatible with concrete unit masonry and in accordance with manufacturer's written recommendations and instructions.

2.5 TOLERANCES

- .1 Tolerances for standard concrete unit masonry tolerances in accordance with CAN/CSA-A165.1, supplemented as follows:
 - .1 Maximum variation between units within specific job lot not to exceed 2 mm.
 - .2 No parallel edge length, width or height dimension for individual unit to differ by more than 2 mm.
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- .3 Out of square tolerance not to exceed 2 mm.
- .2 Tolerances for architectural concrete masonry units in accordance with CAN/CSA-A165.1, supplemented as follows:
 - .1 Maximum variation in length or height between units within specific job lot for specified dimension not to exceed 2 mm.
 - .2 No parallel edge length, width or height dimension for individual unit to differ by more than 2 mm.
 - .3 Out of square tolerance not to exceed 2 mm.
 - .4 Maximum variation in width between units within specific job lot for specified dimension not to exceed 2mm.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verify surfaces and conditions are ready to accept work of this Section.
- .2 Commencing installation means acceptance of existing substrates.

3.2 PREPARATION

- .1 Protect adjacent finished materials from damage due to masonry work.

3.3 INSTALLATION

- .1 Concrete block units:
 - .1 Match existing conditions.

3.4 FLASHING

- .1 Install flashings: in accordance with Section 04 05 23.

3.5 MORTAR PLACEMENT

- .1 Place mortar in accordance with Section 04 05 12.

3.6 CONSTRUCTION

- .1 Cull out masonry units, in accordance with CAN/CSA-A165 and reviewed range of colour samples, with chips, cracks, broken corners, excessive colour and texture variation.
 - .2 Build in miscellaneous items such as bearing plates, steel angles, bolts, anchors, inserts, sleeves and conduits.
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- .3 Construct masonry walls to match existing conditions.
- .4 Build around frames previously set and braced. Fill behind hollow frames within masonry walls with mortar or grout and embed anchors.
- .5 Fit masonry closely against electrical and plumbing outlets so collars, plates and covers overlap and conceal cuts.
- .6 Install movement joints and keep free of mortar where indicated.
- .7 Hollow Units: spread mortar setting bed from outside edge of face shells. Gauge amount of mortar on top and end of unit to create full joints, equivalent to shell thickness. Avoid excess mortar.
- .8 Solid Units: apply mortar over entire vertical and horizontal surfaces. Avoid bridging of airspace between brick veneer and backup wall with mortar.
- .9 Ensure compacted head joints. Use full or face-shell joint as indicated.
- .10 Tamp units firmly into place.
- .11 Do not adjust masonry units after mortar has set. Where resetting of masonry is required, remove, clean and reset units in new mortar.
- .12 Tool exposed joints concave; strike concealed joints flush.
- .13 After mortar has achieved initial set up, tool joints.
- .14 Do not interrupt bond below or above openings.

3.7 REPAIR/RESTORATION

- .1 Upon completion of masonry, fill holes and cracks, remove loose mortar and repair defective work.

3.8 FIELD QUALITY CONTROL

- .1 Site Tests, Inspection: in accordance with Section 04 05 10.
- .2 Manufacturer's Field Services: in accordance with Section 04 05 10.

3.9 CLEANING

- .1 Clean in accordance with Section 01 74 11, supplemented as follows.
 - .1 Progress Cleaning:
 - .1 Standard Concrete Unit Masonry:
 - .1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block. Clean wall surface with suitable brush or burlap.
 - .2 Architectural Concrete Unit Masonry:

- .1 Allow mortar droppings on masonry to partially dry then remove by means of trowel, followed by rubbing lightly with small piece of block. Clean wall surface with suitable brush or burlap.
- .3 Prefaced Concrete Unit Masonry:
 - .1 Clean masonry as work progresses using soft, clean cloths, within few minutes after laying. Upon completion, when mortar has set so that it will not be damaged by cleaning, clean with soft sponge or clean cloths, brush, and clean water. Polish with soft, clean cloths.
 - .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

3.10 PROTECTION

- .1 Brace and protect concrete unit masonry in accordance with Section 04 05 10.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CAN/CSA S16-14, Design of Steel Structures.
 - .3 CSA S136-12 Package, North American Specification for the Design of Cold Formed Steel Structural Members.
 - .4 CSA W47.1-09(R2014), Certification of Companies for Fusion Welding of Steel Structures.
 - .5 CSA W48-14, Carbon Steel Covered Electrodes for Shielded Metal Arc Welding.
 - .6 CSA W55.3-08(R2013), Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
 - .7 CSA W59-13, Welded Steel Construction (Metal Arc Welding) Metric.
 - .2 Canadian Institute of Steel Construction (CISC):
 - .1 Handbook of Steel Construction, May 2006, 9th edition
 - .2 CISC Code of Standard Practice, 1999
 - .3 Fundamentals of Structural Shop Drafting, 1995.
 - .3 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .2 ASTM A490M-14a, Specification for High Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
 - .4 Master Painters Institute
 - .1 MPI INT 5.1 04, Structural Steel and Metal Fabrications
 - .2 MPI EXT 5.1 04, Structural Steel and Metal Fabrications
 - .5 National Research Council Canada (NRC)
 - .1 National Building Code of Canada 2010
 - .6 Unless otherwise specified, perform structural steel work and welding work in compliance with the CAN/CSA-S16 standard.
 - .7 The framework shall be performed only by a member duly approved by the Canadian Welding Bureau (CWB), in accordance with the requirements of the CSA W47.1 standard, Division 1 or Division 2.
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1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Shop Drawings:
 - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Ontario.
 - .3 Erection drawings:
 - .1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including:
 - .1 Description of methods.
 - .2 Sequence of erection.
 - .3 Type of equipment used in erection.
 - .4 Temporary bracings.
 - .4 Fabrication drawings:
 - .1 Submit fabrication drawings showing designed assemblies, components and connections are stamped and signed by a qualified professional engineer licensed in Ontario.
 - .5 Samples:
 - .1 Prepare sample of typical exposed structural connections in accordance with AISC Specifications of Architecturally exposed structural steel for approval of Departmental Representative. Samples to be judged upon alignment of surfaces, uniform contact between surfaces, smoothness and uniformity of finished welds. When approved, sample units will serve as a standard for workmanship, appearance and material acceptable for entire project.
 - .6 Source Quality Control Submittals:
 - .1 Submit 2 copies of 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 Provide mill test reports certified by metallurgists qualified to practice in Canada.
 - .7 Fabricator Reports:
 - .1 Provide structural steel fabricator's affidavit stating that materials and products used in fabrication conform to applicable material and products standards specified and indicated.
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1.3 SHOP DRAWINGS

- .1 Provide the Departmental Representative with complete and detailed shop and erection drawings of the steel framework to be built. The drawings shall be provided in metric units (SI).
- .2 Have Departmental Representative who is a member in good standing of an Association of Professional Engineers in Ontario sign and seal each shop drawing submitted.
- .3 Clearly indicate on the shop drawings all forming and assembly details, including cuts, cut-outs, joints, drill holes, threaded anchors, bolts, shear connectors and welds if any. Use the symbols indicated in the CSA W59 standard to represent welds.
- .4 Submit to the Departmental Representative the description of work methods, the order in which components are to be assembled, and the type of equipment intended for use. Even if this formality has been fulfilled and the document has been submitted, the specialized Contractor remains solely responsible regarding the use of the methods, equipment, and delivery mode and safety measures.
- .5 The shop and erection drawings shall contain all the information mentioned in Articles 4.2 and 4.3 of the CAN/CSA-S16 standard and bear the signature and seal of a licensed professional engineer in Ontario before their submission to the Departmental Representative.
- .6 The project title and the names of the Departmental Representative and Contractor shall appear on each shop and erection drawing.
- .7 The shop and erection drawings shall be sent soon enough to ensure the Departmental Representative has at least ten (10) working days to examine them.
- .8 A copy of each drawing shall be returned to the specialized Contractor who, if required, shall revise the annotated drawing(s) and resubmit it (them). If the Departmental Representative finds that the revisions are too numerous or complex, he shall return the drawings without annotating them. The Contractor shall be responsible for making any additional copies he requires.
- .9 The specialized Contractor shall only manufacture the framework components after the Departmental Representative has returned the shop and erection drawings.

1.4 VERIFICATION OF DIMENSIONS, MEASUREMENTS AND LEVELS

- .1 Before manufacturing the components of the framework, take and check all the dimensions, measurements and levels on site to compare them with the ones on the drawings or to complete the information shown on the drawings.
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Notify the Departmental Representative regarding any errors on the construction site or any incompatibility between the dimensions taken and the instructions provided on the drawings. Await the Departmental Representative's instructions on how to correct the errors and/or make the required adjustments.

- .2 If connecting to an existing framework, check all the dimensions, measurements and levels of the existing framework before producing shop drawings of the new frame that will be connected to it. Adjust the dimensions of the parts to be built according to need and submit the modifications to the Departmental Representative.

1.5 QUALITY ASSURANCE

- .1 Submit 3 copies of shop trial reports prior to assembly of the structural steel work.
 - .1 The shop trial reports shall indicate the steel's chemical and physical properties, as well as other relevant details before it is used for this work,
 - .2 Qualified metallurgists authorized to work in Canada shall certify the trial reports.
- .2 Also provide an affidavit from the manufacturer of the structural steel work certifying that the products, equipment and materials used for this work comply with the relevant standards that apply to the required or indicated equipment and materials.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00.
- .2 Deliver materials in manufacturer's original, undamaged containers with identification labels intact.
- .3 Packaging Waste Management: remove for reuse and return in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

- .1 The specialized Contractor shall provide all the materials, equipment and labour required to perform the detailing, joint design, manufacture, fitting-up, factory painting, transportation and installation of the steel framework.
 - .2 Design details and connections in accordance with requirements of CAN/CSA-S16 and CAN/CSA-S136 with CSA-S136.1 to resist forces, moments, shears and allow for movements indicated.
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- .3 Shear connections:
 - .1 Select framed beam shear connections from an industry accepted publication such as "Handbook of the Canadian Institute of Steel Construction" when connection for shear only (standard connection) is required.
 - .2 Select or design connections to support reaction from maximum uniformly distributed load that can be safely supported by beam in bending, provided no point loads act on beam, when shears are not indicated.
- .4 For composite construction select or design minimum end connection to resist reaction resulting from factored movement resistance as tabulated in the "Handbook of the Canadian Institute of Steel Construction" assuming 100% shear connection with depth of steel deck and/or slab shown on drawings.
- .5 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Ontario for non-standard connections.

2.2 MATERIALS

- .1 Use materials free of dirt, rust, scale, pinholes, leafing or any other defect. No used materials shall be accepted.
 - .2 Structural steel: to CSA-G40.20/G40.21 Grade 300W and/or CAN/CSA-S136.
 - .3 Rolled W sections: complies with the CAN/CSA-G40.20/G40.21, Grade 350 W standard.
 - .4 Hollow Structural Sections (HSS): comply with the CAN/CSA-G40.21 and CAN/CSA-S16 Grade 350W, Class C standards, as indicated on the drawings.
 - .5 Other rolled sections and Steel plates: In accordance with CAN/CSA G40.20/G40.21, Grade 300W.
 - .6 High-strength bolts, nuts and washers: comply with the ASTM A490M standard.
 - .7 Anchor bolts:
 - .1 Lower strength: comply with the CAN/CSA-G40.21, Grade 300W standard and the ASTM A307, Grade A standard.
 - .2 High-strength: comply with the A490M standards with minimum yield strength of 500 MPa.
 - .8 Welding materials: compliant with the CAN/CSA-W59 standard and the CAN/CSA-W48 series standards and approved by the Canadian Welding Bureau.
 - .9 Shear connectors (if required on the drawings): comply with the CSA-W59 standard, Clause 5.5.6 and its Appendix H.
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- .10 Finishing except otherwise indicated
 - .1 Hot dip galvanizing: Galvanize components after assembly where size permits. Apply a minimum 600 g/m² coat of zinc on the indicated areas, in compliance with the CAN/CSA-G164 standard or ASTM A123.
 - .2 Touch-up paint for galvanized steel: In compliance with the CAN/CGSB-1.181 standard, with a metallic zinc content of more than 87% (mass percentage of the non-volatile part). Aerosol coatings are not permitted. The dry film of the coating must contain 95% of metallic zinc.

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 GENERAL

- .1 Structural steel work: in accordance with CAN/CSA-S16 and CAN/CSA-S136.
- .2 Welding in accordance with CSA W59.
- .3 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.

3.3 CONNECTION TO EXISTING WORK

- .1 Verify dimensions and condition of existing work, report discrepancies and potential problem areas to Departmental Representative for direction before commencing fabrication.

3.4 FABRICATION

- .1 Fabricate and assemble the steel components in compliance with the CAN/CSA-S16 standard and according to the shop drawings submitted.
 - .2 Fabricate beams, columns and other members of continuous sections in accordance with CAN/CSA S16-1. Do not splice pieces unless specifically shown on the Drawings or with Departmental Representative's written authorization.
 - .3 The Structural members formed of welded sections shall be rejected if they are not shown as such on the shop drawings.
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- .4 The use of members whose quality and/or dimensions differ from those shown is strictly forbidden without the Departmental Representative's written permission.
- .5 Drill or punch the bolt holes. All burning or cutting with a torch is forbidden.
- .6 The respective manufacturing and assembly tolerances are those described in Sections 28.9 and 30.7 of the CAN/CSA-S16 standard.
- .7 If required, reinforce the openings to maintain design strength.
- .8 Grind visible welds where required.
- .9 Provide the qualified trades with the templates and the parts to be embedded in the concrete or the masonry.
- .10 Once the assembly is completed, touch up the rivets, on-site welds, and bolts as well as burned or scratched surfaces.
- .11 Apply a zinc primer on galvanized surfaces in areas burned as a result of on-site welding work.
- .12 The welding companies shall be certified under the terms of Division 1 of these specifications or Article 2.1 of the CSA W47.1 standard regarding fusion welding of steel structures, and/or the CSA W55.3 standard regarding resistance welding of structural members.

3.5 HOLES

- .1 Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members.
- .2 Cut, drill, or punch holes perpendicular to steel surfaces; do not flame cut holes or enlarge holes by burning.
- .3 Drill holes in bearing plates.

3.6 MARKING

- .1 Mark the materials in compliance with the CAN/CSA-G40.21 standard. Do not use die-stamping. When the steel part must not be painted, stamp the mark in locations that will not be visible after assembly.
- .2 Match marking: shop mark bearing assemblies and splices for fit and match.

3.7 ASSEMBLY

- .1 The proposed technique, as well as the equipment used to erect the frame, is subject to the Departmental Representative's approval. However, this approval
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shall in no way release the specialized Contractor from his full responsibility regarding the choice of technique and the handling of the equipment that will enable him to perform his work quickly and in complete safety.

- .2 Assemble the steel components in compliance with the CAN/CSA-S16 standard and according to the shop drawings.
- .3 Assemble the metal structures ensuring that they are square, plumb, aligned, accurately adjusted, and have tight joints and intersections.
- .4 Where indicated on the drawings, continuously seal all steel members with a continuous weld bead and grind the welds.
- .5 Obtain the Departmental Representative's written authorization before cutting or modifying structural steel members on site.
- .6 Once the assembly is completed, touch up the bolts, rivets, welds, and surfaces where the factory-applied galvanization is degraded.
- .7 Deliver, handle and store all steel on site to avoid any damage. Damaged members and joints shall be rejected.
- .8 Notify the Departmental Representative as soon as possible regarding any defects detected in the assembly of factory-built components and abide by his decision regarding the corrections to be made.
- .9 Straighten slightly deformed components before assembling them on site and replace those that are damaged to the point where the Departmental Representative raises doubts regarding their effectiveness.
- .10 It is strictly forbidden to perform joint welds on site unless they are indicated on the shop drawings or the Departmental Representative has approved them beforehand.
- .11 It is strictly forbidden to drill, cut or modify in any way a component of the frame on site without having obtained the Departmental Representative's written authorization beforehand.
- .12 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.

3.8 FIELD QUALITY CONTROL

- .1 A testing laboratory approved by the Departmental Representative shall inspect and test materials and craftsmanship.
 - .2 The Departmental Representative shall have access to the shop at all times to inspect the manufacturing and assembly work performed there.
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- .3 At the Departmental Representative's request, provide a factory certificate attesting that the quality of the steel meets the requirements of the contract documents.
- .4 The Departmental Representative may require that analytical trials, estimates and calculations be performed. Replace all work or materials found to be defective, at no expense and without any unnecessary project delays.
- .5 The inspection and verification to ensure the framework is aligned, plumb and level shall comply with the CAN/CSA-S16 standard, Clause 29.7.

3.9 JOINTS

- .1 Unless otherwise indicated on the drawings, all factory-built joints shall be welded. If friction joints are specified, high-strength bolts shall be used.
- .2 High-strength bolts shall be used on all friction joints performed on site, in accordance with Section 23 of the CAN/CSA-S16 standard.

3.10 TEMPORARY BRACING

- .1 Use temporary bracing for the assembly where necessary after the instructions from the Departmental Representative to offset any load to which the frame may be subjected, including wind, snow, equipment and its use.
- .2 The specialized Contractor shall be responsible for any negligence in adequately anticipating the stresses exerted during assembly of the framework.
- .3 The specialized Contractor is entirely responsible for the temporary stability of the steel frame.

3.11 GROUT APPLICATION

- .1 Where indicated on the drawings, after the framework has been erected and aligned, completely fill the space under column base plates or other supports with the specified non-shrink grout, following the manufacturer's written instructions.
- .2 Install the grout and wait until it has achieved 75% of its specified strength before pouring the concrete slabs on steel decking.

3.12 SUBSTITUTION

- .1 Do not change the dimension and size of the members shown on the drawings without the Departmental Representative's written authorization. Substitution of members with units stronger than those specified may be accepted at no additional cost.
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3.13 FIELD PAINTING

- .1 Touch up damaged surfaces and surfaces without shop coat with primer to NACE No.3/SSPC-SP-6 except as specified otherwise. Apply in accordance: MPI Architectural Painting Specification Manual.

3.14 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM A123/A123M-13, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
- .2 CSA International
 - .1 CSA G40.20-13/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding (Developed in co-operation with the Canadian Welding Bureau).
 - .3 CSA W59-13, Welded Steel Construction (Metal Arc Welding) Metric.
- .3 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification 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 sections, plates, pipe, tubing, bolts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit two copies of WHMIS MSDS in accordance with Section 01 35 29.
 - .1 For finishes, coatings, primers, and paints applied on site: indicate VOC concentration in g/L.
 - .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
 - .2 Indicate materials, core thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
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1.3 QUALITY ASSURANCE

- .1 Test Reports: submit certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certifications: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 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 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Steel sections and plates: to CSA G40.20/G40.21, Grade 300W 350W.
- .2 Steel pipe: to ASTM A 53/A 53M standard weight extra strong double extra strong, black galvanized finish.
- .3 Welding materials: to CSA W59.
- .4 Welding electrodes: to CSA W48 Series.
- .5 Bolts and anchor bolts: to ASTM A 307.
- .6 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

2.2 FABRICATION

- .1 Fabricate work square, true, straight and accurate to required size, with joints closely fitted and properly secured.
 - .2 Use self-tapping shake-proof flat headed screws on items requiring assembly by screws or as indicated.
 - .3 Where possible, fit and shop assemble work, ready for erection.
 - .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.
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2.3 FINISHES

- .1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/ m², Coating Grade 85, to ASTM A123/A123M.
- .2 Shop coat primer: MPI- INT EXT 5.1A MPI- INT EXT 5.1B in accordance with chemical component limits and restrictions requirements.
- .3 Zinc primer: zinc rich, ready mix to MPI-INT EXT 5.2C in accordance with chemical component limits and restrictions requirements.

2.4 ISOLATION COATING

- .1 Isolate aluminum from following components, by means of bituminous paint:
 - .1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.
 - .2 Concrete, mortar and masonry.
 - .3 Wood.

2.5 SHOP PAINTING

- .1 Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.
- .2 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 degrees C.
- .3 Clean surfaces to be field welded; do not paint.

2.6 ANGLE LINTELS

- .1 Steel angles: prime painted, sizes indicated for openings. Provide 200mm (150 mm minimum) bearing at ends.
- .2 Weld back-to-back angles to profiles as indicated.
- .3 Finish: shop painted.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for metal fabrications 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 welding work in accordance with CSA W59 unless specified otherwise.
- .2 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.
- .3 Provide suitable means of anchorage acceptable to Departmental Representative such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.
- .4 Exposed fastening devices to match finish and be compatible with material through which they pass.
- .5 Supply components for work by other trades in accordance with shop drawings and schedule.
- .6 Weld field connection.
- .7 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.
- .8 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion of:
- .9 Touch-up galvanized surfaces with zinc rich primer where burned by field welding.

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 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.

3.4 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 07 92 00 – Joint Sealants

1.2 REFERENCES

- .1 CSA International
 - .1 CAN/CSA-A247-M86(R1996), Insulating Fiberboard.
 - .2 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
 - .3 CSA O112 Series-M1977(R2006), CSA Standards for Wood Adhesives.
 - .4 CSA O121-08(R2013), Douglas Fir Plywood.
 - .5 CSA O141-05(R2014), Softwood Lumber.
 - .6 CSA O151-09(R2014), Canadian Softwood Plywood.
 - .7 CSA O153-13, Poplar Plywood.
 - .8 CSA O325-07(R2012), Construction Sheathing.
 - .9 CSA O437 Series-93(R2011), Standards on OSB and Waferboard.
- .2 National Lumber Grades Authority (NLGA)
 - .1 Standard Grading Rules for Canadian Lumber December 1, 2010.
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S706-09, Standard for Wood Fibre Insulating Boards for Buildings.

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 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.

1.4 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.
-

1.5 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 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 Framing and board lumber: in accordance with NBC.
- .3 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:
 - .1 S2S is acceptable for all work.
 - .2 Board sizes: "Standard" or better grade.
 - .3 Dimension sizes: "Standard" light framing or better grade
 - .4 Douglas Fir Plywood (DFP): to CSA 0121, standard construction.
 - .5 Polyisocyanurate sheathing: to ASTM C1289-15.
 - .6 Glass fibre board sheathing: non-structural, rigid faced, fiberglass, insulating exterior sheathing board.
 - .7 Gypsum sheathing: to ASTM C 1396/C 1396M.

2.2 ACCESSORIES

- .1 Polyethylene film: to CAN/CGSB-51.34, Type 1, 0.15 mm thick.
 - .2 Air seal: closed cell polyurethane or polyethylene.
 - .3 Sealants: in accordance with Section 07 92 00.
 - .4 General purpose adhesive: to CSA O112.9.
 - .5 Nails, spikes and staples: to CSA B111.
 - .6 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
 - .7 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.
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- .8 Nailing discs: flat caps, minimum 25 mm diameter, minimum 0.4 mm thick, sheet metal, fibre, formed to prevent dishing. Bell or cup shapes not acceptable.
- .9 Fastener Finishes:
 - .1 Galvanizing to: ASTM A 123/A 123M, use galvanized fasteners for exterior work.
- .10 Wood Preservative:
 - .1 Preservative Coating: 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 follows:
 - .1 Wood cants, fascia backing, curbs, nailers, sleepers on roof deck.
 - .2 Wood furring on outside surface of exterior masonry walls.
 - .3 Wood sleepers supporting wood subflooring over concrete slabs in contact with ground or fill.

3.3 MATERIAL USAGE

- .1 Roof sheathing:
 - .1 Construction sheathing product: as indicated.
- .2 Exterior wall sheathing:
 - .1 Glass fibre sheathing, to match existing.
 - .2 Polyisocyanurate sheathing, to match existing.
 - .3 Gypsum sheathing, to match existing.

3.4 INSTALLATION

- .1 Apply wood preservative to wood in contact with roofing and masonry.
- .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 spanning members with "crown-edge" up.
- .6 Install wall sheathing in accordance with manufacturer's printed instructions.
- .7 Install roof sheathing perpendicular to framing; stagger end joints, locate ends over framing. Install in accordance with requirements of NBC.
- .8 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding electrical equipment mounting boards, and other work as required.
- .9 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.
- .10 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .11 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using galvanized steel fasteners.
- .12 Use dust collectors and high quality respirator masks when cutting or sanding wood panels.
- .13 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .14 Countersink bolts where necessary to provide clearance for other work.
- .15 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.

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.

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 07 26 00 – Vapour Retarders
- .2 Section 07 46 13 – Preformed Metal Siding
- .3 Section 07 51 00 – Built-up Bituminous Roofing
- .4 Section 09 22 16 – Non-Structural Metal Framing

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM E96/E96M-14, Standard Test Methods for Water Vapour Transmission of Materials.
 - .2 ASTM C1289-15, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- .2 Canadian Standards Association (CSA).
 - .1 CAN/CSA-B149.1-15, Natural Gas and Propane Installation Code.
 - .2 CAN/CSA-B149.2-15, Propane Storage and Handling Code.
- .3 Underwriters Laboratories of Canada (ULC).
 - .1 CAN/ULC-S701-11, Thermal Insulation, Polystyrene, Boards and Pipe Coverings.
 - .2 CAN/ULC-S704-11, Thermal Insulation Polyurethane and Polyisocyanurate, Boards, Faced.

1.3 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 01 33 00.
 - .2 Submit two copies of WHMIS MSDS - Material Safety Data Sheets.
- .2 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.

1.4 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
 - .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
-

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .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 for recycling in accordance with Waste Management Plan.

PART 2 - PRODUCTS

2.1 ROOF INSULATION

- .1 Rigid Cellular Polyisocyanurate:
 - .1 Faced: to ASTM C1289 CAN/ULC-S704.
 - .1 Polyisocyanurate core: glass fibre reinforced
 - .2 Surfaces: Facers: organic/inorganic.
 - .3 Shape: flat and tapered.
 - .4 Back: reflective foil facer and non-reflective.
 - .5 Thickness: as indicated.
 - .6 Size: 1220 x 2440mm and 1220 x 1220mm, to suit.

2.2 BELOW-GRADE INSULATION

- .1 Extruded polystyrene board
 - .1 To CAN/ULC-S701, Type 4, rigid, closed cell type, with integral high density skin.
 - .1 Thermal Resistance: Long term aged RSI value of 0.87/25 mm, to ASTM C518.
 - .2 Board Size: 600 x 1220 mm, thickness as indicated on Drawings.
 - .3 Compressive Strength: to ASTM D1621, minimum 210 kPa.
 - .4 Water Absorption: to ASTM D2842, 0.7% by volume maximum.
 - .5 Edges: Shiplapped.
 - .6 Water Vapour Permeance: to ASTM E96, 50 ng/Pas m2.
 - .7 Manufacturer and Product Name: Styrofoam SM Extruded Polystyrene Insulation, Dow Chemical Canada, Inc. or approved equivalent.
 - .2 Adhesive: To applicable codes and standards.
 - .3 Clips and Fasteners: corrosion-resistant type, sized to suit application; as supplied by insulation manufacturer.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 WORKMANSHIP

- .1 Install insulation after building substrate materials are dry.
- .2 Install insulation to maintain continuity of thermal protection to building elements and spaces.
- .3 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.
- .4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 type A chimneys and CAN/CSA-B149.1 and CAN/CSA-B149.2 type B and L vents.
- .5 Cut and trim insulation neatly to fit spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.
- .6 Offset both vertical and horizontal joints in multiple layer applications.
- .7 Do not enclose insulation until it has been inspected and approved by Departmental Representative.

3.3 EXAMINATION

- .1 Examine substrates and immediately inform Departmental Representative in writing of defects.
- .2 Prior to commencement of work ensure:
 - .1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.

3.4 ROOF INSULATION INSTALLATION

- .1 Install insulation boards with Factory Mutual approved fasteners (appropriate for the deck type) and plates.
- .2 Leave insulation board joints unbonded over line of expansion and control joints. Bond a continuous 150 mm wide 0.15 mm modified bituminous membrane over expansion and control joints using compatible adhesive and primer before application of insulation.

3.5 SLAB INSULATION

- .1 Place insulation over slabs beneath grade after base is complete.
 - .2 Extended boards over entire area as indicated
 - .3 Cut and fit insulation tight to protrusions or interruptions to insulation plane.
-

- .4 Prevent insulation from being displaced or damaged.

3.6 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM C665-12, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .2 Canadian Standards Association (CSA International).
 - .1 CSA B111-1974(R2003), Wire Nails, Spikes and Staples.
 - .2 CAN/CSA-B149.1-15, Natural Gas and Propane Installation Code.
 - .3 CAN/CSA-B149.2-1, Propane Storage and Handling Code.
- .3 Underwriters Laboratories of Canada (ULC).
 - .1 CAN/ULC-S604-M91, Type A Chimneys.
 - .2 CAN/ULC-S702-14, Standard for Mineral Fibre Insulation.

1.2 SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 01 33 00.
- .2 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.

1.3 QUALITY ASSURANCE

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
 - .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 for recycling in accordance with Waste Management Plan.
-

PART 2 - PRODUCTS

2.1 INSULATION

- .1 Batt and blanket mineral fibre: to CAN/ULC-S702.
 - .1 Exterior walls:
 - .1 Thickness and Thermal resistance: as indicated.
 - .2 Interior partitions: SAFB (Sound Attenuation/Fire Blanket).
 - .1 Thickness: as indicated.

2.2 ACCESSORIES

- .1 Insulation clips:
 - .1 Impale type, perforated 50 x 50 mm cold rolled carbon steel 0.8 mm thick, adhesive back, spindle of 2.5 mm diameter annealed steel, length to suit insulation, 25 mm diameter washers of self-locking type.
- .2 Nails: galvanized steel, length to suit insulation plus 25 mm, to CSA B111.
- .3 Tape: as recommended by manufacturer.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSULATION INSTALLATION

- .1 Install insulation to maintain continuity of thermal protection to building elements and spaces.
- .2 Install insulation with factory applied vapour barrier facing warm side of building spaces and vapour permeable membrane facing cold side. Lap ends and side flanges of membrane over framing members; retain in position with nails, staples, insulation clip or wire ties installed as recommended by manufacturer. Tape seal butt ends and lapped side flange. Do not tear or cut vapour barrier.
- .3 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- .4 Do not compress insulation to fit into spaces.
- .5 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys and CAN/CGA-B149.1 and CAN/CGA-B149.2 Type B and L vents.
- .6 Do not enclose insulation until it has been inspected and approved by Departmental Representative.

3.3 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

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

1.2 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures. Submit proof of manufacturer's CCMC Listing and listing number to Departmental Representative.
- .2 Submit proof of manufacturer's participation certificate for Environmental Choice Program to Departmental Representative.
- .3 Manufacturer's Instructions: Provide to indicate special handling criteria, installation sequence and cleaning procedures.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00. WHMIS acceptable to Labour Canada, and Health and Welfare Canada.
- .3 Submit product data sheets for sheet vapour retarders. Include:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Limitations.

1.4 MOCK-UPS

- .1 Submit mock-ups in accordance with Section 01 45 00.
- .2 Construct mock-up of sheet vapour barrier installation including one lap joint, one inside corner and at one electrical box. Mock-up may be part of finished work.
- .3 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with vapour barrier work.

1.5 QUALITY ASSURANCE

- .1 Quality assurance submittals:
 - .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 and comply with written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.
-

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20, and with the Waste Reduction Workplan
- .2 Use the least toxic sealants and adhesives necessary to comply with requirements of this section.
- .3 Close and seal, tightly, all partly used sealant and adhesive containers and store protected in well ventilated, fire-safe area at moderate temperature.
- .4 Place used hazardous sealant tubes and adhesive containers in areas designated for hazardous materials.
- .5 Collect, package and store polyethylene cut offs and waste material for recycling in accordance with Waste Management Plan.

PART 2 - PRODUCTS

2.1 SHEET VAPOUR BARRIER

- .1 Polyethylene film: to CAN/CGSB-51.34, 0.15 mm thick; containing minimum 50% recycled content, low VOC content.
- .2 Under new interior slabs, heavy duty polyolefin based film: to meet or exceed ASTM E 1745-09 Class A, B & C, 0.381 mm thick.

2.2 ACCESSORIES

- .1 Joint sealing tape: air resistant pressure sensitive adhesive tape, cloth fabric duct tape type recommended by vapour barrier manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.
- .2 Sealant: EcoLogo certified, not to contain total of volatile organic compounds in excess of 5% by weight, asbestos-free sealant, compatible with vapour retarder materials, recommended by vapour retarder manufacturer. To Section 07 92 00.
- .3 Moulded box vapour barrier: factory-moulded polyethylene box for use with recessed electric switch and outlet device boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Ensure services are installed and inspected prior to installation of retarder.
 - .2 Install sheet vapour retarder on warm side of exterior wall ceiling and floor assemblies prior to installation of gypsum board to form continuous retarder.
 - .3 Use sheets of largest practical size to minimize joints.
 - .4 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.
-

3.2 EXTERIOR SURFACE OPENINGS

- .1 Cut sheet vapour retarder to form openings and ensure material is lapped and sealed to frame.

3.3 PERIMETER SEALS

- .1 Seal perimeter of sheet vapour barrier as follows:
- .2 Apply continuous bead of sealant to substrate at perimeter of sheets.
- .3 Lap sheet over sealant and press into sealant bead.
- .4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

3.4 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 staples through lapped sheets at sealant bead into wood substrate.
 - .5 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.

3.5 ELECTRICAL BOXES

- .1 Seal electrical switch and outlet device boxes that penetrate vapour barrier as follows:
 - .1 Install moulded box vapour barrier OR Wrap boxes with film sheet providing minimum 300 mm perimeter lap flange.
 - .2 Apply sealant to seal edges of flange to main vapour barrier and seal wiring penetrations through box cover.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 03 30 00 – Cast in Place Concrete
- .2 Section 07 21 13 – Board Insulation
- .3 Section 07 92 00 – Joint Sealants

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM D4541-09e1, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
 - .2 ASTM E330/E330M-14, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls, by Uniform Static Air Pressure Difference.
 - .3 ASTM E783-02(2010), Standard Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors.
 - .4 ASTM E1186-03(2009), Standard Practices for Air Leakage Site Detection in Building Envelope and Air Retarder Systems.

1.3 PERFORMANCE REQUIREMENTS

- .1 Select and install wall and roof components and assemblies to resist air leakage caused by static air pressure across exterior wall, soffits and roof assemblies, including windows, glass, doors, roof hatches and other interruptions to integrity of wall and roof systems; to maximum air leakage rate of $L/s.m^2$ (cfm/sq ft) when subjected to pressure differential of 75 Pa (1.57 lb/sq ft) as measured in accordance with ASTM E73 and ASTM E330.
- .2 Select and install wall and roof components and assemblies to resist air leakage caused by dynamic air pressure across exterior wall, soffits and roof assemblies, including windows, glass, doors, roof hatches and other interruptions to integrity of wall and roof systems; to maximum air leakage rate of $L/s.m^2$ (cfm/sq ft) when subjected to hourly wind design loads in accordance with NBC, using 1 in 10 year probability, as measured in accordance with ASTM E783 and ASTM E330.
- .3 If ongoing testing is required throughout air/vapour barrier system installation, perform qualitative testing methods in accordance with ASTM E1186 or ASTM D4541.
- .4 Provide continuity of air/vapour barrier materials and assemblies in conjunction with materials described in Section 03 30 00, 07 21 13, 07 92 00.

1.4 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 in accordance with Section 01 35 29.
- .3 Quality Assurance Submittals: submit following in accordance with Section 01 45 00.
- .1 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .3 Avoid spillage, immediately notify Departmental Representative if spillage occurs and start clean up procedures.
- .4 Clean spills and leave area as it was prior to spill.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

1.7 AMBIENT CONDITIONS

- .1 Install solvent curing sealants and vapour release adhesive materials in open spaces with ventilation.
- .2 Ventilate enclosed spaces in accordance with Section 01 56 00.
- .3 Maintain temperature and humidity recommended by materials manufactures before, during and after installation.

1.8 SEQUENCING

- .1 Sequence work in accordance with Section 01 32 16.07.
- .2 Sequence work to permit installation of materials in conjunction with related materials and seals.

1.9 WARRANTY

- .1 Provide a three (3) year warranty under provisions of Section 01 78 00.
 - .2 Warranty: include coverage of installed sealant and sheet materials which:
 - .1 Fail to achieve air tight and watertight seal.
 - .2 Exhibit loss of adhesion or cohesion.
 - .3 Do not cure.
-

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Materials: as required to achieve specified performance criteria; functionally compatible with adjacent materials and components.

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 GENERAL

- .1 Perform Work in accordance with Sealant and Water proofer's Institute - Sealant and Caulking Guide Specification requirements for materials and installation.
- .2 Perform Work in accordance with National Air Barrier Association - Professional Contractor Quality Assurance Program and requirements for materials and installation.
- .3 Perform Work in accordance with Canadian Urethane Foam Contractor's Association - Professional Contractor Quality Assurance Program and requirements for materials and installation.

3.3 PREPARATION

- .1 Prepare substrate surfaces in accordance with air/vapour barrier material manufacturer's instructions.

3.4 INSTALLATION

- .1 Install air/vapour barrier materials in accordance with manufacturer's instructions.
- .2 Install sealant materials in accordance with manufacturer's instructions.
- .3 Apply sealants within recommended application temperature ranges.

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.

3.6 PROTECTION OF FINISHED WORK

- .1 Protect finished work in accordance with Section 01 61 00.
- .2 Do not permit adjacent work to damage work of this section.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI).
 - .1 ANSI B18.6.4-99, Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws.
- .2 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM D 2369-03, Test Method for Volatile Content of Coatings.
 - .2 ASTM D 2832-92(R1999), Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
 - .3 ASTM D 5116-97, Guide For Small-Scale Environmental Chamber Determinations of Organic Emissions From Indoor Materials/Products.
 - .4 ASTM A653/A653M-01 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM A792 / A792M-03 Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .3 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-51.32-M, Sheathing, Membrane, Breather Type.
 - .2 CAN/CGSB-93.3-M, Prefinished Galvanized and Aluminum-Zinc Alloy Steel Sheet for Residential Use.
 - .3 CAN/CGSB-93.4-92, Galvanized Steel and Aluminum-Zinc Alloy Coated Steel Siding, Soffits and Fascia, Prefinished, Residential.
- .4 Canadian Standards Association (CSA International).
 - .1 CSA B111- R2003), Wire Nails, Spikes and Staples.
- .5 Environmental Choice Program (ECP).
 - .1 CCD-045-95, Sealants and Caulking Compounds.
- .6 Underwriters' Laboratories of Canada (ULC).
 - .1 CAN/ULC-S706-02, Wood Fibre Thermal Insulation for Buildings. ‘

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 metal siding 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.
 - .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00.
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- .2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
- .3 Indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, soffits, fascia, metal furring, and related work.
- .4 Samples:
 - .1 Submit duplicate 1200 x1200mm samples of siding material, of colour and profile specified.
- .5 Manufacturer's Instructions:
 - .1 Submit manufacturer's installation instructions.

1.3 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.

1.4 DESIGN REQUIREMENTS

- .1 Design wall system to resist:
 - .1 Wind loads, positive and negative, expected in this geographical region NBCC climatic data, 50 year probability.
 - .2 Deflection of the wall system is not to exceed 1/180th of the span for the wind load based on serviceability limit states.
 - .3 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, overstressing of components, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
 - .1 Temperature Change (Range): 20 °C, ambient; 40 °C, material surfaces.
 - .4 Design expansion joints to accommodate movement in cladding and between cladding and structure to prevent permanent distortion or damage to the cladding.
 - .5 Design wall system to maintain the following erection tolerances:
 - .1 Maximum variation from plane or location shown on shop drawings: 20 mm/10 m.
 - .2 Maximum offset from true alignment between two adjacent members abutting end to end in line: 1 mm.

1.5 MAINTENANCE DATA

- .1 Provide maintenance data for cleaning and maintenance of panel finishes for incorporation into manual specified in Section 01 78 00.

1.6 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 off ground in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal siding from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 20.
 - .1 Divert used metal cut-offs from landfill by disposal into the on-site metals recycling bin, removed for disposal at the nearest metal recycling facility.
 - .2 Divert reusable materials for reuse at nearest used building materials facility.
 - .3 Divert unused caulking, sealants, and adhesive materials from landfill through disposal at hazardous material depot.

1.7 GUARANTEE

- .1 For work in this section, warranty by installer against defects or deficiencies in materials or workmanship shall be for a period of one year from date of substantial completion.

1.8 WARRANTY

- .1 Provide a manufacturer's written warranty: Furnish panel manufacturer's written warranty covering failure of factory-applied exterior finish within the warranty period. Warranty period for finish: 20 years after the date of Substantial Completion. The values below are based on normal environments and exclude any aggressive atmospheric conditions.

PART 2 - PRODUCTS

2.1 ALUMINUM CLADDING COMPONENTS

- .1 Metal Wall System:
 - .1 Sub-girts: Minimum 1.21 mm (0.048") thick formed galvanized steel, ASTM A653/A653M-01 Grade 230 with Z275 zinc coating. Full depth of wall system, factory notched and formed to match liner.
 - .2 Steel Cladding:
 - .1 Profile: To match existing.
 - .2 Fabricated from Z275 galvanized sheet steel conforming to ASTM A653/A653M-01, Grade 33 or AZ150 Galvalume, sheet steel conforming to ASTM A792 / A792M-03 Grade 33; minimum 0.711mm (22ga).

2.2 PANEL FINISHES

- .1 Cladding coating: galvanized
 - .2 Soffit to: CAN/CGSB 93.4-92, Class: plain:
-

- .1 Finish coating: galvanized.
- .2 Thickness: 0.305mm (30ga).
- .3 Profile: flat sheet 'V' crimped for stiffness, preformed with elongated slits and small perforations insect screen cover at vents.
- .3 Fascia facings and exposed trim: to CGSB 93.4, Class plain:
 - .1 Finish coating: galvanized.
 - .2 Thickness: 0.305mm (30ga).
 - .3 Profile: custom and manufacturer's standard as indicated.

2.3 ACCESSORIES

- .1 Flashing: In accordance with Section 07 62 00. Material to match cladding in exposed locations, galvanized material in concealed locations. Custom fabricated to suit Departmental Representative details, as required. Use preformed corner pieces only. Double back exposed edges.
- .2 Exposed trim: inside corners, outside corners, cap strip, drip cap, undersill trim, starter strip and window/door trim of same material, colour and gloss as cladding, with fastener holes pre-punched.
- .3 Closures: Metal closures to suit profiles selected, to manufacturer's recommendations.
- .4 Sealants:
 - .1 Concealed: Tape or compound, non-skinning, non-drying, butyl rubber.
 - .2 Exposed: Acrylic co-polymer to CGSB 19GP-5M

2.4 CAULKING

- .1 Sealants: in accordance with Section 07 92 00.

2.5 SHEATHING PAPER

- .1 Exterior wall sheathing paper: to CAN/CGSB-2-51.32-M, spunbound olefin type as indicated.

2.6 FABRICATION

- .1 Fabricate roof components to comply with dimensions, profiles, gauges and details as shown on the shop drawings, including fascia and soffit panels and all companion flashing.
 - .2 Fabricate all components of the system in the factory, ready for field installation.
 - .3 Provide metal liner and cladding and all accessories in longest practicable length to minimize field lapping of joints.
-

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

- .1 Install cladding in accordance with manufacturer's written instructions.
 - .2 Install one layer exterior wall sheathing paper horizontally by stapling nailing lapping edges 150 mm.
 - .3 Install continuous starter strips, inside and outside corners, edgings, soffit, drip, cap, sill and window/door opening flashings as indicated.
 - .4 Install outside corners, fillers and closure strips with carefully formed and profiled work.
 - .5 Install soffit and fascia cladding as indicated.
 - .6 Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.
 - .7 Attach components in manner not restricting thermal movement.
 - .8 Caulk junctions with adjoining work with sealant. Do work in accordance with Section 07 92 00.
 - .9 Sub-girt framing system:
 - .1 Install sub-girts. Frame all openings in the cladding.
 - .10 Flashing:
 - .1 Install starter flashing, drip and other flashing, and corners, edgings, window and door flashing as shown on the drawings.
 - .11 Exterior Cladding:
 - .1 Install exterior cladding and soffit in accordance with manufacturer's standard installation procedures, providing proper laps and detailing to ensure a weathertight face.
 - .2 Install finishing flashing and cap flashing.
 - .12 Sealants:
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- .1 Install sealants at junctions with adjoining work, and where shown on the drawings, in accordance with Section 07 92 10.

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 Clean exposed panel surfaces in accordance with manufacturer's instructions.
- .3 Repair and touch up with colour matching high grade enamel minor surface damage, only where permitted by the Departmental Representative and only where appearance after touch-up is acceptable.
- .4 Replace damaged panels and components that, in opinion of the Departmental Representative, cannot be satisfactorily repaired.
- .5 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.
- .6 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11.
- .7 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.

3.5 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 06 10 00 – Rough Carpentry
- .2 Section 07 21 13 – Built-Up Bituminous Roofing
- .3 Section 07 92 00 – Joint Sealants

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 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.
 - .2 ASTM D41/D41M-11, Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
 - .3 ASTM D448-12, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
 - .4 ASTM D1863/D1863M-05(2011)e1, Standard Specification for Mineral Aggregate Used on Built-Up Roofs.
 - .2 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A123.4-04(R2013), Asphalt for Constructing Built-Up Roof Coverings Waterproofing Systems.
 - .2 CSA A123.17-05(R2014), Asphalt Glass Felt Used for Roofing and Waterproofing.
 - .3 CSA A123.21-14, Standard Test Method for the Dynamic Wind Uplift Resistance of Mechanically Attached Membrane-Roofing Systems
 - .4 CSA A231.1-14/A231.2-14, Precast Concrete Paving Slabs/Precast Concrete Pavers.
 - .5 CAN/CSA-ISO 9001-08, Quality Management Systems - Requirements.
 - .6 CAN/CSA-ISO 14001-04(R2014), Environmental Management Systems - Requirements with Guidance for Use.
 - .3 Canadian Roofing Contractors' Association (CRCA)
 - .1 CRCA Canadian Roofing Reference Manual - 1999.
 - .4 Factory Mutual (FM Global)
 - .1 FM Approvals - Roofing Products.
 - .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
 - .6 Underwriters' Laboratories of Canada (ULC)
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- .1 CAN/ULC-S704-11, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheets for bitumen roofing felts insulation and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29 for:
 - .1 Primers.
 - .2 Asphalt.
 - .3 Sealers.
- .3 Provide shop drawings:
 - .1 Indicate flashing, control joints, tapered insulation details.
 - .2 Provide layout for tapered insulation.
- .4 Manufacturer's Certificate: certify that products meet or exceed specified requirements.
 - .1 Provide proof of manufacturer's CCMC listing.
 - .2 Provide proof of manufacturer's ISO 9001 registration and compliance.
 - .3 Provide proof of manufacturer's ISO 14001 registration and compliance.
- .5 Test and Evaluation Reports: submit laboratory test reports certifying compliance of bitumen and roofing felts and membrane with specification requirements.
 - .1 Compatibility of materials: submit written declaration to Departmental Representative as described in PART 2, PERFORMANCE CRITERIA.

1.4 QUALITY ASSURANCE

- .1 Mock-ups:
 - .1 Construct mock-up in accordance with Section 01 45 00.
 - .2 Construct mock-up 10 m2 minimum size showing typical lap joint, one inside corner and one outside corner.
 - .3 Construct mock-up where directed.
 - .4 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with roofing work.
 - .5 When accepted, mock-up will demonstrate minimum standard for this work and may not remain as part of the finished work.

1.5 FIRE PROTECTION

- .1 Fire Extinguishers:
 - .1 Maintain one cartridge operated type or stored pressure rechargeable type with hose and shut-off nozzle.
 - .2 ULC labelled for A, B and C class protection.
- .2 Maintain fire watch for 1 hour after each day's roofing operations cease.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01 61 00.
- .2 Delivery and Acceptance Requirements:
 - .1 Deliver materials in original containers, sealed, with labels intact.
 - .1 Ensure shelf life of materials has not expired.
 - .2 Deliver fasteners in boxes or kegs and keep in protective storage until used. Do not oil or grease fasteners.
 - .3 Supply three copies of purchase orders to Departmental Representative. Include following data:
 - .1 Purchase order number.
 - .2 Supplier's name and address.
 - .3 Purchaser's name and address.
 - .4 Contract number and job number.
 - .5 Material and governing specification including type, grade, colour, class and quantity.
 - .6 Bills of lading for liquid asphalt showing Equiviscous Temperature (EVT), Flash Point Temperature (FP) and Final Blowing Temperature (FBT).
 - .7 Shipping instructions.
 - .8 Destination.
 - .4 Identification for delivery: indicate on containers or wrappings of and materials:
 - .1 Manufacturer's name and brand.
 - .2 Compliance with applicable standard.
 - .3 Mass where applicable.
 - .5 Storage and Handling Requirements:
 - .1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of asphalt, sealing compounds, primers and caulking materials.
 - .2 Provide and maintain dry, off-ground weatherproof storage.
 - .3 Store materials on supports to prevent deformation.

- .4 Remove only in quantities required for same day use.
- .5 Store materials in accordance with manufacturers written instructions.
- .6 Store insulation protected from sunlight and weather and deleterious materials exposure.
- .7 Remove damaged and rejected materials from site.
- .6 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 20.
- .7 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .8 Fold up metal banding, flatten and place in designated area for recycling.

1.7 FIELD CONDITIONS

- .1 Ambient Conditions:
 - .1 Apply built-up bituminous membranes only when surfaces and ambient temperatures are within manufacturers' prescribed limits.
 - .2 Do not install built-up bituminous membranes when air and substrate temperature remains below 5°C in accordance with manufacturer's recommendations or when wind chill gives equivalent cooling effect.
 - .3 Install built-up bituminous membranes on dry substrate, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into system.
- .2 Ventilation:
 - .1 Ventilate area of work as directed by Departmental Representative by use of approved portable supply and exhaust fans.
 - .2 Ventilate enclosed spaces in accordance with Section 01 56 00.
 - .3 Provide continuous ventilation during and after roofing application.
 - .1 Run ventilation system 24 hours per day during installation.
 - .2 Provide continuous ventilation for 7 days after completion of roofing installation.

1.8 WARRANTY

- .1 For Work in this Section, 12 months warranty period is extended to 60 months.

PART 2 - PRODUCTS

2.1 PLANT AND EQUIPMENT

- .1 Do not use direct fired equipment.
 - .2 Use only kettles equipped with thermometers or gauges in good working order.
-

- .3 Locate kettles in safe place outside of building or, if approved by Departmental Representative, on non-combustible substrate at location to avoid danger of igniting combustible material below.
 - .1 When locating kettles, give consideration to direction of prevailing winds, building fans and air handling units to minimize possibility of smoke and fumes entering surrounding occupied buildings.
 - .2 If wind direction causes smoke and fume problems, relocate kettles on daily basis when directed by Departmental Representative.
 - .3 Maintain supervision while kettles are in operation and provide metal covers for kettles to smother flames in case of fire.
 - .4 Provide suitable fire extinguishers.
 - .5 Maintain efficiency of kettles and equipment by frequent cleaning.
 - .6 Remove all carbonized bitumen.
 - .7 Use only fibreglass roofing mops.

2.2 DESCRIPTION - ROOFING SYSTEM

- .1 Four ply asphalt organic and fiberglass felt built-up conventional membrane roof system.

2.3 PERFORMANCE CRITERIA

- .1 Compatibility between components of system and adjacent materials is essential.
- .2 Provide written declaration to Departmental Representative stating that materials and components, as assembled in system, meet this requirement.
- .3 Roofing System: to CSA A123.21 for wind uplift resistance.

2.4 DECK SHEATHING

- .1 Cementitious Board: 13 mm thick or as indicated.

2.5 DECK PRIMER

- .1 Asphalt primer: to ASTM D41/D41M.

2.6 VAPOUR RETARDER

- .1 Two-ply bituminous membrane consisting of:
 - .1 No. 15 asphalt saturated felt: Glass roofing felt to CSA A123.17
 - .2 Type 2 asphalt to CAN/CSA-A123.4.

2.7 BITUMEN

- .1 Asphalt: to CAN/CSA-A123.4, Type 2.
-

2.8 OVERLAY BOARD

- .1 Mineral fibre board (roof): to ASTM C 726.
 - .1 Thickness: 12 mm.
 - .2 Size: 1200 x 2400 mm minimum.

2.9 FELTS

- .1 Saturated glass fibre felts: to CSA A123.17 , Type IV-ply sheet.

2.10 POLYISOCYANURATE INSULATION

- .1 To CAN/ULC-S704, Refer to Section 07 21 13.

2.11 SEALERS

- .1 Plastic cement: asphalt coal tar.
- .2 Sealing compound: rubber asphalt type.
- .3 Sealants: asbestos-free sealant, compatible with systems materials, recommended by system manufacturer . In accordance with Section 07 92 00.

2.12 WALKWAYS

- .1 Walkways to consist of one additional ply of cap sheet membrane. Colour to be different from field membrane as selected by Departmental Representative.

2.13 CARPENTRY

- .1 Refer to Section 06 10 00.

2.14 CANT STRIPS

- .1 Cut from pressure-treated wood 38 mm thick, to measure 140 mm on slope.
 - .1 Prefabricated cants: use where applicable.

2.15 FASTENERS

- .1 Sheathing to steel deck: No.10 flat head, self-tapping, Type S, cadmium plated screws to ASTM C1002.
- .2 Insulation to deck: coated insulation fasteners and galvanized plates must meet FM Approval for wind uplift and corrosion resistance, as recommended by insulation manufacturer.

2.16 BALLAST

- .1 Stone: 19 to 32 mm size, well graded crushed stone, gravel ballast to ASTM D448, Gradation 57 opaque, non-porous, washed, free from fines, long splinters, moisture, ice and snow.
- .2 Paving slabs: to CSA A231.1/A231.2, 600 x 600 x 50 mm thick of sizes indicated natural precast concrete paving slabs having non-slip finish with 51 mm plain margin around perimeter.

2.17 SOURCE QUALITY CONTROL

- .1 Provide laboratory test reports certifying compliance of bitumens and roofing felts with specification requirements as described in PART 1, SUBMITTALS/QUALITY CONTROL.

PART 3 - EXECUTION

3.1 QUALITY OF WORK

- .1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual and CRCA Roofing Specification Manual , particularly for health and fire safety precautions.
- .3 Do priming in accordance with manufacturer's written recommendations.
- .4 The interface of the walls and roof assemblies will be fitted with durable rigid material sheet metal plywood providing connection point for continuity of air barrier.
- .5 Assembly, component and material connections will be made in consideration of appropriate design loads, with reversible mechanical attachments.

3.2 SUBSTRATE EXAMINATION

- .1 Verification of Conditions: examine substrates and immediately inform of Departmental Representative in writing of defects.
- .2 Evaluation and Assessment: prior to beginning of work ensure:
 - .1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris.
 - .2 Curbs have been built.
 - .3 Drains have been installed at proper elevations relative to finished roof surface.
 - .4 Plywood and lumber nailer plates have been installed to walls and parapets as indicated.

3.3 PREPARATION - HEATING OF ASPHALT

- .1 Heat asphalt in kettle or tanker sufficiently to provide correct EVT range at point of application.
- .2 In cold weather insulate hauling equipment and re-circulation lines to minimize heat loss.
- .3 Do not heat asphalt above its Final Blowing Temperature (FBT) in tanker.
- .4 Heating asphalt above its FBT may be permissible in kettle as long as asphalt is used up within four hours.
- .5 Equip kettle and tanker with working thermometers.

3.4 PROTECTION OF IN-PLACE CONDITONS

- .1 Cover walls, walks , slopped roofs and adjacent work where materials hoisted or used.
- .2 Use warning signs and barriers.
 - .1 Maintain in good order until completion of work.
- .3 Clean off drips and smears of bituminous material immediately.
- .4 Dispose of rain water off substrates and away from face of building until drains or hoppers installed and connected.
- .5 Protect from traffic and damage.
 - .1 Comply with precautions deemed necessary by Departmental Representative.
- .6 Place plywood runways over work to enable movement of material and other traffic.
- .7 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed work and materials out of storage.
- .8 Install insulation promptly to avoid possibility of condensation beneath vapour retarder.

3.5 DECK SHEATHING

- .1 Mechanically fasten to steel deck Cementitious Board with reversible mechanical attachments to steel deck's upper rib surfaces, spaced 400 mm on centre each way.
- .2 Place sheathing with long axis of each sheet transverse to steel deck ribs, with end joints staggered and fully supported on ribs.

3.6 PRIMING DECK

- .1 Apply deck primer to cementitious board roofing substrate at the rate specified on the container.
-

3.7 VAPOUR RETARDER (CONCRETE / GYPSUM BOARD)

- .1 Embed two piles of felts glass in hot bitumen spread at rate of 1.2 for glass asphalt.
- .2 Apply one ply only for concrete or gypsum board deck.

3.8 INSULATION: FULLY ADHERED, BITUMEN APPLICATION

- .1 Embed insulation in 1 to 1.5 kg/m² mopping of bitumen.
- .2 Place boards in parallel rows with ends staggered, and in firm contact with one another.
- .3 Cut end pieces to suit.

3.9 TAPERED INSULATION: APPLICATION

- .1 Mop insulation to felt vapour retarder and top layer of insulation to bottom layer with hot asphalt at rate of 1 kg/m².
- .2 Install tapered insulation in accordance with shop drawings.
 - .1 Stagger joints between layers 150 mm minimum.

3.10 OVERLAY BOARD: ADHESIVE APPLICATION

- .1 Adhere overlay board to insulation with vulcanized adhesive at rate of one litre per m².
- .2 Place boards in parallel rows with end joints staggered.
 - .1 Cap joints approximately 25 mm.
- .3 Cut ends to suit and apply adhesive in continuous ribbons at 300 mm on centre.

3.11 (EXPOSED) CONVENTIONAL MEMBRANE ROOFING (CMR) APPLICATION

- .1 Membrane application:
 - .1 Starting at low point, perpendicular to slope, embed four plies of roofing felts in hot asphalt over insulation.
 - .2 Overlap sheets 3/4 of their width plus 15 mm for four ply membrane and lap ends 150 mm.
 - .3 Apply asphalt at rate of 1 kg/m² with organic felts and 1.2 kg/m² with glass felts coal tar pitch at rate of 1.5 kg/m².
 - .4 Extend felts up to top of cant strip.
 - .5 Install water cut-offs at end of day, and remove before resuming work.
 - .6 Apply uniform flood coat at rate of 3 kg/m² for asphalt and while bitumen is still hot, apply protective gravel at rate of 20 kg/m².
 - .7 Ensure that there are no skips in flood coat. If some are found, sweep gravel aside and reflow area.

- .2 Flashing application:
 - .1 Build flashings out of two ply of SBS modified asphalt membrane.
 - .2 On exterior walls extend membrane flashing up inside face of parapet and over top to outside face of wall.
 - .3 On interior walls, build base flashing up to cavity wall or through wall flashing.
 - .4 Keep nails 200 mm above top of cant strip.
- .3 Gravel surfacing:
 - .1 Inspect entire area to ensure no wrinkles, buckles or fishmouths exist.
 - .2 Apply bitumen and gravel surfacing only after placement of roofing felts and membrane flashings.
 - .3 Apply flood coat of hot bitumen at 3 kg/m² into which, while hot, embed aggregate at minimum rate of 20 kg/m². Ensure aggregate is dry and free from frost.
- .4 Where double pour is required:
 - .1 Remove loose aggregate and
 - .2 Repeat application of bitumen and gravel at same rate and quantity as first application for total aggregate mass of 30 kg/m² and 5 kg/sq.m. of asphalt.

3.12 FIELD QUALITY CONTROL

- .1 Inspection:
 - .1 Inspection and testing of BUR application will be carried out by testing laboratory designated by Departmental Representative.
 - .2 Costs of tests will be paid by Contractor.

3.13 CLEANING

- .1 Clean work in accordance with Section 01 74 11.
- .2 Clean to Departmental Representative's approval, soiled surfaces, spatters, and damage caused by work of this Section.
- .3 Check drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from site.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
 - .1 Collect, package and store partly used or unused containers of asphalt, sealing compounds, primers and roofing felts for recycling, and return to recycler in accordance with Waste Management Plan.
 - .2 Plan and coordinate insulation work to minimize generation waste.
 - .3 Give preference to suppliers who take back mineral fibre insulation waste for reuse or recycling.

- .4 Place used hazardous sealant tubes, adhesive containers and materials defined as hazardous or toxic in designated containers.
- .5 Clearly label location of salvaged material's storage areas and provide barriers and security devices.
- .6 Ensure emptied containers are sealed and stored safely.
- .7 Divert unused aggregate materials from landfill to local quarry facility for reuse as reviewed by Departmental Representative.
- .8 Unused paint/ coating materials must be disposed of at official hazardous material collections site as reviewed by Departmental Representative.
- .9 Unused adhesive, sealant and asphalt materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .10 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.
- .11 Dispose of unused sealant material at official hazardous material collections site approved by Departmental Representative.
- .12 Dispose of unused asphalt material at official hazardous material collections site approved by Departmental Representative.
- .13 Divert unused gypsum materials from landfill to recycling facility as reviewed by Departmental Representative.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 07 21 13 – Built-Up Bituminous Roofing
- .2 Section 07 92 00 – Joint Sealants

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 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.
 - .2 ASTM C1396/C1396M-14a, Standard Specification for Gypsum Board.
 - .3 ASTM D1863/D1863M-05(2011)e1, Standard Specification for Mineral Aggregate Used on Built-up Roofs.
 - .4 ASTM D4637/D4637M-14e1, Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane.
 - .5 ASTM D7655 / D7655M-12, Standard Classification for Size of Aggregate Used as Ballast for Membrane Roof Systems
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86(1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .3 Canadian Roofing Contractors' Association (CRCA)
 - .1 CRCA Roofing Specification Manual 1997.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA A123.21-14, Standard Test Method for the Dynamic Wind Uplift Resistance of Mechanically Attached Membrane-Roofing Systems
- .5 Factory Mutual (FM Global)
 - .1 FM Approval Standard # 4470-86, Class 1 Roof Covers.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S704-11, Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.
 - .2 CAN/ ULC-S702.2-03, Standard for Mineral Fibre Thermal Insulation for Buildings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Product Data:
-

- .1 Provide manufacturer's printed product literature, specifications and datasheets for membranes insulation and include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29.
- .3 Provide shop drawings:
 - .1 Indicate flashing, control joints, tapered insulation penetrations field fabricated seams details.
 - .2 Provide layout for tapered insulation.
- .4 Test and Evaluation Reports: submit laboratory test reports certifying compliance of roofing membrane with specification requirements.
 - .1 Compatibility of materials: submit written declaration to Departmental Representative as described in PART 2, PERFORMANCE CRITERIA.
- .5 Manufacturer's Installation Instructions: indicate special precautions required for seaming the membrane.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01 61 00.
- .2 Storage and Handling Requirements:
 - .1 Provide and maintain dry, off-ground weatherproof storage.
 - .2 Store materials on supports to prevent deformation.
 - .3 Remove only in quantities required for same day use.
 - .4 Store uncured flashing and jointing materials to prevent premature curing and freezing.
 - .5 Store insulation protected from sunlight and weather and deleterious materials.
 - .6 Store roofing materials in accordance with manufacturer's written instructions, to prevent damage or loss of performance.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 20.
 - .1 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
 - .2 Fold up metal banding, flatten and place in designated area for recycling.

1.5 FIELD CONDITIONS

- .1 Ambient Conditions:
 - .1 Apply EPDM membrane only when surfaces and ambient temperatures are within manufacturers' prescribed limits.
 - .2 Do not install EPDM membrane when air and substrate temperature remains below 5°C in accordance with manufacturer's recommendations or when wind chill gives equivalent cooling effect.
 - .3 Install EPDM membrane on dry substrate, free of snow and ice. Use only dry materials and apply only during weather that will not introduce moisture into system.

- .2 Ventilation:
 - .1 Ventilate area of Work as directed by Departmental Representative by use of approved portable supply and exhaust fans.
 - .2 Ventilate enclosed spaces in accordance with Section 01 56 00.
 - .1 Provide continuous ventilation during and after roofing application.
 - .2 Run ventilation system 24 hours per day during installation.
 - .3 Provide continuous ventilation for 7 days after completion of roofing installation.

1.6 WARRANTY

- .1 For the Work of this Section, 12 months warranty period is extended to 60 months.

PART 2 - PRODUCTS

2.1 DESCRIPTION - ROOFING SYSTEM

- .1 EPDM elastomeric membrane roofing consisting of: reinforced membrane for use in adhered and ballasted system.

2.2 PERFORMANCE CRITERIA

- .1 Compatibility between components of system and adjacent materials is essential.
 - .1 Provide a written declaration to Departmental Representative stating that all materials and components, as assembled in system, meet this requirement.
- .2 Roofing system: to CSA A123.21 for wind uplift resistance.

2.3 DECK COVERING

- .1 Gypsum board: to ASTM C1396/C1396M, Fire Rated Type X Water-resistant, thickness as indicated.

2.4 VAPOUR RETARDER

- .1 Kraft-laminated foil paper: to CAN/CGSB-51.34, and fire resistant adhesive.
- .2 Polyethylene: to CAN/CGSB-51.34, Type 1, 0.25 mm thick.

2.5 MEMBRANE

- .1 Ethylene propylene diene monomer (EPDM sheet membrane): to ASTM D4637/D4637M-14e1.
 - .1 Type 1, Class B, 1.6 mm thick, non-reinforced membrane for use in protected system.
 - .2 Type 2, Class A, 1.6 mm thick, reinforced membrane for use in mechanically fastened system.
 - .3 Self-curing, EPDM based membrane for use as flashing as required by membrane manufacturer.

2.6 POLYISOCYANURATE INSULATION

- .1 To CAN/ULC-S704, Refer to Section 07 21 13.

2.7 OVERLAY BOARD

- .1 Mineral fiber board (roof): to CAN/ULC-S702.2.
 - .1 Thickness: 12 mm.
 - .2 Size: 1200 x 2400 mm minimum.

2.8 OVERLAY BOARD ADHESIVE

- .1 Adhesive for securing overlay board and insulation: as recommended by manufacturer.

2.9 SEALERS

- .1 Sealants: asbestos-free sealant, compatible with systems materials.
- .2 Plastic cement: asphalt.
- .3 Sealing compound: rubber asphalt type.
- .4 As recommended by system manufacturer. In accordance with Section 07 92 00.

2.10 FASTENERS

- .1 Sheathing to steel deck: No.10 flat head, self-tapping, Type S, cadmium plated screws to ASTM C1002.
- .2 Insulation to substrate: fasteners and plates must meet FM Approval Standard #4470 for wind uplift and corrosion resistance.
- .3 Membrane to substrate: fasteners and spacing as recommended by manufacturer.

2.11 FILTER FABRIC

- .1 UV resistant, black woven polyolefin fabric for installation between insulation and stone ballast in protected membrane system.
 - .1 Fabric to meet recommendation of insulation manufacturer.
 - .2 Product weight 77.9 gm/m².

2.12 BALLAST

- .1 Stone: Gravel ballast to ASTM D448, Gradation 57, opaque, non-porous, washed, free from fines, long splinters, ice and snow.
- .2 Gravel: to ASTM D1863/D7655M, water-worn gravel.

2.13 PROTECTION MAT

- .1 Non-woven polypropylene needle punched felt.
-

2.14 FASTENING

- .1 Bar, with pre-punched holes and screws.
- .2 Screws and washers as recommended by manufacturer.

2.15 ADHESIVES, TAPES AND PRIMERS

- .1 Adhesive, tapes and primers, in accordance with manufacturer's recommendations.

2.16 SOURCE QUALITY CONTROL

- .1 Provide laboratory test reports certifying compliance of roofing materials with specification requirements as described in PART 1, SUBMITTALS/QUALITY CONTROL.

PART 3 - EXECUTION

3.1 QUALITY OF WORK

- .1 Compliance: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.
- .2 Do examination, preparation and roofing Work in accordance with Roofing Manufacturer's Specification Manual CRCA Roofing Specification Manual, Provincial/Territorial Roofing Association Manual.

3.2 SUBSTRATE EXAMINATION

- .1 Verification of Conditions: examine substrates and immediately inform Departmental Representative in writing of defects.
- .2 Evaluation and Assessment: prior to beginning work ensure:
 - .1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and swept clean of dust and debris.
 - .2 Curbs have been built.
 - .3 Drains have been installed at proper elevations relative to finished surfaces.
 - .4 Plywood and lumber nailer plates have been installed to walls and parapets as indicated.

3.3 PROTECTION OF IN-PLACE CONDITIONS

- .1 Cover walls, walks, sloped roofs and adjacent work where materials hoisted or used.
 - .2 Use warning signs and barriers: Maintain in good order until completion of Work.
 - .3 Dispose of rain water away from face of building until drains or hoppers installed and connected.
 - .4 Protect from traffic and damage: Comply with precautions deemed necessary by Departmental Representative.
 - .5 Place plywood runways over work to enable movement of material and other traffic.
-

- .6 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed Work and materials out of storage.
- .7 Seal and ballast exposed edges.
- .8 If metal connectors used, treat connectors and decking with rust proofing or galvanization.

3.4 PREPARATION OF STEEL DECK (CHANNEL TYPE)

- .1 Install sound absorbing insulation in flutes of acoustical steel roof deck in accordance with deck manufacturer's instructions.
- .2 If using mechanical fasteners, treat decking with rust proofing or galvanization.

3.5 DECK SHEATHING

- .1 Mechanically fasten Gypsum Board Sheathing to steel deck with reversible mechanical attachments screws spaced 400 mm on center each way.
- .2 Place with long axis of each sheet transverse to steel deck ribs, with end joints staggered and fully supported on ribs.

3.6 VAPOUR RETARDER (CONCRETE / GYPSUM BOARD)

- .1 Apply CGSB approved 0.15 mm (6 mil) polyethylene.
- .2 Embed two piles of felts glass in hot bitumen spread at rate of 1.2 for glass asphalt.

3.7 PROTECTED MEMBRANE ROOFING (PMR) APPLICATION

- .1 Membrane, adhered application:
 - .1 Position membrane over substrate starting at highest point.
 - .2 Overlap sheets 100 mm minimum.
 - .3 Allow membrane to relax for ½ hour.
 - .4 Apply adhesive to membrane and substrate in accordance with manufacturer's written instructions.
 - .5 Do not apply adhesive to splice area.
- .2 Insulation application:
 - .1 Insulation to be loose laid in parallel rows with ends staggered.
 - .2 Where insulation is in contact with cants bevel insulation edges to fit snug to cant slope.
- .3 Flashings:
 - .1 Install cured or uncured EPDM membrane flashings in accordance with manufacturer's written instructions.
- .4 Penetrations:
 - .1 Install drain pans, vent stack covers and other penetration flashings and seal to membrane in accordance with manufacturer's recommendations and details.
- .5 Filter fabric application:

- .1 Apply fabric unbonded over installed insulation.
- .2 Overlap edges 300 mm minimum.
- .3 Cut fabric around drains, vents and other penetrations and extend under metal flashings.

3.8 BALLAST AND PROTECTIVE COVERING

- .1 Apply stone ballast, as soon as possible after placement of fabric, at minimum rate of 75 kg/m².
- .2 Spread stone ballast to an even thickness over entire area.

3.9 FIELD QUALITY CONTROL

- .1 Inspection:
 - .1 Inspection and testing of EPDM membrane application will be carried out by testing laboratory designated by Departmental Representative.
 - .2 Contractor will pay for tests.

3.10 CLEANING

- .1 Clean Work in accordance with Section 01 74 11.
- .2 Clean to Departmental Representative's approval, soiled surfaces, spatters, and damage caused by Work of this Section.
- .3 Check drains to ensure cleanliness and proper function, and remove debris, equipment and excess material from site.
- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.
 - .1 Collect, package and store EPDM membrane cut-offs and waste material for recycling, and return to recycler in accordance with Waste Management Plan.
 - .2 Plan and co-ordinate insulation work to minimize generation waste.
 - .3 Place used hazardous sealant tubes, adhesive containers and materials defined as hazardous or toxic in designated containers.
 - .4 Clearly label location of salvaged material's storage areas and provide barriers and security devices.
 - .5 Ensure emptied containers are sealed and stored safely.
 - .6 Divert unused aggregate materials from landfill to local facility for reuse as reviewed by Departmental Representative.
 - .7 Unused paint/coating material must be disposed of at official hazardous material collections site as reviewed by Departmental Representative.
 - .8 Unused adhesive, sealant materials must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
 - .9 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.
 - .10 Dispose of unused sealant material at official hazardous material collections site approved by Departmental Representative.

- .11 Divert unused gypsum materials from landfill to recycling facility as reviewed by Departmental Representative.
- .12 Divert unused geotextiles from landfill to plastic recycling facility for disposal approved by Departmental Representative.
- .13 Divert wood materials from landfill to recycling/ reuse/composting facility approved by Departmental Representative.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 07 92 00 – Joint Sealants

1.2 REFERENCES

- .1 The Aluminum Association Inc. (AAI)
 - .1 AAI-Aluminum Sheet Metal Work in Building Construction-2002.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A792-10/A792M-10, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .3 Canadian Roofing Contractors Association (CRCA)
 - .1 Roofing Specifications Manual 2012.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 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 in accordance with Section 01 35 29.
- .3 Samples:
 - .1 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, finishes and colours.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 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 Aluminum-zinc alloy coated steel sheet: to ASTM A792/A792M, commercial quality, grade 33 with AZ180 coating, FACTORY Galvalume finish. Minimum 0.61mm base metal thickness, or as indicated.

2.2 PREFINISHED STEEL SHEET

- .1 Prefinished steel with factory applied galvalume finish.

2.3 ACCESSORIES

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Plastic cement: to applicable codes and standards.
- .3 Underlay for metal flashing: asphalt laminated 3.6 to 4.5 kg kraft paper.
- .4 Sealants: as specified in Section 07 92 00.
- .5 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.
- .6 Fasteners: of same material as sheet metal, to CSA B111, 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 Flux: rosin, cut hydrochloric acid, or commercial preparation suitable for materials to be soldered.
- .9 Touch-up paint: as recommended by prefinished material manufacturer.

2.4 FABRICATION

- .1 Fabricate metal flashings and other sheet metal work in accordance with applicable CRCA 'FL' series details.
- .2 Fabricate aluminum flashings and other sheet aluminum work in accordance with AAI-Aluminum Sheet Metal Work in Building Construction.
- .3 Form pieces in 2400 mm maximum lengths.
 - .1 Make allowance for expansion at joints.
- .4 Hem exposed edges on underside 12 mm.
 - .1 Mitre and seal corners with sealant.
- .5 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .6 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

2.5 METAL FLASHINGS

- .1 Form flashings, copings and fascias to profiles indicated of 0.61mm thick prefinished sheets.

2.6 REGLETS AND CAP FLASHINGS

- .1 Form recessed reglets and metal cap flashing of 0.61mm thick sheet metal in accordance with CRCA FL series details.
 - .1 Provide slotted fixing holes and steel/plastic washer fasteners.
 - .2 Cover face and ends with plastic tape.

2.7 SCUPPERS

- .1 Form scuppers from 0.61mm thick prefinished steel sheet metal.
- .2 Sizes and profiles as indicated
- .3 Provide necessary fastenings.

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.
- .2 Provide custom break formed trims to ensure that raw edges of sheet metal are not left exposed.
- .3 Sizes and profiles to suit unless otherwise detailed or indicated.

3.2 INSTALLATION

- .1 Install sheet metal work in accordance with CRCA FL series details.
 - .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 Counter-flash 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 surface mounted reglets true and level, and caulk top of reglet with sealant.
 - .7 Insert metal flashing under cap flashing to form weather tight junction.
 - .8 Turn top edge of flashing into recessed reglet or mortar joint minimum of 25 mm. Lead wedge flashing securely into joint.
 - .9 Caulk flashing at cap flashing with sealant.
-

3.3 SCUPPERS

- .1 Install scuppers as indicated.

3.4 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 SECTION INCLUDES

- .1 Materials, preparation and application for caulking and sealants.

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM)
 - .1 ASTM C919-12, Standard Practice for Use of Sealants in Acoustical Applications.
- .2 Department of Justice Canada (Jus)
 - .1 Canadian Environmental Protection Act, 1999 (CEPA).
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .4 Transport Canada (TC)
 - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00.
- .2 Manufacturer's product to describe.
 - .1 Caulking compound.
 - .2 Primers.
 - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
- .3 Submit samples in accordance with Section 01 33 00.
- .4 Submit duplicate samples of each type of material and colour.
- .5 Cured samples of exposed sealants for each color where required to match adjacent material.
- .6 Submit manufacturer's instructions in accordance with Section 01 33 00.
 - .1 Instructions to include installation instructions for each product used.

1.4 QUALITY ASSURANCE/MOCK-UP

- .1 Construct mock-up in accordance with Section 01 45 00.
 - .2 Construct mock-up to show location, size, shape and depth of joints complete with back-up material, primer, caulking and sealant.
 - .3 Mock-up will be used:
 - .1 To judge workmanship, substrate preparation, operation of equipment and material application.
-

- .4 Locate where directed where indicated.
- .5 Allow 24 hours for inspection of mock-up by Departmental Representative before proceeding with sealant work.
- .6 When accepted, mock-up will demonstrate minimum standard of quality required for this Work. Approved mock-up may remain as part of finished Work.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section 01 61 00.
- .2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels, intact. Protect from freezing, moisture, water and contact with ground or floor.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.
- .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.
- .5 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, Regional and Municipal regulations.
- .6 Unused sealant material must not be disposed of into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.
- .7 Divert unused joint sealing material from landfill to official hazardous material collections site approved by Departmental Representative.
- .8 Empty plastic joint sealer containers are not recyclable. Do not dispose of empty containers with plastic materials destined for recycling.
- .9 Fold up metal banding, flatten, and place in designated area for recycling.

1.7 PROJECT CONDITIONS

- .1 Environmental Limitations:
 - .1 Do not proceed with installation of joint sealants under following conditions:
 - .1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 4.4°C.
 - .2 When joint substrates are wet.
- .2 Joint-Width Conditions:
 - .1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
 - .1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Labour Canada.
- .2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .3 Ventilate area of work as directed by Departmental Representative by use of approved portable supply and exhaust fans.

PART 2 - PRODUCTS

2.1 SEALANT MATERIALS

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

2.2 SEALANT MATERIAL DESIGNATIONS

- .1 Polysulfide Two Part.
 - .1 Self-Leveling to CAN/CGSB-19.24, Type 1, Class B, colour to match adjacent materials.
 - .2 Polysulfide Two Part.
 - .1 Non-Sag to CAN/CGSB-19.24, Type 2, Class B, colour to match adjacent materials.
 - .3 Silicones One Part.
 - .1 Mildew resistant, to CAN/CGSB-19.13.
 - .4 Acoustical Sealant.
 - .1 To ASTM C919, primerless
 - .5 Preformed Compressible and Non-Compressible back-up materials.
 - .1 Polyethylene, Urethane, Neoprene or Vinyl Foam.
 - .1 Extruded open or closed cell foam backer rod.
 - .2 Size: oversize 30 to 50%.
 - .2 Neoprene or Butyl Rubber.
 - .1 Round solid rod, Shore A hardness 70.
 - .3 High Density Foam.
-

- .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m³ density, or neoprene foam backer, size as recommended by manufacturer.
- .4 Bond Breaker Tape.
 - .1 Polyethylene bond breaker tape which will not bond to sealant.

2.3 SEALANT SELECTION

- .1 Perimeters of exterior openings where frames meet exterior facade of building (i.e., block, precast masonry): Sealant type: Polysulfide Two Part, non-sag.
- .2 Expansion and control joints in exterior surfaces of poured-in-place concrete walls: Sealant type: Polysulfide Two Part, non-sag.
- .3 Expansion and control joints in exterior surfaces of precast, architectural wall panels: Sealant type: Polysulfide Two Part, non-sag.
- .4 Cornice and wash (or horizontal surface joints): Sealant type: Polysulfide Two Part, self-levelling.
- .5 Exterior joints in horizontal wearing surfaces (as itemized): Sealant type: Polysulfide Two Part, self-levelling.
- .6 Seal interior perimeters of exterior openings as detailed on drawings: Sealant type: Polysulfide two part. Non Sag
- .7 Joints at tops of non-load bearing masonry walls at the underside of poured concrete: Sealant type: Acoustical Sealant

2.4 JOINT CLEANER

- .1 Non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.
- .2 Primer: as recommended by manufacturer.

PART 3 - EXECUTION

3.1 PROTECTION

- .1 Protect installed Work of other trades from staining or contamination.

3.2 SURFACE PREPARATION

- .1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.
 - .2 Clean bonding joint surfaces of harmful matter substances including dust, rust, oil grease, and other matter 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.

3.3 PRIMING

- .1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.
- .2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

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

3.5 MIXING

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

3.6 APPLICATION

- .1 Sealant.
 - .1 Apply sealant in accordance with manufacturer's written instructions.
 - .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .3 Apply sealant in continuous beads.
 - .4 Apply sealant using gun with proper size nozzle.
 - .5 Use sufficient pressure to fill voids and joints solid.
 - .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
 - .8 Remove excess compound promptly as work progresses and upon completion.
- .2 Curing
 - .1 Cure sealants in accordance with sealant manufacturer's instructions.
 - .2 Do not cover up sealants until proper curing has taken place.
- .3 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 REQUIREMENTS

- .1 Section 07 92 00 – Joint Sealants

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C475/C475M-15, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - .2 ASTM C514-04(2014), Standard Specification for Nails for the Application of Gypsum Board.
 - .3 ASTM C840-13, Standard Specification for Application and Finishing of Gypsum Board.
 - .4 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.
 - .5 ASTM C1047-14a, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
 - .6 ASTM C1280-13a, Standard Specification for Application of Gypsum Sheathing.
 - .7 ASTM C1396/C1396M-14a, Standard Specification for Gypsum Board.
 - .8 ASTM A123/A123M-13, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .2 Association of the Wall and Ceilings Industries International (AWCI)
 - .1 AWCI Levels of Gypsum Board Finish 101a-97.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-M86(R1988), Vapour Barrier, Polyethylene Sheet for Use in Building Construction.

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 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.

1.4 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 Protect prefinished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.
 - .6 Replace defective or damaged materials with new.
- .4 Develop Waste Reduction Workplan related to Work of this Section and in accordance with Section 01 74 20.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 20.

1.5 AMBIENT CONDITIONS

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

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Standard board: to ASTM C1396/C1396M, regular, 12.7 and Type X 15.9mm thick, 1200 mm wide x maximum practical length, ends square cut, edges squared.
- .2 Gypsum sheathing board: to ASTM C1396/C1396M, regular, 12.7 and 15.9mm thick, 1200 mm wide x maximum practical length.
- .3 Metal furring runners, hangers, tie wires, inserts and anchors: to ASTM A123/A123M, minimum coating grade of 75.
- .4 Drywall furring channels: 0.5 mm core thickness galvanized steel channels for screw attachment of gypsum board.
- .5 Resilient clips and drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of gypsum board.
- .6 Nails: to ASTM C514.
- .7 Steel drill screws: to ASTM C1002.
- .8 Stud adhesive: to applicable codes and standards.
- .9 Laminating compound: as recommended by manufacturer, asbestos-free.
- .10 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, metal, zinc-coated by hot-dip process, 0.5 mm base thickness, perforated flanges, one piece length per location.
- .11 Sealants: in accordance with Section 07 92 00.
- .12 Polyethylene: to CAN/CGSB-51.34, Type 2.
- .13 Insulating strip: rubberized, moisture resistant, 3 mm thick closed cell neoprene strip, 12 mm wide, with self-sticking permanent adhesive on one face, lengths as required.
- .14 Joint compound: to ASTM C475/C475M, asbestos-free.
- .15 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 Install work level to tolerance of 1:1200.
- .3 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles.
- .4 Install 19 x 64 mm furring channels parallel to, and at exact locations of steel stud partition header track.
- .5 Fur for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .6 Fur above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.
- .7 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.
- .8 Fur openings and around built-in equipment, cabinets, access panels, on four sides. Extend furring into reveals. Check clearances with equipment suppliers.
- .9 Fur 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 or double layer gypsum board to metal furring or framing using screw fasteners for first layer, laminating adhesive for second layer. Maximum spacing of screws 300 mm on centre.
 - .1 Single-Layer Application:

- .1 Apply gypsum board on ceilings prior to application of walls to ASTM C840.
- .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
- .3 Install 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 or fire-rated assemblies 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 Install shadow mould at gypsum board/ceiling juncture. Minimize joints; use corner pieces and splicers.
- .2 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.
- .3 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 0: no tapping, finishing or accessories required.
 - .2 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable.
- .4 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.
- .5 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .6 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

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 REFERENCES

- .1 ASTM International
 - .1 ASTM C645-14, Standard Specification for Nonstructural Steel Framing Members.

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

1.3 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.

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 metal framing from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
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PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Non-load bearing channel stud framing: to ASTM C645, 92 and 152 mm stud size, roll formed from 0.53 and 0.91mm thickness hot dipped galvanized steel sheet, for screw attachment of gypsum board.
 - .1 Knock-out service holes at 460mm centers.
- .2 Floor and ceiling tracks: to ASTM C645, in widths to suit stud sizes, 32mm flange height.
- .3 Metal channel stiffener: 38mm size, 1.4mm thick cold rolled steel, coated with rust inhibitive coating.

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 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 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 Place studs vertically at 600mm on center 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.
- .2 Erect metal studding to tolerance of 1:1000.
- .3 Attach studs to bottom and ceiling track using screws.
- .4 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .5 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .6 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified.

- .1 Secure studs together, 50mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.
- .7 Install heavy gauge single jamb studs at openings.
- .8 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs.
 - .1 Secure track to studs at each end, in accordance with manufacturer's instructions.
 - .2 Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .9 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .10 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .11 Maintain clearance under beams and structural slabs to avoid transmission of structural loads to studs.
- .12 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 REFERENCES

- .1 The Master Painters Institute (MPI)
 - .1 Maintenance Repainting Manual 2004, Master Painters Institute (MPI), including Identifiers, Evaluation, Systems, Preparation and Approved Product List.
- .2 National Fire Code of Canada, 2010 (NFC).

1.2 QUALITY ASSURANCE

- .1 Conform to latest MPI requirements for exterior repainting work including cleaning, preparation and priming.
- .2 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, and solvents) to be in accordance with the latest edition of the MPI Approved Product List and to be from a single manufacturer for each system used.
- .3 Paint materials such as linseed oil, shellac, and turpentine, to be the highest quality product of an approved manufacturer listed in MPI Maintenance Repainting Manual and shall be compatible with other coating materials as required.
- .4 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.
- .5 Mock-ups:
 - .1 Provide a mock-up in accordance with requirements of Section 01 45 00 to Departmental Representative.
 - .2 Prepare and repaint mock-up designated exterior surface or item to requirements specified herein, with specified paint or coating showing selected colours, number of coats, gloss/sheen, textures and workmanship to MPI Maintenance Repainting Manual standards for review and approval.
 - .3 When approved, repainted surface and/or item shall become acceptable standard of finish quality and workmanship for similar on-site exterior repainting work.

1.3 SCHEDULING

- .1 Submit work schedule for various stages of painting to Departmental Representative for review. Submit schedule minimum of 48 hours in advance of proposed operations.
-

- .2 Paint occupied facilities in accordance with approved schedule. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.
- .3 Obtain written authorization from Departmental Representative for changes in work schedule.
- .4 Schedule repainting operations to prevent disruption by other trades if applicable and by occupants in and about building.

1.4 SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Provide samples in accordance with Section 01 33 00.
 - .1 Submit full range colour sample chips for review and selection. Indicate where colour availability is restricted.
- .3 Provide product data and manufacturer's installation/application instructions for paints and coating products to be used.
- .4 Quality Assurance Submittals:
 - .1 Manufacturer's Instructions: manufacturer's installation instructions.
- .5 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.
 - .2 Provide records of products used. List products in relation to finish system and include following:
 - .1 Product name, type and use (i.e. materials and location).
 - .2 Manufacturer's product number.
 - .3 Colour code numbers.
 - .4 MPI Environmentally Friendly classification system rating.
 - .5 Manufacturer's Material Safety Data Sheets.

1.5 MAINTENANCE

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .2 Deliver, store and handle materials in accordance with Section 01 61 00, supplemented as follows:
 - .1 Deliver and store materials in original containers, sealed, with labels intact.
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- .2 Labels to indicate:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .3 Remove damaged, opened and rejected materials from site.
- .4 Store and handle in accordance with manufacturer's recommendations.
- .5 Store materials and equipment in secure, dry, well-ventilated area with temperature range between 7 degrees C to 30 degrees C. Store materials and supplies away from heat generating devices and sensitive products above minimum temperature as recommended by manufacturer.
- .6 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Departmental Representative. Upon completion of operations, return areas to clean condition to approval of Departmental Representative.
- .7 Remove paint materials from storage in quantities required for same day use.
- .8 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
- .9 Fire Safety Requirements:
 - .1 Provide one 9kg Type ABC dry chemical fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site daily.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada.
- .3 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.
 - .2 Materials that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
 - .3 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
 - .4 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground the following procedures shall be strictly adhered to:
 - .1 Retain cleaning water for water-based materials to allow sediments to be filtered out. In no case shall equipment be cleaned using free draining water.

- .2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
- .3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
- .4 Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
- .5 Empty paint cans are to be dry prior to disposal or recycling (where available).
- .6 Close and seal tightly partly used cans of materials including sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.
- .5 Where paint recycling is available, collect waste paint by type and provide for delivery to recycling or collection facility.
- .6 Set aside and protect surplus and uncontaminated finish materials: Deliver to or arrange collection by employees, individuals or organizations for verifiable re-use or re-manufacturing.

1.7 AMBIENT CONDITIONS

- .1 Temperature, Humidity and Substrate Moisture Content Levels:
 - .1 Unless specifically pre-approved by specifying body, Paint Inspection Agency and, applied product manufacturer.
 - .2 Do not perform repainting work when:
 - .1 Ambient air and substrate temperatures are below 10 degrees C.
 - .2 Substrate temperature is over 32 degrees C unless paint is specifically formulated for application at high temperatures.
 - .3 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.
 - .4 Relative humidity is above 85% or when dew point is less than 3 degrees C variance between air/surface temperature.
 - .5 Rain or snow is forecast to occur before paint has thoroughly cured.
 - .6 It is foggy, misty, raining or snowing at site.
 - .3 Conduct moisture tests using properly calibrated electronic Moisture Meter, except test existing painted concrete floors for moisture using simple "cover patch test" on failed areas.
 - .4 Do not perform repainting work when maximum moisture content of substrate exceeds:
 - .1 12% for concrete and masonry (clay and concrete brick/block).
 - .5 Test painted concrete, masonry and plaster surfaces for alkalinity as required.
- .2 Application Requirements:

- .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind conditions are such that airborne particles will affect quality of finished surface.
- .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits noted.
- .3 Apply paint when previous coat of paint is dry or adequately cured, unless otherwise pre-approved by specific coating manufacturer.
- .4 Apply paint finishes when conditions forecast for entire period of application fall within manufacturer's recommendations.
- .5 Do not apply paint when:
 - .1 Temperature is expected to drop below 10 degrees C before paint has thoroughly cured.
 - .2 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's limits.
 - .3 Surface to be painted is wet, damp or frosted.
- .6 Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by manufacturer. Protect until paint is dry or until weather conditions are suitable.
- .7 Schedule repainting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.
- .8 Remove paint from areas which have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Paint materials listed in latest edition of MPI Approved Product List (APL) are acceptable for use on this project.
- .2 Where required by authorities having jurisdiction, paints and coatings to provide fire resistant rating.
- .3 Paint materials for repaint systems: products of single manufacturer.
- .4 Only qualified products with E2 MPI "Environmentally Friendly" rating are acceptable for use on this project.
- .5 Paints, coatings, thinners, solvents, cleaners and other fluids used in repainting to be as follows:
 - .1 Not contain methylene chloride, chlorinated hydrocarbons, toxic metal pigments.
 - .2 Be manufactured without compounds which contribute to ozone depletion in upper atmosphere.

- .3 Be manufactured without compounds which contribute to smog in lower atmosphere.
- .4 Be manufactured where matter generating 'Biochemical Oxygen Demand' (BOD) in undiluted production plant effluent discharged to natural watercourse or sewage treatment facility lacking secondary treatment does not exceed 15mg/L.
- .5 Be manufactured where total suspended solids (TSS) content in undiluted production plant effluent discharged to natural watercourse or sewage treatment facility lacking secondary treatment does not exceed 15mg/L.
- .6 Paints and coatings must be manufactured and transported in a manner that steps of processes, including disposal of waste products, will meet requirements of applicable governmental acts, by-laws and regulations including, for facilities located in Canada, Fisheries Act and Canadian Environmental Protection Act (CEPA).
- .7 Paints and coatings must not be formulated or manufactured with formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

2.2 COLOURS

- .1 Submit Colour Schedule based on existing conditions to Departmental Representative for review.

2.3 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is allowed with Departmental Representative's written permission.
- .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
- .3 Where thinner is used, addition not to exceed paint manufacturer's recommendations. Do not use kerosene or such organic solvents to thin water-based paints.
- .4 Thin paint for spraying in accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Departmental Representative.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.

2.4 GLOSS/SHEEN RATINGS

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

<u>Gloss Level Category</u>	<u>Units @ 60 Degrees</u>	<u>Units @ 85 Degrees</u>
G1 - matte finish	0 to 5	maximum 10
G2 – velvet finish	0 to 10	10 to 35
G3 – eggshell finish	10 to 25	10 to 35
G4 – satin finish	20 to 35	minimum 35
G5 - semi-gloss finish	35 to 70	
G6 - gloss finish	70 to 85	
G7 – high gloss finish	> 85	

- .2 Gloss level ratings of repainted surfaces to match existing conditions.

2.5 EXTERIOR PAINTING SYSTEMS

- .1 All surfaces to be repainted are to match existing conditions.

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 EXAMINATION

- .1 Exterior repainting work: inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor to notify Paint Inspection Agency minimum of one week prior to commencement of work and provide copy of project repainting specification and Finish Schedule (as well as plans and elevation drawings if available).
- .2 Exterior surfaces requiring repainting: inspected by both painting contractor and Paint Inspection Agency who will notify Departmental Representative in writing of defects or problems, prior to commencing repainting work, or after surface preparation if unseen substrate damage is discovered.
- .3 Where an assessed degree of surface degradation of DSD-1 to DSD-3 before preparation of surfaces for repainting is revealed to be DSD-4 after preparation, repair or replacement of such unforeseen defects discovered are to be corrected, as mutually agreed, before repainting is started.
- .4 Where "special" repainting or recoating system applications (i.e. elastomeric coatings) or non-MPI listed products or systems are to be used, paint or coating manufacturer to provide as part of work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision,

inspection and approval of their paint or coating system application as required at no additional cost to Departmental Representative.

3.3 PREPARATION

- .1 Perform preparation and operations for exterior painting in accordance with MPI Maintenance Repainting requirements except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.
- .3 Clean and prepare exterior surfaces to be repainted in accordance with MPI Maintenance Repainting Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and surface debris by brushing, wiping with dry, clean cloths, or compressed air.
 - .2 Wash surfaces with a biodegradable detergent (and bleach where applicable) and clean warm water using a stiff bristle brush to remove dirt, oil and surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Use trigger operated spray nozzles for water hoses.
 - .5 Allow surfaces to drain completely and to dry thoroughly.
 - .6 Use water-based cleaners in place of organic solvents where surfaces will be repainted using water based paints.
 - .7 Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or such organic solvents to clean up water-based paints.
- .4 Where required, pressure wash exterior surfaces prior to repainting in accordance with MPI standards for type of surfaces and recommended pressures to ensure complete removal of loose paint, stains, dirt, and foreign matter. This work to be carried out by qualified workers experienced in pressure water cleaning. Use of spray equipment such as water hose cleaning will not be considered satisfactory unless specified. Allow sufficient drying time and test surfaces using an electronic moisture meter before commencing work.
- .5 Clean metal surfaces to be repainted by removing rust, dirt, oil, grease and foreign substances in accordance with MPI requirements. Remove such contaminants from surfaces, pockets and corners to be repainted by brushing with clean brushes, blowing with clean dry compressed air, or brushing/vacuum cleaning as required.
- .6 Prevent contamination of cleaned surfaces by salts, acids, alkalis, corrosive chemicals, grease, oil and solvents before priming and between applications of remaining coats. Touch-up, spot prime, and apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.

- .7 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.
- .8 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects from previously painting (e.g. runs, and sags) that are visible from distance up to 1000 mm.

3.4 EXISTING CONDITIONS

- .1 Prior to commencing work, examine site conditions and existing exterior substrates to be repainted and report in writing to Departmental Representative damages, defects, unsatisfactory or unfavourable conditions of surfaces that will adversely affect this work.

3.5 PROTECTION

- .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Departmental Representative.
- .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
- .3 Protect factory finished products and equipment.
- .4 Protect general public and building occupants in and about the building.
- .5 Removal of light fixtures, surface hardware on doors, and surface mounted equipment, fittings and fastenings to be done prior to undertaking painting operations. Store items and re-install after painting is completed.
- .6 Move and cover exterior furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
- .7 As painting operations progress, place "WET PAINT" signs in pedestrian and vehicle traffic areas to approval of Departmental Representative.

3.6 APPLICATION

- .1 Apply paint by method that is best suited for substrate being repainted using roller or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise. In each case method of application to be as pre-approved by Departmental Representative before commencing work.
 - .2 Roller Application:
 - .1 Apply paint in a uniform layer using roller of types suitable for application.
 - .2 Work paint into cracks, crevices and corners.
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- .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
- .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces to be free of roller tracking and heavy stipple unless approved by Departmental Representative.
- .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray Application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern.
 - .4 Back roll spray applications and brush out runs and sags immediately.
 - .5 Use brushes to work paint into cracks, crevices and places that are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers when no other method is practical in places of difficult access and when specifically authorized by Departmental Representative.
- .5 Apply paint coats in a continuous manner and allow surfaces to dry and cure between coats for minimum time period as recommended by manufacturer. Minimum dry film thickness of coats not less than that recommended by manufacturer. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Sand and dust between coats to remove visible defects.
- .7 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as projecting ledges.
- .8 Finish to doors include all edges including top and bottom edges. Surfaces concealed by door hardware be repainted unless otherwise pre-approved.

3.7 MECHANICAL / ELECTRICAL EQUIPMENT

- .1 Unless otherwise noted, repainting to include exposed to view/previously painted exterior mechanical and electrical equipment and components (panels, conduits, piping, hangers, and ductwork).
- .2 Touch up scratches and marks and repaint such mechanical and electrical equipment and components with colour and finish to match existing finish unless otherwise noted or scheduled.
- .3 Do not paint over name plates or instruction labels.
- .4 Standard of Acceptance: when viewed using natural prevailing sunlight at peak period of the day (mid-day) on surface viewed, surfaces to indicate following:

- .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
- .2 Soffits: no defects visible from grade at 45 degrees to surface.
- .3 Final coat to exhibit uniformity of colour and sheen across full surface area.

3.8 FIELD QUALITY CONTROL

- .1 Advise Departmental Representative and Paint Inspection Agency when each surface and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
- .2 Co-operate with Paint Inspection Agency and provide access to areas of work.
- .3 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.

3.9 CLEANING

- .1 Proceed in accordance with Section 01 74 11.
- .2 Remove paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
- .3 Keep work area free from unnecessary accumulation of tools, equipment, surplus materials and debris.
- .4 Remove combustible rubbish materials and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.
- .5 Clean equipment and dispose of wash water used for water borne materials, solvents used for oil based materials as well as cleaning and protective materials (e.g. rags, drop cloths, and masking papers), paints, thinners, paint removers/strippers in accordance with the safety requirements of authorities having jurisdiction and as specified.
- .6 Clean painting equipment in leak-proof containers that will permit particulate matter to settle out and be collected. Sediment remaining from cleaning operations to be disposed of in manner acceptable to authorities having jurisdiction.
- .7 Recycle paint and coatings in excess of repainting requirements as specified.

3.10 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
 - .2 Remove protective coverings and warning signs as soon as practical after operations cease.
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- .3 Remove paint splashings on affected exposed surfaces. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 The Master Painters Institute (MPI)
 - .1 Maintenance Repainting Manual 2004, Master Painters Institute (MPI), including Identifiers, Evaluation, Systems, Preparation and Approved Product List.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 QUALITY ASSURANCE

- .1 Conform to latest MPI requirements for interior repainting work including cleaning, preparation and priming.
 - .2 Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners and solvents) shall be in accordance with the latest edition of the MPI Approved Product List and shall be from a single manufacturer for each system used.
 - .3 Paint materials such as linseed oil, shellac, reducers and turpentine shall be the highest quality product of an approved manufacturer listed in MPI Maintenance Repainting Manual and shall be compatible with other coating materials as required.
 - .4 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Departmental Representative.
 - .5 Standard of Acceptance: when viewed using final lighting source surfaces shall indicate the following:
 - .1 Walls: no defects visible from a distance of 1000 mm at 90 degrees to surface.
 - .2 Ceilings: no defects visible from floor at 45 degrees to surface.
 - .3 Final coat to exhibit uniformity of colour and sheen across full surface area.
 - .6 Mock-ups: construct mock-ups in accordance with Section 01 45 00.
 - .1 Provide a mock-up in accordance with requirements of Section 01 45 00 to Departmental Representative.
 - .2 Prepare and repaint mock-up designated interior room, surface or item to requirements specified herein, with paint or coating matching existing conditions (gloss/sheen, textures and workmanship) to MPI Maintenance Repainting Manual standards for review and approval.
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- .3 When approved, repainted room, surface and/or item shall become acceptable standard of finish quality and workmanship for similar on-site interior repainting work.

1.3 PERFORMANCE REQUIREMENTS

- .1 Environmental Performance Requirements:
 - .1 Where indoor air quality (odour) is a problem, use only MPI listed materials having a minimum E2 rating.

1.4 SCHEDULING

- .1 Submit work schedule for various stages of painting to Departmental Representative for review. Submit schedule a minimum of 48 hours in advance of proposed operations.
- .2 Paint occupied facilities in accordance with approved schedule. Schedule operations to approval of Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.
- .3 Obtain written authorization from Departmental Representative for changes in work schedule.
- .4 Schedule repainting operations to prevent disruption by other trades if applicable and by occupants in and about building.

1.5 SUBMITTALS

- .1 Provide product data and manufacturer's installation/application instructions for each paint and coating product to be used in accordance with the requirements of Section 01 33 00.
- .2 Provide samples in accordance with Section 01 33 00.
 - .1 Submit full range colour sample chips for review and selection. Indicate where colour availability is restricted.
 - .2 Submit WHMIS MSDS - Material Safety Data Sheets for paint and coating materials.
- .3 Closeout Submittals:
 - .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.
 - .1 Submit records of products used. List products in relation to finish system and include following:
 - .1 Product name, type and use (i.e. materials and location).
 - .2 Manufacturer's product number.
 - .3 Colour code numbers.
 - .4 MPI Friendly classification system rating.

- .5 Manufacturer's Material Safety Data Sheets (MSDS).

1.6 DELIVERY, HANDLING AND STORAGE

- .1 Deliver, store and handle materials in accordance with Section 01 61 00, supplemented as follows:
- .1 Deliver and store materials in original containers, sealed, with labels intact.
 - .2 Labels to indicate:
 - .1 Manufacturer's name and address.
 - .2 Type of paint or coating.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
 - .3 Remove damaged, opened and rejected materials from site.
 - .4 Store and handle in accordance with manufacturer's recommendations.
 - .5 Store materials and equipment in secure, dry, well-ventilated area with temperature range between 7 degrees C to 30 degrees C. Store materials and supplies away from heat generating devices and sensitive products above minimum temperature as recommended by manufacturer.
 - .6 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Departmental Representative. After completion of operations, return areas to clean condition to approval of Departmental Representative.
 - .7 Remove paint materials from storage in quantities required for same day use.
 - .8 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
 - .9 Fire Safety Requirements:
 - .1 Provide one 9kg Type ABC dry chemical fire extinguisher adjacent to storage area.
 - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site daily.
 - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with National Fire Code of Canada.
- .2 Waste Management and Disposal:
- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 20.
 - .2 Paint, stain and wood preservative finishes and related materials (thinners, and solvents) are hazardous products and are subject to regulations for disposal. Information on these controls can be obtained from Provincial Ministries of Environment and Regional levels of Government.

- .3 Materials that cannot be reused must be treated as hazardous waste and disposed of in an appropriate manner.
- .4 Place materials defined as hazardous or toxic waste, including used sealant and adhesive tubes and containers, in containers or areas designated for hazardous waste.
- .5 To reduce the amount of contaminants entering waterways, sanitary/storm drain systems or into the ground the following procedures shall be strictly adhered to:
 - .1 Retain cleaning water for water-based materials to allow sediments to be filtered out. In no case shall equipment be cleaned using free draining water.
 - .2 Retain cleaners, thinners, solvents and excess paint and place in designated containers and ensure proper disposal.
 - .3 Return solvent and oil soaked rags used during painting operations for contaminant recovery, proper disposal, or appropriate cleaning and laundering.
 - .4 Dispose of contaminants in an approved legal manner in accordance with hazardous waste regulations.
 - .5 Empty paint cans are to be dry prior to disposal or recycling (where available).
 - .6 Close and seal tightly partly used cans of materials including sealant and adhesive containers and store protected in well ventilated fire-safe area at moderate temperature.
- .6 Where paint recycling is available, collect waste materials by type and provide for delivery to recycling or collection facility.
- .7 Set aside and protect surplus and uncontaminated finish materials: Deliver to or arrange collection by employees, individuals, or organizations for verifiable re-use or re-manufacturing.

1.7 SITE CONDITIONS

- .1 Heating, Ventilation and Lighting:
 - .1 Do not perform repainting work unless adequate and continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above 10 degrees C for 24 hours before, during and after paint application and until paint has cured sufficiently.
 - .2 Ventilate enclosed spaces in accordance with Section 01 35 29. Where required, provide continuous ventilation for seven days after completion of application of paint.
 - .3 Co-ordinate use of existing ventilation system with Departmental Representative and ensure its operation during and after application of paint as required.

- .4 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements. Use of gas-fired appliances is not permitted.
- .5 Do not perform painting work unless minimum lighting level of 323 Lux is provided on surfaces to be painted.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
 - .1 Unless specifically pre-approved by specifying body, Paint Inspection Agency and, applied product manufacturer, do not perform repainting work when:
 - .1 Ambient air and substrate temperatures are below 10 degrees C.
 - .2 Substrate temperature is over 32 degrees C unless paint is specifically formulated for application at high temperatures.
 - .3 Relative humidity within area to be repainted is above 85%.
 - .2 Conduct moisture tests using properly calibrated electronic Moisture Meter, except use simple "cover patch test" on concrete floors to be repainted.
 - .3 Do not perform repainting work when maximum moisture content of substrate exceeds:
 - .1 12% for concrete and masonry (clay and concrete brick/block).
 - .2 12% for plaster and gypsum board.
 - .4 Test painted concrete, masonry and plaster surfaces for alkalinity as required.
- .3 Surface and Environmental Conditions:
 - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when ventilation conditions are such that airborne particles will not affect quality of finished surface.
 - .2 Apply paint to adequately prepared surfaces and to surfaces within moisture limits noted herein.
 - .3 Apply paint when previous coat of paint is dry or adequately cured, unless otherwise pre-approved by specific coating manufacturer.
 - .4 Apply paint in occupied facilities during silent hours only. Schedule operations to approval of the Departmental Representative such that painted surfaces will have dried and cured sufficiently before occupants are affected.

1.8 MAINTENANCE

- .1 Extra Materials:
 - .1 Submit maintenance materials in accordance with Section 01 78 00.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Paint materials listed in latest edition of MPI Approved Product List (APL) are acceptable for use on this project.
- .2 Where required by authorities having jurisdiction, paints and coatings to provide a fire resistant rating.
- .3 Paint materials for repaint systems to be products of single manufacturer.
- .4 Only qualified products with MPI "Environmentally Friendly" E2 rating are acceptable for use on this project.
- .5 Paints and coatings must not be formulated or manufactured with formaldehyde, halogenated solvents, mercury, lead, cadmium, hexavalent chromium or their compounds.

2.2 COLOURS

- .1 Submit proposed Colour Schedule based on existing conditions to Departmental Representative for approval.
- .2 Selection of colours will be from manufacturers full range of colours.
- .3 Where specific products are available in restricted range of colours, selection will be based on limited range.
- .4 First coat in two coat (Premium) repaint system to be tinted slightly lighter colour than top coat to show visible difference between coats.

2.3 MIXING AND TINTING

- .1 Perform colour tinting operations prior to delivery of paint to site. On-site tinting of painting materials is allowed with Departmental Representative's written permission.
 - .2 Mix paste, powder or catalyzed paint mixes in accordance with manufacturer's written instructions.
 - .3 Where thinner is used, addition not to exceed paint manufacturer's recommendations. Do not use kerosene or such organic solvents to thin water-based paints.
 - .4 Thin paint for spraying in accordance with paint manufacturer' instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to Departmental Representative.
 - .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.
-

2.4 GLOSS/SHEEN RATINGS

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

<u>Gloss Level Category</u>	<u>Units @ 60 Degrees</u>	<u>Units @ 85 Degrees</u>
G1 - matte finish	0 to 5	maximum 10
G2 – velvet finish	0 to 10	10 to 35
G3 – eggshell finish	10 to 25	10 to 35
G4 – satin finish	20 to 35	minimum 35
G5 - semi-gloss finish	35 to 70	
G6 - gloss finish	70 to 85	
G7 – high gloss finish	> 85	

- .2 Gloss level ratings of repainted surfaces shall be as specified herein.

2.5 INTERIOR PAINTING SYSTEMS

- .1 All surfaces to be repainted are to match existing conditions.

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 EXAMINATION

- .1 Interior repainting work: inspected by MPI Accredited Paint Inspection Agency (inspector) acceptable to specifying authority and local Painting Contractor's Association. Painting contractor to notify Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of project repainting specification and Finish Schedule (as well as plans and elevation drawings).
- .2 Interior surfaces requiring repainting: inspected by both painting contractor and Paint Inspection Agency who will notify Departmental Representative in writing of defects or problems, prior to commencing repainting work, or after surface preparation if unseen substrate damage is discovered.
- .3 Where an assessed degree of surface degradation of DSD-1 to DSD-3 before preparation of surfaces for repainting is revealed to be DSD-4 after preparation, repair or replacement of such unforeseen defects discovered are to be corrected, as mutually agreed, before repainting is started.

- .4 Where "special" repainting or recoating system applications (i.e. elastomeric coatings) or non-MPI listed products or systems are to be used, paint or coating manufacturer to provide as part of work, certification of surfaces and conditions for specific paint or coating system application as well as on site supervision, inspection and approval of their paint or coating system application as required at no additional cost to Departmental Representative.

3.3 PREPARATION

- .1 Perform preparation and operations for interior painting in accordance with MPI Maintenance Repainting Manual requirements except where otherwise specified.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.
- .3 Clean and prepare interior surfaces to be repainted in accordance with MPI Maintenance Repainting Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
 - .1 Remove dust, dirt, and surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
 - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using stiff bristle brush to remove dirt, oil and surface contaminants.
 - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
 - .4 Allow surfaces to drain completely and to dry thoroughly. Allow sufficient drying time and test surfaces using an electronic moisture meter before commencing work.
 - .5 Use water-based cleaners in place of organic solvents where surfaces will be repainted using water based paints.
 - .6 Many water-based paints cannot be removed with water once dried. Minimize use of kerosene or such organic solvents to clean up water-based paints.
- .4 Clean metal surfaces to be repainted by removing rust, dirt, oil, grease and foreign substances in accordance with MPI requirements. Remove such contaminants from surfaces, pockets and corners to be repainted by brushing with clean brushes, blowing with clean dry compressed air, or brushing/vacuum cleaning as required.
- .5 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before priming and between applications of remaining coats. Touch-up, spot prime, and apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.
- .6 Do not apply paint until prepared surfaces have been accepted by Departmental Representative.

- .7 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from distance up to 1000mm.

3.4 EXISTING CONDITIONS

- .1 Prior to commencing work, examine site conditions and existing interior substrates to be repainted. Report in writing to Departmental Representative damages, defects, or unsatisfactory or unfavourable conditions or surfaces that will adversely affect this 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" and report findings to Departmental Representative. Maximum moisture content not to exceed specified limits.

3.5 PROTECTION

- .1 Protect existing surfaces and adjacent fixtures and furnishings from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Departmental Representative.
- .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
- .3 Protect factory finished products and equipment.
- .4 Protect general public and building occupants in and about building.
- .5 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories and surface mounted equipment, fittings and fastenings prior to undertaking re-painting operations. Store items and re-install after painting is completed.
- .6 Move and cover furniture and portable equipment as necessary to carry out repainting operations. Replace as painting operations progress.
- .7 As repainting operations progress, place "WET PAINT" signs in occupied areas to approval of Departmental Representative.

3.6 APPLICATION

- .1 Apply paint by method that is best suited for substrate being repainted using roller or airless sprayer. Conform to manufacturer's application instructions unless specified otherwise. Methods of application as pre-approved by Departmental Representative before commencing work.
- .2 Roller Application:
 - .1 Apply paint in uniform layer using brush and/or roller of types suitable for application.

- .2 Work paint into cracks, crevices and corners.
- .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
- .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces free of roller tracking and heavy stipple unless approved by Departmental Representative.
- .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Spray Application:
 - .1 Provide and maintain equipment that is suitable for intended purpose, capable of properly atomizing paint to be applied, and equipped with suitable pressure regulators and gauges.
 - .2 Keep paint ingredients properly mixed in containers during paint application by intermittent agitation frequently as necessary.
 - .3 Apply paint in uniform layer, with overlapping at edges of spray pattern.
 - .4 Back roll spray applications and brush out runs and sags immediately.
 - .5 Use brushes to work paint into cracks, crevices and places which are not adequately painted by spray.
- .4 Use dipping, sheepskins or daubers when no other method is practical in places of difficult access and when specifically authorized by Departmental Representative.
- .5 Apply paint coats in continuous manner and allow surfaces to dry and properly cure between coats for minimum time period as recommended by manufacturer. Minimum dry film thickness of coats not less than that recommended by manufacturer. Repaint thin spots or bare areas before next coat of paint is applied.
- .6 Sand and dust between coats to remove visible defects.
- .7 Repaint surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .8 Repaint top, bottom, and vertical edges of doors to be repainted.

3.7 MECHANICAL/ELECTRICAL EQUIPMENT

- .1 Unless otherwise noted, repainting to include exposed to view / previously painted mechanical and electrical equipment and components (panels, conduits, piping, hangers, and ductwork.).
 - .2 Touch up scratches and marks and repaint such mechanical and electrical equipment and components with colour, and sheen finish to match existing unless otherwise noted or scheduled.
 - .3 Do not paint over name plates or instruction labels.
-

- .4 Leave unfinished exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish.
- .5 Keep sprinkler heads free of paint.
- .6 Do not paint interior transformers and substation equipment.
- .7 Standard of Acceptance: when viewed using natural prevailing sunlight at peak period of day (mid-day) on surface viewed, surfaces to indicate following:
 - .1 Walls: no defects visible from distance of 1000 mm at 90 degrees to surface.
 - .2 Soffits: no defects visible from grade at 45 degrees to surface.
 - .3 Final coat to exhibit uniformity of colour and sheen across full surface area.

3.8 FIELD QUALITY CONTROL

- .1 Inspection:
 - .1 Advise Departmental Representative and Paint Inspection Agency when each surface and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been approved.
 - .2 Co-operate with Paint Inspection Agency and provide access to areas of work.

3.9 CLEANING

- .1 Proceed in accordance with Section 01 74 11, supplemented as follows:
 - .1 Remove paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
 - .2 Keep work area free from unnecessary accumulation of tools, equipment, surplus materials and debris.
 - .3 Remove combustible rubbish materials and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.
 - .4 Clean equipment and dispose of wash water used for water borne materials, solvents used for oil based materials as well as other cleaning and protective materials (e.g. rags, drop cloths, and masking papers), paints, thinners, paint removers/strippers in accordance with safety requirements of authorities having jurisdiction and as noted herein.
 - .5 Clean painting equipment in leak-proof containers that will permit particulate matter to settle out and be collected. Sediment remaining from cleaning operations to be recycled or disposed of in manner acceptable to authorities having jurisdiction.
 - .6 Recycle paint and coatings in excess of repainting requirements as specified.

3.10 RESTORATION

- .1 Clean and re-install hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on affected exposed surfaces. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to approval of Departmental Representative. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by Departmental Representative.

END OF SECTION

PART 1 - GENERAL

1.1 MINIMUM STANDARDS

- .1 Conform to or exceed:
 - .1 National Plumbing Code (NPC) 2010.
 - .2 Canadian Standards Association Standards.
 - .3 Local Municipal By-laws and Regulations.
 - .4 National Building Code of Canada (NBC) 2010.
 - .5 Ontario Building Code (OBC) 2012.
 - .6 National Fire Code of Canada 2010 (NFC)
 - .7 FCC No. 403(M)-1985 Sprinkler Systems
 - .8 CSA B651-12, Accessible Design for the Built Environment.

1.2 REFERENCES

- .1 ASME A112.18.1-2012/CSA-B125.1-12, Plumbing Supply Fittings.
 - .2 ASME B16.22-2013, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASTM B88M-13, Standard Specification for Seamless Copper Water Tube (Metric).
 - .4 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .5 ASTM B306-13, Standard Specification for Copper Drainage Tube (DWV).
 - .6 ASTM D2564-12, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - .7 CAN/CSA-B70-12, Cast Iron Soil Pipe, Fittings and Means of Joining.
 - .8 CAN/CSA-B125.3-12, Plumbing Fittings.
 - .9 CAN/CSA-B181.2-02, PVC Drain, Waste and Vent Pipe and Fittings.
 - .10 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
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1.3 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets in accordance with Sections 01 11 00, 01 33 00, 01 78 00 and 23 05 00 for the following:
 - .1 Plumbing fixtures.
 - .2 Water hammer arrestors.
 - .3 Cleanouts.
 - .4 Trap seal primers. .
 - .5 Domestic H W heater.
 - .6 Domestic H W recirculating pump.

PART 2 - PRODUCTS

2.1 SOIL, STORM, WASTE AND VENT PIPE AND FITTINGS

- .1 Piping inside building above ground: copper tube type DWV to ASTM B306 with drainage pattern wrought copper or cast brass solder joint fittings to CAN/CSA-B125.3; cast iron soil pipe to CAN/CSA-B70 with cast iron fittings, hub and spigot joints or mechanical joints, and with heavy bituminous coating.
- .2 Piping inside building below ground: cast iron soil pipe to CAN/CSA-B70 with cast iron fittings, hub and spigot joints or mechanical joints, and heavy bituminous coated. Buried vent pipe 40 mm and smaller to be copper tube type "L" to ASTM B88M with drainage pattern wrought copper or cast brass solder joint fittings to ASME B16.22.
- .3 PVC piping inside building above or below ground: type DWV to ASME A112.18.1/CSA-B181.2 with solvent weld joints to ASTM D2564. Do not use PVC where the piping passes through fire wall or is buried under traffic area.

2.2 WATER PIPE AND FITTINGS

- .1 Above ground water piping size 50 mm and smaller: copper tube type L to ASTM B88M with sweat wrought copper fittings to ASME B16.22.
 - .2 Make joints with 95:5 antimonial tin solder.
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2.3 VALVES

- .1 Gate valve size 50 mm and smaller: bronze, rising stem, wedge disc, solder joint ends, ANSI Class 125, 1.4 MPa cold working pressure non-shock.
- .2 Globe valve size 50 mm and smaller: bronze, solder joint ends, renewable composition disc, ANSI Class 125, 1.4 MPa cold working pressure non-shock.
- .3 Check valve size 50 mm and smaller: bronze swing check, solder joint ends, ANSI 125, 1.4 MPa cold working pressure non-shock.
- .4 Provide gate valves at each piece of plumbing equipment and at each branch line take-off, and globe valves where balancing is required.

2.4 2.7 WATER HAMMER ARRESTORS (SHOCK ABSORBERS)

- .1 Provide arrestors sized and located on branch water supplies to each group of fixtures in accordance with Plumbing and Drainage Institute Standard PD1 - WH201.
- .2 Construction: stainless steel with welded nested bellows.

2.5 TRAP SEAL PRIMER

- .1 Provide trap seal primer to each floor drain. Trap seal primer shall be all brass with integral vacuum breaker, NPS ½ solder inlet and outlet connections and NPS ½ drip line connection.

2.6 CLEANOUTS

- .1 Provide cleanouts to conform to National Plumbing Code and where shown on drawings.
 - .2 Type: heavy CI male ferrule with bronze bolted plug.
 - .3 Make each cleanout accessible and wherever necessary, extend branch connections to finished surfaces of wall, etc., and provide access covers or plates.
-

2.7 SLOPE OF DRAINS

- .1 Drainage piping shall have a minimum slope as follows:
- .2 Size 75 mm and smaller: 2% slope.
- .3 Size 100 mm and larger: 1% slope.

2.8 PIPE INSULATION

- .1 Insulate hot water piping with 25 mm thick rigid mineral fibre sleeving to CAN/CGSB-51.9 and factory applied all service jacket to CGSB 51-GP-52Ma.
 - .2 Insulate cold water piping with 25 mm thick rigid mineral fibre sleeving to CAN/CGSB-51.9 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .3 Provide polyvinyl chloride (PVC) cover over insulated piping in exposed areas:
 - .4 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .5 Colours: to match adjacent finish paint by Departmental Representative.
 - .6 Minimum service temperatures: -20°C.
 - .7 Maximum service temperature: 65°C.
 - .8 Moisture vapour transmission: 0.02 perm.
 - .9 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .10 Provide aluminum cover over insulated piping in exposed areas:
 - .11 To ASTM B209.
 - .12 Thickness: 0.50 mm sheet.
 - .13 Finish: smooth.
 - .14 Joining: longitudinal and circumferential slip joints with 50 mm laps.
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- .15 Fittings: 0.5 mm thick die-shaped fitting covers with factory-attached protective liner.
- .16 Metal jacket banding and mechanical seals: stainless steel, 19 mm wide, 0.5 mm thick at 300 mm spacing.
- .17 Insulate underside of roof drain body and horizontal storm drainage piping for 5 m from drain with 25 mm thick mineral fibre blanket and vapour barrier jacket.
- .18 Use self-adhesive tape rated under 25 for flame spread and under 50 for smoke development.
- .19 Use quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.
- .20 Provide canvas cover over all insulated pipes in exposed areas. Canvas cover: compact, firm, ULC listed, heavy plain weave, cotton fabric at 220 g/m.sq. Provide two coats of diluted fire retardant lagging adhesive over canvas covering.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install material and fixtures in accordance with referenced standards and manufacturer's written instructions.

3.2 ADJUSTING

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments:
- .3 Adjust water flow rate to design flow rates.
- .4 Refer to other Sections for requirements of commissioning.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTION

- .1 Section 09 91 13 – Exterior Re-Painting

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 plumbing 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 Indicate on drawings:
 - .1 Mounting arrangements.
 - .2 Operating and maintenance clearances.
 - .3 Shop drawings and product data accompanied by:
 - .1 Detailed drawings of bases, supports, and anchor bolts.
 - .2 Acoustical sound power data, where applicable.
 - .3 Points of operation on performance curves.
 - .4 Manufacturer to certify current model production.
 - .5 Certification of compliance to applicable codes.
 - .4 In addition to transmittal letter referred to in Section 01 33 00: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for Plumbing for incorporation into manual.
 - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
 - .2 Operation data to include:
 - .1 Control schematics for systems including environmental controls.

- .2 Description of systems and their controls.
 - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
 - .4 Operation instruction for systems and component.
 - .5 Description of actions to be taken in event of equipment failure.
 - .6 Valves schedule and flow diagram.
 - .7 Colour coding chart.
 - .3 Maintenance data to include:
 - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
 - .2 Data to include schedules of tasks, frequency, tools required and task time.
 - .4 Performance data to include:
 - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
 - .2 Equipment performance verification test results.
 - .3 Special performance data as specified.
 - .5 Approvals:
 - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
 - .2 Make changes as required and re-submit as directed by Departmental Representative.
 - .6 Additional data:
 - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
 - .7 Site records:
 - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of white prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
 - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
 - .3 Use different colour waterproof ink for each service.
 - .4 Make available for reference purposes and inspection.
 - .8 As-built drawings:
 - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
-

- .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
- .3 Submit to Departmental Representative for approval and make corrections as directed.
- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

1.4 MAINTENANCE MATERIAL SUBMITTALS

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

1.5 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect plumbing components from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
 - .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 20.
-

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for plumbing equipment installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PAINTING REPAIRS AND RESTORATION

- .1 Do painting in accordance with Section 09 91 13.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

3.3 SYSTEM CLEANING

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

3.4 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
-

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

3.5 DEMONSTRATION

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

3.6 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.

3.7 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 23 05 01 - Use of HVAC Systems During Construction

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM B32-08(2014), Standard Specification for Solder Metal.
 - .2 ASTM B306-13, Standard Specification for Copper Drainage Tube (DWV).
 - .3 ASTM C564-14, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .2 Canadian Standards Association (CSA International).
 - .1 CSA B67-1972(R1996), Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
 - .2 CSA B70-12, Cast Iron Soil Pipe, Fittings and Means of Joining.
 - .3 CSA B125.3-12, Plumbing Fittings.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
 - .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
-

- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding and packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- .1 Above ground sanitary and vent Type DWV to: ASTM B306.
 - .1 Fittings.
 - .1 Cast brass: to CSA B125.3.
 - .2 Wrought copper: to CSA B125.3.
 - .2 Solder: lead free, to ASTM B32.

2.2 CAST IRON PIPING AND FITTINGS

- .1 Buried sanitary and vent minimum NPS 2, to: CSA B70,
 - .1 Joints:
 - .1 Mechanical joints:
 - .1 Neoprene or butyl rubber compression gaskets: to CSA B70. ASTM C564 or
 - .2 Stainless steel clamps.
 - .2 Hub and spigot:
 - .1 Caulking lead: to CSA B67.
 - .2 Cold caulking compounds.
 - .2 Above ground sanitary and vent: to CSA B70.
 - .1 Joints:
 - .1 Hub and spigot:
 - .1 Caulking lead: to CSA B67.
 - .2 Mechanical joints:
 - .1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 In accordance with Section 23 05 01.
- .2 Install in accordance with National Plumbing Code.

3.3 TESTING

- .1 Pressure test buried systems before backfilling.
- .2 Hydraulically test to verify grades and freedom from obstructions.

3.4 PERFORMANCE VERIFICATION

- .1 Cleanouts:
 - .2 Ensure accessible and that access doors are correctly located.
 - .3 Open, cover with linseed oil and re-seal.
 - .4 Verify that cleanout rods can probe as far as the next cleanout, at least.
- .2 Test to ensure traps are fully and permanently primed.
- .3 Storm water drainage:
 - .1 Verify domes are secure.
 - .2 Ensure weirs are correctly sized and installed correctly.
 - .3 Verify provisions for movement of roof system.
- .4 Ensure that fixtures are properly anchored, connected to system and effectively vented.
- .5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

END OF SECTION

PART 1 - GENERAL

1.1 GENERAL

- .1 This Section covers items common to more than one section of the Mechanical Divisions 22 and 23.
- .2 "Provide" shall mean "supply, install and connect".
- .3 Provide new materials, equipment and plant of proven design and quality, and of current models with published ratings for which replacement parts are readily available.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CAN/CSA-B51-14, Boiler, Pressure Vessel and Pressure Piping Code
- .2 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-2014, Power Piping

1.3 HALOCARBONS

- .1 Comply with Federal Halocarbon Regulations 2003 under the Canadian Environmental Protection Act 1999, EPAM and PWGSC Ontario Region Halocarbon Information Sheet dated March 2010.

1.4 EQUIPMENT LIST

- .1 Complete list of equipment to be used on this project by adding manufacturer's name and model number. Submit for approval within one week of award of contract.
 - .2 The Contractor is to complete the following list of equipment with manufacturer's name and model number:
 - .1 Heat exchanger: Manufacturer and model
 - .2 Wall-mounted exhaust fans: Manufacturer and model
 - .3 Roof-top A/C units: Manufacturer and model
 - .4 Air cooled condensing units: Manufacturer and model
 - .5 Air handling units: Manufacturer and model
 - .6 Control and instrumentation: Manufacturer and model
-

- .3 It is the Contractor's responsibility to ensure that the equipment to be used will meet the performance specifications and will fit the spaces allocated.
- .4 Submit for review within 48 h after Award of Contract.

1.5 CUTTING AND REMEDIAL WORK

- .1 Cutting and remedial work is specified in Section 01 73 00.
- .2 Assume full responsibility for laying out mechanical work and for any damage caused by incorrectly located equipment and mechanical services.
- .3 Set sleeves and mark openings in concrete forms and in masonry before placing of concrete and erection of masonry.

1.6 CO-ORDINATION

- .1 Locate distribution systems, equipment and materials to provide minimum interference and maximum useable space.
- .2 Where interference occurs, Departmental Representative shall approve relocation of equipment and materials.

1.7 DRAWINGS

- .1 Working drawings, except where dimensioned, indicate general mechanical layouts only. Do not scale.
 - .2 Existing equipment and services shown on the drawings:
 - .3 The information shown on the drawings is incomplete and is for reference only. Some of the existing equipment, ducts, pipes and other services are not shown on the drawings.
 - .4 The Contractor shall make arrangements to examine existing conditions, determine conditions affecting the work, and verify sizes and location of existing equipment, ducts, pipes and any other services.
 - .5 Unless the discrepancies are noted and reported to the Departmental Representative prior to close of the bid, the Contractor shall be responsible for the work to relocate existing equipment and to reroute existing ducts, pipes and any other services required for the installation of new work at no extra cost to the contract.
-

- .6 If required by Departmental Representative, provide field drawings to show relative positions of various services. Obtain approval before beginning work.

1.8 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets for major equipment listed in each section.
- .2 Submit early enough to permit Project Schedules to be met.
- .3 Show materials; sizes, dimensions, performance ratings, curves and operating characteristics, compliance with codes and standards, wiring, controls, piping diagrams, installation instructions, fabrication, assembly and installation details.
- .4 For additional requirements pertaining to shop drawings and product data refer to Sections 01 33 00 and 01 78 00.

1.9 OPERATION AND MAINTENANCE DATA

- .1 Supply operating and maintenance instructions complete with names and addresses of spare parts suppliers in accordance with requirements of Section 01 78 00.

1.10 EQUIPMENT DESIGN AND INSTALLATION

- .1 Uniformity:
 - .1 For equipment or material of same type or classification, use product of one manufacturer.
- .2 Installation:
 - .1 Install equipment to manufacturer's recommendations with adequate and easy access for inspection, servicing and lubrication.
 - .2 Install equipment to permit maintenance and disassembly with minimum disturbance to connecting piping and duct systems and without interference with building structure or equipment.
 - .3 Provide screwdriver stops on supplies to plumbing fixtures.
 - .4 Provide support brackets, bases, and all necessary fastenings.
- .3 Pressure Tanks:
 - .1 Constructed, tested and stamped to CAN/CSA-B51.

1.11 ELECTRIC MOTORS AND CONTROLS

- .1 Electrical equipment shall bear CSA label. Obtain inspection labels required by Provincial authority having jurisdiction.
- .2 Use high efficiency motors. Minimum acceptable motor efficiency levels shall be based on the latest table of motor efficiency levels in accordance with CSA C390-10, Test methods, marking requirements, and energy efficiency levels for three-phase induction motors.
- .3 Unless otherwise specified or indicated, motors ½ HP and larger shall be 3 phase.
- .4 Refer to Electrical Division 26, 27 & 28 regarding specifications of power wiring (i.e. wiring carrying the full load current), conduits, starters, disconnect switches, etc., for mechanical equipment specified in Mechanical Divisions. Unless noted and specified in Electrical Divisions to be provided by Electrical Divisions, all field installed power wiring, conduit, starters, disconnect switches, etc., shall be provided by Mechanical Divisions.
- .5 Provide motors, control wiring and controls together with associated relays, signalling devices, thermostats, control transformers, firestats, pressure switches, electric- pneumatic switches, required to form a complete control system for the equipment specified in Mechanical Divisions.

1.12 GUARDS

- .1 Provide vibration free guards on exposed drives and rotating parts to meet safety requirements of Provincial Ministry of Labour and local authorities having jurisdiction.
- .2 Provide 20 mm mesh wire screen on inlet or outlet of exposed fan blades.
- .3 Provide restraining chains and fasteners to hold access doors open when doors close in direction of air pressure.

1.13 EQUIPMENT SUPPORTS

- .1 Unless noted otherwise, fabricate equipment supports from structural grade steel. Submit structural calculations with shop drawings.
 - .2 Mount base mounted equipment on chamfered edge concrete housekeeping pads, minimum of 100 mm high and 50 mm larger than equipment dimensions all around. Refer to structural drawings for details.
-

1.14 PIPING INSTALLATION

- .1 Conform to requirements of ASME B31.1.
- .2 Provide dielectric couplings where piping of dissimilar metals are joined.
- .3 Provide easily accessible unions close to equipment, to permit easy removal of equipment with minimum disturbance to piping systems.
- .4 Valves:
 - .1 Provide easy access for servicing and operation. Install access doors where concealed.
 - .2 Install with stems above horizontal.
- .5 Drainage:
 - .1 Provide easily accessible drain valves at low points to permit complete drainage of piping systems.
 - .2 Extend equipment drain piping to discharge into floor or hub drain.
 - .3 Provide drain piping from drain pan of air handling units, full size of outlet connection and equip with deep-seal trap.
- .6 Expansion and Contraction:
 - .1 Make adequate provision for expansion and contraction of piping systems.
 - .2 Use expansion joints and compensators, flexible connections, pipe loops and offsets as indicated and required.
 - .3 Support piping to prevent any stress or strain from occurring at connections to equipment.
 - .4 Install and guide expansion joints in accordance with manufacturer's recommendations.
 - .5 Provide steel anchors welded to piping, fastened to building structure or embedded in concrete pier so that forces acting on anchor points are restrained without causing damage to structure or systems.
 - .6 Base design axial traverse on temperature difference between -18°C ambient and corresponding fluid temperature plus 25% safety facto.

1.15 PIPE HANGERS AND SUPPORTS

- .1 Fabricate hangers, supports and sway braces in accordance with ASME B31.1.
 - .2 Provide adjustable clevis type hangers on all sizes of pipe except where roller type hangers are required.
-

- .3 Minimum 150 mm hanger rod length.
- .4 Provide hangers on piping with heated or cooled contents as follows:
 - .1 Rigid hangers when rod length is 300 mm or more, pipe expansion to hanger rod length ratio is less than 1:24 and hanger is supported from top of structural steel.
 - .2 Swing hangers when rod length is 300 mm or more, pipe expansion to hanger rod length ratio is less than 1:6 and hanger is supported from top of structural steel.
 - .3 Roller hangers when rod length is less than 300 mm or pipe expansion to hanger rod length ratio is more than 1:6 or hanger is not supported from top of structural steel.
- .5 On uninsulated copper piping, ensure steel hangers in contact with copper piping are copper plated. Copper pipe shall not contact steel, iron or cinder materials. Covered 12 mm diameter copper pipe may be supported on copper straps.

1.16 PAINTING

- .1 Apply at least one coat of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up.

1.17 ACCESS DOORS

- .1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm for body entry and 300 x 300 mm for hand entry unless otherwise noted. Doors to open 180°, have rounded safety corners, concealed hinges, screwdriver latches and anchor straps.
- .3 Material:
 - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Departmental Representative.
 - .2 Remaining areas: use prime coated steel.
- .4 Installation:
 - .1 Locate so that concealed items are accessible.

- .2 Locate so that hand or body entry (as applicable) is achieved.

1.18 DRAIN VALVES

- .1 Minimum NPS 3/4 unless otherwise specified: bronze, with hose end male thread and complete with cap and chain.

1.19 INSTRUCTION OF OPERATING STAFF

- .1 Furnish competent instructors to fully instruct operating staff in care, adjustment and operation of mechanical systems. Use factory trained instructors.
- .2 Instruct during regular work hours before systems accepted and turned over to operating staff for regular operation.
- .3 Where significant changes or modifications in equipment are made under terms of guarantee, instruct operating staff about changes or modifications.

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 USE OF SYSTEMS

- .1 Use of new and/or existing permanent ventilating systems for supplying temporary ventilation is permitted only under following conditions:
 - .1 Entire system is complete, pressure tested, cleaned, flushed out.
 - .2 Specified water treatment system has been commissioned, water treatment is being continuously monitored.
 - .3 Building has been closed in, areas to be heated/ventilated are clean and will not thereafter be subjected to dust-producing processes.
 - .4 There is no possibility of damage.
 - .5 Supply ventilation systems are protected by 60% filters, inspected daily, changed every 2 weeks or more frequently as required.
 - .6 Return systems have approved filters over openings, inlets, outlets.
 - .7 Systems will be:
 - .1 Operated as per manufacturer's recommendations and instructions.
 - .2 Operated by Contractor.
 - .3 Monitored continuously by Contractor.
 - .8 Warranties and guarantees are not relaxed.
 - .9 Regular preventive and other manufacturers recommended maintenance routines are performed by Contractor at own expense and under supervision of Departmental Representative.
 - .10 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.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.
-

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA B149.1-15, Natural Gas and Propane Installation Code.
- .2 National Fire Code of Canada (NFCC 2010)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

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 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.

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Paint:
 - .1 Primers, Paints: in accordance with manufacturer's recommendations for surface conditions.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 CONNECTIONS TO EQUIPMENT

- .1 In accordance with manufacturer's instructions unless otherwise indicated.
- .2 Use valves and either unions or flanges for isolation and ease of maintenance and assembly.
- .3 Use double swing joints when equipment mounted on vibration isolation and when piping subject to movement.

3.3 CLEARANCES

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA B149.
- .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 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.

3.6 PIPEWORK INSTALLATION

- .1 Install pipework to CSA B149.
 - .2 Screwed fittings jointed with Teflon tape.
 - .3 Protect openings against entry of foreign material.
 - .4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.
 - .5 Assemble piping using fittings manufactured to ANSI standards.
-

- .6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.
 - .1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.
- .7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.
- .8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.
- .9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.
- .10 Install, except where indicated, to permit separate thermal insulation of each pipe.
- .11 Group piping wherever possible and as indicated.
- .12 Ream pipes, remove scale and other foreign material before assembly.
- .13 Use eccentric reducers at pipe size changes to ensure positive drainage and venting.
- .14 Provide for thermal expansion as indicated.
- .15 Valves:
 - .1 Install in accessible locations.
 - .2 Remove interior parts before soldering.
 - .3 Install with stems above horizontal position unless indicated.
 - .4 Valves accessible for maintenance without removing adjacent piping.
 - .5 Install globe valves in bypass around control valves.
 - .6 Use ball valves at branch take-offs for isolating purposes except where specified.
 - .7 Install plug cocks for glycol service.
 - .8 Use chain operators on valves NPS 2 1/2 and larger where installed more than 2400 mm above floor in Mechanical Rooms.
- .16 Check Valves:
 - .1 Install silent check valves on discharge of pumps and as indicated.
 - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

3.7 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.
- .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.

3.8 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.

3.9 PREPARATION FOR FIRE STOPPING

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation.
- .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 fire stopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

3.10 FLUSHING OUT OF PIPING SYSTEMS

- .1 Flush system in accordance with Section 23 08 02.
 - .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11, 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.

3.11 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK

- .1 Advise Departmental Representative 48 hours minimum prior to performance of pressure tests.
- .2 Pipework: test as specified in relevant sections of heating, ventilating and air conditioning work.
- .3 Maintain specified test pressure without loss for 4 hours minimum unless specified for longer period of time in relevant mechanical sections.
- .4 Prior to tests, isolate equipment and other parts which are not designed to withstand test pressure or media.
- .5 Conduct tests in presence of Departmental Representative.
- .6 Pay costs for repairs or replacement, retesting, and making good. Departmental Representative to determine whether repair or replacement is appropriate.
- .7 Insulate or conceal work only after approval and certification of tests by Departmental Representative.

3.12 EXISTING SYSTEMS

- .1 Connect into existing piping systems at times approved by Departmental Representative.
- .2 Request written approval by Departmental Representative 10 days minimum, prior to commencement of work.
- .3 Be responsible for damage to existing plant by this work.

3.13 CLEANING

- .1 Clean in accordance with Section 01 74 11.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
 - .1 ASHRAE 90.1-13, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
- .2 Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Shop Drawings: in accordance with Section 01 33 00.

1.3 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 33 00.

1.4 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Motors: high efficiency, in accordance with local Hydro company standards and to ASHRAE 90.1.

2.2 MOTORS

- .1 Provide motors for mechanical equipment as specified.
-

- .2 Motors under 373 W - 1/2 HP: speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120 V, unless otherwise specified or indicated.
- .3 Motors 373 W - 1/2 HP and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40 degrees C, 3 phase, 600 V, unless otherwise indicated.

2.3 TEMPORARY MOTORS

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

2.4 BELT DRIVES

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise indicated.
- .3 For motors under 7.5 kW - 10 HP: standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW - 10 HP and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Correct size of sheave determined during commissioning.
- .6 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .7 Motor slide rail adjustment plates to allow for centre line adjustment.
- .8 Supply one set of spare belts for each set installed in accordance with Section 01 78 00.

2.5 DRIVE GUARDS

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives;
 - .1 Expanded metal screen welded to steel frame.
 - .2 Minimum 1.2 mm thick sheet metal tops and bottoms.
 - .3 38 mm dia holes on both shaft centres for insertion of tachometer.
 - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
 - .1 "U" shaped, minimum 1.6 mm thick galvanized mild steel.

- .2 Securely fasten in place.
- .3 Removable for servicing.
- .5 Unprotected fan inlets or outlets:
 - .1 Wire or expanded metal screen, galvanized, 19 mm mesh.
 - .2 Net free area of guard: not less than 80% of fan openings.
 - .3 Securely fasten in place.
 - .4 Removable for servicing.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

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

3.3 CLEANING

- .1 Proceed in accordance with Section 01 74 11.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 17 - Pipe Welding
- .2 Section 23 08 01 - Performance Verification: Mechanical Piping Systems.
- .3 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems

1.2 REFERENCES

- .1 ASTM International Inc.
 - .1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A105/A105M-14, Standard Specification for Carbon Steel Forgings, for Piping Applications.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for fixtures, and include product characteristics, performance criteria, physical size, finish and limitations.
 - .1 Manufacturer, model number, line contents, pressure and temperature rating.
 - .2 Movement handled, axial, lateral, angular and the amounts of each.
 - .3 Nominal size and dimensions including details of construction and assembly.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance and operation data in accordance with Section 01 78 00.
 - .1 Data to include:
 - .1 Servicing requirements, including special requirements, stuffing box packing, lubrication and recommended procedures.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
 - .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
-

- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 SLIP TYPE EXPANSION JOINTS

- .1 Application: for axial pipe movement, as indicated.
- .2 Repacking: under full line pressure.
- .3 Body and packing housings: Class 150, 1MPa carbon steel pipe to ASTM A53/A53M, Grade B. Wall thickness to match pipe with ends for welding.
- .4 Slip or traverse sleeves: carbon steel pipe to ASTM A53/A53M, Grade B, hard chrome plated.
- .5 Anchor base: construction steel, welded to body.
- .6 Guides (internal and external): embody into packing housing with concentric alignment of slip or traverse sleeve with packing housing.
- .7 Extension limit stop: stainless steel, to prevent over-extension with accessible and removable pins.
- .8 Packing rings: 6 minimum, PTFE impregnated non-asbestos.
- .9 Thermal plastic packing: PTFE impregnated non-asbestos slug supplied loose.
- .10 Lubricating fittings: pet cocks with grease nipple.
- .11 Plunger body and plunger:
 - .1 Plunger body: heavy wall carbon steel welded to body.
 - .2 Plunger: carbon steel with hex head for use with socket wrench.
- .12 Lubricant: to manufacturer's recommendations.
- .13 Lubricant gun: complete with hose assembly.
- .14 Drip connection: 20 MPa forged steel to ASTM A105/A105M. Include half coupling with drain plug.

2.2 BELLOWS TYPE EXPANSION JOINTS

- .1 For axial, lateral or angular movements, as indicated.
 - .2 Maximum operating pressure: as indicated.
 - .3 Maximum operating temperature: 93.3 degrees C.
 - .4 Type A: free flexing, factory tested to 1 times maximum working pressure. Provide test certificates.
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- .5 Type B: externally pressurized, constant volume, pressure balanced, designed to eliminate pressure thrust, factory tested to 1 times maximum working pressure. Provide test certificates.
- .6 Bellows:
 - .1 Multiple bellows, hydraulically formed, two ply, austenitic stainless steel for specified fluid, pressure and temperature, water treatment and pipeline cleaning procedures.
- .7 Reinforcing or control rings:
 - .1 2 piece nickel iron.
- .8 Ends:
 - .1 For butt welding flanges to match pipe.
- .9 Liner:
 - .1 Austenitic stainless steel in direction of flow.
- .10 Shroud:
 - .1 Carbon steel, painted.

2.3 FLEXIBLE CONNECTION

- .1 Application: to suit motion as indicated.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset as indicated.
- .3 Inner hose: stainless steel corrugated.
- .4 Stainless steel outer jacket.
- .5 Diameter and type of end connection: as indicated.
- .6 Operating conditions:
 - .1 Working pressure: 1034 kPa.
 - .2 Working temperature: 93.3 degrees C.
 - .3 To match system requirements.

PART 3 - EXECUTION

3.1 APPLICATION

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

3.2 INSTALLATION

- .1 Install expansion joints with cold setting, as indicated. Make record of cold settings.
- .2 Install pipe anchors and guides as indicated. Anchors to withstand 150% of axial thrust.
- .3 Do welding in accordance with Section 23 05 17.

3.3 PIPE CLEANING AND START-UP

- .1 In accordance with Section 23 08 02.

3.4 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11.
- .2 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
 - .1 ANSI/ASME B31.1-2014, Power Piping.
 - .2 ANSI/ASME B31.3-2014, Process Piping.
 - .3 ANSI/ASME Boiler and Pressure Vessel Code-2015:
 - .1 BPVC 2015 Section V: Nondestructive Examination.
 - .2 BPVC 2015 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C206-11, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
 - .1 AWS C1.1M/C1.1-2012, Recommended Practices for Resistance Welding.
 - .2 AWS Z49.1-2012, Safety in Welding, Cutting and Allied Process.
 - .3 AWS W1-2015, 9th edition Welding Inspection Handbook.
- .4 Canadian Standards Association (CSA International)
 - .1 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
 - .2 CSA B51-14, Boiler, Pressure Vessel and Pressure Piping Code.
 - .3 CSA-W1117.2-12, Safety in Welding, Cutting and Allied Processes.
 - .4 CSA W178.1-14, Certification of Welding Inspection Organizations.
 - .5 CSA W178.2-14, Certification of Welding Inspectors.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 QUALITY ASSURANCE

- .1 Qualifications:
 - .1 Welders:
 - .1 Welding qualifications in accordance with CSA B51.
 - .2 Use qualified and licensed welders possessing certificate for each procedure performed from authority having jurisdiction.
 - .3 Submit welder's qualifications to Departmental Representative.
 - .4 Each welder to possess identification symbol issued by authority having jurisdiction.

- .5 Certification of companies for fusion welding of aluminum in accordance with CSA W47.2.
- .2 Inspectors:
 - .1 Inspectors qualified to CSA W178.2.
- .3 Certifications:
 - .1 Registration of welding procedures in accordance with CSA B51.
 - .2 Copy of welding procedures available for inspection.
 - .3 Safety in welding, cutting and allied processes in accordance with CSA-W117.2.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 ELECTRODES

- .1 Electrodes: in accordance with CSA W48 Series.

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 QUALITY OF WORK

- .1 Welding: in accordance with ANSI/ASME B31.1, ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX and ANSI/AWWA C206, using procedures conforming to AWS B3.0, AWS C1.1, applicable requirements of provincial authority having jurisdiction.

3.3 INSTALLATION REQUIREMENTS

- .1 Identify each weld with welder's identification symbol.
 - .2 Backing rings:
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- .1 Where used, fit to minimize gaps between ring and pipe bore.
- .2 Do not install at orifice flanges.
- .3 Fittings:
 - .1 NPS 2 and smaller: install welding type sockets.
 - .2 Branch connections: install welding tees or forged branch outlet fittings.

3.4 INSPECTION AND TESTS - GENERAL REQUIREMENTS

- .1 Review weld quality requirements and defect limits of applicable codes and standards with Departmental Representative before work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Departmental Representative.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect welds during early stages of welding procedures in accordance with Welding Inspection Handbook. Repair or replace defects as required by codes and as specified.

3.5 SPECIALIST EXAMINATIONS AND TESTS

- .1 General:
 - .1 Perform examinations and tests by specialist qualified to CSA W178.1 and CSA W178.2 and approved by Departmental Representative.
 - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
 - .3 Inspect and test 30 % of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination magnetic particle (hereinafter referred to as "particle") tests.
 - .2 Hydrostatically test welds to ANSI/ASME B31.1.
 - .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
 - .4 Failure of visual examinations:
 - .1 Upon failure of welds by visual examination, perform additional testing as directed by Departmental Representative.
 - .5 Full radiographic tests for heating piping systems.
 - .1 Spot radiography:
 - .1 Conduct spot radiographic tests of up to 10% of welds, selected at random by Departmental Representative from welds which would be most difficult to repair in event of failure after system is operational.
 - .2 Radiographic film:
-

- .1 Identify each radiographic film with date, location, name of welder, and submit to Departmental Representative. Replace film if rejected because of poor quality.
- .3 Interpretation of radiographic films:
 - .1 By qualified radiographer.
- .4 Failure of radiographic tests:
 - .1 Extend tests to welds by welder responsible when those welds fails tests.

3.6 DEFECTS CAUSING REJECTION

- .1 As described in ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessels Code.

3.7 REPAIR OF WELDS WHICH FAILED TESTS

- .1 Re-inspect and re-test repaired or re-worked welds at Contractor's expense.

3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11.
- .2 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 53.01 - Mechanical Identification

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B40.100-2013, Pressure Gauges and Gauge Attachments.
 - .2 ASME B40.200-2008, Thermometers, Direct Reading and Remote Reading.
- .2 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2014 Version.

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 thermometers and pressure gauges 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.
- .4 Certificates:
 - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test and Evaluation Reports:
 - .1 Submit certified test reports for thermometers and pressure gauges from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.

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 thermometers and pressure gauges off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect thermometers and pressure gauges 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.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Design point to be at mid-point of scale or range.

2.2 DIRECT READING THERMOMETERS

- .1 Industrial, variable angle type, mercury-free, liquid filled, 125 mm scale length.
 - .1 Resistance to shock and vibration.

2.3 REMOTE READING THERMOMETERS

- .1 100 mm diameter mercury-free liquid filled vapour activated dial type: accuracy within one scale division, brass movement, stainless steel capillary, stainless steel spiral armour, stainless steel bulb and polished stainless steel case for wall mounting.

2.4 THERMOMETER WELLS

- .1 Copper pipe: copper or bronze.
- .2 Steel pipe: stainless steel.

2.5 PRESSURE GAUGES

- .1 112 mm, dial type: to ASME B40.100, Grade 2A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.
- .2 Provide:
 - .1 Siphon for steam service.
 - .2 Snubber for pulsating operation.
 - .3 Diaphragm assembly for corrosive service.

- .4 Gasketted pressure relief back with solid front.
- .5 Bronze stop cock.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 GENERAL

- .1 Install thermometers and gauges so they can be easily read from floor or platform.
 - .1 If this cannot be accomplished, install remote reading units.
- .2 Install between equipment and first fitting or valve.

3.3 THERMOMETERS

- .1 Install in wells on piping. Include heat conductive material inside well.
- .2 Install in locations as indicated and on inlet and outlet of:
 - .1 Heat exchangers.
 - .2 Water heating and cooling coils.
 - .3 Water boilers.
- .3 Install wells as indicated only for balancing purposes.
- .4 Use extensions where thermometers are installed through insulation.

3.4 PRESSURE GAUGES

- .1 Install in locations as follows:
 - .1 Suction and discharge of pumps.
 - .2 Upstream and downstream of PRV's.
 - .3 Upstream and downstream of control valves.
 - .4 Inlet and outlet of coils.
 - .5 Inlet and outlet of liquid side of heat exchangers.

- .6 Outlet of boilers.
- .7 In other locations as indicated.
- .2 Install gauge cocks for balancing purposes, elsewhere as indicated.
- .3 Use extensions where pressure gauges are installed through insulation.

3.5 NAMEPLATES

- .1 Install engraved lamicaid nameplates in accordance with Section 23 05 53.01, identifying medium.

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 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/or recycling in accordance with Section 01 74 20.
 - .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 thermometer and gauge installation.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.1-2013, Pipe Threads, General Purpose (Inch).
 - .2 ANSI/ASME B16.18-2012, Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASTM International
 - .1 ASTM A276/A276M-15, Standard Specification for Stainless Steel Bars and Shapes.
 - .2 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.
 - .3 ASTM B283-14a, Standard Specification for Copper and Copper Alloy Die Forgings (Hot-Pressed).
 - .4 ASTM B505/B505M-14, Standard Specification for Copper-Base Alloy Continuous Castings.
- .3 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)
 - .1 MSS-SP-25-2013, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS-SP-80-2013, Bronze Gate Globe, Angle and Check Valves.
 - .3 MSS-SP-110-2010, Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Product Data:
 - .1 Provide manufacturer's printed product literature and data sheets for equipment and systems and include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
 - .2 Submit data for valves specified in this Section.
-

1.3 CLOSEOUT SUBMITTALS

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

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials/Spare Parts:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size. Minimum 1.
 - .3 Stem packing: one for every 10 valves, each size. Minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
 - .2 Tools:
 - .1 Furnish special tools for maintenance of systems and equipment.
 - .2 Include following:
 - .1 Lubricant gun for expansion joints.

1.5 DELIVERY, STORAGE AND HANDLING

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

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Valves:
 - .1 Except for specialty valves, to be single manufacturer.
 - .2 Products to have CRN registration numbers.
- .2 End Connections:
 - .1 Connection into adjacent piping/tubing:
 - .1 Steel pipe systems: screwed ends to ANSI/ASME B1.20.1.
 - .2 Copper tube systems: grooved ends to ANSI/ASME B16.18.

- .3 Gate Valves:
 - .1 Requirements common to gate valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Bonnet: union with hexagonal shoulders.
 - .3 Connections: screwed with hexagonal shoulders.
 - .4 Inspection and pressure testing: to MSS SP-80. Tests to be hydrostatic.
 - .5 Packing: non-asbestos.
 - .6 Handwheel: non-ferrous.
 - .7 Handwheel Nut: bronze to ASTM B62.
 - .2 NPS 2 and under, non-rising stem, solid wedge disc, Class 125
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: Handwheel.
 - .3 NPS 2 and under, non-rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet with stem retaining nut.
 - .2 Operator: handwheel.
 - .4 NPS 2 and under, rising stem, split wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Disc: split wedge, bronze to ASTM B283, loosely secured to stem.
 - .3 Operator: handwheel.
 - .5 NPS 2 and under, rising stem, solid wedge disc, Class 125:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
 - .6 NPS 2 and under, rising stem, solid wedge disc, Class 150:
 - .1 Body: with long disc guides, screwed bonnet.
 - .2 Operator: handwheel.
 - .4 Check Valves:
 - .1 Requirements common to check valves, unless specified otherwise:
 - .1 Standard specification: MSS SP-80.
 - .2 Connections: screwed with hexagonal shoulders.
 - .2 NPS 2 and under, swing type, bronze disc, Class 125:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
 - .3 NPS 2 and under, swing type, bronze disc:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
-

- .2 Disc and seat: renewable rotating disc, two-piece hinge disc construction; seat: regrindable.
- .4 NPS 2 and under, swing type, composition disc, Class 200:
 - .1 Body: Y-pattern with integral seat at 45 degrees, screw-in cap with hex head.
 - .2 Disc: renewable rotating disc of number 6 composition to suit service conditions, bronze two-piece hinge disc construction.
- .5 NPS 2 and under, horizontal lift type, composition disc, Class 150:
 - .1 Body: with integral seat, union bonnet ring with hex shoulders, cap.
 - .2 Disc: renewable PTFE rotating disc in disc holder having guides top and bottom, of bronze to ASTM B62.
- .6 NPS 2 and under, vertical lift type, bronze disc, Class 125:
 - .1 Disc: rotating disc having guides top and bottom, disc guides, retaining rings.
- .5 Ball Valves:
 - .1 NPS 2 and under:
 - .1 Body and cap: cast high tensile bronze to ASTM B62.
 - .2 Pressure rating: Class125, 860 kPa steam.
 - .3 Connections: screwed ends to ANSI B1.20.1 and with hexagonal shoulders.
 - .4 Stem: tamperproof ball drive.
 - .5 Stem packing nut: external to body.
 - .6 Ball and seat: replaceable stainless steel solid ball and Teflon seats.
 - .7 Stem seal: TFE with external packing nut.
 - .8 Operator: removable lever handle.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Remove internal parts before soldering.
- .3 Install valves with unions at each piece of equipment arranged to allow servicing, maintenance, and equipment removal.

3.2 CLEANING

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

- .2 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5-2013, Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 - .2 ANSI/ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.
 - .3 ANSI/ASME B16.25-2012, Buttwelding Ends.
 - .4 ANSI/ASME B16.34- 2013, Valves Flanged, Threaded and Welding End.
 - .2 American Petroleum Institute (API)
 - .1 API STD 598-2015, Valve Inspection and Testing.
 - .3 ASTM International
 - .1 ASTM A49-12, Standard Specification for Heat-Treated Carbon Steel Joint Bars, Micro Alloyed Joint Bars, and Forged Carbon Steel Comprise Joint Bars.
 - .2 ASTM A182/A182M-15, Standard Specification for Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valve Parts for High Temperature Service.
 - .3 ASTM A193/A193M-15, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature or High Pressure Service and Other Special Purpose Applications.
 - .4 ASTM A194/A194M-15, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service, or Both.
 - .5 ASTM A216/A216M-14, Standard Specification for Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service.
 - .6 ASTM B85/B85M-14, Standard Specification for Aluminum-Alloy Die Castings.
 - .4 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2014 Version.
 - .5 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
 - .1 MSS SP-25-2013, Standard Marking System for Valves, Fittings, Flanges and Unions.
 - .2 MSS SP-61-2013, Pressure Testing of Valves.
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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 each valve 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.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for valves for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect valves from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
 - .2 Extra Stock Materials:
 - .3 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
-

- .2 Discs: one for every 10 valves, each size, minimum 1.
- .3 Stem packing: one for every 10 valves, each size. Minimum 1.
- .4 Valve handles: 2 of each size.
- .5 Gaskets for flanges: one for every 10 flanged joints.

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Valves:
 - .1 To be of single manufacturer.
 - .2 Test valves individually.
- .2 Requirements common to valves, unless specified otherwise:
 - .1 Pressure-temperature ratings: to ANSI B16.34.
 - .2 Inspections and tests: to API 598.
 - .3 Pressure testing: to MSS SP-61.
 - .4 Flanged valves:
 - .1 Face-to-face dimensions: to ANSI B16.10.
 - .2 Flange dimensions: to ANSI B16.5 with 1.6 mm raised face.
 - .5 Butt-weld valves:
 - .1 End-to-end dimensions: to ANSI B16.10.
 - .2 End dimensions: to ANSI B16.25 bored for standard pipe schedule.
 - .6 Handwheel: non-heating type with raised rim of die-cast aluminum alloy to ASTM B85 or malleable iron to ASTM A49.
 - .7 Markings: to MSS SP-25.
 - .8 Identification:
 - .1 Plate showing catalogue number, size, material of body disc, stem seat, fluid, pressure-temperature rating.
 - .2 Body markings: manufacturer, size, primary service rating, material symbol.
 - .9 CRN registration number required for all products.

2.2 GATE VALVES

- .1 NPS 2 1/2 - 12, rising stem, OS Y, solid wedge disc, flanged ends, Class 150:
 - .1 Body and multiple-bolted integral yoke and bonnet: cast steel to ASTM A216/A216M WCB, with full length disc guides designed to ensure correct re-assembly.
 - .2 Body/bonnet joint: flat face with corrugated metallic gasket.
 - .3 Bonnet studs: to ASTM A193/A193M Type B7.

- .4 Bonnet nuts: to ASTM A194/A194M Type 2H.
- .5 Stuffing box: including non-galling two-piece ball jointed packing gland, with swing-type eye bolts and nuts.
- .6 Gland packing: containing corrosion inhibitor to prevent stem pitting.
- .7 Yoke sleeve: Ni-Resist, minimum melting point above 954 degrees C.
- .8 Hydraulic grease fitting: for lubrication of yoke sleeve bearing surfaces.
- .9 Disc: with disc stem ring to connect to stem, guided throughout its travel.
 - .1 NPS 2 1/2 - 6: solid corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
 - .2 NPS 8 and larger: carbon steel faced with corrosion and heat resistant 13% chromium steel with minimum hardness of 350 HB.
- .10 Seat ring: seamless carbon steel with hard-faced cobalt-chromium-tungsten alloy seating surface, slipped in, seal welded, ground to match disc.
- .11 Stem: heat treated corrosion and heat resistant 13% chromium steel with accurately-cut precision-machined Acme or 60 degrees V threads, top screwed for handwheel nut, T-head disc-stem connection.
- .12 Operator: see elsewhere in this Section.

2.3 VALVE OPERATORS

- .1 Handwheel: on all valves.
- .2 Handwheel with chain operators: on valves installed more than 2400 mm above floor in boiler rooms and mechanical equipment rooms.
- .3 Motors:
 - .1 Application: full open and full close applications.
 - .2 Position and precision control.

2.4 CHECK VALVES

- .1 NPS 2 1/2 and over, flanged ends, Class 150: swing check.
 - .1 Body and multiple-bolted cap: cast steel to ASTM A216/A216M WCB.
 - .2 Cap studs: to ASTM A193/A193M Type B7.
 - .3 Cap nuts: to ASTM A194/A194M Type 2H.
 - .4 Body/cap joint: male-female face with corrugated metallic gasket.
 - .5 Disc: heat treated corrosion and heat resistant 13% chromium steel.
 - .6 Seat rings: heat treated corrosion and heat resistant 13% chromium steel, slipped in, seal welded, ground to match disc.
 - .7 Hinge: ASTM A182/A182M.
 - .8 Hinge pin: ASTM A182/A182M.
 - .9 Hinge pin plugs: ASTM A182/A182M.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's recommendations in upright position with stem above horizontal.

3.3 COMMISSIONING

- .1 As part of commissioning activities, develop schedule of valves and record thereon identifier, location, service, purchase order number and date, manufacturer, identification data specified above.

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.
- .3 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American National Standards Institute (ANSI)/American Society of Mechanical Engineers (ASME)
 - .1 ANSI/ASME B1.20.2M-2013, Pipe Threads, 60 deg. General Purpose (Metric).
 - .2 ASME B16, Fittings and Valves Package.
 - .3 ANSI/ASME B16.1-2010, Grey Iron Pipe Flanges and Flanged Fittings. Classes 25, 125, and 250.
 - .4 ANSI/ASME B16.10-2009, Face-to-Face and End-to-End Dimensions Valves.
 - .5 ANSI/ASME B16.11-2011, Forged Fittings, Socket-Welding and Threaded.
 - .6 ANSI/ASME B16.25-2012, Buttwelding Ends.
 - .7 ANSI/ASME B16.34-2013, Valves Flanged, Threaded and Welding End. Includes Supplement (2010).
- .2 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.
 - .3 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 Canadian Registration Number (CRN)
- .4 Efficiency Valuation Organization (EVO)
 - .1 International Performance Measurement and Verification Protocol (IPMVP)
 - .1 IPMVP 2014 Version.
- .5 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
 - .1 MSS SP-78-2011, Cast Iron Plug Valves, Flanged and Threaded Ends.

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 each valve 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.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for valves - lubricated plug for incorporation into manual.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect valves from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
 - .2 Extra Stock Materials:
 - .3 Furnish following spare parts:
 - .1 Valve seats: one for every 10 valves each size, minimum 1.
 - .2 Discs: one for every 10 valves, each size, minimum 1.
 - .3 Stem packing: one for every 10 valves, each size, minimum 1.
 - .4 Valve handles: 2 of each size.
 - .5 Gaskets for flanges: one for every 10 flanged joints.
-

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Valves:
 - .1 To be of single manufacturer.
 - .2 Ensure products have CRN registration number.

2.2 ECCENTRIC PLUG VALVES - SCREWED ENDS

- .1 General:
 - .1 Dead-tight shut-off on liquids and gases at pressure differentials up to 1.2 MPa in forward direction, 520 kPa in reverse direction.
- .2 Up to NPS 2, screwed ends:
 - .1 Body: cast iron to ASTM B209 Class B.
 - .2 Plug:
 - .1 NPS 1/2 and 3/4: bronze to ASTM B62.
 - .2 NPS 1 to NPS 2: bronze to ASTM B62.
 - .3 Bearings: permanently lubricated, bronze to ASTM B62 in upper and lower journals.
 - .4 Seals: double-seal consisting of:
 - .1 Plastic seat coating between plug and body.
 - .2 Resilient seal moulded into groove in plug face.
 - .3 Seal materials: BUNA stem seals with HYCAR plug seals.
 - .4 VITON stem seals with fluorinated hydrocarbon plug seals.
 - .5 Isobutene isoprene stem seal with isobutene-isoprene plug seals.
 - .5 End connections: roll grooved.
 - .6 Operators: lever.
- .3 NPS 2 1/2 to NPS 4, flanged ends:
 - .1 Body: cast iron to ASTM B209 Class B.
 - .2 Plug: nickel-plated cast iron to ANSI.
 - .3 Bearings: permanently lubricated, bronze to ASTM B62 in upper and lower journals.
 - .4 Seals: double-seal consisting of:
 - .1 Plastic seat coating between plug and body.
 - .2 Resilient seal moulded into groove in plug face.
 - .3 Seal materials: BUNA stem seals with HYCAR plug seals.
 - .4 VITON stem seals with fluorinated hydrocarbon plug seals.
 - .5 Isobutene isoprene stem seal with isobutene-isoprene plug seals.
 - .5 End connections: flanged to ANSI B16.1.
 - .6 Operators: lever.

2.3 LUBRICATED PLUG VALVES

- .1 Principle of operation:
 - .1 Special sealing compound used to effect tight seal. When line pressure applied to valve in closed position, parallel plug forced against downstream side of valve. Metal-to-metal contact and sealing compound ensures leak-tight seal.
 - .2 Testing: to MSS SP-78 for non-shock pressure as per manufacturers.
 - .3 End connections:
 - .1 NPS to 2: screwed ends.
 - .2 NPS 2 to 12: flanged ends.
 - .4 Valve:
 - .1 Body: cast iron to ASTM A126 Class B semi-steel.
 - .2 Pressure rating: NPS to 12:
 - .1 Screwed end valves: screwed to NPT standards.
 - .2 Flanged end valves: flanged to ANSI B16.1 Class 125. Flanged valves NPS 2-8 face dimensions in accordance with ANSI B16.10 short pattern, making them interchangeable with Class 125 flanged cast iron gate valves.
 - .3 Hydrostatic tests: body 300 psig. Seat: 100 psig.
 - .3 Plug: tapered, with round pattern port - 90 degrees from full open to full closed, complete with PTFE thrust ring: 100% full port.
 - .4 Number of ports: 2.
 - .5 Ends: flanged to ANSI B16.1.
 - .6 Lubrication system, nickel-plated.
 - .7 Lubricant: to suit type, temperature and pressure of contained fluid.
 - .8 Include sealing compound injection gun designed for use with pre-packed sealing compound cartridges and valve fitted with button head nipples and combination sealing screws.
 - .9 Feeding system: lubricant forced into lubrication grooves between seating surfaces of plug and body to form positive seal, leak proof operation, and corrosion preventing film.
 - .1 Ensure lubricant receptacle can hold additional lubricant.
 - .2 Include lubricant screw for lubrication.
 - .3 Include check valve to prevent reverse flow of lubricant.
 - .4 Include O-rings between body and plug.
 - .5 Operator:
 - .1 Up to NPS 5: manual lever.
-

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION OF LUBRICATED PLUG VALVES

- .1 Install with line pressure acting to hold plug against body ports.
 - .1 Cut off from higher pressure.

3.3 COMMISSIONING OF LUBRICATED PLUG VALVES

- .1 Determine type of sealing compound for particular application.
- .2 Ensure even distribution of sealing compound and tight shut-off by opening and closing valve 3 times minimum.
- .3 Ensure that plug is free to float when operating valve by easing valve off body.
- .4 Determine frequency of re-lubrication during commissioning of remainder of system.

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.
- .3 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.5 PROTECTION

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

- .2 Repair damage to adjacent materials caused by plug valve installation.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B31.1-14, Power Piping.
- .2 ASTM International
 - .1 ASTM A125-96(2013)e1, Standard Specification for Steel Springs, Helical, Heat-Treated.
 - .2 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .3 ASTM A563-15, 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 SP58-2009, Pipe Hangers and Supports - Materials, Design and Manufacture.
- .5 Underwriter's Laboratories of Canada (ULC)

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

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:
 - .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.

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 and ASME B31.1.
- .2 Use components for intended design purpose only. Do not use for rigging or erection purposes.

2.3 PIPE HANGERS

- .1 Finishes:
 - .1 Pipe hangers and supports: galvanized.
 - .2 Use hot dipped galvanizing process.
 - .3 Ensure steel hangers in contact with copper piping are 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.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts and washers, to MSS-SP58.
 - .3 Upper attachment structural: suspension from upper flange of I-Beam:
 - .1 Cold piping NPS 2 maximum: ductile iron top-of-beam C-clamp with hardened steel cup point setscrew, locknut and carbon steel retaining clip, to MSS SP58.
 - .2 Cold piping NPS 2 1/2 or greater, hot piping: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer and nut.
 - .4 Upper attachment to concrete:
 - .1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.
 - .2 Concrete inserts: wedge shaped body with knockout protector plate to MSS SP58.
 - .5 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.
 - .6 Pipe attachments: material to MSS SP58:
 - .1 Attachments for steel piping: carbon steel galvanized.
 - .2 Attachments for copper piping: copper plated black steel.
 - .3 Use insulation shields for hot pipework.
-

- .4 Oversize pipe hangers and supports.
- .7 Adjustable clevis: material to MSS SP58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.
 - .1 Ensure "U" has hole in bottom for rivetting to insulation shields.
- .8 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP58.
- .9 U-bolts: carbon steel to MSS SP58 with 2 nuts at each end to ASTM A563.
 - .1 Finishes for steel pipework: galvanized.
 - .2 Finishes for copper, glass, brass or aluminum pipework: epoxy coated, with formed portion plastic coated.
- .10 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP58.

2.4 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
 - .1 64 kg/m³ density insulation plus insulation protection shield to: MSS SP58, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
 - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP58.

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 HOUSE-KEEPING PADS

- .1 Provide 100 mm high concrete housekeeping pads for base-mounted equipment; size pads 50 mm larger than equipment; chamfer pad edges.
- .2 Concrete: to Section 03 30 00.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install in accordance with:
 - .1 Manufacturer's instructions and recommendations.
 - .2 Vibration Control Devices:
 - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
 - .3 Clamps on riser piping:
 - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
 - .2 Bolt-tightening torques to industry standards.
 - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
 - .4 Cast iron pipes: install below joint.
 - .4 Clevis plates:
 - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
 - .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
 - .6 Use approved constant support type hangers where:
 - .1 Vertical movement of pipework is 13 mm or more.
 - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
-

- .7 Use variable support spring hangers where:
 - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
 - .2 Variation in supporting effect does not exceed 25 % of total load.

3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code.
- .2 Gas piping: up to NPS 1/2: every 1.8 m.
- .3 Copper piping: up to NPS 1/2: every 1.5 m.
- .4 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.
- .5 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	

- .6 Pipework greater than NPS 12: to MSS SP58.

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 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.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

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 National Building Code of Canada (NBC) - 2010

1.2 SHOP DRAWINGS

- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
- .2 Provide separate shop drawings for each isolated system complete with performance and product data.
- .3 Provide detailed drawings of all seismic control measures for equipment and piping.
- .4 Contractor to provide engineering calculations for site, stamped and signed by a professional seismic engineer in registered or licensed in the Province of Ontario.
 - .1 Seismic calculations are to dictate seismic restraint measures installed for new work. All new seismic restraints are to meet all local, provincial, and federal codes and regulations

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .2 Divert unused metal and wiring materials from landfill to metal recycling facility approved by Departmental Representative.
- .3 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .4 Dispose of corrugated cardboard, polystyrene, plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Size and shape of bases type and performance of vibration isolation as indicated.
-

2.2 ELASTOMERIC PADS

- .1 Type EP1 - neoprene waffle or ribbed; 9 mm minimum thick; 50 durometer; maximum loading 350 kPa.
- .2 Type EP2 - rubber waffle or ribbed; 9 mm minimum thick; 30 durometer natural rubber; maximum loading 415 kPa.
- .3 Type EP3 - neoprene-steel-neoprene; 9 mm minimum thick neoprene bonded to 1.71 mm steel plate; 50 durometer neoprene, waffle or ribbed; holes sleeved with isolation washers; maximum loading 350 kPa.
- .4 Type EP4 - rubber-steel-rubber; 9 mm minimum thick rubber bonded to 1.71 mm steel plate; 30 durometer natural rubber, waffle or ribbed; holes sleeved with isolation washers; maximum loading 415 kPa.

2.3 ELASTOMERIC MOUNTS

- .1 Type M1 - colour coded; neoprene in shear; maximum durometer of 60; threaded insert and two bolt-down holes; ribbed top and bottom surfaces.

2.4 SPRINGS

- .1 Design stable springs: ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height. Select for 50% travel beyond rated load. Units complete with levelling devices.
- .2 Ratio of height when loaded to diameter of spring between 0.8 to 1.0.
- .3 Colour code springs.

2.5 SPRING MOUNT

- .1 Zinc or cadmium plated hardware; housings coated with rust resistant paint.
- .2 Type M2 - stable open spring: support on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
- .3 Type M3 - stable open spring: 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate; levelling bolt for rigidly mounting to equipment.
- .4 Type M4 - restrained stable open spring: supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad; built-in resilient limit stops, removable spacer plates.
- .5 Type M5 - enclosed spring mounts with snubbers for isolation up to 950 kg maximum.

2.6 HANGERS

- .1 Colour coded springs, rust resistant, painted box type hangers. Arrange to permit hanger box or rod to move through a 30 degrees arc without metal to metal contact.
-

- .2 Type H1 - neoprene - in-shear, moulded with rod isolation bushing which passes through hanger box.
- .3 Type H2 - stable spring, elastomeric washer, cup with moulded isolation bushing which passes through hanger box.
- .4 Type H3 - stable spring, elastomeric element, cup with moulded isolation bushing which passes through hanger box.
- .5 Type H4 - stable spring, elastomeric element with pre-compression washer and nut with deflection indicator.

2.7 ACOUSTIC BARRIERS FOR ANCHORS AND GUIDES

- .1 Acoustic barriers: between pipe and support, consisting of 25 mm minimum thick heavy duty duck and neoprene isolation material.

2.8 HORIZONTAL THRUST RESTRAINT

- .1 Spring and elastomeric element housed in box frame; assembly complete with rods and angle brackets for equipment and ductwork attachment; provision for adjustment to limit maximum start and stop movement to 9 mm.
- .2 Arrange restraints symmetrically on either side of unit and attach at centerline of thrust.

2.9 SEISMIC CONTROL MEASURES

- .1 General:
 - .1 Following systems and/or equipment to remain operational during and after earthquakes:
 - .1 AHU-WW27-1 to AHU-WW27-4
 - .2 Seismic control systems to work in every direction.
 - .3 Fasteners and attachment points to resist same maximum load as seismic restraint.
 - .4 Drilled or power driven anchors and fasteners not permitted.
 - .5 No equipment, equipment supports or mounts to fail before failure of structure.
 - .6 Supports of cast iron or threaded pipe not permitted.
 - .7 Seismic control measures not to interfere with integrity of firestopping.
- .2 Static equipment:
 - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
 - .2 Suspended equipment:
 - .1 Use one or more of following methods depending upon site conditions as indicated:
 - .1 Install tight to structure.

- .2 Cross brace in every direction.
- .3 Brace back to structure.
- .4 Cable restraint system.
- .3 Seismic restraints:
 - .1 Cushioning action gentle and steady.
 - .2 Never reach metal-like stiffness.
- .3 Vibration isolated equipment:
 - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
 - .2 Incorporate seismic restraints into vibration isolation system to resist complete isolator unloading.
 - .3 As indicated.
- .4 Piping systems:
 - .1 Piping systems: hangers longer than 300 mm; brace at each hanger.
 - .2 Compatible with requirements for anchoring and guiding of piping systems.
- .5 Bracing methods:
 - .1 Approved by Departmental Representative.
 - .2 Structural angles or channels.
 - .3 Cable restraint system incorporating grommets, shackles and other hardware to ensure alignment of restraints and to avoid bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Seismic control measures to meet requirements of NBC.
 - .2 Install vibration isolation equipment in accordance with manufacturers' instructions and adjust mountings to level equipment.
 - .3 Ensure piping, ducting and electrical connections to isolated equipment do not reduce system flexibility and that piping, conduit and ducting passage through walls and floors do not transmit vibrations.
-

- .4 Unless indicated otherwise, support piping connected to isolated equipment with spring mounts or spring hangers with 25 mm minimum static deflection as follows:
 - .1 Up to NPS 4: first 3 points of support. NPS 5 to NPS 8: first 4 points of support. NPS 10 and Over: first 6 points of support.
 - .2 First point of support: static deflection of twice deflection of isolated equipment, but not more than 50 mm.
- .5 Where isolation is bolted to floor use vibration isolation rubber washers.
- .6 Block and shim level bases so that ductwork and piping connections can be made to rigid system at operating level, before isolator adjustment is made. Ensure that there is no physical contact between isolated equipment and building structure.

3.3 SITE VISIT

- .1 Manufacturer to visit site and provide written certification that installation is in accordance with manufacturer's instructions and submit report to Departmental Representative.
- .2 Provide Departmental Representative with notice 24 h in advance of visit.
- .3 Make adjustments and corrections in accordance with written report.

3.4 CLEANING

- .1 Proceed in accordance with Section 01 74 11.
- .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 REFERENCES

- .1 Canadian Gas Association (CGA)
 - .1 CSA/CGA B149.1-15, Natural Gas and Propane Installation Code.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-24.3-92, Identification of Piping Systems.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
- .2 Product data to include paint colour chips, other products specified in this section.
- .3 Samples:
 - .1 Submit samples in accordance with Section 01 33 00.
 - .2 Samples to include nameplates, labels, tags, lists of proposed legends.

1.3 QUALITY ASSURANCE

- .1 Quality assurance submittals: submit following in accordance with Section 01 33 00.
- .2 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
 - .1 Deliver, store and handle in accordance with Section 01 61 00.
 - .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/or recycling in accordance with Section 01 74 20.
 - .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 Terminal cabinets, control panels: use size # 5.
 - .2 Equipment in Mechanical Rooms: use size # 9.
- .5 Identification for PWGSC Preventive Maintenance Support System (PMSS):
 - .1 Use arrangement of Main identifier, Source identifier, Destination identifier.
 - .2 Equipment in Mechanical Room:
 - .1 Main identifier: size #9.
 - .2 Source and Destination identifiers: size #6.

- .3 Terminal cabinets, control panels: size #5.
- .3 Equipment elsewhere: sizes as appropriate.

2.3 EXISTING IDENTIFICATION SYSTEMS

- .1 Apply existing identification system to new work.
- .2 Where existing identification system does not cover for new work, use identification system specified this section.
- .3 Before starting work, obtain written approval of identification system from Departmental Representative.

2.4 PIPING SYSTEMS GOVERNED BY CODES

- .1 Identification:
 - .1 Natural gas: to CSA/CGA B149.1.

2.5 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking, pictogram (as necessary), legend; direction of flow by arrows. To CAN/CGSB 24.3 except where specified otherwise.
 - .2 Pictograms:
 - .1 Where required: Workplace Hazardous Materials Information System (WHMIS) regulations.
 - .3 Legend:
 - .1 Block capitals to sizes and colours listed in CAN/CGSB 24.3.
 - .4 Arrows showing direction of flow:
 - .1 Outside diameter of pipe or insulation less than 75 mm: 100 mm long x 50 mm high.
 - .2 Outside diameter of pipe or insulation 75 mm and greater: 150 mm long x 50 mm high.
 - .3 Use double-headed arrows where flow is reversible.
 - .5 Extent of background colour marking:
 - .1 To full circumference of pipe or insulation.
 - .2 Length to accommodate pictogram, full length of legend and arrows.
 - .6 Materials for background colour marking, legend, arrows:
 - .1 Pipes and tubing 20 mm and smaller: waterproof and heat-resistant pressure sensitive plastic marker tags.
 - .2 Other pipes: pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150 degrees C and intermittent temperature of 200 degrees C.
-

.7 Colours and Legends:

- .1 Where not listed, obtain direction from Departmental Representative.
- .2 Colours for legends, arrows: to following table:

Background colour:	Legend, arrows:
Yellow	BLACK
Green	WHITE
Red	WHITE

.3 Background colour marking and legends for piping systems:

Contents	Background colour marking	Legend
** Add design temperature		
++ Add design temperature and pressure		
Hot water heating supply	Yellow	HEATING SUPPLY
Hot water heating return	Yellow	HEATING RETURN
Refrigeration suction	Yellow	REF. SUCTION
Refrigeration liquid	Yellow	REF. LIQUID
Refrigeration hot gas	Yellow	REF. HOT GAS
Natural gas	to Codes	

2.6 IDENTIFICATION DUCTWORK SYSTEMS

- .1 50 mm high stencilled letters and directional arrows 150 mm long x 50 mm high.
- .2 Colours: back, or co-ordinated with base colour to ensure strong contrast.

2.7 VALVES, CONTROLLERS

- .1 Brass tags with 12 mm stamped identification data filled with black paint.
- .2 Include flow diagrams for each system, of approved size, showing charts and schedules with identification of each tagged item, valve type, service, function, normal position, location of tagged item.

2.8 CONTROLS COMPONENTS IDENTIFICATION

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

2.9 LANGUAGE

- .1 Identification in English.
 - .2 Use one nameplate and label for each 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 INSTALLATION

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.
- .2 Provide ULC and CSA registration plates as required by respective agency.
- .3 Identify systems, equipment to conform to PWGSC PMSS.

3.3 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.

3.4 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.

3.5 VALVES, CONTROLLERS

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

3.6 CLEANING

- .1 Proceed in accordance with Section 01 74 11.
- .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 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 Associated Air Balance Council (AABC)
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

1.2 RELATED REQUIREMENTS

- .1 Section 23 23 00 – Refrigerant Piping.

1.3 GENERAL

- .1 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.

1.4 QUALIFICATIONS OF TAB PERSONNEL

- .1 Names of personnel it is proposed to perform TAB to be submitted to and approved by Departmental Representative within 90 days of award of contract.

1.5 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 so as 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.
-

1.6 EXCEPTIONS

- .1 TAB of systems and equipment regulated by codes, standards to be to satisfaction of authority having jurisdiction.

1.7 CO-ORDINATION

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule so as 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.

1.8 PRE-TAB REVIEW

- .1 Review contract documents before project construction is started and confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing all proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

1.9 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.

1.10 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.

1.11 START OF TAB

- .1 Notify Departmental Representative 7 days prior to start of TAB.
 - .2 Start TAB when building is essentially completed, including:
-

- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, caulking.
- .5 All pressure, leakage, other tests specified elsewhere in Division 23.
- .6 All provisions for TAB installed and operational.
- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
 - .1 Proper thermal overload protection in place for electrical equipment.
 - .2 Air systems:
 - .1 Filters in place, clean.
 - .2 Duct systems clean.
 - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
 - .4 Correct fan rotation.
 - .5 Fire, smoke, volume control dampers installed and open.
 - .6 Coil fins combed, clean.
 - .7 Access doors, installed, closed.
 - .8 Outlets installed, volume control dampers open.
 - .3 Liquid systems:
 - .1 Flushed, filled, vented.
 - .2 Correct pump rotation.
 - .3 Strainers in place, baskets clean.
 - .4 Isolating and balancing valves installed, open.
 - .5 Calibrated balancing valves installed, at factory settings.
 - .6 Chemical treatment systems complete, operational.

1.12 APPLICATION TOLERANCES

- .1 Do TAB to following tolerances of design values:
 - .1 HVAC systems: plus 5%, minus 5%.
 - .2 Hydronic systems: plus or minus 10%.

1.13 ACCURACY TOLERANCES

- .1 Measured values to be accurate to within plus or minus 2% of actual values.
-

1.14 INSTRUMENTS

- .1 Prior to TAB, submit to Departmental Representative list of instruments to be 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.

1.15 SUBMITTALS

- .1 Submit, prior to commencement of TAB:
- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

1.16 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.

1.17 TAB REPORT

- .1 TAB report to show results in SI units and to include:
 - .1 Project record drawings.
 - .2 System schematics.
- .2 Submit 6 copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

1.18 VERIFICATION

- .1 Reported results subject to verification by Departmental Representative.
 - .2 Provide manpower and instrumentation to verify up to 30% of reported results.
-

- .3 Number and location of verified results to be at discretion of Departmental Representative.
- .4 Bear costs to repeat TAB as required to satisfaction of Departmental Representative.

1.19 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. Markings not to be eradicated or covered in any way.

1.20 COMPLETION OF TAB

- .1 TAB to be considered complete when final TAB Report received and approved by Departmental Representative.

1.21 AIR SYSTEMS

- .1 Standard: TAB to be to most stringent of this section or TAB standards of AABC, SMACNA, and ASHRAE.
 - .2 Do TAB of systems, equipment, components, controls specified Division 22 and 23.
 - .3 Qualifications: personnel performing TAB to be qualified to standards of AABC.
 - .4 Quality assurance: Perform TAB under direction of supervisor qualified to standards of AABC.
 - .5 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
 - .6 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
-

- .7 Locations of systems measurements to include, but not be limited to, following as appropriate: Main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

1.22 HYDRONIC SYSTEMS

- .1 Definitions: for purposes of this section, to include low pressure hot water heating, glycol systems.
- .2 Standard: TAB to be to most stringent of this section or TAB standards of AABC, SMACNA, and ASHRAE.
- .3 Do TAB of systems, equipment, components, controls specified Division 22 and 23.
- .4 Qualifications: personnel performing TAB to be qualified to standards of AABC.
- .5 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .6 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power, voltage, noise, vibration.
- .7 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of heat exchangers (primary and secondary sides), coil, pump, PRV, control valve, other equipment causing changes in conditions.
 - .2 At controllers, controlled device.
- .8 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of primary and secondary loops (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water).

1.23 OTHER SYSTEMS

- .1 Refrigeration systems forming part of HVAC systems:
 - .1 TAB procedures: refer to Section 23 23 00.
-

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 Ducts over 5 m in length, forming part of a supply, return or exhaust ductwork system directly or indirectly connected to air handling equipment to be pressure tested for leaks.

1.2 TIMING

- .1 Ducts to be tested before installation of insulation or any other form of concealments.
- .2 Test after seals have cured.
- .3 Test when ambient temperature will not affect effectiveness of seals, gaskets, etc.

1.3 EXCLUSIONS

- .1 Flexible connections to VAV boxes.

1.4 REFERENCES

- .1 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .2 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
 - .1 SMACNA HVAC Air Duct Leakage Test Manual, 2012.

1.5 TEST PROCEDURES

- .1 Maximum lengths of ducts to be tested to be consistent with capacity of test equipment.
- .2 Section of duct to be tested to include:
 - .1 Fittings, branch ducts, tap-ins.
- .3 Repeat tests until specified pressures are attained. Bear costs for repairs and repetition to tests.
- .4 Base partial system leakage calculations on Reference Standard.
- .5 Seal leaks that can be heard or felt, regardless of their contribution to total leakage.

1.6 TESTING AGENCY

- .1 Installing Contractor.
-

1.7 VERIFICATION

- .1 Departmental Representative to witness tests and to verify reported results.
- .2 To be certified by the same TAB agency approved by Departmental Representative to undertake TAB on this project.

1.8 TEST INSTRUMENTS

- .1 Testing agency to provide instruments for tests.
- .2 Test apparatus to include:
 - .1 Fan capable of producing required static pressure.
 - .2 Duct section with calibrated orifice plate mounted and accurately located pressure taps.
 - .3 Flow measuring instrument compatible with the orifice plate.
 - .4 Calibration curves for orifice plates used.
 - .5 Flexible duct for connecting to ductwork under test.
 - .6 Smoke bombs for visual inspections.
- .3 Test apparatus to be accurate to within +/- 3% of flow rate and pressure.
- .4 Submit details of test instruments to be used to Departmental Representative at least three months before anticipated start date.
- .5 Test instruments to be calibrated and certificate of calibration deposited with Departmental Representative no more than 28 days before start of tests.
- .6 Instruments to be re-calibrated every six months thereafter.

1.9 1.9 SYSTEM LEAKAGE TOLERANCES

- .1 System leakage tolerances specified herein are stated as a percentage of total flow rate handled by the system. Therefore, when testing sections of ductwork this acceptable leakage shall be pro-rated to entire system. Leakage for sections of duct systems shall not exceed the total allowable leakage.
- .2 Leakage tests on following systems not to exceed specified leakage rates.
 - .1 Duct systems: Leakage 2%.
- .3 Evaluation of test results to use surface area of duct and pressure in duct as basic parameters.

1.10 1.10 EQUIPMENT LEAKAGE TOLERANCES

- .1 Equipment and system components such as VAV boxes, duct heating:
 - .1 Leakage: 2 %.

1.11 REPORT FORMS

- .1 Submit proposed report form and test report format to Departmental Representative for approval at least three months before proposed date of first series of tests. Do not start tests until approval received in writing from Departmental Representative.

1.12 PRESSURE TEST REPORTS

- .1 Prepare report of results and submit to Departmental Representative within 24 hours of completion of tests. Include:
 - .1 Schematic of entire system.
 - .2 Schematic of section under test showing test site.
 - .3 Required and achieved static pressures.
 - .4 Orifice differential pressure at test sites.
 - .5 Permissible and actual leakage flow rate (L/s) for test sites.
 - .6 Witnessed certification of results.
- .2 Include test reports in final TAB report.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not used.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 90.1-13-SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .2 ASTM International Inc.
 - .1 ASTM C335-10e1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C449/C449M-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .3 ASTM C547-15, Standard Specification for Mineral Fiber Pipe Insulation.
 - .4 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52MA-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB 51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Thermal Insulation Association of Canada (TIAC)
 - .1 National Insulation Standards 2005.
- .6 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
 - .2 Product Data:
 - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.
 - .3 Samples:
-

- .1 Provide for review: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
 - .1 Mount sample on 12 mm plywood board.
 - .2 Affix typewritten label beneath sample indicating service.
- .4 Manufacturer's Instructions:
 - .1 Include procedures to be used and installation standards to be achieved.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

- .1 Fire and smoke ratings to CAN/ULC-S102:
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre: includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: ASTM C547.
 - .2 Maximum "k" factor: ASTM C547.
- .4 TIAC Code C-1: rigid mineral fibre board, unfaced.
 - .1 Mineral fibre: ASTM C612.
 - .2 Maximum "k" factor: ASTM C612.

2.3 CEMENT

- .1 Thermal insulating and finish
-

- .1 To: ASTM C449.
- .2 Hydraulic setting or Air drying on mineral wool, to ASTM C449.

2.4 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB 51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.
 - .7 Covering adhesive: compatible with insulation.
 - .1 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.

2.5 INSULATION SECUREMENTS

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
 - .1 Maximum VOC limit 80 g/L to SCAQMD Rule 1168.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm wide, 0.5 mm thick.
- .6 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation with expanded metal lath on other face.
- .7 Fasteners: 2 mm diameter pins with 35 mm diameter clips. Length of pin to suit thickness of insulation.

2.6 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.

2.7 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
-

2.8 OUTDOOR VAPOUR RETARDER MASTIC

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m².

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 testing of equipment and adjacent piping systems complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards
 - .1 Hot equipment: To TIAC code 1503-H.
 - .2 Cold equipment: to TIAC code 1503-C.
- .2 Elastomeric Insulation: to remain dry. Overlaps to manufacturer's instructions. Joints tight and sealed properly.
- .3 Provide vapour retarder as recommended by manufacturer.
- .4 Apply materials in accordance with insulation and equipment manufacturer's instructions and this specification.
- .5 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .6 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Hangers, supports outside vapour retarder jacket.
- .7 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .8 Hot Equipment:
 - .1 TIAC code A-1 with bands and 13 mm cement reinforced with one layer of reinforcing mesh.

- .2 Thicknesses:
 - .1 Heat exchangers 50mm

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: At expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Installation to permit movement of expansion joint to permit periodic removal and replacement without damage to adjacent insulation.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
 - .1 ASHRAE Standard 90.1-14, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C335-10e1, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
 - .2 ASTM C449/C449M-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - .3 ASTM C921-10, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .3 Canadian General Standards Board (CGSB)
 - .1 CGSB 51-GP-52Ma-89, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
 - .2 CAN/CGSB-51.53-95, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).
- .5 Manufacturer's Trade Associations
 - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2005).
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
 - .2 CAN/ULC-S702-14, Thermal Insulation, Mineral Fibre, for Buildings
 - .3 CAN/ULC-S702.2-15, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

1.2 DEFINITIONS

- .1 For purposes of this section:
 - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
 - .2 "EXPOSED" - will mean "not concealed" as specified.

- .2 TIAC ss:
 - .1 CRF: Code Rectangular Finish.
 - .2 CPF: Code Piping Finish.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00. 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.
- .3 Shop Drawings:
 - .1 Submit shop drawings in accordance with Section 01 33 00.
 - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
- .4 Samples:
 - .1 Submit samples in accordance with Section 01 33 00.
 - .2 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed. Mount sample on 12 mm plywood board. Affix label beneath sample indicating service.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00.
 - .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.

1.4 QUALITY ASSURANCE

- .1 Health and Safety:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 29.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:

- .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00.
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .3 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2 Storage and Protection:
 - .1 Protect from weather, construction traffic.
 - .2 Protect against damage.
 - .3 Store at temperatures and conditions required by manufacturer.
- .3 Waste Management and Disposal:
 - .1 Construction/Demolition Waste Management and Disposal: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.
 - .2 Place excess or unused insulation and insulation accessory materials in designated containers.
 - .3 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
 - .4 Dispose of unused adhesive material at official hazardous material collections site approved by Departmental Representative.

PART 2 - PRODUCTS

2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102.
 - .1 Maximum flame spread rating: 25.
 - .2 Maximum smoke developed rating: 50.

2.2 INSULATION

- .1 Mineral fibre specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code A-1: rigid moulded mineral fibre without factory applied vapour retarder jacket.
 - .1 Mineral fibre: to CAN/ULC-S702.
 - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-6: flexible unicellular tubular elastomer.
 - .1 Insulation: with vapour retarder jacket.
 - .2 Jacket: to CGSB 51-GP-52Ma.

- .3 Certified by manufacturer: free of potential stress corrosion cracking corrodants.

2.3 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, reinforced, 50 mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: 1.5 mm diameter stainless steel.
- .5 Bands: stainless steel, 19mm wide, 0.5 mm thick.

2.4 CEMENT

- .1 Thermal insulating and finishing cement:
 - .1 Air drying on mineral wool, to ASTM C449/C449M.

2.5 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.

2.6 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

2.7 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m².

2.8 JACKETS

- .1 Polyvinyl Chloride (PVC):
 - .1 One-piece moulded type and sheet to CAN/CGSB-51.53 with pre-formed shapes as required.
 - .2 Colours: to match adjacent finish paint.
 - .3 Minimum service temperatures: -20 degrees C.
 - .4 Maximum service temperature: 65 degrees C.
 - .5 Moisture vapour transmission: 0.02 perm.
 - .6 Fastenings:
 - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
 - .2 Tacks.
 - .3 Pressure sensitive vinyl tape of matching colour.

- .2 Canvas:
 - .1 220 and 120 gm/m² cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
 - .2 Lagging adhesive: compatible with insulation.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PRE-INSTALLATION REQUIREMENT

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces clean, dry, free from foreign material.

3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers' instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
 - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
 - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .6 Make good all existing insulation where previously damaged by others or damaged by work under this Contract.

3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
 - .2 Design: to permit movement of expansion joint to permit periodic removal and replacement without damage to adjacent insulation.
 - .3 Insulation:
-

- .1 Insulation, fastenings and finishes: same as system.
- .2 Jacket: PVC.

3.5 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturers' instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 TIAC Code: A-1.
 - .1 Securements: bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H.
- .3 TIAC Code: A-6.
 - .1 Insulation securements: bands at 300 mm on centre.
 - .2 Seals: lap seal adhesive, lagging adhesive.
 - .3 Installation: TIAC Code 1501-H
- .4 Thickness of insulation as listed in following table.
 - .1 Run-outs to individual units and equipment not exceeding 4000 mm long.
 - .2 Do not insulate exposed runouts to plumbing fixtures, chrome plated piping, valves, fittings.

Application	Temp degrees C	TIAC code	Pipe sizes (NPS) and insulation thickness (mm)					
			Run out	to 1	1 1/4 to 2	2 1/2 to 4	5 to 6	8
Hot Water Heating	60 - 94	A-1	25	38	38	38	38	38
Hot Water Heating	up to 59	A-1	25	25	25	25	38	38
Glycol Heating	60 - 94	A-1	25	38	38	38	38	38
Glycol Heating	up to 59	A-1	25	25	25	25	38	38
Refrigerant hot gas liquid suction	4 - 13	A-6	25	25	25	25	25	25
Refrigerant hot gas liquid suction	below 4	A-6	25	25	38	38	38	38

- .5 Finishes:
 - .1 Exposed indoors: canvas jacket.
 - .2 Exposed in mechanical rooms: PVC jacket.

- .3 Concealed, indoors: canvas on valves, fittings. No further finish.
- .4 Finish attachments: SS bands, at 150 mm on centre. Seals: wing.
- .5 Installation: to appropriate TIAC code CRF/1 through CPF/5.
- .6 Provide weatherproofing for all outdoor pipe insulation. Apply two 3 mm thick coats of asphalt or vinyl mastic with glass reinforcing fibre between coats, lapping joints a minimum of 305 mm.

3.7 CLEANING

- .1 Proceed in accordance with Section 01 74 11.
- .2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

-
- .2 The Contractor is responsible for the following standard commissioning activities and enhanced commissioning activities during project construction, commissioning and operation phases.
 - .1 Construction Phase:
 - .1 Designate an experienced personnel on commissioning as single point of contact for all matters relating to commissioning (enhanced activity).
 - .2 Conduct separate commissioning meetings and prepare minutes of meetings.
 - .2 Commissioning Phase:
 - .1 Conduct separate commissioning meetings and prepare minutes of meetings.
 - .2 Conduct Functional Performance Testing and complete PV Report forms (enhanced activity).
 - .3 Demonstrate system operation (standard activity).
 - .4 Submit Maintenance Manuals (formerly called O&M Manuals) (standard activity).
 - .5 Update Standard Operating Procedures (SOP) manual (enhanced activity).
 - .6 Prepare commissioning report (enhanced activity).
 - .7 Conduct O&M training (standard activity).
 - .3 Contractor's Responsibilities during Operation Phase:
 - .1 Conduct separate commissioning meetings and prepare minutes of meetings.
 - .2 Conduct deferred Functional Performance Testing and complete PV Report forms (enhanced activity).
 - .3 Provide fine-tuning (standard activity).
 - .4 Provide specified inspection and maintenance services during warranty period (standard activity).
 - .3 The Departmental Representative will carry out the following commissioning activities:
 - .1 Review shop drawings (standard activity).
 - .2 Review and inspect installation, and prepare construction deficiencies report (standard activity).
 - .3 Review TAB report (standard activity).
 - .4 Direct System Startup Verification Testing (enhanced activity).
 - .5 Direct Functional Performance Testing (enhanced activity).
 - .6 Review Maintenance Manuals (standard activity).
 - .7 Review "As-Built" drawings (standard activity).
 - .8 Review O&M training (standard activity).
-

- .9 Witness post-acceptance commissioning testing (enhanced activity).
 - .10 Direct post-acceptance fine-tuning and review warranty services (standard activity).
 - .11 Update commissioning report (enhanced activity).
- .4 The PWGSC Commissioning Manager will carry out the following commissioning activities related to the Contractor and the Departmental Representative:
- .1 Review and approve the qualifications of the System Commissioning Administrator (SCA) submitted by the Contractor.
 - .2 Review and approve Startup Checklists, PI and PV Report forms prepared by the Contractor.
 - .3 Witness System Startup Verification Testing conducted by the Contractor and review test reports.
 - .4 Witness Functional Performance Testing conducted by the Contractor and review test reports.
 - .5 Review and approve O&M training conducted by the Contractor.
 - .6 Review commissioning documentation submitted by the Contractor and Departmental Representative.
 - .7 Review and approved commissioning report prepared by the Contractor.
 - .8 Witness the post-acceptance commissioning testing conducted by the Contractor and review test reports.
 - .9 Review and approve updated commissioning report prepared by the Contractor.

1.4 QUALIFICATIONS OF SYSTEM COMMISSIONING ADMINISTRATOR (SCA)

- .1 The System Commissioning Administrator: a qualified independent System Commissioning Administrator (SCA) for scheduling, coordination and supervision of Contractor's commissioning activities during construction, acceptance, and post-acceptance stages. The System Commissioning Administrator shall provide Contractor's Commissioning Documentation.
- .2 Unless approved by the PWGSC Commissioning Manager, the System Commissioning Administrator shall be a NEBB qualified SCA in building systems commissioning. The Contractor shall hire and submit the name of SCA with documentation confirming qualifications within 15 working days of award of contract.

1.5 SCHEDULING

- .1 Within 15 working days of contract award, the Contractor shall submit bar chart commissioning schedules indicating anticipated date of start, duration, and date of completion for the following key activities:
-

- .1 Commissioning meetings.
 - .2 Shop drawings.
 - .3 Pre-startup installation inspections and tests.
 - .4 System and Equipment Startup and Verification.
 - .5 TAB.
 - .6 Functional Performance Test.
 - .7 O&M manuals.
 - .8 "As-Built" drawings.
 - .9 O&M Training.
 - .10 O&M Training Report.
- .2 A bar chart commissioning schedule shall be prepared for each component, equipment, sub-system, system and integrated system to be commissioned as listed under paragraph 1.11.
 - .3 The Commissioning shall be carried out to meet the approved project schedule.

1.6 CONTRACTOR'S COMMISSIONING DOCUMENTATION

- .1 The Contractor's Commissioning Documentation shall include the following:
 - .1 Commissioning Schedule.
 - .2 Minutes of commissioning meetings.
 - .3 Shop drawings and product data.
 - .4 Installation inspection and test reports.
 - .5 TAB reports.
 - .6 Startup Checklists.
 - .7 Product Information (PI) Report forms.
 - .8 Performance Verification (PV) Report forms.
 - .9 "As-Built" drawings.
 - .10 Maintenance Manuals.
 - .11 O&M Training Schedule
 - .12 O&M Training Report.

1.7 PRE- COMMISSIONING TESTING - STARTUPS

- .1 Requirements of Pre-commissioning Verification: a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems (eg., emergency, fire, and life safety) operate in accordance with contact documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions. Verification of the proper operation of the control system also includes verifying the interface of the control system with the TAB criteria and the response of EMCS controllers and sensors. Also, the Departmental Representative shall select, at random, 10

percent of the reported TAB and EMCS data for verification, and a failure of selected items shall result in the rejection of the final TAB report or the report of system startup and testing.

- .2 The Startup Checklists and PI Report forms shall be completed by the Contractor and verified by the Departmental Representative.

1.8 COMMISSIONING TESTING

- .1 Commissioning Testing shall include System Operation Demonstration and Functional Performance Testing of mechanical systems. Test each system independently and then in unison with integrated systems.
- .2 Requirements of Functional Performance Testing (FPT): FPT shall determine if the HVAC system is providing the required heating, ventilating, and cooling services in accordance with the finalized design intent. FPT shall also determine the as-built installed capacity of the heating and cooling plant and the heat transfer equipment. If FPT cannot be completed due to seasonal reasons, lack of occupancy, deficiencies beyond the scope of the mechanical work, or any other reason, this shall be noted along with an indication of when tests will be rescheduled. If any identified performance deficiencies need to be corrected, the tests shall be repeated after corrective work is carried out, and this process shall continue until acceptable performance is achieved.
- .3 The Functional Performance Tests forms shall be completed by the Contractor and verified by the Departmental Representative.

1.9 EXTENT OF COMMISSIONING

- .1 Systems to be commissioned with the comprehensive commissioning to include:
 - .1 Hydronic Systems.
 - .2 Air Systems.

1.10 O&M TRAINING

- .1 The Contractor shall provide qualified training instructors to conduct O&M training.
 - .2 Four weeks prior to commencement of O&M training, the Contractor shall submit training schedule with course outline, agenda and a copy of training manual in accordance with the training plan for review by the Departmental Representative and the PWGSC Commissioning Manager.
 - .3 Training shall include familiarization sessions, hands-on instruction, and classroom sessions.
-

- .4 Classroom training shall include: review of Maintenance Manuals, Standard Operating Procedures (SOP) Manual, System Operational Procedures for all modes of operation, acceptable tolerances for system adjustments and procedures for dealing with abnormal and emergency situations.

1.11 COMMISSIONING REPORT AND POST-ACCEPTANCE COMMISSIONING

- .1 When the acceptable Functional Performance Testing, O&M Training, and commissioning documentation have been completed, the Contractor shall prepare a commissioning report. The report will identify the completed functional performance tests, the deferred functional performance tests, construction deficiencies, design deficiencies, user's changes of requirement, and outstanding commissioning issues. The report will provide review comments on test results, O&M training and commissioning documentation, and will recommend follow-up actions to be taken during post-acceptance commissioning.
- .2 The Project Manager will not issue the Certificate of Substantial Performance until the commissioning report with a recommendation of acceptance is submitted by the PWGSC Commissioning Manager.

1.12 ADDITIONAL COMMISSIONING REQUIREMENTS

- .1 Refer to other specifications sections for additional commissioning requirements.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

1.3 CLEANING AND START-UP OF MECHANICAL PIPING SYSTEMS

- .1 In accordance with Section 23 08 02.

1.4 HYDRONIC SYSTEMS - PERFORMANCE VERIFICATION (PV)

- .1 Perform hydronic systems performance verification after cleaning is completed and system is in full operation.
- .2 When systems are operational, perform following tests:
 - .1 Conduct full scale tests at maximum design flow rates, temperatures and pressures for continuous consecutive period of 48 hours to demonstrate compliance with design criteria.
 - .2 Verify performance of hydronic system circulating pumps as specified, recording system pressures, temperatures, fluctuations by simulating maximum design conditions and varying.
 - .1 Pump operation.
 - .2 Boiler and/or chiller operation.
 - .3 Pressure bypass open/closed.
 - .4 Control pressure failure.
 - .5 Maximum heating demand.
 - .6 Maximum cooling demand.
 - .7 Boiler and/or chiller failure.
 - .8 Cooling tower (and/or industrial fluid cooler) fan failure.
 - .9 Outdoor reset. Re-check heat exchanger output supply temperature at 100% and 50% reset, maximum water temperature.

1.5 HYDRONIC SYSTEM CAPACITY TEST

- .1 Perform hydronic system capacity tests after:
 - .1 TAB has been completed

- .2 Verification of operating, limit, safety controls.
- .3 Verification of primary and secondary pump flow rates.
- .4 Verification of accuracy of temperature and pressure sensors and gauges.
- .2 Calculate system capacity at test conditions.
- .3 Using manufacturer's published data and calculated capacity at test conditions, extrapolate system capacity at design conditions.
- .4 When capacity test is completed, return controls and equipment status to normal operating conditions.
- .5 Submit sample of system water to approved testing agency to determine if chemical treatment is correct. Include cost.
- .6 Heating system capacity test:
 - .1 Perform capacity test when ambient temperature is within 10% of design conditions. Simulate design conditions by:
 - .1 Increasing OA flow rates through heating coils (in this case, monitor heating coil discharge temperatures to ensure that coils are not subjected to freezing conditions) or
 - .2 Reducing space temperature by turning of heating system for sufficient period of time before starting testing.
 - .2 Test procedures:
 - .1 Open fully heat exchanger, heating coil and radiation control valves.
 - .2 With boilers on full firing and hot water heating supply temperature stabilized, record flow rates and supply and return temperatures simultaneously.
 - .3 Conduct flue gas analysis test on boilers at full load and at low fire conditions.

1.6 GASEOUS FUEL SYSTEMS

- .1 Operation tests:
 - .1 Measure gas pressure at gas meter outlet and at burner manifold.
 - .2 Verify details of temperature and pressure compensation at meter.
 - .3 Verify settings, operation, venting of high and low pressure cut-outs, alarms.
 - .4 Check terminals of vents for gas pressure regulators.

1.7 HYDRONIC SYSTEMS

- .1 Give written 48 hours notice of date when tests will be made.
 - .2 Conduct tests in presence of Departmental Representative and representatives of agencies having jurisdiction.
-

- .3 Bear all costs in connection with all tests.
- .4 Obtain acceptance certificates from authorities having jurisdiction. Work shall not be considered complete until certificates are delivered to the Departmental Representative.
- .5 Piping pressure tests:
 - .1 Fill water piping with water and test at 1-1/2 times system operating pressure or at 860 kPa, whichever is greater.
 - .2 Maintain test pressures without loss for four hour period.
 - .3 Test natural gas systems with nitrogen gas at 690 kPa for 24 hour period without loss.
 - .4 Repair leaks and defects. Retest until approved by Departmental Representative.
- .6 Flushing and cleaning:
 - .1 After pressure tests are completed and approved, prior to start-up and placing into operation, flush and clean out piping systems.
 - .2 For water and oil systems fill with solution of water and approved non-foaming, phosphate free detergent. Circulate solution throughout piping systems.
 - .3 Flush and drain systems until free of dirt, sludge, oil, grease and other foreign material. Clean strainers.
 - .4 Refill water systems with clean water.
 - .5 Use compressed air to remove moisture from interior surfaces of fuel oil piping systems before filling with oil.
- .7 Testing and balancing of heating, ventilating, and air-conditioning systems:
 - .1 Use qualified personnel approved by the Departmental Representative to test and balance systems and keep records of operating results.
 - .2 After systems balanced and tests concluded, submit test and balance report showing relevant operating data of equipment and systems.
 - .3 Report shall certify compliance with requirements of drawings and specifications.

1.8 GLYCOL SYSTEMS

- .1 Test to prove concentration will prevent freezing to minus 40 degrees C Test inhibitor strength and include in procedural report. Refer to ASTM E202.

1.9 REPORTS

- .1 In accordance with Section 01 91 31, supplemented as specified herein.

1.10 TRAINING

- .1 In accordance with Section 01 91 41, supplemented as specified herein.
-

- .2 Furnish competent instructors to fully instruct operating staff in care, adjustment and operation of mechanical systems. Use factory trained instructors.
- .3 Instruct during regular work hours before systems accepted and turned over to operating staff for regular operation.
- .4 Where significant changes or modifications in equipment are made under terms of guarantee, instruct operating staff about changes or modifications.

PART 2 - PRODUCTS

2.1 NOT USED

- .1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

- .1 Not Used.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 25 00 - HVAC Water Treatment Systems.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .2 Dispose of unused cleaning solutions at official hazardous material collections site approved by the Departmental Representative.
- .3 Do not dispose of unused cleaning solutions into sewer system, into streams, lakes, onto ground or in other locations where it will pose health or environmental hazard.
- .4 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .5 Dispose of corrugated cardboard, polystyrene, plastic packaging material in appropriate on-site bin for recycling in accordance with site waste management program.

PART 2 - PRODUCTS

2.1 CLEANING SOLUTIONS

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
 - .2 Sodium carbonate: 0.40 kg per 100 L water in system.
 - .3 Low-foaming detergent: 0.01 kg per 100 L water in system.
-

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 CLEANING HYDRONIC SYSTEMS

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
 - .2 Cleaning Agency:
 - .1 Retain qualified water treatment specialist to perform system cleaning.
 - .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
 - .4 Cleaning procedures:
 - .1 Provide detailed report outlining proposed cleaning procedures at least 4 weeks prior to proposed starting date. Report to include:
 - .1 Cleaning procedures, flow rates, elapsed time.
 - .2 Chemicals and concentrations used.
 - .3 Inhibitors and concentrations.
 - .4 Specific requirements for completion of work.
 - .5 Special precautions for protecting piping system materials and components.
 - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
 - .5 Conditions at time of cleaning of systems:
 - .1 Systems: free from construction debris, dirt and other foreign material.
 - .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
 - .3 Strainers: clean prior to initial fill.
 - .4 Install temporary filters on pumps not equipped with permanent filters.
 - .5 Install pressure gauges on strainers to detect plugging.
 - .6 Report on Completion of Cleaning:
 - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
 - .7 Hydronic Systems:
 - .1 Fill system with water, ensure air is vented from system.
-

- .2 Fill expansion tanks 1/3 to 1/2 full, charge system with compressed air to at least 35 kPa (does not apply to diaphragm type expansion tanks).
 - .3 Use water metre to record volume of water in system to +/- 0.5%.
 - .4 Add chemicals under direct supervision of chemical treatment supplier.
 - .5 Closed loop systems: circulate system cleaner at 60 degrees C for at least 36 h. Drain as quickly as possible. Refill with water and inhibitors. Test concentrations and adjust to recommended levels.
 - .6 Flush velocity in system mains and branches to ensure removal of debris. System pumps may be used for circulating cleaning solution provided that velocities are adequate.
 - .7 Add chemical solution to system.
 - .8 Establish circulation, raise temperature slowly to maximum design. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).
- .8 Glycol Systems:
- .1 In addition to procedures specified above perform specified procedures.
 - .2 Test to prove concentration will prevent freezing to minus 40 degrees C. Test inhibitor strength and include in procedural report. Refer to ASTM E202.

3.3 FILLING OF HYDRONIC SYSTEMS

- .1 Refill systems with clean water adding water treatment as required.
- .2 Charge glycol systems with glycol solution of 50/50% ethylene by weight with inhibitor for both testing and final operation.

3.4 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
 - .1 Establish circulation and expansion tank level, set pressure controls.
 - .2 Ensure air is removed.
 - .3 Check pumps to be free from air, debris, possibility of cavitation when system is at design temperature.
 - .4 Dismantle system pumps used for cleaning, inspect, replace worn parts, install new gaskets and new set of seals.
 - .5 Clean out strainers repeatedly until system is clean.
 - .6 Commission water treatment systems as specified in Section 23 25 00.
 - .7 Check water level in expansion tank with cold water with circulating pumps OFF and again with pumps ON.
 - .8 Repeat with water at design temperature.

- .9 Check pressurization to ensure proper operation and to prevent water hammer, flashing, cavitation. Eliminate water hammer and other noises.
- .10 Bring system up to design temperature and pressure over a 48 hour period.
- .11 Adjust pipe supports, hangers, springs as necessary.
- .12 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .13 If sliding type expansion joints bind or if bellows type expansion joints flex incorrectly, shut down system, re-align, repeat start-up procedures.
- .14 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .15 Check operation of drain valves.
- .16 Adjust valve stem packings as systems settle down.
- .17 Fully open balancing valves (except those that are factory-set).
- .18 Check operation of over-temperature protection devices on circulating pumps.
- .19 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 11.
- .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 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 electric and electronic control system for HVAC and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.2 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect electric and electronic control systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

1.3 EXISTING SITE CONTROLS

- .1 As the existing EMCS is a proprietary system and only a licensed Delta Partner can service the panels, system, equipment and devices, it is required that when the existing mechanical equipment is being demolished during the project that **ONLY** the Delta Partner disconnect the existing units from the Delta Controls Panels.
-

1.4 NEW CONTROLS

- .1 That the new equipment, systems, devices, etc. to be completely native BACnet, fully mapped and programmed by the equipment manufacturer, stand alone, fully operational and functioning, and ready for future connection to the existing Delta EMCS. Connecting the new Units to the Delta EMCS will not be part of this project. The project specifications shall indicate a sequence of operation and a point list identifying objects specifically used by the project. These objects shall be native BACnet, mapped and identified by the Contractor.

PART 2 - PRODUCTS

2.1 THERMOSTAT (LINE VOLTAGE-HEATING AND COOLING)

- .1 Line voltage, wall-mounted thermostat, for heating, cooling, heating-cooling with:
 - .1 Full load rating: 16 A at 120 V.
 - .2 Temperature setting range: 5 degrees C to 30 degrees C.
 - .3 Thermometer range: 5 degrees C to 30 degrees C.
 - .4 Markings in 5 degree increments.
 - .5 Differential temperature fixed at 1.1 degrees C.

2.2 THERMOSTAT (LINE VOLTAGE, HEATING)

- .1 Line voltage wall mounted electric heating thermostat with:
 - .1 Full load rating: 22 A at 120 V.
 - .2 Temperature setting range: 5 degrees C to 30 degrees C.
 - .3 Double pole.
 - .4 Thermometer range: 5 degrees C to 30 degrees C.
 - .5 Scale markings: off-5-10-15-20-25 degrees C.

2.3 THERMOSTAT (REMOTE BULB)

- .1 Line voltage remote bulb type thermostat with:
 - .1 8 A rating on 120 V.
 - .2 3 m copper capillary tube nylon coated.
 - .3 Moisture and dust-resistant enclosure.

2.4 THERMOSTAT GUARDS

- .1 Thermostat guards: lockable, clear Slots for air circulation to thermostat.
-

2.5 LOW LIMIT TEMPERATURE ALARM

- .1 Low limit temperature alarm with:
 - .1 Rating: 10.2 A at 120 V, 6.5 A at 240 V.
 - .2 Sensing bulb and 1.5 m long capillary tube.
 - .3 Switching action: manual.
 - .4 Temperature setting range: 0 degrees C to 15 degrees C.

2.6 OUTDOOR AIR TEMPERATURE SENSORS

- .1 Outside air type: complete with probe length 100 - 150 mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to 13 mm conduit, weatherproof construction in NEMA 4 enclosure.

2.7 HIGH LIMIT TEMPERATURE ALARM

- .1 High limit temperature alarm with:
 - .1 Rating 10 A at 120 V .
 - .2 Positive lock-out.
 - .3 Manual reset only after 14 degrees C drop-in temperature.
 - .4 Cutout setting: 50 degrees C.

2.8 SAIL SWITCH

- .1 Sail switch, mercury bulb type with stainless steel sail, adjustable range set for 2.54 m/s air velocity. Full load: 15 A at 120 V. Maximum ambient temperature: 82 degrees C.

2.9 PRESSURE SWITCH

- .1 Pressure switch for water at range 172 kPa – 689kPa to gauge pressure of 1034 kPa with manual reset, contacts open on rise. Maximum allowable gauge pressure of 1.2 MPa. Full load 16 A at 120 V, ULC rated.

2.10 ROOM TEMPERATURE SENSORS

- .1 Temperature sensing and display wall module.
 - .1 LCD display to show space temperature and temperature setpoint.
 - .2 Buttons for occupant selection of temperature setpoint and occupied/unoccupied mode.
 - .3 Jack connection for plugging in laptop personal computer contractor supplied zone terminal unit 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 10-50 mm long RTD with ceramic tube or equivalent protection or thermistor, 10,000 ohm, accuracy of plus or minus 0.2 degrees C.

2.11 DUCT TEMPERATURE SENSORS

- .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length 460 mm.
- .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length 6000 mm. Bend probe at field installation time to 100 mm radius at point along probe without degradation of performance.

2.12 CO2 SENSORS AND TRANSMITTERS

1. The CO2 sensor for demand control ventilation shall be non-dispersive infrared sensor. The diffusion gas chamber in the sensor shall incorporate a reflective light pipe or waveguide surrounded by a gas permeable membrane that prevents particulate contamination of the sensor. For long term signal stability, the sensor shall utilize a dual channel infrared detector, one channel for CO2 absorption, the other for reference. The sensor shall have a five year recommended calibration interval. In addition, the sensor shall be provided with a five-year calibration guarantee, providing for free factory calibration if the sensor is found to be out of calibration within five years of the purchase date. The sensor shall incorporate on board elevation correction adjustment. The sensor shall incorporate Time Extended Measurement Algorithm (TEMA) software for self-correction of drift to better than ± 10 ppm per year. The sensor shall have accuracy of ± 50 ppm and repeatability of ± 20 ppm. All adjustments to the sensor including output scaling, elevation adjustment, relay setpoint, relay dead-band, linear or exponential output, and single point calibration shall be made via on-board push buttons and LCD display. For ease of installation, the sensor shall have a detachable base with all field wiring terminals on the base. Each sensor comes with a solid door to cover the digital display.

2.13 SEQUENCE OF OPERATION

- .1 AHU-WW27-1, AHU-WW27-3 AND AHU-WW27-4 :

Motorized dampers on the return air and outside air will be modulated in order to provide free cooling, supply air temperature of 12.8°C, when possible. As the outside air temperature falls below 12.8°C the outside air damper closes while the return air damper opens. When the outside air volume falls to 20% of maximum

unit air flow the heating coil will modulate to maintain the space temperature of 22.2°C.

.2 AHU-WW27-2:

Motorized dampers on the return air and outside air will be modulated in order to provide free cooling, supply air temperature of 12.8°C, when possible. As the outside air temperature falls below 12.8°C the outside air damper closes while the return air damper opens. As the outside air temperature goes above 12.8°C the outside air damper closes while the return air damper opens when the outside air volume falls to 20% of maximum unit air flow the cooling coil will modulate to maintain a discharge temperature of 12.8°C during the summer and the hydronic heating coil control valve will modulate to maintain as space temperature of 22.2°C during the winter.

.3 AHU-WW27-5:

Motorized dampers on the return air and outside air will be modulated in order to provide free cooling, supply air temperature of 12.8°C, when possible. As the outside air temperature falls below 12.8°C the outside air damper closes while the return air damper opens. As the outside air temperature goes above 12.8°C the outside air damper closes while the return air damper opens when the outside air volume falls to 20% of maximum unit air flow the cooling coil will modulate to maintain a discharge temperature of 12.8°C during the summer and the electric heating coil will modulate to maintain as space temperature of 22.2°C during the winter.

.4 AHU-WW26-1

Motorized dampers on the return air and outside air will be modulated in order to provide free, supply air temperature of 12.8°C, when possible. As the outside air temperature falls below 12.8°C the outside air damper closes while the return air damper opens. As the outside air temperature goes above 12.8°C the outside air damper closes while the return air damper opens when the outside air volume falls to 20% of maximum unit air flow the cooling coil will modulate to maintain a discharge temperature of 12.8°C during the summer and the electric heating coil will modulate to maintain as space temperature of 22.2°C during the winter. The return air will pass through a heat recovery coil prior to being exhausted to the outside in order to recover some of the heating and or cooling from the return air

.5 AHU-WW26-2:

Motorized dampers on the return air and outside air will be modulated in order to provide free cooling, supply air temperature of 12.8°C, when possible. As the outside air temperature falls below 12.8°C the outside air damper closes while the return air damper opens. When the outside air volume falls to 20% of maximum unit air flow the heating coil will modulate to maintain the space temperature of 22.2°C.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for electric and electronic control systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install control devices.
- .2 On outside wall, mount thermostats on bracket or insulated pad 25 mm from exterior wall.
- .3 Install remote sensing device and capillary tube in metallic conduit. Conduit enclosing capillary tube must not touch heater or heating cable.

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 Waste Management: separate waste materials for reuse and/or 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 REQUIREMENTS

- .1 Section 23 05 05 - Installation of Pipework
- .2 Section 23 08 01 - Performance Verification of Mechanical Piping Systems.
- .3 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems

1.2 REFERENCES

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.5-13, Pipe Flanges and Flanged Fittings.
 - .2 ASME B16.18-12, Cast Copper Alloy Solder Joint Pressure Fittings.
 - .3 ASME B16.22-13, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
 - .4 ASME B18.2.1-12, Square and Hex Bolts and Screws Inch Series.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM A47/A47M-99(2014), Standard Specification for Ferritic Malleable Iron Castings.
 - .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - .3 ASTM B837-10, Standard Specification for Seamless Copper Tube for Natural Gas and Liquefied Petroleum (LP) Gas Fuel Distribution Systems.
- .3 Canadian Standards Association (CSA International)
 - .1 CSA W47.1-09(2014), Certification of Companies for Fusion Welding of Steel.
- .4 Canadian Standards Association (CSA)/Canadian Gas Association (CGA)
 - .1 CAN/CSA B149.1-15, Natural Gas and Propane Installation Code
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00.
- .2 Indicate on manufacturer's catalogue literature following: valves.

1.4 CLOSEOUT SUBMITTALS

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

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan.
- .3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Schedule 40, seamless as follows:
 - .1 NPS 1/2 to 2, screwed.
 - .2 NPS 2 1/2 and over, plain end.
- .2 Copper tube: to ASTM B837.

2.2 JOINTING MATERIAL

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

2.3 FITTINGS

- .1 Steel pipe fittings, screwed, flanged or welded:
 - .1 Malleable iron: screwed, banded, Class 150.
 - .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
 - .3 Fittings size NPS 1-1/2 and smaller: Class 150, 1 MPa malleable iron threaded, to ASME B16.3.
 - .4 Fittings size NPS 2 and larger: schedule 40, steel buttwelding to ASME B16.9.
 - .5 Welding: butt-welding fittings.
 - .6 Unions: malleable iron, brass to iron, ground seat, to ASTM A47/A47M.
 - .7 Bolts and nuts: to ASME B18.2.1.
 - .8 Nipples: schedule 40, to ASTM A53/A53M.
 - .2 Copper pipe fittings, screwed, flanged or soldered:
 - .1 Cast copper fittings: to ASME B16.18.
 - .2 Wrought copper fittings: to ASME B16.22.
-

2.4 VALVES

- .1 Provincial Code approved, lubricated plug type.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 PIPING

- .1 Install in accordance with Section 23 05 05, applicable Provincial Codes, CAN/CSA B149.1, supplemented as specified.
- .2 Install drip points:
 - .1 At low points in piping system.
 - .2 At connections to equipment.
- .3 Paint entire length of gas piping in yellow colour.

3.3 VALVES

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

3.4 FIELD QUALITY CONTROL

- .1 Test system in accordance with CAN/CSA B149 and requirements of authorities having jurisdiction.

3.5 PURGING

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

3.6 PRE-START-UP INSPECTIONS

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

3.7 CLEANING AND START-UP

- .1 In accordance with Section 23 08 02.
- .2 In accordance with requirements of CAN/CSA B149.1.

3.8 PERFORMANCE VERIFICATION (P.V.)

- .1 Refer to Section 23 08 01.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 – Common Work Results - Mechanical
- .2 Section 23 08 00 – Mechanical Commissioning
- .3 Section 23 09 33 – Electric and Electronic Control System for HVAC

1.2 MINIMUM STANDARDS

- .1 Conform to or exceed:
 - .1 Ontario Gas Utilization Code.
 - .2 CSA Standards.
 - .3 ASME Boiler and Pressure Vessel Code 2010.
 - .4 ASHRAE Standards.
 - .5 Provincial Codes, Local Municipal By-Laws, all codes of utility authorities having jurisdiction.

1.3 REFERENCES

- .1 Material and installation standards:
 - .1 ASTM A53-12/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - .2 ASTM A516/A516M-10, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate-and Lower- Temperature Service.
 - .3 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - .4 ASTM C547-15,, Standard Specification for Mineral Fiber Pipe Insulation.
 - .5 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - .6 ASME B16.1-2010, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - .7 ASME B16.3-2013, Malleable-Iron Threaded Fittings: Classes 150 and 300.
 - .8 ASME B16.5-2013, Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 Metric/Inch Standard.
 - .9 ASME B16.9-2012, Factory Made Wrought Buttwelding Fittings.
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- .10 CAN/CGSB-14.4-M88, Thermometers, Liquid- in-glass, Self-indicating Commercial/Industrial Type.
- .11 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .12 CAN/ULC-S702-09, Standard for Mineral Fibre Thermal Insulation for Buildings.
- .13 ASME BPVC-VIII - 2013 BPVC Section VIII- Rules for Construction of Pressure Vessels Division 1.
- .14 ASME BPVC-VIII-2 - 2013 BPVC Section VIII-Rules for Construction of Pressure Vessels Division 2-Alternative Rules

1.4 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets in accordance with Sections 01 33 00, 01 78 00 and 23 05 00 for the following:
 - .1 Diaphragm type expansion tank.
 - .2 Glycol mixing and fill equipment.
 - .3 Pumps.
 - .4 Chemical pot feeder.
 - .5 Hot water unit heaters.
 - .6 Plate and frame heat exchanger

PART 2 - PRODUCTS

2.1 PIPE SLOPE

- .1 Slope water piping up in direction of flow 1:500.
- .2 Slope horizontal water drainage piping down in direction of flow 1:240 minimum.

2.2 PIPE VENTING

- .1 Make reductions in water piping with eccentric reducing fittings so that air cannot collect in piping except at air vents and air separators.
- .2 Provide, at high points on lines and on equipment connections and as indicated, collecting chambers and high capacity float operated automatic air vents.
- .3 Automatic air vents:
 - .1 Standard float vent with brass body and NPS 1/8 connection and rated at 690 kPa working pressure.

- .2 Float: solid material suitable for 115°C working temperature.
- .4 Provide where indicated in-line air separator approved by ASME for 860 kPa working pressure.

2.3 STRAINERS

- .1 Provide strainers ahead of each pump, each automatic control valve (except radiation) and as indicated.
- .2 Install in horizontal or down flow lines. Ensure clearance for removal of basket.
- .3 Strainers:
 - .1 Body: "Y" type, cast iron, semi-steel or bronze.
 - .2 Screen: stainless steel or monel.
 - .3 Ends: threaded for sizes NPS 2 and smaller, flanged for sizes over NPS 2.
 - .4 Working pressure: 860 kPa.

2.4 THERMOMETERS AND PRESSURE GAUGES

- .1 Thermometers:
 - .1 To CAN/CGSB-14.4-M88, industrial, variable angle, liquid filled, 175 mm scale length, direct reading.
 - .2 Thermometer wells to be brass or stainless steel.
 - .3 Install in supply and return water piping of heating coils.
- .2 Pressure gauges:
 - .1 100 mm dial, 1/2 of 1% accuracy, bronze stop cock, snubber for pulsating action, diaphragm for corrosive service, compound type for pump suction; direct reading. Select ranges so normal operating pressure is at mid-scale.
 - .2 Install in supply and return water piping of heating and heat exchangers, refrigerant condensers; in pump suction and discharge.

2.5 AUTOMATIC CONTROLS

- .1 Refer to Section 23 09 33 for controls and controls components.
-

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install material and equipment in accordance with referenced standards and manufacturer's written instructions.

3.2 BALANCING

- .1 Use qualified personnel and approved instruments to balance each hydronic system.
 - .2 Submit water balancing report showing measurements of flow, pressure and temperature at location of inlet and outlet of each:
 - .1 Heat exchanger.
 - .2 Coil.
 - .3 Boiler.
 - .4 Chiller.
 - .5 Pump.
 - .6 Wall fin or cabinet convactor.
 - .7 Unit heater.
 - .8 Fan coil unit.
 - .3 Provide all fittings and take-off points for balancing.
 - .4 Permissible deviation from design quantities shall be 10%.
 - .5 Balance hydronic systems including low pressure hot water heating, chilled water, condenser water, glycol systems.
 - .6 Standard: testing, adjusting and balancing (TAB) to be to most stringent of this section or TAB standards of ASHRAE.
 - .7 Do TAB of all hydronic systems.
 - .8 Qualifications: personnel performing TAB to be current member in good standing of AABC, NEBB, or NBCTA.
 - .9 Quality assurance: perform TAB under direction of supervisor qualified by AABC, NEBB, or NBCTA.
 - .10 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, specific gravity, density, RPM, electrical power voltage, noise, vibration.
-

- .11 Locations of equipment measurement: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each heat exchanger (primary and secondary sides), boiler, chiller, coil, humidifier, cooling tower, condenser, pump, PRV, control valve, other equipment causing changes in conditions.
 - .2 At each controller, controlled device.
- .12 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of each primary and secondary loop (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water).
- .13 For additional requirements refer to Sections 23 05 00 and 23 08 00.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results - Mechanical.
- .2 Section 23 05 23.01 – Valves – Bronze.
- .3 Section 23 05 23.02 - Valves - Cast Iron.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)/American Welding Society (AWS)
 - .1 ANSI/AWS A5.8/A5.8M-11, AMD1 Specification Filler Metals for Brazing and Braze Welding.
- .2 ASME
 - .1 ANSI/ASME B16.4-2011, Gray-Iron Threaded Fittings Classes 125 and 250.
 - .2 ANSI/ASME B16.15-13, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
 - .3 ASME B16.18-12, Cast Copper Alloy, Solder Joint Pressure Fittings.
 - .4 ANSI/ASME B16.22-13, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings.
- .3 ASTM International
 - .1 ASTM B32-08(2014), Standard Specification for Solder Metal.
 - .2 ASTM B88M-2013, Standard Specification for Seamless Copper Water Tube (Metric).
 - .3 ASTM E202-12, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 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.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for hydronic systems 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.
 - .3 Shop Drawings:
-

- .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
- .2 Indicate on manufacturer's catalogue literature the following: valves.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
- .3 Submit 2 copies of operation and maintenance manual.

1.5 MAINTENANCE MATERIALS SUBMITTALS

- .1 Extra Materials:
 - .1 Furnish following spare parts:
 - .1 Valve seats: one for every ten valves, each size. Minimum one.
 - .2 Discs: one for every ten valves, each size. Minimum one.
 - .3 Stem packing: one for every ten valves, each size. Minimum one.
 - .4 Valve handles: two of each size.
 - .5 Gaskets for flanges: one for every ten flanges.

1.6 QUALITY ASSURANCE

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

1.7 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.

- .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.

PART 2 - PRODUCTS

2.1 TUBING

- .1 Type A hard drawn copper tubing: to ASTM B88M.

2.2 FITTINGS

- .1 Cast bronze threaded fittings: to ANSI/ASME B16.15.
- .2 Wrought copper and copper alloy solder joint pressure fittings: to ANSI/ASME B16.22.
- .3 Cast iron threaded fittings: to ANSI/ASME B16.4.
- .4 Cast copper alloy solder joint pressure fittings: to ASME B16.18.

2.3 FLANGES

- .1 Brass or bronze: threaded.
- .2 Cast iron: threaded.
- .3 Orifice flanges: slip-on, raised face, 2100 kPa.

2.4 JOINTS

- .1 Solder, tin-antimony, 95:5: to ASTM B32.
- .2 Silver solder BCUP: to ANSI/AWS A5.8.
- .3 Brazing: as indicated.

2.5 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: ends for soldering.
 - .2 NPS 2 1/2 and larger: flanged ends.
- .2 Gate Valves: application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: Class 125, 860 kPa rising stem split wedge disc, as specified in Section 23 05 23.01.
 - .2 Elsewhere: Class 125, 860 kPa non-rising stem, solid wedge disc, as specified in Section 23 05 23.01.
 - .3 Globe valves: application: throttling, flow control, emergency bypass:

- .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, Class 125, 860 kPa as specified in Section 23 05 23.01.
 - .2 Elsewhere: globe, with composition disc, Class 125, 860 kPa as specified in Section 23 05 23.01.
- .4 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified.
 - .2 NPS 2 and under:
 - .1 Mechanical rooms: Class 125, 1.7 MPa maximum WP, 121°C maximum temperature, Y style globe valve with valved ports for connecting to differential pressure meter. Readout accuracy to be within plus or minus 2% of actual flow at design flow rate. Flow control to include digital hand wheel and tamperproof concealed mechanical memory. as specified in Section 23 05 23.01.
 - .2 Elsewhere: globe, Class 125, 1.7 MPa maximum WP, 121°C maximum temperature, Y style globe valve with valved ports for connecting to differential pressure meter. Readout accuracy to be within plus or minus 2% of actual flow at design flow rate. Flow control to include digital hand wheel and tamperproof concealed mechanical memory. as specified in Section 23 05 23.01.
- .5 Drain valves: gate, Class 125 as specified in Section 23 05 23.01.
- .6 Swing check valves:
 - .1 NPS 2 and under:
 - .1 Class 125, 860 kPa swing, bronze body with composition disc, as specified in Section 23 05 23.01.
- .7 Ball valves:
 - .1 NPS 2 and under: Class 150, 1 MPa as specified in Section 23 05 23.01.
- .8 Lubricated Plug Valves:
 - .1 NPS 2 and under: as per Section 23 05 23.01.
 - .2 NPS 2 1/2 and over: as specified in Section 23 05 23.02.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
-

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

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 PIPING INSTALLATION

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping where ever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Assemble piping using fittings manufactured to ANSI standards.

3.4 VALVE INSTALLATION

- .1 Install rising stem valves in upright position with stem above horizontal.
- .2 Install ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .3 Install globe valves for balancing and in by-pass around control valves as indicated.
- .4 Install swing check valves in horizontal lines on discharge of pumps and as indicated.
- .5 Install chain operators on valves NPS 2 1/2 and over where installed more than 2400 mm above floor in Mechanical Equipment Rooms.
- .6 Install ball valves for glycol service.

3.5 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
 - .2 Remove handwheel after installation and TAB is complete.
 - .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.
-

3.6 FLUSHING AND CLEANING

- .1 Flush and clean in presence of Departmental Representative.
- .2 Flush after pressure test for a minimum of 4 hours.
- .3 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 hours.
- .4 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.
- .5 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- .6 Drainage to include drain valves, dirt pockets, strainers, low points in system.
- .7 Re-install strainer screens/baskets only after obtaining Departmental Representative's approval.

3.7 FILLING OF SYSTEM

- .1 Refill system with clean water adding water treatment as specified or glycol.

3.8 FIELD QUALITY CONTROL

- .1 Testing:
 - .1 Test system in accordance with Section 23 05 00.
 - .2 For glycol systems, retest with ethylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.
- .2 Balancing:
 - .1 Balance water systems to within plus or minus 5% of design output.
- .3 Glycol Charging:
 - .1 Provide mixing tank and positive displacement pump for glycol charging.
 - .2 Retest for concentration to ASTM E202 after cleaning.
 - .3 Provide report to Departmental Representative.

3.9 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/or 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 REQUIREMENTS

- .1 Section 23 05 00 - Common Work Results - Mechanical.
- .2 Section 23 05 05 - Installation of Pipe Work
- .3 Section 23 05 23.01 - Valves - Bronze
- .4 Section 23 05 23.02 - Valves - Cast Iron
- .5 Section 23 08 01 - Performance Verification Mechanical Piping Systems.
- .6 Section 23 08 02 - Cleaning and Start-Up of Mechanical Piping Systems.

1.2 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C111/A21.11-12, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - .2 American Society of Mechanical Engineers (ASME)
 - .1 ASME B16.3-11, Malleable Iron Threaded Fittings: Classes 150 and 300.
 - .2 ASME B16.5-13, Pipe Flanges and Flanged Fittings: NPS through NPS 24 Metric/Inch Standard.
 - .3 ASME B16.9-12, Factory-Made Wrought Buttwelding Fittings.
 - .4 ASME B18.2.1-12, Square Hex, Heavy Hex and Askew Head Bolts and Hex, Heavy Hex, Hex Flange. Loded Head and Lag Screws (Inch Series).
 - .5 ASME B18.2.2-10, Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
 - .3 ASTM International
 - .1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
 - .2 ASTM E202-12, Standard Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
 - .4 CSA International
 - .1 CSA B242-05(R2011), Groove and Shoulder Type Mechanical Pipe Couplings.
 - .5 Manufacturer's Standardization of the Valve and Fittings Industry (MSS)
 - .1 MSS-SP-70-11, Gray Iron Gate Valves, Flanged and Threaded Ends.
 - .2 MSS-SP-71-11, Gray Iron Swing Check Valves Flanged and Threaded Ends.
 - .3 MSS-SP-80-13, Bronze Gate, Globe, Angle and Check Valves.
-

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 hydronic systems 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.
 - .2 Indicate on drawings:
 - .1 Components and accessories.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic systems for incorporation into manual.
 - .1 Include special servicing requirements.

1.5 EXTRA STOCK MATERIALS

- .1 Supply spare parts as follows:
 - .1 Valve seats: 1 minimum for every ten valves, each size. Minimum one.
 - .2 Discs: 1 minimum for every ten valves, each size. Minimum one.
 - .3 Stem packing: 1 minimum for every ten valves, each size. Minimum one.
 - .4 Valve handles: 2 minimum of each size.
 - .5 Gaskets for flanges: 1 minimum for every ten flanges.

1.6 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic systems from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
-

- .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.

PART 2 - PRODUCTS

2.1 PIPE

- .1 Steel pipe: to ASTM A53/A53M, Grade B, as follows:
 - .1 To NPS 6: Schedule 40.
 - .2 Ream pipes and tubes. Hammer and clean scale and dirt, inside and outside, before assembly.

2.2 PIPE JOINTS

- .1 NPS 2 and under: screwed fittings with teflon tape.
- .2 NPS 2-1/2 and over: welding fittings and flanges to ASME B16.5.
- .3 Roll grooved: standard coupling to CSA B242.
- .4 Flanges: raised face, to ANSI/AWWA C111/ A21.11.
- .5 Orifice flanges: slip-on raised face, 2100 kPa.
- .6 Flange gaskets: to ANSI/AWWA C111/ A21.11.
- .7 Pipe thread: taper.
- .8 Bolts and nuts: to ASME B18.2.1.
- .9 Roll grooved coupling gaskets: type EPDM.

2.3 FITTINGS

- .1 Malleable iron screwed fittings: Class 150 to ASME B16.3.
- .2 Steel pipe flanges and flanged fittings: to ASME B16.5.
- .3 Steel butt-welding fittings: to ASME B16.9.
- .4 Unions: malleable iron to ASME B16.3.

2.4 VALVES

- .1 Connections:
 - .1 NPS 2 and smaller: screwed ends.
 - .2 NPS 2-1/2 and larger: flanged ends.
- .2 Gate valves: to MSS-SP-70 application: isolating equipment, control valves, pipelines:
 - .1 NPS 2 and under:

- .1 Mechanical Rooms : Class 125, rising stem, split wedge disc, as specified in Section 23 05 23.01.
 - .2 Elsewhere: Class 125, non-rising stem, solid wedge disc, as specified in Section 23 05 23.01.
 - .2 NPS 2-1/2 and over:
 - .1 Mechanical Rooms: rising stem, split wedge disc, lead free bronze trim, as specified in Section 23 05 23.02.
 - .1 Operators: manual.
 - .2 Elsewhere: non-rising stem, solid wedge disc, bronze trim, as specified in Section 23 05 23.02.
 - .1 Operators: Handwheel.
 - .3 Globe valves: to application: throttling, flow control, emergency bypass MSS-SP-80:
 - .1 NPS 2 and under:
 - .1 Mechanical Rooms: with PTFE disc, as specified in Section 23 05 23.01
 - .2 Elsewhere: globe, with composition disc, as specified in Section 23 05 23.01.
 - .2 NPS 2-1/2 and over:
 - .1 With bronze disc, bronze trim, as specified in Section 23 05 23.02
 - .2 Operators: Handwheel.
 - .4 Balancing, for TAB:
 - .1 Sizes: calibrated balancing valves, as specified this section.
 - .2 NPS 2 and under:
 - .1 Mechanical Rooms: globe, with plug disc as specified in Section 23 05 23.01.
 - .2 Elsewhere: globe, with plug disc as specified in Section 23 05 23.01.
 - .5 Drain valves: Gate, Class 125, non-rising stem, solid wedge disc, as specified in Section 23 05 23.01.
 - .6 Swing check valves: to MSS-SP-71.
 - .1 NPS 2 and under:
 - .1 Class 125, swing, with composition disc, as specified in Section 23 05 23.01.
 - .2 NPS 2-1/2 and over:
 - .1 Flanged ends: as specified in Section 23 05 23.02.
 - .7 Silent check valves:
 - .1 NPS 2 and under:
 - .1 As specified in Section 23 05 23.01.
 - .2 NPS 2-1/2 and over:
-

- .1 Flanged ends: as specified in Section 23 05 23.02.
- .8 Ball valves:
 - .1 NPS 2 and under: as specified in Section 23 05 23.01.
- .9 Lubricated Plug Valves
 - .1 NPS 2 and under: as specified in Section 23 05 23.01.
 - .2 NPS 2-1/2 and over:
 - .1 As specified in Section 23 05 23.02.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PIPING INSTALLATION

- .1 Install pipework in accordance with Section 23 05 05.

3.3 CIRCUIT BALANCING VALVES

- .1 Install flow measuring stations and flow balancing valves as indicated.
- .2 Remove handwheel after installation and when TAB is complete.
- .3 Tape joints in prefabricated insulation on valves installed in chilled water mains.

3.4 CLEANING, FLUSHING AND START-UP

- .1 In accordance with Section 23 08 02.

3.5 TESTING

- .1 Test system in accordance with Section 23 05 00.
 - .2 For glycol systems, retest propylene glycol to ASTM E202, inhibited, for use in building system after cleaning. Repair leaking joints, fittings or valves.
-

3.6 BALANCING

- .1 Balance water systems to within plus or minus 5% of design output.

3.7 GLYCOL CHARGING

- .1 Include mixing tank and positive displacement pump for glycol charging.
- .2 Retest for concentration to ASTM E202 after cleaning.

3.8 PERFORMANCE VERIFICATION

- .1 In accordance with Section 23 08 01.

3.9 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/or recycling in accordance with Section 01 74 20.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.10 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 ASTM International
 - .1 ASTM A278/A278M-01(2011), Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
 - .2 ASTM A536-84(2014), Standard Specification for Ductile Iron Castings.
 - .3 ASTM B62-09, Standard Specification for Composition Bronze or Ounce Metal Castings.

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 expansion tanks, air vents, separators, valves, and strainers 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.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.
- .3 Submit 2 copies of operation and maintenance manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect hydronic specialties from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 DIAPHRAGM TYPE EXPANSION TANK

- .1 Horizontal steel pressurized diaphragm type expansion tank.
- .2 Capacity: 95L tank volume, 40 L acceptance volume
- .3 Size: 1067 mm long x 355 mm diameter.
- .4 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.
- .5 Working pressure: 860 kPa with ASME stamp and certification.
- .6 Air precharged to 84 kPa (initial fill pressure of system).
- .7 Base mount for vertical installation.
- .8 Supports: provide supports with hold down bolts and installation templates incorporating seismic restraint systems.
- .9 Renewable diaphragm.

2.2 AUTOMATIC AIR VENT

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 310 kPa working pressure.
- .2 Industrial float vent: cast iron body and NPS 1/2 connection and rated at 860 kPa working pressure.
- .3 Float: solid material suitable for 115 degrees C working temperature.

2.3 PIPE LINE STRAINER

- .1 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern.
 - .2 NPS 2 1/2 to 12: cast steel body to ASTM A278/A278M, Class 30, flanged connections.
 - .3 NPS 2 to 12: T type with ductile iron body to ASTM A536, grooved ends.
-

- .4 Blowdown connection: NPS 1.
- .5 Screen: stainless steel with 1.19 mm perforations.
- .6 Working pressure: 860 kPa.

2.4 GLYCOL MIXING AND FILL EQUIPMENT

- .1 Provide portable manual glycol mixing and fill equipment including hand pump and container.
- .2 Hand pump shall be piston type, corrosion- resistant, all-metal construction, teflon packing, self-priming, 75 L per hundred strokes, and complete with telescoping suction pipe and 2.5 m hose.
- .3 Container shall be plastic 170 L capacity complete with swivel wheels.

2.5 IN-LINE STANDARD DUTY CIRCULATING PUMPS

- .1 Construction:
 - .1 Volute: cast iron radially split, with tapped openings for gauge connections, with screwed or flanged suction and discharge connections.
 - .2 Impeller: non-ferrous.
 - .3 Shaft: stainless steel shaft and sleeve.
 - .4 Seal assembly: mechanical for normal hot water application to 135°C.
 - .5 Coupling: flexible rigid self-aligning.
 - .6 Motor: resilient mounted, drip proof, sleeve bearing.
- .2 Capacity and size: as indicated.
- .3 Ensure pump body does not support piping or equipment. Provide stanchions or hangers for this purpose. Refer to manufacturer's installation instructions for details.

2.6 PLATE HEAT EXCHANGER

- .1 Water to glycol
 - .1 Designed, constructed and tested in accordance with ASME Boiler and Pressure Vessel Code and provincial pressure vessel regulations.
 - .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
 - .3 Plates: 316 stainless steel.
 - .4 Gaskets: as recommended by manufacturer to suit fluid temperature.
 - .5 Nozzles: 1034 kPa, ASA rubber rated flange type.
 - .6 Supports: as indicated.
 - .7 Piping connections: as indicated.
-

- .8 Capacity: as indicated on schedule

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic specialties 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 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 GENERAL

- .1 Run drain lines and blow off connections to terminate above nearest drain.
- .2 Maintain adequate clearance to permit service and maintenance.
- .3 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Check shop drawings for conformance of tappings for ancillaries and for equipment operating weights.

3.4 STRAINERS

- .1 Install in horizontal or down flow lines.
- .2 Ensure clearance for removal of basket.
- .3 Install ahead of each pump.
- .4 Install ahead of each automatic control valve larger than NPS 1 and as indicated.

3.5 AIR VENTS

- .1 Install at high points of systems.
-

- .2 Install gate valve on automatic air vent inlet. Run discharge to nearest drain or service sink.

3.6 EXPANSION TANKS

- .1 Adjust expansion tank pressure as indicated to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

3.7 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/or 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

- .1 CSA Group
 - .1 CAN/CSA-B214-12, Installation Code for Hydronic Heating Systems.

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 pump, circulator, and equipment and include product characteristics, performance criteria, physical size, finish and limitations indicate point of operation, and final location in field assembly.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
 - .2 Submit manufacturer's detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.
- .3 Submit 2 copies of operation and maintenance manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
-

- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 Size and select components to: CAN/CSA-B214.

2.2 IN-LINE CIRCULATORS (P-WW27-1)

- .1 Volute: cast iron radially split, with screwed or flanged design suction and discharge connections.
- .2 Impeller: alloy steel.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: flexible self-aligning.
- .6 Motor: sleeve bearing.
- .7 Capacity: as indicated.
- .8 Design pressure: 860 kPa.

2.3 GEAR PUMPS (P-WW27-2)

- .1 Rugged corrosion resistant bronze construction
 - .2 Compact close-coupled design · stainless steel shafts
 - .3 Durable bronze helical gears provide quiet operation
 - .4 Process lubricated carbon graphite bearings · o-ring cover seal for maximum leak protection
 - .5 Mechanical seal easy field assembly.
 - .6 For compact ac motor pump units close coupled bronze adapterless rotary gear pumps
 - .7 Liquids and temperature
 - .8 These pumps are suitable for all liquids that are compatible with bronze. Most common liquids are water, oil, and mild chemicals in the pH range of 4 to 11. Viscous liquids require reduced shaft speeds of 1150 RPM or lower. (Consult factory.)
-

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hydronic pump installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of 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 APPLICATION

- .1 Manufacturer's Instructions: comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and data sheets.

3.3 INSTALLATION

- .1 Install hydronic pumps to: CAN/CSA-B214.
- .2 In line circulators: install as indicated by flow arrows.
 - .1 Support at inlet and outlet flanges or unions.
 - .2 Install with bearing lubrication points accessible.
- .3 Base mounted type: supply templates for anchor bolt placement.
 - .1 Include anchor bolts with sleeves. Place level, shim unit and grout.
 - .2 Align coupling in accordance with manufacturer's recommended tolerance.
 - .3 Check oil level and lubricate. After run-in, tighten glands.
- .4 Ensure that pump body does not support piping or equipment.
 - .1 Provide stanchions or hangers for this purpose.
 - .2 Refer to manufacturer's installation instructions for details.
- .5 Pipe drain tapping to floor drain.
- .6 Install volute venting pet cock in accessible location.
- .7 Check rotation prior to start-up.
- .8 Install pressure gauge test cocks.

3.4 START-UP

- .1 General:
 - .1 In accordance with Section 01 91 13; supplemented as specified herein.
 - .2 In accordance with manufacturer's recommendations.
- .2 Procedures:
 - .1 Before starting pump, check that cooling water system over-temperature and other protective devices are installed and operative.
 - .2 After starting pump, check for proper, safe operation.
 - .3 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
 - .4 Check base for free-floating, no obstructions under base.
 - .5 Run-in pumps for 12 continuous hours minimum.
 - .6 Verify operation of over-temperature and other protective devices under low- and no-flow condition.
 - .7 Eliminate air from scroll casing.
 - .8 Adjust water flow rate through water-cooled bearings.
 - .9 Adjust flow rate from pump shaft stuffing boxes to manufacturer's recommendation.
 - .10 Adjust alignment of piping and conduit to ensure true flexibility.
 - .11 Eliminate cavitation, flashing and air entrainment.
 - .12 Adjust pump shaft seals, stuffing boxes, glands.
 - .13 Measure pressure drop across strainer when clean and with flow rates as finally set.
 - .14 Replace seals if pump used to degrease system or if pump used for temporary heat.
 - .15 Verify lubricating oil levels.

3.5 PERFORMANCE VERIFICATION (PV)

- .1 General:
 - .1 Verify performance in accordance with Section 01 91 13, supplemented as specified herein.
- .2 Verify that manufacturer's performance curves are accurate.
- .3 Ensure valves on pump suction and discharge provide tight shut-off.
- .4 Net Positive Suction Head (NPSH):
 - .1 Application: measure NPSH for pumps which operate on open systems and with water at elevated temperatures.
 - .2 Measure using procedures prescribed in Section 01 91 13.
 - .3 Where procedures do not exist, discontinue PV, report to Departmental Representative and await instructions.

- .5 Multiple Pump Installations - Series and Parallel:
 - .1 Repeat PV procedures specified above for pump performance and pump BHP for combinations of pump operations.
- .6 Mark points of design and actual performance at design conditions as finally set upon completion of TAB.
- .7 Commissioning Reports: in accordance with Section 01 91 13 reports supplemented as specified herein. Reports to include:
 - .1 Record of points of actual performance at maximum and minimum conditions and for single and parallel operation as finally set at completion of commissioning on pump curves.
 - .2 Use Report Forms specified in Section 01 91 33.
 - .3 Pump performance curves (family of curves).

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 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/or 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 REQUIREMENTS

- .1 Section 23 05 05 - Installation of Pipe Work

1.2 REFERENCES

- .1 ASME
 - .1 ASME B16.22-13, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
 - .2 ASME B16.24-11, Cast Copper Pipe Flanges and Flanged Fittings: Class 150, 300, 600, 900, 1500 and 2500.
 - .3 ASME B16.26-13, Cast Copper Alloy Fittings for Flared Copper Tubes.
 - .4 ASME B31.5-13, Refrigeration Piping and Heat Transfer Components.
- .2 ASTM International
 - .1 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, and Threaded Rod 60,000 PSI Tensile Strength.
 - .2 ASTM B280-13, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .3 CSA Group
 - .1 CSA B52-2013, B52 Package, Mechanical Refrigeration Code.
- .4 Environment Canada (EC)
 - .1 EPS 1/RA/1-96, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings:
 - .1 Convene pre-installation meeting 1 week prior to beginning work of this Section, with contractor's representative, 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 construction subtrades.
 - .4 Review manufacturer's written installation instructions and warranty requirements.
 - .2 Contractor shall be qualified by TSSA for installation of materials and equipment of this section.

- .1 Contractor is to provide documentation to Departmental Representative illustrating that they are authorized by TSSA to install work of this section.

1.4 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 refrigerant piping, fittings and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for refrigerant piping for incorporation into manual.
- .3 Submit 2 copies of operation and maintenance manual.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect refrigerant piping, fittings and equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 TUBING

- .1 Processed for refrigeration installations, deoxidized, dehydrated and sealed.
 - .1 Hard copper: to ASTM B280, type ACR.
 - .2 Annealed copper: to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.

2.2 FITTINGS

- .1 Service: design pressure 2070 kPa and temperature 121 degrees C.
- .2 Brazed:
 - .1 Fittings: wrought copper to ASME B16.22.
 - .2 Joints: silver solder, copper-phosphorous, non-corrosive flux.
- .3 Flanged:
 - .1 Bronze or brass, to ASME B16.24, Class 150 and Class 300.
 - .2 Gaskets: suitable for service.
 - .3 Bolts, nuts and washers: to ASTM A307, heavy series.
- .4 Flared:
 - .1 Bronze or brass, for refrigeration, to ASME B16.26.

2.3 PIPE SLEEVES

- .1 Hard copper or steel, sized to provide 6 mm clearance around between sleeve and uninsulated pipe or between sleeve and insulation.

2.4 VALVES

- .1 22 mm and under: Class 500, 3.5 Mpa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moisture proof seal for below freezing applications, brazed connections.
 - .2 Over 22 mm: Class 375, 2.5 Mpa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moisture proof seal for below freezing applications, brazed connections.
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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 refrigerant piping installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 GENERAL

- .1 Install in accordance with CSA B52, EPS1/RA/1 and ASME B31.5 Section 23 05 05.
- .2 Install in accordance with TSSA requirements and obtain TSSA approval for work. Contractor is responsible for paying all fees associated with involving TSSA for this project and obtaining TSSA approval for work of this project.

3.4 BRAZING PROCEDURES

- .1 Use a flow of dry nitrogen through piping while being brazed to eliminate formation of copper oxide scale on the inside of the piping.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

3.5 PIPING INSTALLATION

- .1 General:
 - .1 Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
 - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
 - .2 Provide trap at base of risers greater than 2400 mm high and at each 7600 mm thereafter.

- .3 Provide inverted deep trap at top of risers.
- .4 Insulate refrigeration suction line with 12 mm thick flexible elastomeric unicellular pipe covering to ASTM C534/C534M.
- .5 Use a flow of dry nitrogen through piping while being brazed to eliminate formation of copper oxide scale on the inside of the piping.
- .6 Provide double risers for compressors having capacity modulation.
 - .1 Large riser: install traps as specified.
 - .2 Small riser: size for 5.1 m³/s at minimum load. Connect upstream of traps on large riser.

3.6 PRESSURE AND LEAK TESTING

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively.
- .3 Test procedure: build pressure up to 35 kPa with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

3.7 FIELD QUALITY CONTROL

- .1 Perform all tests required by TSSA and provide all certifications and approvals required by TSSA to Departmental Representative.
 - .2 Site Tests/Inspection:
 - .1 Close service valves on factory charged equipment.
 - .3 Ambient temperatures to be at least 13 degrees C for at least 12 hours before and during dehydration.
 - .4 Use copper lines of largest practical size to reduce evacuation time.
 - .5 Use two-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.
 - .6 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
 - .7 Triple evacuate system components containing gases other than correct refrigerant or having lost holding charge as follows:
 - .1 Twice to 14 Pa absolute and hold for 4 hours.
 - .2 Break vacuum with refrigerant to 14 kPa.
 - .3 Final to 5 Pa absolute and hold for at least 12 hours.
 - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
 - .5 Submit test results to Departmental Representative.
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- .8 Charging:
 - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
 - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
 - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .9 Checks:
 - .1 Make checks and measurements as per manufacturer's operation and maintenance instructions.
 - .2 Record and report measurements to Departmental Representative.
- .10 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 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.

3.8 DEMONSTRATION

- .1 Instructions:
 - .1 Post instructions in frame with glass cover in accordance with Section 01 78 00 and CSA B52.

3.9 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.
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- .3 Waste Management: separate waste materials for reuse and/or 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

- .1 ASME
 - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII-2013.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
 - .1 Material Safety Data Sheets (MSDS).

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 HVAC water treatment systems 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. Indicate VOC's for adhesive and solvents during application and curing.
- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for HVAC water treatment systems for incorporation into manual.
- .3 Include following:
 - .1 Log sheets as recommended by manufacturer and Departmental Representative.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect HVAC water treatment systems from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- .1 Equipment, chemicals, and service provided by one supplier.

2.2 POT FEEDER

- .1 Welded steel, pressure rating 862 kPa. Temperature rating: 90 degrees C.

2.3 CHEMICAL FEED PIPING

- .1 Resistant to chemicals employed. Pressure rating: 862 kPa.

2.4 CHEMICALS

- .1 Provide 1 years supply.

2.5 TEST EQUIPMENT

- .1 Provide one set of test equipment for each system to verify performance.
- .2 Complete with carrying case, reagents for chemicals, specialized or supplementary equipment.

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 HVAC water treatment systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 MANUFACTURER'S INSTRUCTIONS

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

3.3 INSTALLATION

- .1 Install HVAC water treatment systems in accordance with ASME Boiler and Pressure Code Section VII, and requirements and standards of authorities having jurisdiction, except where specified otherwise.
- .2 Ensure adequate clearances to permit performance of servicing and maintenance of equipment.

3.4 CHEMICAL FEED PIPING

- .1 Install crosses at changes in direction. Install plugs in unused connections.

3.5 CLEANING OF MECHANICAL SYSTEM

- .1 Provide copy of recommended cleaning procedures and chemicals for approval by Departmental Representative.
- .2 Flush mechanical systems and equipment with approved cleaning chemicals designed to remove deposition from construction such as pipe dope, oils, loose mill scale and other extraneous materials. Use chemicals to inhibit corrosion of various system materials that are safe to handle and use.
- .3 Examine and clean filters and screens, periodically during circulation of cleaning solution, and monitor changes in pressure drop across equipment.
- .4 Drain and flush systems until alkalinity of rinse water is equal to make-up water. Refill with clean water treated to prevent scale and corrosion during system operation.
- .5 Disposal of cleaning solutions approved by authority having jurisdiction.

3.6 FIELD QUALITY CONTROL

- .1 Start-up:
 - .1 Start-up water treatment systems in accordance with manufacturer's instructions.

3.7 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/or 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 REQUIREMENTS

- .1 Section 23 05 00 – Common Work Results – Mechanical
- .2 Section 23 08 00 – Mechanical Commissioning
- .3 Section 23 09 33 – Electric and Electronic Control System for HVAC

1.2 MINIMUM STANDARDS

- .1 Conform to or exceed:
 - .1 CSA Standards.
 - .2 ASHRAE Standards.
 - .3 SMACNA Standards.
 - .4 Provincial Codes, Local Municipal By-Laws, all codes of utility authorities having jurisdiction.

1.3 REFERENCES

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible, 2006.
 - .2 SMACNA Duct Leakage Test Manual 2012.
 - .3 NFPA 90A-2015, Installation of Air Conditioning and Ventilating Systems.
 - .4 CAN/ULC-S110-13, Standard Methods of Test for Air Ducts.
 - .5 CAN/ULC-S702-14, Standard for Mineral Fibre Thermal Insulation for Buildings.
 - .6 CSA B52-13, Mechanical Refrigeration Code.
 - .7 CAN/CSA-B149.1-15, Natural Gas and Propane Installation Code.
 - .8 CGSB 51-GP-52Ma-89, Vapour Barrier Jacket and Facing Material.
 - .9 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process.
 - .10 ASTM B209-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
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- .11 ASTM B280-13, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- .12 ASTM C423-09a, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- .13 ASTM C518-10, Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- .14 ASTM C534/534M-14, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- .15 ASTM C547-15, Standard Specification for Mineral Fiber Pipe Insulation.
- .16 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .17 ASTM C919-12, Standard Practice for Use of Sealants in Acoustical Applications.
- .18 ASTM C1071-12, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .19 ASTM F683-10, Standard Practice for Selection and Application of Thermal Insulation for Piping and Machinery.
- .20 ASTM G21-15, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

1.4 SHOP DRAWINGS AND PRODUCT DATA SHEETS

- .1 Submit shop drawings and product data sheets in accordance with Sections 01 33 00, and 23 05 00 for the following:
 - .1 Motorized dampers.
 - .2 Air intake louvres. .
 - .3 Grilles, registers and diffusers.
 - .4 Wall-mounted exhaust fans.
 - .5 Wall-mounted A/C unit.
 - .6 Roof-mounted exhaust fans.
 - .7 Packaged roof-top A/C unit.
 - .8 Hydronic duct heater.
 - .9 Split System air-cooled condensing unit.
 - .10 Split System blower coil unit.
 - .11 Air handling unit.
 - .12 Controls and instrumentation.

PART 2 - PRODUCTS

2.1 PACKAGED ROOF-TOP A/C UNIT (AHU-WW27-5)

- .1 Provide CSA approved and labelled packaged roof-top unit of capacity and performance as indicated on the drawings.
- .2 Unit shall consist of cabinet, fans, coils, air filters, compressors, operating controls, economizer and shall be factory-assembled.
- .3 Cabinet: weatherproof construction, galvanized steel with baked enamel finish. Insulation: coated rigid fibrous glass on surfaces where conditioned air to be handled, 25 mm thick, 32 kg/m³ density.
- .4 Fans:
 - .1 Supply fan: centrifugal forward-curved wheel, rubber-mounted, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley, rubber isolated hinge-mounted motor.
 - .2 Outdoor fans: propeller type with single-piece, spun venturi outlets and zinc-plated guards. Motors shall be sequenced for head pressure control.
- .5 Heat exchangers and burners: gas fired, multiple flue passes, with heating surface of aluminized steel. Gas burners shall be continuous port steel or inshot type with forced or induced draft fan and electronic ignition system.
- .6 Operating controls shall include high and low pressure controls, anti-cycle timers, motor overload protection, contactors, relays and 24 volt control circuit.
- .7 Air filters: renewable 50 mm thick glass fibre media with adhesive enclosed in permanent metal filter frames. Air filters to have ASHRAE rated arrestance performance of 75 to 90% or better.
- .8 Economizer shall include outside, return and relief air dampers with spring return damper operator and control package to automatically introduce up to 100% outside air for free cooling. Mixed air controls: maintain 16°C mixed air temperature, lock-out compressor at 14°C ambient, restart at 17°C, revert dampers to provide minimum outside air above 21°C, adjustable.
- .9 Provide low voltage room thermostat complete with system selector switch and fan control switch.

2.2 SPLIT SYSTEM AIR-COOLED CONDENSING UNIT (PART OF AC-WW27-1)

- .1 Provide CSA approved and labelled air-cooled condensing unit of capacity and performance as indicated on the drawings.
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- .2 Unit shall be designed for outdoor installation and shall consist of casing, condenser fans, condenser coil, compressors, operating controls and shall be factory- assembled and charged with R-410A.
- .3 Casing: weatherproof construction, galvanized steel with baked enamel finish.
- .4 Condenser fans: propeller type with single piece, spun venturi outlets and zinc-plated guards.
- .5 Condenser coil: seamless copper tubes expanded into aluminum fins.
- .6 Compressors: vibration isolated hermetic compressors with crankcase heaters. On multi-compressor unit provide separate independent refrigerant circuit to each compressor.
- .7 Operating controls shall include high and low pressure controls, anti-cycle timers, motor overload protection, contactors, relays, and 24 volt control circuit.
- .8 Provide low ambient thermostat to lock out compressor at 14°C ambient.
- .9 Provide low ambient control to allow operation down to -18°C ambient.

2.3 SPLIT SYSTEM BLOWER COIL UNIT (AC-WW27-1)

- .1 Provide CSA approved and labelled blower coil unit of capacity and performance as indicated on the drawings.
- .2 Unit shall be vertical type, designed to match the split system air-cooled condensing unit, and shall consist of casing, drip pan, fan, coil, air-filters, operating controls and holding charge of R-410A.
- .3 Casing: galvanized steel with baked enamel finish and lined with 25 mm thick neoprene coated rigid fibrous glass insulation. Removable panels shall provide access to internal parts.
- .4 Drip pan: welded galvanized steel and insulated. Provide drip pan with drain connection and deep seal trap at low point and access panel located adjacent to drip pan allowing access for cleaning.
- .5 Evaporator coil: seamless copper tubes expanded into aluminum fins. Provide factory-installed capillary tube expansion device or thermal expansion valve.
- .6 Blower: centrifugal forward-curved wheel, rubber-mounted, statically and dynamically balanced. V-belt drive with adjustable variable pitch motor pulley, rubber isolated hinge-mounted motor.
- .7 Air filters: renewable 50 mm thick glass fibre media with adhesive enclosed in permanent metal filter frames. Air filters to have ASHRAE rated arrestance performance of 75 to 90% or better.

- .8 Operating controls shall include motor overload protection, contactor, relay and control transformer for 24 volt control circuit.

2.4 AUTOMATIC CONTROLS

- .1 Refer to Section 23 09 33.

2.5 THERMAL INSULATION AND JACKETING

- .1 Insulate all supply air ducting and all exhaust air ducting from fan to exhaust louvre.
 - .2 Material:
 - .1 On exposed rectangular ducting: 25 mm thick rigid mineral glass fibre board to ASTM C612-04e1 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .2 On concealed rectangular ducting: 25 mm thick rigid mineral glass fibre board to ASTM C612-04e1 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .3 On round ducting: 25 mm thick glass fiber blanket to CAN/ULS-S702 and vapour barrier jacket to CGSB 51-GP-52Ma.
 - .3 Fastenings on rectangular ducts:
 - .1 Use 50% coverage of insulation adhesive. Flame spread 15, smoke development 0.
 - .2 If duct is over 635 mm wide, provide weld pins in addition to insulation adhesive. Place weld pins at not more than 200 mm centres, and not less than 2 rows per side.
 - .4 Fastenings on round ducts: Use 100% coverage of insulation adhesive of flame spread 15, smoke development 0, and 100 mm wide self-adhesive tape rated under 25 for flame spread and under 50 for smoke development.
 - .5 Vapour barriers: Use quick-setting adhesive for joints and lap sealing of vapour barriers. Flame spread 10, smoke development 0.
 - .6 Vapour barriers and insulation to be complete over the full length of duct or surface, without penetration for hangers, standing duct seams and without interruption at sleeves.
 - .7 Provide canvas cover over all insulated ducts in exposed areas. Canvas cover to be compact, firm, ULC listed heavy plain weave, cotton fabric at 272 g/cu.m. Provide two coats of diluted fire retardant lagging adhesive over canvas covering.
 - .8 Provide weatherproofing for all outdoor duct insulation. Apply two 3 mm thick coats of asphalt or vinyl mastic to external type duct insulation, with a glass
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reinforcing fibre between coats lapping joints a minimum of 305 mm. Secure 10 mm thick plywood over all horizontal ducts exposed to weather, and cover plywood with sheet metal. Turn over all edges.

- .9 Provide weatherproofing for all outdoor duct insulation. Aluminum:
 - .1 To ASTM B209 with moisture barrier.
 - .2 Thickness: 0.50 mm sheet.
 - .3 Finish: Smooth.
 - .4 Jacket banding and mechanical seals: 19 mm wide, 0.5 mm thick stainless steel.
 - .1 Stainless steel, type: 316.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install material and equipment in accordance with referenced standards and manufacturer's written instructions.
- .2 Make good all existing insulation where previously damaged by others or damaged by work under this contract.

3.2 AIR BALANCING

- .1 Use qualified personnel and approved instruments to balance each air system to air flow rates specified on the drawings.
 - .2 Standard: Testing, Adjusting and Balancing (TAB) to be to most stringent of this section or TAB standards of SMACNA.
 - .3 Do TAB of all air systems.
 - .4 Qualifications: personnel performing TAB to be current member in good standing of AABC.
 - .5 Quality assurance: Perform TAB under direction of supervisor qualified by AABC, NEBB, or NBCTA.
 - .6 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
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- .7 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
 - .1 Inlet and outlet of each damper, filter, coil, humidifier, fan, other equipment causing changes in conditions.
 - .2 At each controller, controlled device.
- .8 Locations of systems measurements to include, but not be limited to, following as appropriate: Each main duct, main branch, sub-branch, run-out (or grille, register or diffuser).
- .9 Permissible deviation from design air quantities shall be 5%.
- .10 Permanently mark settings of all splitters, dampers and other adjustment devices.
- .11 For additional requirements refer to Section 23 05 00 and Section 23 08 00.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- .2 Section 23 05 94 - Pressure Testing of Ducted Air Systems

1.2 REFERENCES

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
- .2 ASTM International
 - .1 ASTM A653/A653M-13, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
- .3 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 2007.

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 ducts 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.
- .4 Test and Evaluation Reports:
 - .1 Certification of Ratings:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect metal ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 MATERIAL

- .1 Gauge and construction of ducts and fittings shall be in accordance with SMACNA HVAC Duct Construction Standards for rectangular ducts for positive and negative static pressure up to 500 Pa with leakage rate of 5% maximum.

2.2 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, tape or combination thereof.
 - .3 Class C: transverse joints and connections made air tight with gaskets, sealant, tape or combination thereof. Longitudinal seams unsealed.
 - .4 Unsealed seams and joints.

2.3 SEALANT

- .1 Sealant: oil resistant, polymer type flame resistant duct sealant. Temperature range of minus 30 degrees C to plus 93 degrees C.

2.4 TAPE

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

2.5 DUCT LEAKAGE

- .1 In accordance with SMACNA HVAC Air Duct Leakage Test Manual.

2.6 FITTINGS

- .1 Fabrication: to SMACNA.
 - .2 Radius of duct elbow shall be at least equal to the width of the elbow. Use square elbow with double thickness turning vanes when space is limited.
 - .3 Provide balancing dampers at all branch ducts and as indicated. Each damper shall be fitted with locking type quadrant operator.
 - .4 Radiused elbows:
 - .1 Rectangular: centreline radius: 1 times width of duct.
 - .2 Round: smooth radius, centreline radius: 1 times diameter.
 - .5 Mitred elbows, rectangular:
 - .1 To 400 mm: with double thickness turning vanes.
 - .2 Over 400 mm: with double thickness turning vanes.
 - .6 Branches:
 - .1 Rectangular main and branch: with 45 degrees entry on branch.
 - .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.
 - .7 Transitions:
 - .1 Diverging: 20 degrees maximum included angle.
 - .2 Converging: 30 degrees maximum included angle.
 - .8 Offsets:
 - .1 Full radiused elbows.
 - .9 Obstruction deflectors: maintain full cross-sectional area.
 - .1 Maximum included angles: as for transitions.
-

2.7 FIRE STOPPING

- .1 Retaining angles around duct, on both sides of fire separation.
- .2 Fire stopping material and installation must not distort duct.

2.8 GALVANIZED STEEL

- .1 Lock forming quality: to ASTM A653/A653M, Z90 zinc coating.
- .2 Thickness, fabrication and reinforcement: to SMACNA.
- .3 Joints: to SMACNA.

2.9 HANGERS AND SUPPORTS

- .1 Hangers and Supports: in accordance with Section 23 05 29.
 - .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.
 - .1 Ducts up to size 900 mm shall be supported with 25 mm x 1.6 mm thick galvanized strap hangers spaced at not over 3 m centres.
 - .2 Ducts over 900 mm shall be supported with 10 mm steel rods and 50 x 50 x 6 mm angles. Maximum spacing of hangers to be 2.5 m.
 - .3 Hangers: galvanized steel angle with galvanized steel rods.
 - .4 Upper hanger attachments:
 - .1 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel deck or use powder actuated fasteners.

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 metal duct 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 GENERAL

- .1 Do work in accordance with SMACNA.
- .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.
- .4 Install breakaway joints in ductwork on sides of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths and diameter to accommodate installation of acoustic duct lining.

3.3 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
- .4 Hangers:
 - .1 Ducts up to size 900 mm shall be supported with 25 mm x 1.6 mm thick galvanized strap hangers spaced at not over 3 m centres.
 - .2 Ducts over 900 mm shall be supported with 10 mm steel rods and 50 x 50 x 6 mm angles. Maximum spacing of hangers to be 2.5 m.
 - .3 Hanger attachments: manufactured concrete inserts, expansion shields and bolted steel clamps. Do not weld rods to steel deck or use powder actuated fasteners.

3.4 SEALING AND TAPING

- .1 Apply sealant in accordance with SMACNA.
- .2 Bed tape in sealant and recoat with minimum of 1 coat of sealant to manufacturers recommendations.

3.5 LEAKAGE TESTS

- .1 Refer to Section 23 05 94.
 - .2 In accordance with SMACNA HVAC Duct Leakage Test Manual.
 - .3 Do leakage tests in sections.
 - .4 Make trial leakage tests as instructed to demonstrate workmanship.
 - .5 Do not install additional ductwork until trial test has been passed.
-

- .6 Test section minimum of 30 m long with not less than three branch takeoffs and two 90 degrees elbows.
- .7 Complete test before performance insulation or concealment Work.

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 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/or 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

- .1 Underwriters Laboratories Canada (CAN/ULC)
 - .1 CAN/ULC S112-10, Standard Methods of Fire Test of Fire-Damper Assemblies.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
 - .1 SMACNA - HVAC Duct Construction Standards - Metal and Flexible, 2005.

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 duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Flexible connections.
 - .2 Duct access doors.
 - .3 Turning vanes.
 - .4 Instrument test ports.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
-

- .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.

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 4 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 Hold open devices.

2.4 TURNING VANES

- .1 Factory or shop fabricated double thickness with trailing edge, to recommendations of SMACNA and as indicated.

2.5 INSTRUMENT TEST

- .1 1.6 mm thick steel zinc plated after manufacture.
 - .2 Cam lock handles with neoprene expansion plug and handle chain.
 - .3 28 mm minimum inside diameter. Length to suit insulation thickness.
-

- .4 Neoprene mounting gasket.

2.6 SPIN-IN COLLARS

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

2.7 FIRE DAMPERS

- .1 Fire dampers: listed and bear label of ULC, and shall meet requirements of Federal Fire Commissioner (FFC), CAN/ULC-S112 "Test of Fire Damper Assemblies", and authorities having jurisdiction.
- .2 Factory fabricated for fire rating requirement to maintain integrity of membrane being pierced.
- .3 Fire dampers shall be single-blade, multi-blade or curtain type, sized to maintain full flow cross section as indicated.
- .4 Complete with frame and 40 x 40 x 3 mm steel angle on full perimeter of frame on both sides of barrier being pierced.
- .5 Provide at each fire damper an access door for access to fusible links.
- .6 Follow NFPA 90A and manufacturer's installation instructions including the installation of drywall filler pieces when installed in a gypsum board wall.

2.8 BALANCING DAMPERS

- .1 Approved units of thicknesses and type of construction in accordance with SMACNA HVAC Duct Construction Standards.
- .2 Splitter dampers: where indicated with control rod with locking device on exterior of duct. Damper to be single thickness one gauge heavier than duct.
- .3 Single blade butterfly dampers: where indicated with locking quadrant.
- .4 Round butterfly dampers to be 1.6 mm thick in medium pressure ducts and 0.8 mm in low pressure ducts.
- .5 Rectangular butterfly dampers to thicknesses indicated in SMACNA.
- .6 Multi-leaf opposed blade dampers: designed to SMACNA details with locking quadrant.

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 duct accessories installation in accordance with manufacturer's written instructions.
-

- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 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 Fire and smoke dampers.
 - .2 Control dampers.
 - .3 Devices requiring maintenance.
 - .4 Required by code.
 - .5 Reheat coils.
 - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
 - .1 General:
 - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
 - .2 Locate to permit easy manipulation of instruments.
 - .3 Install insulation port extensions as required.
 - .4 Locations:
 - .1 For traverse readings:
 - .1 Ducted inlets to roof and wall exhausters.
 - .2 Inlets and outlets of other fan systems.
 - .3 Main and sub-main ducts.

- .4 And as indicated.
- .2 For temperature readings:
 - .1 At outside air intakes.
 - .2 In mixed air applications in locations as approved by Departmental Representative.
 - .3 At inlet and outlet of coils.
 - .4 Downstream of junctions of two converging air streams of different temperatures.
 - .5 And as indicated.
- .4 Turning Vanes:
 - .1 Install in accordance with recommendations of SMACNA and as indicated.

3.3 CLEANING

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

- .1 Sheet Metal and Air Conditioning National Association (SMACNA)
 - .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible - 2005.

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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
 - .5 Packaging Waste Management: remove for reuse and return and by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 20.
-

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Manufacture to SMACNA standards.

2.2 SPLITTER DAMPERS

- .1 Fabricate from same material as duct but one sheet metal thickness heavier, with appropriate stiffening.
- .2 Double thickness construction.
- .3 Control rod with locking device and position indicator.
- .4 Rod configuration to prevent end from entering duct.
- .5 Pivot: piano hinge.
- .6 Folded leading edge.

2.3 SINGLE BLADE DAMPERS

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

2.4 MULTI-BLADED DAMPERS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3 Locate balancing dampers in each branch duct, for supply, return and exhaust systems.
- .4 Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5 Dampers: vibration free.
- .6 Ensure damper operators are observable and accessible.
- .7 Corrections and adjustments conducted by Departmental Representative.

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 Waste Management: separate waste materials for reuse and/or 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 REQUIREMENTS

- .1 Section 23 09 33 – Electric and Electronic Control System for HVAC
- .2 Section 23 33 00 - Air Duct Accessories.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.

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 dampers and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for dampers for incorporation into manual.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect dampers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
-

- .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.

PART 2 - PRODUCTS

2.1 MULTI-LEAF DAMPERS

- .1 Opposed blade type as indicated.
- .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 500 Pa differential across damper.
 - .2 Pressure drop: at full open position less than 62 Pa differential across damper at 2.54 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, spring assisted.

2.3 MOTORIZED DAMPERS

- .1 Motorized dampers shall be supplied and installed under Section 23 09 33.
 - .2 Sizes: blades maximum 150 mm wide and 1200 mm long. Modular maximum 1200 mm wide and 2400 mm high.
 - .3 Materials: frame to be 2.5 mm thick galvanized sheet steel. Blades to be 1.6 mm thick galvanized sheet steel.
 - .4 Bearings: oil impregnated sintered bronze or nylon bearings. Provide additional thrust bearings for vertical blades.
 - .5 Linkage: zinc-plated steel.
 - .6 Seals: replaceable neoprene seals on both sides, top and bottom of frame and along all blade edges and blade ends.
-

- .7 Performance: 50 L/s maximum allowable leakage against 1.0 kPa static pressure, and temperature range -40°C to 90°C.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for damper installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00.
- .5 Ensure dampers are observable and accessible.

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 Waste Management: separate waste materials for reuse and/or 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

- .1 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S110-2007, Standard Methods of Tests for Air Ducts.

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 flexible ducts and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate:
 - .1 Thermal properties.
 - .2 Friction loss.
 - .3 Acoustical loss.
 - .4 Leakage.
 - .5 Fire rating.
- .3 Test and Evaluation Reports:
 - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect flexible ducts from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
-

- .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.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Factory fabricated to CAN/ULC-S110.
- .2 Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3 Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

2.2 FLEXIBLE DUCTWORK

- .1 Spiral wound flexible aluminum with factory applied, 37 mm thick flexible glass fibre thermal insulation with vapour barrier and reinforced mylar/neoprene laminate jacket, as indicated.
- .2 Performance:
 - .1 Factory tested to 2.5 kPa without leakage.
 - .2 Maximum relative pressure drop coefficient: 3.
- .3 Maximum length of flexible duct connections: 1.2 m.
- .4 Support flexible ducts at 0.6 m centres. Do not lay ducts across any lighting fixtures or hot surfaces.
- .5 Make connections between flexible duct and terminal devices airtight with duct tape.

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 flexible ducts 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 DUCT INSTALLATION

- .1 Install in accordance with: SMACNA.

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 Waste Management: separate waste materials for reuse and/or 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 REQUIREMENTS

- .1 Section 23 05 13 - Common Motors Requirements for HVAC Equipment
- .2 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
- .3 Section 23 33 00 - Air Duct Accessories

1.2 REFERENCES

- .1 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
 - .1 ANSI/AMCA Standard 99-2010, Standards Handbook.
 - .2 ANSI/AMCA Standard 210-2007/(ANSI/ASHRAE 51-07), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - .3 ANSI/AMCA Standard 300-2014, Reverberant Room Method for Sound Testing of Fans.
 - .4 ANSI/AMCA Standard 301-2014, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .2 The Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
 - .1 MPI #18, Primer, Zinc Rich, Organic.

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 HVAC fans 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.
 - .2 Provide:
 - .1 Fan performance curves showing point of operation, kW and efficiency.
 - .2 Sound rating data at point of operation.
 - .3 Indicate:
 - .1 Motors, sheaves, bearings, shaft details.
-

- .2 Minimum performance achievable with variable speed controllers.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Submit in accordance with Section 01 78 00.
 - .1 Provide:
 - .1 Matched sets of belts.
 - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
 - .1 Bearings and seals.
 - .2 Addresses of suppliers.
 - .3 List of specialized tools necessary for adjusting, repairing or replacing.

1.5 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect HVAC fans from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

- .2 Capacity: flow rate, external static pressure, W, revolutions per minute, power, size, sound power data as indicated on schedule.
- .3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.
- .4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300. Supply unit with ANSI/AMCA certified sound rating seal.
- .5 Performance ratings: based on tests performed in accordance with ANSI/AMCA Standard 210. Supply unit with ANSI/AMCA certified rating seal, except for propeller fans smaller than 300 mm diameter.

2.2 FANS GENERAL

- .1 Motors:
 - .1 In accordance with Section 23 05 13 supplemented as specified herein.
 - .2 For use with variable speed controllers.
 - .3 Sizes as indicated.
- .2 Factory primed before assembly in colour standard to manufacturer.
- .3 Scroll casing drains: as indicated.
- .4 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .5 Vibration isolation: to Section 23 05 48.
- .6 Flexible connections: to Section 23 33 00.

2.3 WALL-MOUNTED EXHAUST FANS (EF-WW26-1 TO 4)

- .1 Provide CSA approved and labelled wall- mounted exhaust fans of capacities and performance as indicated on the drawings.
- .2 Exhaust fans shall be direct-driven centrifugal type complete with spun aluminum housing, centrifugal wheel, aluminum birdscreen, backdraft damper, unit-mounted disconnect switch.

2.4 CEILING DESTRATIFICATION FANS (VP-WW26-1 TO 4)

- .1 Commercial ceiling fans have variable speed motors (all motors shall be thermally protected variable speed with permanently lubricated bearings).
 - .2 Painted steel blades with curved ends deliver maximum airflow over wide areas.
 - .3 Reversible motor provides both winter heat destratification and summer time cooling
 - .4 5 Year Manufacturer's Warranty.
-

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 HVAC fans 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 FAN INSTALLATION

- .1 Install fans as indicated, complete with resilient mountings specified in Section 23 05 48, flexible electrical leads and flexible connections in accordance with Section 23 33 00.
- .2 Provide sheaves and belts required for final air balance.
- .3 Bearings and extension tubes to be easily accessible.
- .4 Access doors and access panels to be easily accessible.

3.3 ANCHOR BOLTS AND TEMPLATES

- .1 Size anchor bolts to withstand seismic acceleration and velocity forces.

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.
- .3 Waste Management: separate waste materials for reuse and/or 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 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 diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Indicate following:
 - .1 Capacity.
 - .2 Throw and terminal velocity.
 - .3 Noise criteria.
 - .4 Pressure drop.
 - .5 Neck velocity.

1.2 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00.
 - .2 Include:
 - .1 Keys for volume control adjustment.
 - .2 Keys for air flow pattern adjustment.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect diffuser, registers and grilles from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

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

2.2 GENERAL

- .1 To meet capacity, throw, noise level as indicated.
- .2 Frames:
 - .1 Full perimeter gaskets.
 - .2 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: standard.

2.3 MANUFACTURED UNITS

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

2.4 RETURN AND EXHAUST GRILLES AND REGISTERS

- .1 General: with opposed blade dampers.
- .2 For T-bar lay-in installation: Aluminum, 19 mm border, 12 x 12 x 12 mm egg crate with removable key operated volume damper.
- .3 For surface-mount installation: single deflection, air foil shape, horizontal bar type with 45° deflection, opposed blade damper with concealed operator and rubber sealing strips.

2.5 DIFFUSERS

- .1 General:
 - .1 Sizes indicated are nominal. Provide correct standard product nearest to nominal.
 - .2 Construction: steel with baked enamel to match existing anodized aluminum.
- .2 Supply grilles and registers: double deflection with airfoil shape vertical face and horizontal rear bars, opposed blade dampers with concealed manual operator and gaskets.
- .3 Square or circular diffusers:

- .1 For surface-mount installation: circular or square type to match existing, size and capacity indicated for neck diameter indicated, having adjustable pattern and volume control dampers with flow-straightening devices and blank-off quadrants.
- .2 Diffusers shall be aluminum face and core and shall have custom dimensions to suit the existing ceiling grid. Paint finish and colour shall match existing ceiling grid.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for diffuser, register and grille installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturers' instructions.
- .2 Install with flat head screws in countersunk holes where fastenings are visible.
- .3 Bolt grilles, registers and diffusers, in place, in gymnasium and similar game rooms.

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 Waste Management: separate waste materials for reuse and/or 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

- .1 American National Standard Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
 - .1 ANSI/ASHRAE 52.2-12, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size (ANSI approved).
- .2 International Organization of Standardization (ISO)
 - .1 ISO 14644-1-99, Clean Rooms and Associated Controlled Environments - Part 1: Classification of Air Cleanliness.
- .3 Underwriters' Laboratories of Canada (ULC)
 - .1 ULC -S111-13, Standard Method of Fire Tests for Air Filter Units.

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 HVAC filters 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.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

1.3 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Materials:
 - .1 Provide maintenance materials in accordance with Section 01 78 00.
 - .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.
-

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect HVAC filters from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 GENERAL

- .1 Media: suitable for air at 100% RH and air temperatures between -40 and 50 degrees C.
- .2 Number of units, size and thickness of panels, overall dimensions of filter bank, configuration and capacities: as indicated.
- .3 Pressure drop when clean and dirty, sizes and thickness: as indicated on schedule.

2.2 ACCESSORIES

- .1 Holding frames: permanent channel section construction of galvanized steel, 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: with adhesive.
 - .2 Holding frame: 1.2 mm minimum thick galvanized steel with 3 mm diameter hinged wire mesh screen.
-

- .3 Performance: to ANSI/ASHRAE 52.2 minimum average synthetic dust weight arrestance 70%.
- .4 Fire rated: to ULC -S111.

2.4 COTTON PANEL FILTERS

- .1 Disposable pleated reinforced cotton dry media.
- .2 Holding frame: galvanized steel, or slide in channel for side access.
- .3 Performance:
 - .1 Average atmospheric dust spot efficiency 30% to ANSI/ASHRAE 52.2.
 - .2 Average synthetic dust weight arrestance 90% to ANSI/ASHRAE 52.2.
- .4 Fire Rated: to ULC -S111.

2.5 CARTRIDGE TYPE FILTERS, 80-85% EFFICIENCY

- .1 Media: deep pleated, disposable, high efficiency.
- .2 Holding frame: galvanized steel with bracing.
- .3 Media support: welded wire grid.
- .4 Performance: average atmospheric dust spot efficiency 80-85% to ANSI/ASHRAE 52.2.
- .5 Fire rated: to ULC -S111.

2.6 FILTER GAUGES - DIAL TYPE

- .1 Diaphragm actuated, direct reading.
- .2 Range: 0 to 2 times initial pressure 0 to 250 Pa.

2.7 FILTER GAUGES - MANOMETER TYPE

- .1 Inclined acrylic tube.
- .2 Complete with levelling screws.
- .3 Range: 0 to 2 times initial pressure 0 to 250 Pa.

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 filter installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION GENERAL

- .1 Install in accordance with manufacturer's recommendations and with adequate space for access, maintenance and replacement.

3.3 REPLACEMENT MEDIA

- .1 Replace media with new upon acceptance.
- .2 Filter media new and clean, as indicated by pressure gauge, at time of acceptance.

3.4 FILTER GAUGES

- .1 Install type as indicated across each filter bank (pre-filter and final filter) 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.

3.5 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/or 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 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 duct heaters and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit product data and include:
 - .1 Heater: total kW rating,
 - .2 Maximum discharge temperature.
 - .3 Unit support.
 - .4 Pressure drop operating airflow
 - .5 Water inlet and outlet temperatures
 - .6 Water flow (L/s)
 - .7 Water pressure drop
 - .8 Heater dimensions

1.2 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 20.
- .2 Collect and separate plastic, paper packaging and corrugated cardboard in accordance with Waste Management Plan
- .3 Fold up metal banding, flatten and place in designated area for recycling.

PART 2 - PRODUCTS

2.1 DUCT HEATERS

- .1 Duct heaters: flange type.
 - .2 Maximum temperature at discharge: 32 degrees Celsius.
-

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 duct heaters 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 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 01 9113.
- .2 Perform tests in presence of Departmental Representative.
 - .1 Provide test report and include copy with Operations and Maintenance Manuals.

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 Waste Management: separate waste materials for reuse and/or 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

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME Boiler and Pressure Vessel Code, 2015.
- .2 CSA International
 - .1 CSA B51-14, Boiler, Pressure Vessel, and Pressure Piping Code.

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings:
 - .1 Convene pre-installation meeting 1 week prior to beginning on-site installation, with Contractor's Representative 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 written installation instructions and warranty requirements.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit submittals in accordance with Section 01 33 00.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for heat exchangers 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.
 - .2 Shop drawings to indicate project layout, including layout and dimensions of heat exchangers and system.
 - .1 Indicate manufacturer's recommended clearances for tube withdrawal and manipulation of tube cleaning tools.
 - .4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
-

- .6 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .7 Manufacturers Reports:
 - .1 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for heat exchangers for incorporation into manual.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra Stock Materials:
 - .1 Submit in accordance with Section 01 78 00.
- .2 Supply following spare parts:
 - .1 Head gaskets: 2

1.6 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect heat exchangers from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 Plate Heat Exchanger:
-

- .1 Water to glycol.
 - .1 Designed, constructed and tested in with accordance ASME Boiler and Pressure Vessel Code and CSA B51 and provincial pressure vessel regulations.
- .2 Frames: carbon steel with baked epoxy enamel paint, stainless steel side bolts and shroud.
- .3 Plates: type 304/316 stainless steel.
- .4 Gaskets: as recommended by manufacturer to suit fluid temperature.
- .5 Nozzles: 862 kPa, ASA rubber rated flange type.
- .6 Supports: floor mounted.
- .7 Piping connections: as indicated.
- .8 Capacity: as indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for heat exchanger 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 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 General: install level and firmly anchored to supports in accordance with manufacturer's recommendations.
 - .3 Tube in shell heat exchangers: arrange piping so that tube bundle can be removed after disconnecting two unions or flanges adjacent to head and without disturbing other equipment and systems.
 - .4 Plate exchangers: install in accordance with manufacturer's recommendations.
-

3.3 APPURTENANCES

- .1 Install thermometer wells with thermometers on inlet and outlet of primary and secondary side.
- .2 Install pressure gauge on steam inlet.

3.4 FIELD QUALITY CONTROL

- .1 Site Tests and Inspections:
 - .1 Perform tests as directed by Departmental Representative to ensure heat exchangers are functional.
 - .2 Obtain reports within 3 days of review and submit immediately to Departmental Representative.
- .2 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
- .3 Manufacturer's Field Services:
 - .1 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .2 Ensure manufacturer's representative is present before and during testing.
 - .3 Schedule site visits:
 - .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.

3.5 SYSTEM START-UP

- .1 General: perform start-up operations in accordance with Section 01 91 13, supplemented as specified herein.
 - .2 Check heater for cleanliness on primary and secondary sides.
 - .3 Check water treatment system is complete, operational and correct treatment is being applied.
 - .4 Check installation, settings, operation of relief valves and safety valves.
 - .5 Check installation, location, settings and operation of operating, limit and safety controls.
 - .6 Check supports, seismic restraint systems.
 - .7 General: perform performance verification in accordance with Section 01 91 13, supplemented as specified.
 - .8 Timing: only after TAB of hydronic systems have been successfully completed.
-

- .9 Primary side:
 - .1 Measure flow rate, pressure drop, and water temperature at heater inlet and outlet.
 - .2 Control valve: verify proper operation without binding, slack in components. Measure temperature at control valve inlet or 2 if control is three-port type, pressure drop across inlet to common, bypass to common, inlet to bypass.
 - .3 Secondary side:
 - .1 Measure flow rate, pressure drop and water temperature at heater inlet and outlet.
 - .2 Verify installation and operation of air elimination devices.
 - .4 Calculate heat transfer from primary and secondary sides.
 - .5 Simulate heating water temperature schedule and repeat above procedures.
 - .6 Verify settings, operation of operating, limit and safety controls and alarms.
 - .7 Reports:
 - .1 In accordance with Section 01 91 33, supplemented as specified herein.

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 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/or recycling in accordance with Section 01 74 20.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.7 DEMONSTRATION

- .1 Training: provide training in accordance with Section 01 91 41.

3.8 PROTECTION

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

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.

1.2 PRODUCTS SUPPLIED BUT NOT INSTALLED UNDER THIS SECTION

- .1 Anchor bolts: size anchor bolts to withstand seismic acceleration and velocity forces as defined in Section 23 05 48.

1.3 REFERENCES

- .1 ASTM International
 - .1 ASTM B117-11, Standard Practice for Operating Salt Spray (Fog) Apparatus.
- .2 CSA Group
 - .1 CSA B52-13, Mechanical Refrigeration Code.
- .3 Cooling Technology Institute (CTI)
 - .1 CTI-ATC-105-00, Acceptance Test Code.

1.4 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00.
- .2 Indicate:
 - .1 Connections, piping, fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.
 - .2 Wiring as assembled and schematically.
 - .3 Dimensions, construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.
 - .4 Vibration and seismic control measures.
 - .5 Manufacturers recommended clearances.

1.5 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for condensers for incorporation into manual.
- .3 Include:

- .1 Description of equipment giving manufacturers name, type, model year, capacity.
- .2 Start-up and commissioning procedures.
- .3 Details of operation, servicing and maintenance.
- .4 Recommended spare parts list.

1.6 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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect condensers and cooling equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 CONDENSING UNIT

- .1 General Description
 - .1 Condensing unit shall include compressors, air-cooled condenser coils, condenser fans, suction and liquid connection valves, and unit controls.
 - .2 Unit shall be factory assembled and tested including leak testing of the coil and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
 - .3 Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - .4 Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
 - .5 Installation, Operation and Maintenance manual shall be supplied within the unit.
 - .6 Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.

- .7 Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.
- .2 Construction
 - .1 Unit shall be completely factory assembled, piped, and wired and shipped in one section.
 - .2 Unit shall be specifically designed for outdoor application.
 - .3 The condenser coil shall be mechanically protected from physical damage by painted galvanized steel louvers covering the full area of the coil.
 - .4 Access to condenser coils, condenser fans, compressors, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles.
 - .5 Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117 test procedure.
 - .6 Unit shall include a forkliftable base.
- .3 Electrical
 - .1 Unit shall be provided with standard power block for connecting power to the unit.
 - .2 Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.
- .4 Refrigeration System
 - .1 Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
 - .2 Each compressor shall be furnished with a crankcase heater.
 - .3 Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.
 - .4 Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
 - .5 Unit shall include a factory holding charge of R-410A refrigerant and oil.
 - .6 Condensing unit shall be provided with adjustable on/off condenser fan cycling head pressure control and adjustable compressor lockout to allow cooling operation down to 35°F.
- .5 Client requirements:
 - .1 Provide CSA approved and labelled air-cooled condensing unit of capacity and performance as indicated on the drawings.

- .2 Unit shall be designed for outdoor installation and shall consist of casing, condenser fans, condenser coil, compressors, operating controls and shall be factory- assembled and charged with R-410A.
- .3 Casing: weatherproof construction, galvanized steel with baked enamel finish.
- .4 Condenser fans: propeller type with single piece, spun venturi outlets and zinc-plated guards.
- .5 Condenser coil: seamless copper tubes expanded into aluminum fins.
- .6 Compressors: vibration isolated hermetic compressors with crankcase heaters. On multi-compressor unit provide separate independent refrigerant circuit to each compressor.
- .7 Operating controls shall include high and low pressure controls, anti-cycle timers, motor overload protection, contactors, relays, and 24 volt control circuit.
- .8 Provide low ambient thermostat to lock out compressor at 14°C ambient.
- .9 Provide low ambient control to allow operation down to -18°C ambient.

2.2 VIBRATION ISOLATORS

- .1 To Section 23 05 48.

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 condensers, coolers and cooling tower 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 GENERAL

- .1 Mount on structural supports and vibration isolators and to manufacturer's recommendations.
- .2 Ensure clearance for servicing and maintenance as recommended by manufacturer.
- .3 Manufacturers field service representative to approve installation, to supervise start up and to instruct operators.

3.3 FIELD QUALITY CONTROL

- .1 Site Tests:
 - .1 Test under actual operating conditions in accordance with CTI-ATC-105 to verify specified performance.
- .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.

3.4 ADJUSTING

- .1 Lubricate bearings with oil or grease as recommended by manufacturer.
- .2 Tighten belts to manufacturer's specified tension.

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 Wipe equipment clean, and remove traces of oil, dust, dirt, or paint spots.
- .3 Maintain system in clean condition until final acceptance.
- .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/or 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

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D1929-14, Standard Test Method for Determining Ignition Temperature of Plastics.

1.2 QUALITY ASSURANCE

- .1 Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- .2 Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- .3 Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- .4 Unit shall be safety certified by ETL and ETL US listed. Unit nameplate shall include the ETL/ETL Canada label.

1.3 SUBMITTALS

- .1 Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics, and connection requirements. Installation, Operation and Maintenance manual with start-up requirements shall be provided.
- .2 Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Unit shall be wrapped in plastic prior to shipment to prevent damage during transport and thereafter while in storage awaiting installation.
 - .2 Unit shall be crated for shipment. Crate shall be fabricated of dimensional lumber and plywood.
 - .3 Follow Installation, Operation and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
-

- .4 Unit shall be handled carefully to avoid damage to components, enclosures and finish.
- .5 Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation and Maintenance manual.

1.5 WARRANTY

- .1 Manufacturer shall provide a limited parts and labour warranty for a period of 12 months from the date of equipment startup or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.

PART 2 - PRODUCTS

2.1 AIR HANDLING UNITS (AHU-WW26-2, AHU-WW27-1 TO AHU-WW27-4)

- .1 General Description
 - .1 Indoor air handling units shall include filters, supply fans, DX evaporator coil (AHU-WW27-2 Only), hot water coil (all AHU units except AHU-WW27-3), glycol water coil (AHU-WW27-3 only) and unit controls.
 - .2 Unit shall have a draw-through supply fan configuration and discharge air vertically.
 - .3 Unit shall be factory assembled and tested including leak testing of the DX coil, leak testing of the hot water coil, leak testing of the glycol coil, and run testing of the supply fans and factory wired electrical system. Run test report shall be supplied with the unit.
 - .4 Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - .5 Unit components shall be labeled, including pipe stub outs, pipe stub outs, refrigeration system components and electrical and controls components.
 - .6 Installation, Operation and Maintenance manual shall be supplied within the unit.
 - .7 Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
 - .8 Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.
- .2 Construction

- .1 All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
 - .2 Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929 for a minimum flash ignition temperature of 610°F.
 - .3 Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
 - .4 Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
 - .5 Access to filters, cooling coil (AHU-WW27-2 Only), heating coil, supply fans, and electrical and controls components shall be through hinged access doors.
 - .6 Access doors shall be flush mounted to cabinetry. Coil access door and supply fan access door shall include quarter-turn lockable handles. Supply fan access door shall include removable pin hinges.
 - .7 Units with a cooling coil shall include sloped 304 stainless steel drain pan. Refer to plans for drain pan connection location.
 - .8 Cooling coil shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.
- .3 Electrical
- .1 Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.
 - .2 Unit shall be provided with standard power block for connecting power to the unit.
 - .3 Unit shall include a factory installed 24V control circuit transformer.
- .4 Supply Fans
- .1 Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
 - .2 Blower and motor assembly shall be dynamically balanced.
 - .3 Blower and motor assembly shall be mounted on rubber isolators.
 - .4 Motor shall be a high efficiency electronically commutated motor (ECM).
 - .5 ECM driven supply fan cfm setpoint shall be set with factory installed potentiometer within the control compartment.
- .5 Cooling Coil – AHU-WW27-2 Only
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- .1 Evaporator Coil
 - .1 Coil shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - .2 Coil shall two circuits and interlaced circuitry.
 - .3 Coil shall be 6 row high capacity and 12 fins per inch.
 - .4 Coil shall be hydrogen or helium leak tested.
 - .5 Coil shall be furnished with factory installed thermostatic expansion valves. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet.
 - .6 Coil shall have external piping connections on left or right side as indicated on plans. Liquid and suction connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing, to minimize air leakage.
 - .6 Refrigeration System
 - .1 Air handling unit and matching condensing unit shall be capable of operation as an R-410A split system air conditioner.
 - .2 Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
 - .7 Heating Coil
 - .1 Hot Water Heating Coil
 - .1 Coil shall be certified in accordance with AHRI Standard 410 and be hydrogen or helium leak tested.
 - .2 Coil shall be constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
 - .3 Coil shall have external piping connections on left or right side as indicated on plans. Supply and return connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing and be factory sealed on both the interior and exterior of the unit casing, to minimize air leakage.
 - .4 Control valves shall be field supplied and field installed.
 - .5 Coils shall be located in the preheat position upstream of the cooling coil.
 - .8 Filters
 - .1 Unit shall include 4 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the coils.
 - .2 Unit shall include a clogged filter switch.
 - .9 Controls
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- .1 Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.
- .2 Standard Terminal Block
 - .1 Unit shall be provided with a terminal block for field installation of controls.
- .3 Unit to be complete with all controls shown on drawing M008 and shall comply with Division 23 requirements and quality and be supplied by unit manufacturer for field installation where required and tied back to factory supplied control panel.
- .4 Controls shall be Native BACnet, completely mapped by the manufacturer, and completely interoperable with the existing Institution EMCS. All programming and mapping shall be by unit manufacturer. Controls shall be factory installed and ready for future connection to existing EMCS.

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 Provide appropriate protection apparatus.
- .2 Install units in accordance with manufacturer's instructions and as indicated.

3.3 FANS

- .1 Install fan sheaves required for final air balance.
- .2 Install flexible connections at fan inlet and fan outlets.
- .3 Install vibration isolators.

3.4 DRIP PANS

- .1 Install deep seal P-traps on drip lines.
 - .1 Depth of water seal to be 1.5 times static pressure at this point.

3.5 CLEANING

- .1 Clean in accordance with Section 01 74 11.
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- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 20.

3.6 INSTALLATION, OPERATION AND MAINTENANCE

- .1 Installation, Operation and Maintenance manual shall be supplied with the unit.
- .2 Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.
- .3 Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D1929-14, Standard Test Method for Determining Ignition Temperature of Plastics.
 - .2 ASTM B 117-11, Standard Practice for Operating Salt Spray (Fog) Apparatus.

1.2 QUALITY ASSURANCE

- .1 Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236-15, Safety Standard for Heating and Cooling Equipment.
- .2 Unit shall be certified in accordance with CSA ANSI Z21.47-2012/CSA 2.3-2012, Safety Standard Gas-Fired Furnaces and CSA 2.6-2013/ANSI Z83.8-2013, Standard for Gas unit heaters, gas packaged heaters, gas utility heaters and gas-fired duct furnaces.
- .3 Unit shall be certified by ETL and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label. The nameplate, safety labels and warnings will be in English and French.

1.3 SUBMITTALS

- .1 Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with start-up requirements shall be provided.
- .2 Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance data for incorporation into manual specified in Section 01 78 00.
- .2 Indicate:
 - .1 Brief description of unit, indexed, with details of function, operation, control, and service for components.

- .3 Manufacturer's installation instructions shall govern and unless otherwise noted, operation, maintenance and service of items. Include names and addresses of spare part suppliers.
- .4 Include following:
 - .1 Provide for units, manufacturer's name, type, year, number of units, and capacity.

1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Unit shall be shipped with doors screwed shut and outside air hood closed to prevent damage during transport and thereafter while in storage awaiting installation.
- .2 Follow Installation, Operation, and Maintenance manual instructions for rigging, moving, and unloading the unit at its final location.
- .3 Unit shall be stored in a clean, dry place protected from construction traffic in accordance with the Installation, Operation, and Maintenance manual.

1.6 WARRANTY

- .1 Manufacturer shall provide a limited "parts only" warranty for a period of 12 months from the date of equipment start up or 18 months from the date of original equipment shipment from the factory, whichever is less. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for Installation, Operation, and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and filters.

PART 2 - PRODUCTS

2.1 ROOFTOP UNITS (AHU-WW26-1 AND AHU-WW27-5)

- .1 General Description
 - .1 Outdoor air handling unit shall include filters, supply fans, dampers, gas or electric heaters as indicated, exhaust fans, and unit controls.
 - .2 Unit shall be factory assembled and tested including and run testing of the completed unit. Run test report shall be supplied with the unit in the service compartment's literature pocket.
 - .3 Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
 - .4 Unit components shall be labeled, including electrical and controls components.
 - .5 Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
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- .6 Installation, Operation, and Maintenance manual shall be supplied within the unit.
 - .7 Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door.
 - .8 Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.
- .2 Construction
- .1 All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
 - .2 Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929 for a minimum flash ignition temperature of 610°F.
 - .3 Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
 - .4 Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
 - .5 Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.
 - .6 Access to filters, dampers, heaters, exhaust fans, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
 - .7 Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117 test procedure.
 - .8 Unit AHU-WW26-1 shall be provided with top discharge and side return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
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- .9 Unit AHU-WW27-5 shall be provided with side discharge and side return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
 - .10 Unit shall include lifting lugs on the top of the unit.
 - .11 Unit base shall be fabricated of 1 inch thick double wall, impact resistant, rigid polyurethane foam panels.
 - .12 Unit shall include factory wired control panel compartment LED service lights.
 - .3 Electrical
 - .1 Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
 - .2 Unit shall be provided with a factory installed and factory wired 115V, 13 amp GFI outlet disconnect switch in the unit control panel.
 - .4 Supply Fans
 - .1 Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
 - .2 Blowers and motors shall be dynamically balance and mounted on rubber isolators.
 - .3 Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
 - .4 Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
 - .5 Exhaust Fans – (AHU-WW26-1 only)
 - .1 Exhaust dampers shall be sized for 100% relief.
 - .2 Fans and motors shall be dynamically balanced.
 - .3 Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
 - .4 Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
 - .5 Unit shall include direct drive, axial flow exhaust fans. Blades shall be adjustable pitch.
 - .6 Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.
 - .6 Gas Heating (AHU-WW26-1 only)
 - .1 Stainless steel heat exchanger furnace shall carry a 25 year non-prorated warranty, from the date of original equipment shipment from the factory.
 - .2 Gas furnace shall consist of stainless steel heat exchangers with multiple concavities, an induced draft blower and an electronic pressure switch to lockout the gas valve until the combustion chamber is purged and combustion airflow is established.
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- .3 Furnace shall include a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
 - .4 Unit shall include a single gas connection and have gas supply piping entrances in the unit base for through-the-curb gas piping and in the outside cabinet wall for across the roof gas piping.
 - .5 Natural gas furnace shall be equipped with modulating gas valves, adjustable speed combustion blowers, stainless steel tubular heat exchangers, and electronic controller. Combustion blowers and gas valves shall be capable of modulation. Electronic controller includes a factory wired, field installed supply air temperature sensor. Sensor shall be field installed in the supply air ductwork. Supply air temperature set point shall be adjustable on the electronic controller within the controls compartment. 796 MBH gas heating assemblies shall be capable of operating at any firing rate between 100% and 30% of their rated capacity.
 - .7 Electric Heating (AHU-WW27-5 only)
 - .1 Unit shall include an include electric heater consisting of electric heating coils, fuses, and a high temperature limit switch, with capacities as shown on the plans.
 - .2 Electric heating coils shall be located in the reheat position downstream of the supply fans.
 - .3 Electric heater shall have full modulation capacity controlled by an SCR (Silicon Controlled Rectifier). A 0-10 VDC heating control signal shall be field provided to control the amount of heating.
 - .8 Filters
 - .1 Unit shall include 4 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the heating coil.
 - .2 Unit shall include a clogged filter switch.
 - .9 Outside Air/Economizer- (AHU-WW26-1only)
 - .1 Unit shall include 0-100% economizer consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 20 cfm of leakage per sq ft. at 4 in. w.g. air pressure differential across the damper. Low leakage dampers shall be Class 2 AMCA certified, in accordance with AMCA Standard 511. Damper assembly shall be controlled by spring return DDC actuator. Unit shall include outside air opening bird screen, outside air hood, and barometric relief dampers.
 - .10 Energy Recovery
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- .1 Unit shall contain factory mounted and tested energy recovery wheels. The energy recovery wheels shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
 - .2 The energy recovery component shall incorporate rotary wheels in an insulated cassette frame complete with seals, drive motor and drive belt.
 - .3 Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
 - .4 Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
 - .5 Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
 - .6 All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
 - .7 The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and ARI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the ARI Certified Products.
 - .8 Energy recovery wheel cassette shall carry a 5 year warranty, from the date of original equipment shipment from the factory.
 - .9 Unit shall include 4 inch thick, pleated panel outside air filters with an ASHRAE efficiency of 30% and MERV rating of 8, upstream of the wheel.
 - .10 Hinged service access doors shall allow access to the wheels.
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- .11 Controls
 - .1 Controls shall be Native BACnet, completely mapped by the manufacturer, and completely interoperable with the existing Institution EMCS. All programming and mapping shall be by unit manufacturer. Controls shall be factory installed and ready for future connection to existing EMCS.
- .12 Accessories
 - .1 Unit shall be provided with a safety shutdown terminal block for field installation of a smoke detector which shuts off the unit's control circuit.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install as per manufacturers' instructions.
- .2 Manufacturer to certify installation, supervise start-up and commission unit.

3.2 START-UP

- .1 Verify accessibility, serviceability of components including motorized dampers, filters coils, fans, motors, operators, humidifiers, sensors, electrical disconnects.
- .2 Verify accessibility, cleanability, drainage of drain pans for coils, humidifiers.

3.3 PERFORMANCE VERIFICATION (PV)

- .1 Air Handling Units
 - .1 Set zone mixing dampers for full cooling, except that where diversity factor forms part of design set that % of zone dampers to full heating.
 - .2 Set outside air and return air dampers for minimum outside air.
 - .3 Set face and bypass dampers so face dampers are fully open and bypass dampers are fully closed.
 - .4 Check for smooth, vibrationless correct rotation of supply fan impeller.
 - .5 Measure supply fan capacity.
 - .6 Adjust impeller speed as necessary and repeat measurement of fan capacity.
 - .7 Measure pressure drop each component of air handling unit.
 - .8 Set outside air and return air dampers for the % of outside air required by design and repeat measurements of fan capacity.
 - .9 Reduce differences between fan capacity at minimum and maximum outside air less than 5%.
 - .10 Set face and bypass dampers to full bypass and repeat measurement of fan capacity.

- .11 Reduce difference between fan capacity with F&BPD fully closed to bypass and fully open to bypass to less than 5%.
- .12 Reduce difference between fan capacity at full cooling and fan capacity at full heating to less than 5%.
- .13 OAD: Verify for proper stroking, interlock with RAD.
- .14 Measure DBT, WBT of SA, RA, EA.
- .15 Measure flow rates (minimum and maximum) of SA, RA, EA, relief air.
- .16 Use smoke test to verify no short-circuiting of EA, relief air to outside air intake or to condenser intake.
- .17 Simulate maximum heating load and:
 - .1 Verify temperature rise across heat exchanger.
 - .2 Perform flue gas analysis. Adjust for peak efficiency.
 - .3 Verify combustion air flow to heat exchanger.
 - .4 Simulate minimum heating load and repeat measurements.
- .18 Measure radiated and discharge sound power levels under maximum heating demand and under maximum cooling demand with compressors running.
- .19 Verify operating control strategies, including:
 - .1 Heat exchanger operating and high limit.
 - .2 Early morning warm-up cycle.
 - .3 Freeze protection.
 - .4 Economizer cycle operation, temperature of change-over.
 - .5 Alarms.
 - .6 Voltage drop across thermostat wiring.
 - .7 Operation of remote panel including pilot lights, failure modes.
- .20 Set zone mixing dampers for full heating and repeat measurements.
- .21 Measure leakage past zone mixing dampers by taking temperature measurements. Reduce leakage to less than 5%.
- .22 Check for smooth, vibrationless, correct rotation of return fan impeller.
- .23 Measure return fan capacity.
- .24 Adjust impeller speed as necessary and repeat measurement of return fan capacity.
- .25 Check capacity of heating unit.
- .26 Refer to other sections of these specifications for PV procedures for other components.

3.4 COMMISSIONING REPORTS

- .1 In accordance with Section 01 91 31.
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3.5 TRAINING

- .1 In accordance with Section 01 91 41.

3.6 INSTALLATION, OPERATION, AND MAINTENANCE

- .1 Installation, Operation, and Maintenance manual shall be supplied with the unit.
- .2 Installing contractor shall install unit, including field installed components, in accordance with Installation, Operation, and Maintenance manual instructions.
- .3 Start up and maintenance requirements shall be complied with to ensure safe and correct operation of the unit.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Underwriters' Laboratories (UL) Inc.
 - .1 UL 2021-2013, Fixed and Location-Dedicated Electric Room Heaters.

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 unit heaters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Manufacturer's Instructions: provide to indicate special handling criteria, installation sequence, cleaning procedures.
- .4 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
 - .2 Indicate on drawings:
 - .1 Equipment, capacity and piping connections.
 - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for unit heaters for incorporation into manual.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
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- .2 Store and protect unit 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 and in accordance with Section 01 74 20.
- .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.

PART 2 - PRODUCTS

2.1 VERTICAL UNIT HEATERS

- .1 Vertical Unit Heaters: to UL 2021.
- .2 Casing: 1.6 mm thick cold rolled steel, glossed enamel finish, with threaded connections for hanger rods.
- .3 Coils: hydrostatically test to 1 MPa.
 - .1 Hot water coil: copper tube, mechanically bonded aluminum fins spaced 25 mm maximum rated 1378 kPa minimum working pressure and 104 degrees C maximum entering-water temperature. Include manual air vent and drain.
- .4 Fan: direct drive propeller type, factory balanced, with anti-corrosive finish.
- .5 Motor: speed as indicated, continuous duty, ball bearing motor with built-in overload protection, and resilient motor supports.
- .6 Air outlet: adjustable multi-vane diffuser with finish to match casing.
- .7 Capacity: as indicated.
- .8 Control room thermostat: electric, line voltage, locking cover, set point locking device, concealed adjustment, plastic cover and guard.
- .9 Provide each unit with isolating gate valve on supply, lockshield globe balancing valve on return, and automatic air vent with cock.
- .10 Install unit heaters according to piping layout. Provide for pipe movement during normal operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for unit heaters installation in accordance with manufacturer's written instructions.
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- .1 Visually inspect substrate in presence of Departmental Representative.
- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Include double swing pipe joints as indicated.
- .3 Check final location with Departmental Representative if different from that indicated prior to installation.
 - .1 Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .4 Hot water units: for each unit, install gate valve on inlet and balancing valve on outlet of each unit. Install drain valve at low point.
 - .1 Install manual air vent at high point.
- .5 Clean finned tubes and comb straight.
- .6 Provide supplementary suspension steel as required.
- .7 Install thermostats in locations indicated.
- .8 Before acceptance, set discharge patterns and fan speeds to suit requirements.

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 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.
 - .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 unit heaters installation.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Definitions:
 - .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.
- .2 Reference Standards
 - .1 CSA Group
 - .1 CSA C22.1-15, Canadian electrical code, part 1 (23rd edition), safety standard for electrical installations.
 - .2 CSA C22.3 No. 7-15, Underground systems
 - .3 CAN3-C235-83(R2015), Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
 - .4 CSA Z462-15, Workplace Electrical Safety Standard.
 - .5 CSA Z460-13, Control of Hazardous Energy, Lock-out and Other Methods.
 - .6 CAN/ULC-S537-13, Standard for the Verification of Fire Alarm Systems
 - .2 Ontario Provincial Standards
 - .1 Ontario Electrical Safety Code (OESC) 26th Edition, 2015, and Electrical Safety Authority Bulletins.
 - .3 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.
 - .4 American National Standards Institute / National Electrical Testing Association (ANSI / NETA)
 - .1 ANSI/NETA MTS-2015, Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 - .2 ANSI/NETA ATS-2013, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

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 and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop drawings:
 - .1 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
 - .2 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .3 Indicate of drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .4 Submit 1 copy of 600 x 600 mm minimum size drawings and product data to authority having jurisdiction.
 - .5 If changes are required, notify Departmental Representative of these changes before they are made.
- .4 Certificates:
 - .1 Provide CSA certified equipment and material.
 - .2 Where CSA certified equipment and material is not available, submit such equipment and material to authority having jurisdiction and/or inspection authorities for approval before delivery to site.
 - .3 Submit test results of installed electrical systems and instrumentation.
 - .4 Permits and fees: in accordance with General Conditions of contract.
 - .5 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .5 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
 - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
 - .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.

- .3 Safety precautions.
- .4 Procedures to be followed in event of equipment failure.
- .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.

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 off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacture of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates for control items in English and French.
- .4 Use one nameplate for both languages.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00.
 - .2 Material and equipment to be CSA certified
 - .3 Factory assemble control panels and component assemblies.
-

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

2.4 WARNING SIGNS

- .1 Warning Signs: in accordance with requirements of authority having jurisdiction and Departmental Representative.
- .2 Decal signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.6 EQUIPMENT IDENTIFICATION

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Nameplates: plastic laminate lamicaid 3 mm thick plastic engraving sheet black face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
 - .2 Sizes as follows:

NAMEPLATE SIZES			
Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
- .4 Allow for minimum of twenty-five (25) letters per nameplate.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Identify equipment with Size 3 labels engraved "ASSET INVENTORY NO. []" as directed by Departmental Representative.
- .7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .8 Terminal cabinets and pull boxes: indicate system and voltage.
- .9 Transformers: indicate capacity, primary and secondary voltages.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Prime	Auxiliary	
up to 250 V	Yellow	
up to 600 V	Yellow	Green
Other Communication Systems	Green	Blue
Fire Alarm	Red	

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
 - .2 Do underground systems in accordance with CAN/CSA-C22.3 No.7 except where specified otherwise.
-

3.3 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.4 CONDUIT AND CABLE INSTALLATION

- .1 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .2 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: 1400 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 - ACTION AND INFORMATIONAL SUBMITTALS, phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00.
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.

- .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
- .5 Systems: fire alarm.
- .6 Insulation resistance testing:
 - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.

3.8 SYSTEM STARTUP

- .1 Instruct Departmental Representative in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

3.9 FIELD QUALITY CONTROL ON FIRE ALARM SYSTEM

- .1 Hire and carry the cost for an independent and certified fire alarm testing consultant for any work on the existing or new fire alarm system and devices.
- .2 Perform tests in accordance with this Section and CAN/ULC-S537 and once completed provide a certificate of compliance.
- .3 Fire alarm system:
 - .1 Test such device and alarm circuit to ensure that detectors and auxiliary devices transmit alarm to control panel and actuate alarm.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of systems.

3.10 SAFE WORK

- .1 The contractor shall perform all work safely and as a minimum follow the following procedures and standards over and above those indicated in Division 01:
 - .1 CSA Z462-15, Workplace Electrical Safety Standard.

- .2 CAN/CSA Z460-13, Control of Hazardous Energy, Lock Out and Other Methods.
- .2 Contractor shall provide to their own personnel and sub-contractors Personal Protective Equipment (PPE) required to suit the arc flash hazard/risk category (as calculated above) of the equipment being surveyed and/or tested in an energized state. Contractor shall ensure personnel and sub-contractors use recommended tools in accordance with CSA Z462-12.
- .3 No work on energized equipment shall be permitted unless proper PPE and procedures are followed as outlined in CSA Z462.

3.11 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/or 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 REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 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.

1.3 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.

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.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
- .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.
 - .2 Cable Colour Coding: to Section 26 05 00.
 - .3 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
-

- .4 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.

3.3 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34.

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 CSA Group
 - .1 CSA C22.2 No.41-13, Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590ANCE and UL 467).
 - .2 CSA C22.2 No.65-13, Wire connectors (Tri-National Standard, with UL 486A-486B NMX-J-543-ANCE).
- .2 Ontario Electrical Safety Code (OESC) 26th Edition, 2015 and E.S.A. Bulletins.

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 connectors and terminations and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00.
- .2 Operation and Maintenance Data: submit operation and maintenance data for connectors and terminations for incorporation into manual.

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

PART 2 - PRODUCTS

2.1 CONNECTORS AND TERMINATIONS

- .1 Copper compression connectors to CSA C22.2 No.65 as required sized for conductors.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for connectors and terminations installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2 Bond and ground as required to CSA C22.2 No.41.

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 Waste Management: separate waste materials for reuse and/or 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 REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.

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 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.
- .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 and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect grounding equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .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.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- .1 Grounding conductors: bare stranded copper, soft annealed, size as required.
 - .2 Insulated grounding conductors: green, copper conductors, size as required.
-

- .3 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 Bonding jumpers, straps.
 - .5 Pressure wire connectors.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for grounding equipment installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.

3.3 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical electrical equipment included in, but not necessarily limited to following list. Service equipment, frames of motors, starters.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00.
-

- .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.

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.

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 hangers and supports and include product characteristics, performance criteria, physical size, finish and limitations.

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

PART 2 - PRODUCTS

2.1 SUPPORT CHANNELS

- .1 U shape, size 41 x 41 mm, 2.5 mm thick, surface mounted suspended set in poured concrete walls and ceilings.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for hangers and supports installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
-

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Secure equipment to hollow masonry, tile and plaster surfaces with lead anchors.
 - .2 Secure equipment to poured concrete with expandable inserts.
 - .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
 - .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
 - .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
 - .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
 - .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm diameter threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
 - .8 For surface mounting of two or more conduits use channels.
 - .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
 - .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
 - .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
 - .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
-

- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

3.3 CLEANING

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

END OF SECTION

PART 1 - GENERAL

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.2 No. 18-98(R2003), Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
 - .2 CSA C22.2 No. 56-13, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .3 CSA C22.2 No. 83-M1985(R2013), Electrical Metallic Tubing.
 - .4 CSA C22.2 No. 211.2-06(R2011), Rigid PVC (Unplasticized) Conduit.
 - .5 CAN/CSA C22.2 No. 227.3-15, Non-metallic Mechanical Protection Tubing (NMPT), A National Standard of Canada (February 2006).

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product data: submit manufacturer's printed product literature, specifications and datasheets.
 - .1 Submit cable manufacturing data.
- .3 Quality assurance submittals:
 - .1 Test reports: submit certified test reports.
 - .2 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .3 Instructions: submit manufacturer's installation instructions.

1.3 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.

PART 2 - PRODUCTS

2.1 CABLES AND REELS

- .1 Provide cables on reels or coils.
-

- .1 Mark or tag each cable and outside of each reel or coil, to indicate cable length, voltage rating, conductor size, and manufacturer's lot number and reel number.
- .2 Each coil or reel of cable to contain only one continuous cable without splices.
- .3 Identify cables for exclusively dc applications.

2.2 CONDUITS

- .1 Electrical metallic tubing (EMT): to CSA C22.2 No. 83, with couplings with expanded ends.
- .2 Rigid pvc conduit: to CSA C22.2 No. 211.2.
- .3 Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal and steel.

2.3 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller.
 - .1 Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits.
- .4 Threaded rods, 6 mm diameter, to support suspended channels.

2.4 CONDUIT FITTINGS

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT.
 - .1 Set-screws are not acceptable.

2.5 FISH CORD

- .1 Polypropylene.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms in unfinished areas.
- .3 Use electrical metallic tubing (EMT) for interior.
- .4 Use rigid pvc conduit for exterior.
- .5 Use flexible metal conduit for connection to motors in dry areas.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Minimum conduit size for lighting and power circuits: 19 mm.
- .8 Bend conduit cold:
 - .1 Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Mechanically bend steel conduit over 19 mm diameter.
- .10 Install fish cord in empty conduits.
- .11 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .12 Dry conduits out before installing wire.

3.3 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.4 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
 - .2 Do not install horizontal runs in masonry walls.
 - .3 Do not install conduits in terrazzo or concrete toppings.
-

3.5 CLEANING

- .1 Proceed in accordance with Section 01 74 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 ACTION AND INFORMATIONAL SUBMITTALS

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

1.2 DELIVERY, STORAGE AND HANDLING

- .1 Ship fuses in original containers.
- .2 Do not ship fuses installed in switchboard.
- .3 Store fuses in original containers in storage cabinet, moisture free location.
- .4 Waste Management and Disposal:
 - .1 Separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

1.3 EXTRA MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00.

PART 2 - PRODUCTS

2.1 FUSES - GENERAL

- .1 Fuse type references L1, L2, J1, R1, etc. have been adopted for use in this specification.
- .2 Fuses: product of one manufacturer.

2.2 FUSE TYPES

- .1 Class J fuses.
 - .1 Type J1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
 - .2 Type J2, fast acting.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install fuses in mounting devices immediately before energizing circuit.
- .2 Ensure correct fuses fitted to physically matched mounting devices.
 - .1 Install rejection clips for Class R fuses.
- .3 Ensure correct fuses fitted to assigned electrical circuit.
- .4 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.
- .5 Install spare fuses in fuse storage cabinet.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 26 05 00 - Common Work Results for Electrical.
- .2 Section 26 28 13.01 - Fuses - Low Voltage.

1.2 REFERENCES

- .1 CSA Group
 - .1 CAN/CSA-C22.2 No.4-04(R2014), Enclosed and Dead-Front Switches (Tri-National Standard, with ANCE NMX-J-162-2004 and UL 98).
 - .2 CSA C22.2 No.39-13, Fuseholder Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for disconnect switches - fused and non-fused and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and with manufacturer's written instructions.
 - .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
 - .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect disconnect switches - fused and non-fused from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
 - .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.
-

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- .1 Fusible, and Non-fusible, Horsepower rated disconnect switch in CSA enclosure, 1 inside and 3 outside, to CAN/CSA-C22.2 No.4 size as indicated.
- .2 Provision for padlocking in on-off switch position by 3 locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated, in accordance with Section 26 28 13.01.
- .5 Fuseholders: to CSA C22.2 No.39 relocatable and suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Indicate name of load controlled on size 4 nameplate.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for disconnect switches - fused and non-fused installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

3.3 CLEANING

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

- .1 Section 26 05 00 - Common Work Results for Electrical

1.2 REFERENCES

- .1 International Electrotechnical Commission (IEC)
 - .1 IEC 947-4-1-2012, Part 4: Electromechanical contactors and motor-starters.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Product Data:
 - .1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Provide shop drawings: in accordance with Section 01 33 00.
 - .1 Provide shop drawings for each type of starter to indicate:
 - .1 Mounting method and dimensions.
 - .2 Starter size and type.
 - .3 Layout and components.
 - .4 Enclosure types.
 - .5 Wiring diagram.
 - .6 Interconnection diagrams.

1.4 CLOSEOUT SUBMITTALS

- .1 Provide maintenance materials in accordance with Section 01 78 00.
 - .2 Submit operation and maintenance data for each type and style of motor starter for incorporation into maintenance manual.
 - .3 Extra Materials:
 - .1 Provide listed spare parts for each different size and type of starter.
 - .1 3 contacts, stationary.
 - .2 3 contacts, movable.
 - .3 1 contacts, auxiliary.
 - .4 1 control transformers.
-

- .5 1 operating coil.
- .6 2 fuses.
- .7 10% indicating lamp bulbs used.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle in accordance with Section 01 61 00.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 20.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Starters: to IEC 947-4 with AC4 utilization category.

2.2 FULL VOLTAGE MAGNETIC STARTERS

- .1 Combination magnetic starters of size, type, rating and enclosure type as indicated with components as follows:
 - .1 Contactor solenoid operated, rapid action type.
 - .2 Motor overload protective device in each phase, manually reset from outside enclosure.
 - .3 Wiring and schematic diagram inside starter enclosure in visible location.
 - .4 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
 - .2 Combination type starters to include fused disconnect switch with operating lever on outside of enclosure to control disconnect and motor circuit interrupter and provision for:
 - .1 Locking in "OFF" position with up to 3 padlocks.
 - .2 Independent locking of enclosure door.
 - .3 Provision for preventing switching to "ON" position while enclosure door open.
 - .3 Accessories:
 - .1 Pushbuttons: heavy duty industry standard labelled.
 - .2 Indicating lights: heavy duty LED type and industry standard color.
 - .3 1-N/O and 1-N/C spare auxiliary contacts unless otherwise indicated.
-

2.3 CONTROL TRANSFORMER

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with secondary fuse, installed in with starter as indicated.
- .2 Size control transformer for control circuit load plus 20% spare capacity.

2.4 ACCESSORIES

- .1 Pushbutton: heavy duty, as required.
- .2 Selector switches: heavy duty, as required.
- .3 Indicating lights: heavy duty, type and colour as indicated.

2.5 FINISHES

- .1 Apply finishes to enclosure in accordance with Section 26 05 00.

2.6 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00.
- .2 Magnetic starter designation label, white plate, black letters, engraved as existing.

PART 3 - EXECUTION

3.1 INSTALLATION

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses installed.
- .4 Confirm motor nameplate and adjust overload device to suit.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 and manufacturer's instructions.
 - .2 Operate switches and contactors to verify correct functioning.
 - .3 Perform starting and stopping sequences of contactors and relays.
 - .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.
-

3.3 CLEANING

- .1 Clean in accordance with Section 01 74 11.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and/or recycling in accordance with Section 01 74 20.

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 D698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m).
 - .4 ASTM D1557-12e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m).
 - .5 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-8.1,8.2-M88, Sieves, Testing, Woven Wire, Metric.

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 with 0.95 to 1.15 m³ bucket. Frozen material not classified as rock.
 - .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
 - .2 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.
 - .3 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
 - .4 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
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- .5 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .6 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136: Sieve sizes to CAN/CGSB-8.1 and CAN/CGSB-8.2.
 - .2 Table:

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45
 - .3 Coarse grained soils containing more than 20 % by mass passing 0.075 mm sieve.
- .7 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Quality Control:
 - .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 testing and 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 clearance record from utility authority 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.

1.4 EXISTING CONDITIONS

- .1 Examine soil report available at the time of bidding.
 - .2 Buried services:
 - .1 Before commencing work verify and establish location of buried services on and adjacent to site. Provide copies of all locate sheets to the Departmental Representative from all utility companies before any excavation work.
 - .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 to establish state of use of buried utilities and structures, and clearly mark the locations to prevent disturbance during Work.
 - .6 Confirm locations of buried utilities by careful test excavations or 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 removing or re-routing. Costs for such Work is to be paid by Contractor.
 - .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.
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- .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 Fill material: to Ontario Provincial Standard Specification 1010 and the following requirements:
 - .1 Crushed, pit run or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified as per ASTM C136. Sieve sizes to CAN/CGSB-8.1 and CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation	% Passing	
Type 1	Type 2	
75 mm	-	100
50 mm	-	-
37.5 mm	-	-
25 mm	100	-
19 mm	75-100	-
12.5 mm	-	-
9.5 mm	50-100	-
4.75 mm	30-70	22-85
2.00 mm	20-45	-
0.425 mm	10-25	5-30
0.180 mm	-	-
0.075 mm	3-8	0-10

- .2 Type 3 fill: selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, refuse or other deleterious materials.
- .3 Granular material: to Ontario Provincial Standard Specification 1010 for:
 - .1 Granular A, maximum size 13.2 mm.
 - .2 Granular B, Type II, maximum size 26.5 mm.
- .4 Insulation Board: refer to Section 07 21 13.

PART 3 - EXECUTION

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures.
-

3.2 SITE PREPARATION

- .1 Remove obstructions 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.

3.3 PREPARATION/PROTECTION

- .1 Keep excavations clean, free of standing water, and loose soil.
- .2 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative approval.
- .3 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.
- .4 Protect buried services that are required to remain undisturbed.

3.4 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping of areas as directed by Departmental Representative after area has been cleared of brush, weeds and grasses and removed from site.
- .2 Strip topsoil to depths as directed by Departmental Representative.
 - .1 Do not mix topsoil with subsoil.
- .3 Stockpile in locations as directed by Departmental Representative.
 - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .4 Dispose of unused topsoil as directed by Departmental Representative.

3.5 STOCKPILING

- .1 Stockpile fill materials in areas designated by Departmental Representative.
 - .1 Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.
- .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.6 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.
-

- .1 Where conditions are unstable, Departmental Representative to verify and advise methods.
- .2 Obtain permit from authority having jurisdiction for temporary diversion of water course.
- .3 Construct temporary Works to depths, heights and locations as indicated or directed by Departmental Representative.
- .4 During backfill operation:
 - .1 Unless otherwise indicated or directed by Departmental Representative, remove sheeting and shoring from excavations.
 - .2 Pull sheeting in increments that will ensure compacted backfill is maintained at elevation.
- .5 Upon completion of substructure construction:
 - .1 Remove cofferdams, shoring and bracing after written approval from the Departmental Representative.
 - .2 Remove excess materials from site and restore watercourses as indicated and 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 to approved runoff areas and 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 Excavate to lines, grades, elevations and dimensions as indicated.
 - .2 Remove concrete, masonry, paving, walks, demolished foundations and rubble and other obstructions encountered during excavation.
 - .3 Excavation must not interfere with bearing capacity of adjacent foundations.
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- .4 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.
- .5 For trench excavation if required, 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.
- .6 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
- .7 Restrict vehicle operations directly adjacent to open trenches.
- .8 Dispose of surplus and unsuitable excavated material off site.
- .9 Do not obstruct flow of surface drainage or natural watercourses.
- .10 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .11 Notify Departmental Representative when bottom of excavation is reached.
- .12 Obtain Departmental Representative approval of completed excavation.
- .13 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.
- .14 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 FILL TYPES AND COMPACTION

- .1 Use types of fill as indicated. Compaction densities are percentages of maximum densities obtained from ASTM D698 and ASTM D1557.
 - .1 Provide granular material A to depth indicated on the Drawings, compacted to 95% of maximum dry density.

3.10 BEDDING AND SURROUND OF UNDERGROUND SERVICES

- .1 Place and compact granular material for bedding and surround of underground services as indicated.
 - .2 Place bedding and surround material in unfrozen condition.
-

3.11 BACKFILLING

- .1 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 shoring and bracing; backfilling of voids with satisfactory soil material after approval from the Departmental Representative.
- .2 Areas to be backfilled to be free from debris and water.
- .3 Do not use backfill material which contains debris.
- .4 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Backfilling around installations:
 - .1 Place bedding and surround material as specified elsewhere.
- .6 Place unshrinkable recycled fill in areas as indicated.
- .7 Consolidate and level unshrinkable fill with internal vibrators.
- .8 Install drainage system in backfill as indicated.

3.12 RESTORATION

- .1 Cleaning the site as per the requirement of Section 01 74 11.
- .2 Replace topsoil as directed by Departmental Representative.
- .3 Reinstate lawns to elevation which existed before excavation.
- .4 Clean and reinstate areas affected by Work as directed by Departmental Representative.
- .5 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
- .6 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

PART 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 03 30 00 – Cast-In-Place Concrete
- .2 Section 09 91 13 – Exterior Re-Painting.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A90-13/A90M-13, Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - .3 ASTM A123-13/A123M-13, Standard Specification for Zinc (Hot Dip Galvanized) coatings on Iron and Steel Products.
 - .4 ASTM A653/A653M-15, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM C618-12a, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
 - .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-138.1-96, Fabric for Chain Link Fence.
 - .2 CAN/CGSB-138.2-96, Steel Framework for Chain Link Fence.
 - .3 CAN/CGSB-138.3-96, Installation of Chain Link Fence.
 - .4 CAN/CGSB-138.4-96, Gates for Chain Link Fence.
 - .3 CSA International
 - .1 CSA A23.1-09/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.
 - .4 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.
 - .5 Correctional Services Canada (CSC) Technical Criteria.
 - .1 SP-1 – Site Planning and Development
 - .2 SP-3 – Gates/Sallyports
 - .3 SP-4 – Exterior Lighting
 - .4 SP-5 – Traffic Circulations and Parking
 - .5 ST-1 – Guard Towers
-

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 concrete mixes, fences, posts and gates and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 01 33 00.
 - .2 Drawings to indicate: extent of fencing, location of gates, and anchoring details.

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 accordance with manufacturer's recommendations.
 - .2 Store and protect fence and gate materials from damage.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 Concrete mixes and materials: in accordance with Section 03 30 00 and CSA A23.1/A23.2.
 - .1 Nominal coarse aggregate size: 20.
 - .2 Compressive strength: 35 MPa minimum at 28 days.
 - .3 Additives: fly ash to CSA A3000 and ASTM C618.
 - .2 Chain-link fence fabric: to CAN/CGSB-138.1.
 - .1 Fabric Type 1, Class A, Style 2-medium.
 - .2 Height of fabric: as indicated.
 - .3 Posts, braces and rails: to CAN/CGSB-138.2, galvanized steel pipe. Dimensions as indicated.
 - .4 Top and bottom tension wire: to CAN/CGSB-138.2, single strand, galvanized steel wire.
 - .5 Tie wire fasteners: 3.7mm diameter galvanized steel wire.
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- .6 Tension bar: to ASTM A653/A653M, 5 x 20 mm minimum galvanized steel.
- .7 Gates: to CAN/CGSB-138.4, Type I hot rolled, butt or electric resistance welded; Style 2 double swing, frame, braces and post sizes as indicated.
 - .1 Gates fabricated as indicated with electrically welded joints, and hot-dip galvanized after welding. Gate frames: to ASTM A53/A53M, standard weight, 45mm outside diameter pipe for outside frame, 35mm outside diameter pipe for interior bracing.
 - .2 Fasten fence fabric to gate with twisted selvage at top.
 - .3 Furnish swing gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate.
 - .4 Furnish double swing gates with chain hook to hold gates open and centre rest with foot bolt for closed position.
- .8 Fittings and hardware: to CAN/CGSB-138.2, galvanized steel.
 - .1 Tension bar bands: 3 x 20 mm minimum galvanized steel or 5 x 20 mm minimum aluminum.
 - .2 Post caps to provide waterproof fit, to fasten securely over posts and to carry top rail.
- .9 Bands: galvanized steel 6 x 25 mm, offset and centered type as required.
- .10 Clips: galvanized sheet metal, 3.8 mm.
- .11 Organic zinc rich coating: to applicable codes and standards.
- .12 Grounding rod: 16 mm diameter copperweld rod, 3 m long.

2.2 FINISHES

- .1 Galvanizing:
 - .1 For chain link fabric: to CAN/CGSB-138.1 Grade 2.
 - .2 For pipe: 550 g/m² minimum to ASTM A90.
 - .3 For other fittings: to ASTM A123-09/A123M-09, minimum Coating Grade 85, minimum 600 g/m².

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for fence and gate 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 Grading: Remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts.
 - .1 Provide clearance between bottom of fence and ground surface of center of bottom rail and ground of 50 mm.

3.3 ERECTION OF FENCE

- .1 Erect fence along lines as indicated and to CAN/CGSB-138.3.
 - .2 Excavate post holes to dimensions and depth of 300mm and 1200mm by methods approved by Departmental Representative.
 - .3 Space line posts maximum 2.5 m apart, measured parallel to ground surface.
 - .4 Space straining posts at equal intervals not to exceed 60m m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade, is greater than 60m.
 - .5 Install additional straining posts at sharp changes in grade and where directed by Departmental Representative.
 - .6 Install corner post where change in alignment exceeds 10 degrees.
 - .7 Install end posts at end of fence and at buildings.
 - .1 Install gate posts on both sides of gate openings.
 - .8 Place concrete in post holes then embed posts into concrete to depths indicated.
 - .1 Extend concrete 50 mm above ground level and slope to drain away from posts.
 - .2 Brace to hold posts in plumb position and true to alignment and elevation until concrete has set.
 - .9 Install fence fabric after concrete has cured, minimum of 5 days.
 - .10 Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface.
 - .1 Install braces on both sides of corner and straining posts in similar manner.
 - .11 Install overhang tops and caps.
 - .12 Install top and bottom rail between posts and fasten securely to posts with waterproof caps.
 - .13 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals.
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- .1 Knuckled selvedge at bottom.
- .2 Twisted selvedge at top.
- .14 Secure fabric to top rails, line posts and bottom rail with tie wires at 300mm intervals. Give tie wires minimum two twists.
- .15 Secure bottom rail to ground barrier with galvanized anchor clamp.
- .16 Install grounding rods as indicated.

3.4 INSTALLATION OF GATES

- .1 Install gates in locations as indicated.
- .2 Level ground between gate posts and set gate bottom approximately 40 mm above ground surface.
- .3 Determine position of centre gate rest for double gate.
 - .1 Cast gate rest in concrete as directed.
 - .2 Dome concrete above ground level to shed water.
- .4 Install gate stops where indicated.

3.5 TOUCH UP

- .1 Clean damaged surfaces with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas in accordance with Section 09 91 13.
 - .1 Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.

3.6 GROUNDING

- .1 Install grounding rods as indicated or directed.

3.7 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 Clean and trim areas disturbed by operations. Dispose of surplus excavated material and replace damaged sod.
- .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
