

# **SPECIFICATION MANUAL**

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## **Jasper Park Staff Housing**

Jasper, Alberta

for

PARKS CANADA AGENCY

Issued for Tender

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# **NORR**

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**1.1 WORK COVERED BY CONTRACT DOCUMENTS**

- .1 Work of this Contract comprises construction of a five plex housing unit located at 910 Patricia Street, Jasper, Alberta.
- .2 Work includes main building and service building at northwest corner of site.

**1.2 CONTRACT METHOD**

- .1 Construct Work under single stipulated price contract.

**1.3 CONTRACTOR USE OF PREMISES**

- .1 Contractor shall have complete use of site during course of the work.

**1.4 EXISTING SERVICES**

- .1 Notify, Departmental Representative and utility companies of intended interruption of services and obtain required permission.
- .2 Establish location and extent of service lines in area of work before starting Work. Notify Departmental Representative of findings.
- .3 Submit schedule to and obtain approval from Departmental Representative for any shut-down or closure of active service or facility including power and communications services. Adhere to approved schedule and provide notice to affected parties.
- .4 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.

**1.5 DOCUMENTS REQUIRED**

- .1 Maintain at job site, one copy each document as follows:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Reviewed Shop Drawings.
  - .5 List of Outstanding Shop Drawings.
  - .6 Change Orders.
  - .7 Other Modifications to Contract.
  - .8 Field Test Reports.
  - .9 Copy of Approved Work Schedule.
  - .10 Health and Safety Plan and Other Safety Related Documents.
  - .11 Other documents as specified.

**END OF SECTION**

**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 Consultant will assign sanitary facilities for use by Contractor's personnel. Keep facilities clean and assume responsibility as a result of their use.
- .5 Contractor MAY NOT use the new elevator.
- .6 Closures: protect work temporarily until permanent enclosures are completed.

**1.3 EXISTING SERVICES**

- .1 Provide for personnel, pedestrian and vehicular traffic.
- .2 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

**1.4 SPECIAL REQUIREMENTS**

- .1 Contractor may work 7AM to 7PM daily. Carry out noise generating activities as agreed upon with the DR. All noise generating activities may only occur during daylight hours between 7AM and 7PM in order to lessen stress on wildlife.
- .2 Submit schedule in accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM).
- .3 Ensure that Contractor 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 Comply with and implement all environmental protection and mitigation measures in the approved *Canadian Environmental Assessment Act* Screening Report as approved by Parks Canada.
- .6 Comply with requirements of the Canada Parks Act and all other conditions pertaining to working in a National Park and National Historic Site.

**1.5 BUILDING SMOKING ENVIRONMENT**

- .1 Smoking is not allowed within the building or the surrounding site.

**END OF SECTION**

**1.1 ADMINISTRATIVE**

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

**1.2 PRECONSTRUCTION MEETING**

- .1 Within 15 days after award of Contract, request a meeting of parties in contract to discuss and resolve administrative procedures and responsibilities.
- .2 Departmental Representative, Consultant, Contractor, major Subcontractors, field inspectors and supervisors will be in attendance.
- .3 Establish time and location of meeting and notify parties concerned minimum 5 days before meeting.
- .4 Incorporate mutually agreed variations to Contract Documents into Agreement, prior to signing.
- .5 Agenda to include:
  - .1 Appointment of official representative of participants in the Work.
  - .2 Schedule of Work: in accordance with Section 01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart.
  - .3 Schedule of submission of shop drawings, samples, colour chips. Submit submittals in accordance with Section 01 33 00 - Submittal Procedures.
  - .4 Requirements for temporary facilities, site sign, offices, storage sheds, utilities, fences in accordance with Section 01 52 00 - Construction Facilities.
  - .5 Delivery schedule of specified equipment.
  - .6 Site security.
  - .7 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
  - .8 Owner provided products.
  - .9 Record drawings in accordance with Section 01 33 00 - Submittal Procedures.
  - .10 Take-over procedures, acceptance, warranties in accordance with Section 01 78 00 - Closeout Submittals.

- .11 Monthly progress claims, administrative procedures, photographs, hold backs.
- .12 Appointment of inspection and testing agencies or firms.
- .13 Insurances, transcript of policies.

**1.3 PROGRESS MEETINGS**

- .1 During course of Work schedule bi-weekly progress meetings.
- .2 Contractor, major Subcontractors involved in Work Departmental Representative, Consultant are to be in attendance.
- .3 Notify parties minimum 5 days prior to meetings.
- .4 Record minutes of meetings and circulate to attending parties and affected parties not in attendance within 48 hours after meeting.
- .5 Agenda to include the following:
  - .1 Review and 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.

**END OF SECTION**

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## 1.1 DEFINITIONS

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

## 1.2 REQUIREMENTS

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



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**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 MASTER PLAN**

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

**1.5 PROJECT SCHEDULE**

- .1 Develop detailed Project Schedule derived from Master Plan.
- .2 Ensure detailed Project Schedule includes as minimum milestone and activity types as follows:
  - .1 Award.
  - .2 Shop Drawings, Samples.
  - .3 Permits.
  - .4 Mobilization.
  - .5 Selective Demolition.
  - .6 Roofing.
  - .7 Re-roofing of existing areas.
  - .8 Re-installation of existing mechanical units.

**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.

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**1.7 PROJECT MEETINGS**

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

**END OF SECTION**

**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's review.
- .10 Keep one reviewed copy of each submission on site.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in the Province of Alberta, Canada.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .4 Allow 10 days for Departmental Representative's review of each submission.
- .5 Adjustments made on shop drawings by Departmental Representative are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Departmental Representative prior to proceeding with Work.

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

- .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
- .2 Testing must have been within 3 years of date of contract award for project.
- .13 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
  - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
  - .2 Certificates must be dated after award of project contract complete with project name.
- .14 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Departmental Representative.
  - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .15 Submit electronic]copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .16 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.
- .17 Delete information not applicable to project.
- .18 Supplement standard information to provide details applicable to project.
- .19 If upon review by Departmental Representative, no errors or omissions are discovered or if only minor corrections are made, electronic copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

### **1.3 PHOTOGRAPHIC DOCUMENTATION**

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

### **1.4 CERTIFICATES AND TRANSCRIPTS**

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

**END OF SECTION**

**1.1 REFERENCES**

- .1 Canada Labour Code, Part 2, Canada Occupational Safety and Health Regulations
- .2 Province of Alberta
  - .1 Occupational Health and Safety Act, R.S.A. - Updated 2013.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit site-specific Health and Safety Plan: Within 7 days after date of Notice to Proceed and prior to commencement of Work. Health and Safety Plan must include:
  - .1 Results of site specific safety hazard assessment.
- .3 Submit two copies of Contractor's authorized representative's work site health and safety inspection reports weekly to Departmental Representative.
- .4 Submit copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
- .5 Submit copies of incident and accident reports.
- .6 Submit WHMIS MSDS - Material Safety Data Sheets.
- .7 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within 10 days after receipt of plan. Revise plan as appropriate and resubmit plan within 10 days after receipt of comments.
- .8 Departmental Representative's review of Contractor's final Health and Safety plan should not be construed as approval and does not reduce the Contractor's overall responsibility for construction Health and Safety.

**1.3 SAFETY ASSESSMENT**

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

**1.4 MEETINGS**

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

**1.5 REGULATORY REQUIREMENTS**

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

**1.6 GENERAL REQUIREMENTS**

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

**1.7 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.

**1.8 COMPLIANCE REQUIREMENTS**

- .1 Comply with Occupational Health and Safety Act, General Safety Regulation, Alberta.
- .2 Comply with Canada Labour Code, Canada Occupational Safety and Health Regulations.

**1.9 UNFORSEEN HAZARDS**

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

**1.10 POSTING OF DOCUMENTS**

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

**1.11 CORRECTION OF NON-COMPLIANCE**

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

**1.12 BLASTING**

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

**1.13 POWDER ACTUATED DEVICES**

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

**1.14 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.

**END OF SECTION**

**1.1 REFERENCES AND CODES**

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

**1.2 BUILDING SMOKING ENVIRONMENT**

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

**END OF SECTION**



## **1.1 INSPECTION**

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

## **1.2 INDEPENDENT INSPECTION AGENCIES**

- .1 Independent Inspection/Testing Agencies will be engaged by Departmental Representative for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by Departmental Representative.
- .2 Provide equipment required for executing inspection and testing by appointed agencies.
- .3 Employment of inspection/testing agencies does not relax responsibility to perform Work in accordance with Contract Documents.
- .4 If defects are revealed during inspection and/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. Pay costs for retesting and re-inspection.

## **1.3 ACCESS TO WORK**

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

## **1.4 PROCEDURES**

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

**1.5 REJECTED WORK**

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

**1.6 REPORTS**

- .1 Submit 4 copies of inspection and test reports to Departmental Representative.
- .2 Provide copies to subcontractor of work being inspected or tested and manufacturer or fabricator of material being inspected or tested.

**1.7 TESTS AND MIX DESIGNS**

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

**1.8 MOCK-UPS**

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

**1.9 MILL TESTS**

- .1 Submit mill test certificates as requested or required within specification Sections.

**END OF SECTION**

### 1.1 WATER SUPPLY

- .1 Departmental Representative will provide continuous supply of potable water for construction use.
- .2 Departmental Representative will pay for utility charges at prevailing rates.

### 1.2 TEMPORARY HEATING AND VENTILATION

- .1 Provide temporary heating required during construction period, including attendance, maintenance and fuel.
- .2 Provide temporary heat and ventilation in enclosed areas as required to:
  - .1 Facilitate progress of Work.
  - .2 Protect Work and products against dampness and cold.
  - .3 Prevent moisture condensation on surfaces.
  - .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
  - .5 Provide adequate ventilation to meet health regulations for safe working environment.
- .3 Maintain temperatures of minimum 10 degrees C in areas where construction is in progress.
- .4 Ventilating:
  - .1 Prevent accumulations of dust, fumes, mists, vapours or gases in areas occupied during construction.
  - .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
  - .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
  - .4 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.
- .5 Maintain strict supervision of operation of temporary heating and ventilating equipment to:
  - .1 Conform with applicable codes and standards.
  - .2 Enforce safe practices.
  - .3 Prevent abuse of services.
  - .4 Prevent damage to finishes.
  - .5 Vent direct-fired combustion units to outside.
- .6 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

### 1.3 TEMPORARY POWER AND LIGHT

- .1 Departmental Representative will provide for temporary power during construction for operating of power tools.

**1.4 TEMPORARY COMMUNICATION FACILITIES**

- .1 Provide and pay for temporary telephone necessary for own use.

**1.5 FIRE PROTECTION**

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

**END OF SECTION**

## 1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-S269.2, Access Scaffolding for Construction Purposes.
  - .2 CAN/CSA-Z321, Signs and Symbols for the Occupational Environment.

## 1.2 SCAFFOLDING

- .1 Scaffolding in accordance with CAN/CSA-S269.2.
- .2 Provide and maintain scaffolding, swing staging and platforms.

## 1.3 HOISTING

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

## 1.4 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.

## 1.5 CONSTRUCTION PARKING

- .1 Parking will not be permitted on site.

## 1.6 OFFICES

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

## 1.7 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.

## 1.8 SANITARY FACILITIES

- .1 Departmental Representative will designate sanitary facilities for use by work force.

## 1.9 CLEAN-UP

- .1 Remove construction debris, waste materials, packaging material from work site daily.
- .2 Clean dirt or mud tracked onto paved or surfaced roadways.

- .3 Store materials resulting from demolition activities that are salvageable.
- .4 Stack stored new or salvaged material not in construction facilities.

**END OF SECTION**

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## **1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CGSB 1.59-[97], Alkyd Exterior Gloss Enamel.
  - .2 CAN/CGSB 1.189-[00], Exterior Alkyd Primer for Wood.
- .2 Canadian Standards Association (CSA International)
  - .1 CSA-0121-08 Douglas Fir Plywood.

## **1.2 INSTALLATION AND REMOVAL**

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

## **1.3 HOARDING**

- .1 Erect temporary site enclosure using new 1.8 m high snow fence wired to rolled steel "T" bar fence posts spaced at 2.4 m on centre. Provide two lockable truck gates. Maintain fence in good repair.
- .2 Provide barriers around trees and plants designated to remain. Protect from damage by equipment and construction procedures.

## **1.4 GUARD RAILS AND BARRICADES**

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

## **1.5 WEATHER ENCLOSURES**

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

## **1.6 DUST TIGHT SCREENS**

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



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**1.7 ACCESS TO SITE**

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

**1.8 PUBLIC TRAFFIC FLOW**

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

**1.9 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.

**1.12 WASTE MANAGEMENT AND DISPOSAL**

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

**END OF SECTION**

**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 born by Departmental Representative in event of conformance with Contract Documents or by Contractor in event of non-conformance.

**1.2 QUALITY**

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

**1.3 AVAILABILITY**

- .1 Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify Departmental Representative of such, in order that substitutions or other remedial action may be authorized in ample time to prevent delay in performance of Work.
- .2 In event of failure to notify Departmental Representative at commencement of Work and should it subsequently appear that Work may be delayed for such reason, reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

**1.4 STORAGE, HANDLING AND PROTECTION**

- .1 Handle and store products in manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions when applicable.
- .2 Store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .3 Store products subject to damage from weather in weatherproof enclosures.
- .4 Store cementitious products clear of earth or concrete floors, and away from walls.
- .5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.
- .6 Store sheet materials, lumber on flat, solid supports and keep clear of ground. Slope to shed moisture.
- .7 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.
- .8 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.
- .2 Notify Departmental Representative in writing, of conflicts between specifications and manufacturer's instructions, so that Departmental Representative can establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Departmental Representative to require removal and re-installation at no increase in Contract Price or Contract Time.

**1.7 QUALITY OF WORK**

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

**1.8 CO-ORDINATION**

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

**1.9 REMEDIAL WORK**

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

**1.10 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.

**1.11 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.

**END OF SECTION**

**1.1 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.2 MATERIALS**

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

**1.3 PREPARATION**

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

**1.4 EXECUTION**

- .1 Execute cutting, fitting, and patching [including excavation and fill,] to complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.

- .5 Provide openings in non-structural elements of Work for penetrations of mechanical and electrical Work.
- .6 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .7 Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements, and sight-exposed surfaces.
- .8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .9 Restore work with new products in accordance with requirements of Contract Documents.

**1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for recycling in accordance with Section [01 74 21 - Construction/Demolition Waste Management And Disposal.

**END OF SECTION**

**1.1 PROJECT CLEANLINESS**

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris.
- .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 containers for collection of waste materials and debris.
- .5 Provide and use marked separate bins for recycling. Refer to Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .6 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .7 Provide adequate ventilation during use of volatile or noxious substances..

**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.
- .5 Remove dirt and other disfiguration from exterior surfaces.
- .6 Clean roofs, downspouts, and drainage systems.

**END OF SECTION**

**1.1 WASTE MANAGEMENT**

- .1 This Project shall generate the least amount of waste possible and that processes shall be employed that ensure the generation of as little waste as possible including prevention of damage due to error, poor planning, breakage, mishandling, improper storage, contamination, inadequate protection or other factors as well as minimizing over-packaging and poor quantity estimating, consistent with “Built-Green” or recognized sustainability practices.
- .2 Of the inevitable waste that is generated, the waste materials designated in this specification shall be salvaged for reuse and/or recycling. Waste disposal in landfills or incinerators shall be minimized. This means careful recycling of job site waste. On demolition projects this also means careful removal or salvage of materials.
- .3 Minimize waste disposal to landfills.
- .4 Subcontractors shall cooperate with Contractor and comply with his Construction Waste Management Plan in order to ensure conformance with Sustainability Certification requirements.

**END OF SECTION**



## **1.1 ADMINISTRATIVE REQUIREMENTS**

- .1 Acceptance of Work Procedures:
  - .1 Contractor's Inspection: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
    - .1 Notify Departmental Representative in writing of satisfactory completion of inspection and submit verification that corrections have been made.
    - .2 Request Departmental Representative inspection.
  - .2 Departmental Representative Inspection:
    - .1 Departmental Representative, Consultant and Contractor to inspect Work and identify defects and deficiencies.
    - .2 Contractor to correct Work as directed.
  - .3 Completion Tasks: submit written certificates in English that tasks have been performed as follows:
    - .1 Work: completed and inspected for compliance with Contract Documents.
    - .2 Defects: corrected and deficiencies completed.
  - .4 Final Inspection:
    - .1 When completion tasks are done, request final inspection of Work by Departmental Representative.
    - .2 When Work incomplete according to Departmental Representative, complete outstanding items and request re-inspection.
  - .5 Declaration of Substantial Performance: when Departmental Representative considers deficiencies and defects corrected and requirements of Contract substantially performed, make application for Certificate of Substantial Performance.

## **1.2 FINAL CLEANING**

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

**END OF SECTION**

## 1.1 ADMINISTRATIVE REQUIREMENTS

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

## 1.2 AS -BUILT DOCUMENTS AND SAMPLES

- .1 Maintain at site one record copy of:
  - .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Change Orders and other modifications to Contract.
  - .5 Reviewed shop drawings, product data, and samples.
  - .6 Field test records.
  - .7 Inspection certificates.
  - .8 Manufacturer's certificates.
- .2 Store record documents and samples in field office apart from documents used for construction.
  - .1 Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in List of Contents of this Project Manual.
  - .1 Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition.
  - .1 Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by Departmental Representative.

**1.3 RECORDING INFORMATION ON PROJECT RECORD DOCUMENTS**

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

**1.4 WARRANTIES AND BONDS**

- .1 Submit, warranty information made available during construction phase, to Departmental Representative for approval prior to each monthly pay estimate.
- .2 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial Performance is determined.
- .3 Respond in timely manner to oral or written notification of required construction warranty repair work.

**END OF SECTION**

**1.1 DESCRIPTION**

- .1 Demonstrate operation and maintenance of equipment and systems to Users personnel two weeks prior to date of substantial performance.
- .2 Owner will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times.

**1.2 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.

**1.3 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Departmental Representative approval.
- .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
- .4 Give time and date of each demonstration, with list of persons present.

**1.4 CONDITIONS FOR DEMONSTRATIONS**

- .1 Testing, adjusting, and balancing has been performed in accordance with Section 01 91 31 Commissioning Plan and equipment and systems are fully operational.
- .2 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

**1.5 PREPARATION**

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

**1.6 DEMONSTRATION AND INSTRUCTIONS**

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

- .3 Review contents of manual in detail to explain aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

**END OF SECTION**

**1.1              SUMMARY**

- .1      A formal commissioning process is in place for this project. Work shall include but not limited to implementation of coordinated commissioning activities, executed by the Contractor and Commissioning Agents.
- .2      Work specified in this section is to be performed by an independent Agency specializing in this type of work and paid by the Departmental Representative.
- .3      This section describes the commissioning of the building components, equipment and systems and outlines the duties and responsibilities of the Commissioning Team.
- .4      The commissioning process shall be applied to listed building components, and all products, equipment and systems provided under Divisions 20 to 28.
- .5      The Commissioning Manager as directed by the Departmental Representative shall develop a Commissioning Plan.

**1.2              DEFINITIONS**

- .1      Commissioning Team
  - .1      Personnel that will be directly involved in the building commissioning process. The Commissioning Team shall comprise of Commissioning Manager, Commissioning Agents, Departmental Representatives, Contractors, and Independent Third Party Testing Agencies.
- .2      Commissioning Plan
  - .1      The Commissioning Plan defines the scope and approach to the Total Building Commissioning Program that is to be executed for the project.
- .3      Commissioning Manager
  - .1      The firm responsible for management of the commissioning process for the project.
- .4      Contractor
  - .1      The construction firm and its sub-contractors whom are responsible for physical construction of the project.
- .5      Consultants
  - .1      The architects / engineers that are responsible for production of the design drawings and specifications for the project as well as the base contract administration, inspection, quality assurance and acceptance activities.
  - .2      The design consultants are not required to be involved in any of the commissioning verifications or performance testing programs, but may witness these activities at their discretion.

- .6 Third Party Testing Agencies
  - .1 Specialty firms or agencies retained to conduct acceptance tests on a system of component and provide a certificate of acceptance and conformance to governing standards.
- .7 Out of Contract Tests
  - .1 Testing requirements that are not covered as part of the construction documents but are required to be carried out by certified agencies. Examples would be high voltage testing programs, building envelope testing and air quality testing.
- .8 In Contract Tests
  - .1 Testing requirements that are defined in the contract documents and are the contractors responsibility to carry out. Tests may be witnessed by the Consultant, Departmental Representative's Representative and Commissioning Agents. Documented test results are turned over for review.
- .9 Check Sheets
  - .1 Architectural, Mechanical and Electrical check sheets that are specific to systems and components for the project that are used for verifying and testing of the work.
  - .2 The commissioning check sheets will be layed out to record three types of site information; technical equipment data, static installation checks and operation checks. Sample check sheets are included at the end of this section.
  - .3 The check sheets will have the equipment's specified and approved shop drawing information input by the Commissioning Manager. The Contractors shall be responsible for completing the technical data section by verifying through the equipment nameplates on site that the equipment installed matches the approved shop drawings.
  - .4 The check sheet manuals will be turned over to site following review of shop drawings.
- .10 Contractor Start-Up Program
  - .1 Contractor / Supplier checking of the physical installation of the work and reviewing the completeness of system installation and readiness for start-up prior to Commissioning verification activities occurring.
  - .2 Contractor start-up program activities are conducted by the mechanical and electrical contractors or their sub-trades and their equipment suppliers, and may be witnessed by the Consultant and / or Commissioning Agents.
- .11 Static Inspections
  - .1 Systematic detailed inspections of mechanical and electrical systems and components carried out under the Commissioning Program by personnel from the Commissioning Team. Site personnel will utilize check sheets for recording installation readiness or deficiencies on a component system bases. Timing of static inspections is tied to construction progress and occurs once contractor checks have been completed.
- .12 Acceptance Inspections
  - .1 A series of formal inspections carried out by the Consultants for systems that result in acceptance of the Work as complete.

.13      Performance Testing

- .1      Performance tests are specific hand-on tests conducted with test instruments, to prove that the systems as installed meet both the specified performance requirements for major pieces of equipment and that installed system performance meets the design intent and specified operating requirements.

**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      Use this Plan as master planning document for Commissioning:

- .1      Outlines organization, scheduling, allocation of resources, documentation, pertaining to implementation of Commissioning.
- .2      Communicates responsibilities of team members involved in Commissioning Scheduling, documentation requirements, and verification procedures.
- .3      Sets out deliverables relating to O&M, process and administration of Commissioning.
- .4      Describes process of verification of how built works meet Departmental Representative's 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 Commissioning.
  - .2      General description of elements that make up Commissioning Plan.
  - .3      Process and methodology for successful Commissioning.

.3      Acronyms:

- .1      BAS - Building Automation System
- .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.

.4      Commissioning terms used in this Section:

- .1      Bumping: short term start-up to prove ability to start and prove correct rotation.
- .2      Deferred Commissioning - activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.



#### **1.4                      REFINEMENT OF COMMISSIONING PLAN**

- .1      During construction phase, Commissioning Manager will revise, refine and update Plan to include:
  - .1              Changes resulting from Client program modifications.
  - .2              Approved design and construction changes.
- .2      Departmental Representative to include testing parameters at full range of operating conditions and check responses of equipment and systems.

#### **1.5                      COMMISSIONING PARTICIPANTS**

- .1      Ensure that Commissioning 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.
- .2      Provide names of participants to Commissioning Manager and details of instruments and procedures to be followed for Commissioning 1 month prior to starting date of Commissioning for review and approval.

#### **1.6                      EXTENT OF COMMISSIONING**

- .1      Commissioning Structural and Architectural Systems:
  - .1              Architectural and structural:
    - .1              Concrete Testing [Third Party Testing]
    - .2              Structural Testing [Third Party Testing]
    - .3              Weld Testing [Third Party Testing]
    - .4              Roofing: [Third Party Testing]
    - .5              Materials Testing: [Third Party Testing]
    - .6              Building Envelope Test [Third Party Testing]
    - .7              Doors, windows, related hardware:
      - .1              Door Hardware – Egress Door Hardware Operating Force
      - .2              Accessibility and operational safety:
        - .1              Accessible Door Operating Force
        - .2              Automatic Door Operator
- .2      Commission mechanical systems and associated equipment:
  - .1              Plumbing systems:
    - .1              Domestic CWS and HWS – Hydrostatic Test
    - .2              Sanitary waste systems
    - .3              Back Flow Preventer
    - .4              Trap Seal Primers

- .5 Instantaneous Hot Water Heaters.
- .6 Plumbing Fixtures:
  - .1 Electronic Flush Valve Operators
  - .2 Faucets
  - .3 Shower balancing mixing valve
- .7 Natural Gas Piping – Hydrostatic Test
- .2 HVAC and exhaust systems:
  - .1 HVAC systems:
    - .1 TAB
    - .2 Rooftop AHU
    - .3 Energy Recovery Wheels
  - .2 Gas Fired Unit Heaters
- .3 Fire and life safety systems:
  - .1 Standpipe and hose systems.
  - .2 Fire extinguishers.
  - .3 Fire Damper / Shutter Operation.
  - .4 Fire Stop Verification
- .4 IAQ environmental control systems:
  - .1 Building Flush Out
- .5 EMCS / BAS:
  - .1 Static Testing
  - .2 Dynamic Operational Test
  - .3 Energy Monitoring Systems for Domestic Water ; Power ; Natural Gas
- .3 Commission electrical systems and equipment:
  - .1 Low voltage below 750 V:
    - .1 Power Distribution System [Third Party Testing]
    - .2 Building System Grounding [Third Party Testing]
    - .3 Load Balancing
    - .4 Public Address (PA) System
    - .5 Low voltage equipment.
  - .2 Lighting systems:
    - .1 Lighting equipment
      - .1 Interior Lighting Level Verification
      - .2 Exterior Lighting Level Verification
    - .2 Control systems
    - .3 Emergency lighting systems, including battery packs
    - .4 Fire exit emergency signage
  - .3 Fire and life safety systems:
    - .1 Fire Alarm System verification.
  - .4 Other systems and equipment:
    - .1 Voice / Data Cabling Test
    - .2 Security Intrusion Alarm System
    - .3 Security Access Control System
    - .4 Security CCTV System.
    - .5 Variable Frequency Drives

.6      Motor Starters

**1.7      DELIVERABLES RELATING TO O&M PERSPECTIVES**

- .1      General requirements:
  - .1      Compile documentation.
  - .2      Documentation to be computer-compatible format ready for inputting for data management.
- .2      Provide deliverables:
  - .1      Warranties.
  - .2      Operations & Maintenance Manual.
  - .3      Inventory of spare parts, special tools and maintenance materials.
  - .4      Computerized Maintenance Management System (CMMS) 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.

**1.8      DELIVERABLES RELATING TO THE COMMISSIONING PROCESS**

- .1      General:
  - .1      Start-up, testing and Commissioning requirements, conditions for acceptance and specifications form part of relevant technical sections of these specifications.
- .2      Definitions:
  - .1      Commissioning as used in this section includes:
    - .1      Commissioning of components, equipment, systems, subsystems, and integrated systems.
    - .2      Factory inspections and performance verification tests.
- .3      Deliverables: provide:
  - .1      Commissioning Specifications.
  - .2      Startup, pre-Commissioning 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 Commissioning activities and documentation.
  - .8      Description of Commissioning of integrated systems and documentation.
  - .9      Training Plans.
  - .10      Commissioning Reports.
  - .11      Prescribed activities during warranty period.
- .4      Departmental Representative and Commissioning Manager to witness and certify tests and reports of results provided to by Contractor.

**1.9      PRE-COMMISSIONING ACTIVITIES AND RELATED DOCUMENTATION**

- .1      Items listed in this Commissioning Plan include the following:

- .1 Pre-Start-Up inspections: by Commissioning Manager and Departmental Representative prior to permission to start up and rectification of deficiencies to Commissioning Manager and Departmental Representative satisfaction.
- .2 Commissioning Agent to use approved check lists.
- .3 Commissioning Manager and Departmental Representative will monitor some of these pre-start-up inspections.
- .4 Include completed documentation with Commissioning report.
- .5 Conduct pre-start-up tests: conduct pressure, static, flushing, cleaning, and "bumping" during construction as specified in technical sections. To be witnessed and certified by Commissioning Manager and Departmental Representative and does not form part of Commissioning specifications.
- .6 Commissioning Manager and Departmental Representative will monitor some of these inspections and tests.
- .7 Include completed documentation in Commissioning report.
- .2 Pre-Commissioning activities - MECHANICAL:
  - .1 Plumbing systems:
    - .1 Complete pre-start-up checks and complete relevant documentation.
  - .2 HVAC equipment and systems:
    - .1 "Bump" each item of equipment in its "stand-alone" mode.
    - .2 At this time, complete pre-start-up checks and complete relevant documentation.
    - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.
  - .3 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 Commissioning Manager and Departmental Representative
    - .5 Perform final Commissioning and operational tests during demonstration period
    - .6 Only additional testing after foregoing have been successfully completed to be "Off-Season Tests".
- .3 Pre-Commissioning activities - LIFE SAFETY SYSTEMS
  - .1 Include equipment and systems identified above.
    - .1 Fire Damper / Shutter Operation
    - .2 Sprinkler System – pressure tests and flow tests
    - .3 Fire Alarm System – Pre-verification checks, refer to Section 28 31 03.
    - .4 Emergency and Exit lighting systems:
      - .1 Tests to include verification of lighting levels and coverage, initially by disrupting normal power.
  - .2 Reports of test results to be witnessed and certified by Commissioning Manager and Departmental Representative before verification.
- .4 Pre-Commissioning activities - ELECTRICAL:
  - .1 Low voltage distribution systems under 750 V:
    - .1 Requires independent testing agency to perform pre- energization and post-energization tests.

.2      Load Balancing.

- .2 Lighting systems:
  - .1 Lighting systems:
    - .1 Tests to include verification of lighting levels and coverage, aiming angle adjustments.
    - .2 Control system programming, testing and verification. Requires manufacturer's representative.
- .3 Other systems and equipment:
  - .1 Voice / Data Cabling:
    - .1 Visual inspection.
    - .2 Manufacturers VAR testing requirements.
  - .2 Security Intrusion Alarm System:
    - .1 System programming, testing and verification.
  - .3 Security Access Control System:
    - .1 System programming, testing and verification. Requires manufacturer's representative.
  - .4 Security CCTV System:
    - .1 Function tests.

#### **1.10      START-UP**

- .1 Start up components, equipment and systems.
- .2 Performance Verification (PV):
  - .1 Approved Commissioning Agent to perform.
    - .1 Repeat when necessary until results are acceptable to Departmental Representative and Commissioning Manager
  - .2 Use procedures modified generic procedures to suit project requirements.
  - .3 Commissioning Manager to witness and certify reported results using approved PI and PV forms.
  - .4 Commissioning Manager and Departmental Representative to approve completed PV reports.
  - .5 Commissioning Manager and 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 start-up and testing.

#### **1.11      COMMISSIONING ACTIVITIES AND RELATED DOCUMENTATION**

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

**1.12                      COMMISSIONING OF INTEGRATED SYSTEMS AND RELATED DOCUMENTATION**

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

**1.13                      DELIVERABLES RELATING TO ADMINISTRATION OF COMMISSIONING**

- .1      General:
  - .1          Complete Commissioning of occupancy, weather and seasonal-sensitive equipment and systems in these areas before building is occupied.

**1.14                      COMMISSIONING SCHEDULES**

- .1      Contractor to prepare detailed Commissioning Schedule and submit to Commissioning Manager for review and approval same time as project Construction Schedule. Include:
  - .1          Milestones, testing, documentation, training and Commissioning activities of components, equipment, subsystems, systems and integrated systems, including:
    - .1              Submission of list of instrumentation with relevant certificates
    - .2              Notification of intention to start TAB: 14 days before start of TAB.
    - .3              TAB: after successful start-up, correction of deficiencies and verification of normal and safe operation.
    - .4              Notification of intention to start Commissioning: 14 days before start of Commissioning.
    - .5              Notification of intention to start Commissioning of integrated systems: after Commissioning of related systems is completed 14 days before start of integrated system Commissioning.
    - .6              Identification of deferred Commissioning.
    - .7              Implementation of training plans.
    - .8              Commissioning reports: immediately upon successful completion of Commissioning.
  - .2          Detailed training schedule to demonstrate no conflicts with testing, completion of project and hand-over.
  - .3          Commissioning schedule for verification of performance in all seasons and wear conditions.

- .2 After approval, incorporate Commissioning Schedule into Construction Schedule.
- .3 Consultant, Contractor, Contractor's Commissioning agent, and Departmental Representative will monitor progress of Commissioning against this schedule.

#### **1.15 COMMISSIONING REPORTS**

- .1 Include completed and certified PV reports in properly formatted Commissioning Reports.
- .2 Before reports are accepted, reported results to be subject to verification by Commissioning Manager and Departmental Representative.

#### **1.16 ACTIVITIES DURING WARRANTY PERIOD**

- .1 Commissioning activities must be completed before issuance of Interim Certificate, it is anticipated that certain Commissioning 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.

#### **1.17 TESTS TO BE PERFORMED BY DEPARTMENTAL REPRESENTATIVE**

- .1 As required

#### **1.18 FINAL SETTINGS**

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

#### **1.19 COMMISSIONING CHECK LIST SCHEDULE**

- .1 Following Commissioning Check Lists and Verification Lists are appended hereto:
  - .1 01 91 31.01 Architectural Verification Check Lists:
    - .1 Concrete
    - .2 Masonry
    - .3 Structural Steel
    - .4 Architectural Woodwork
    - .5 Waterproofing Membranes
    - .6 Roofing
    - .7 Door Hardware
    - .8 Ceramic and Quarry Tile
    - .9 Painting
    - .10 Elevators
  - .2 01 91 31.02 Air Handling Unit AH-1
  - .3 01 91 31.03 Exhaust Fan EF-1
  - .4 01 91 31.04 Exhaust Fan EF-2
  - .5 01 91 31.05 Exhaust Fan EF-3
  - .6 01 91 31.06 Exhaust Fan EF-4
  - .7 01 91 31.07 Exhaust Fan EF-5
  - .8 01 91 31.08 Force Flow FF-1
  - .9 01 91 31.09 Force Flow FF-2
  - .10 01 91 31.10 Force Flow FF-3



.11	01 91 31.11	Glycol Feed P-3
.12	01 91 31.12	Heating Boiler B-1
.13	01 91 31.13	Heating Boiler B-2
.14	01 91 31.14	Heating Water Expansion Tank TK-1
.15	01 91 31.15	Hot Water Circulation Pump P-1
.16	01 91 31.16	Hot Water Circulation Pump P-2
.17	01 91 31.17	Hot Water Circulation Pump P-4
.18	01 91 31.18	Hot Water Circulation Pump P-5
.19	01 91 31.19	Hot Water Circulation Pump P-6
.20	01 91 31.20	Hot Water Circulation Pump P-7
.21	01 91 31.21	Hot Water Circulation Pump P-8
.22	01 91 31.22	Unit Heater UH-1
.23	01 91 31.23	Unit Heater UH-2
.24	01 91 31.24	Pump DHW Circ P-9
.25	01 91 31.25	Domestic Water Heater DWH-1
.26	01 91 31.26	VAV Box Schedule VAV-1
.27	01 91 31.27	VAV Box Schedule VAV-2
.28	01 91 31.28	VAV Box Schedule VAV-3
.29	01 91 31.29	VAV Box Schedule VAV-4
.30	01 91 31.30	VAV Box Schedule VAV-5
.31	01 91 31.31	VAV Box Schedule VAV-6
.32	01 91 31.32	VAV Box Schedule VAV-7
.33	01 91 31.33	Electrical Panel Boards Pre-Functional Check List
.34	01 91 31.34	Panel Board A Pre-Functional Check List
.35	01 91 31.35	Panel Board A1 Pre-Functional Check List
.36	01 91 31.36	Panel Board B Pre-Functional Check List
.37	01 91 31.37	Panel Board C Pre-Functional Check List
.38	01 91 31.38	Panel Board D Pre-Functional Check List
.39	01 91 31.39	Panel Board G Pre-Functional Check List
.40	01 91 31.40	Panel Board H Pre-Functional Check List
.41	01 91 31.41	Panel Board J Pre-Functional check List
.42	01 91 31.42	Fire Alarm Panel
.43	01 91 31.43	Interior Lighting Control Panel
.44	01 91 31.44	Exterior Lighting Control Panel
.45	01 91 31.45	Security Door Hardware
.46	01 91 31.46	Security System
.47	01 91 31.47	Security Video Surveillance
.48	01 91 31.48	Structural Cabling System

**END OF SECTION**

**Part 1. Departmental RepresentativeGeneral**

**1.1 REFERENCE DOCUMENTS**

- .1 Alberta Building Code and Alberta Fire Code Regulations pertaining to Demolition of Buildings.

**1.2 EXISTING CONDITIONS**

- .1 Take over structures to be demolished based on their condition at date and time of bid closing.
- .2 When unidentified subsurface foundations, tanks or services are encountered during the work, immediately cease operations, notify the Departmental Representative, and await for instruction.

**1.3 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00
- .2 Where required by authorities having jurisdiction, submit for approval, drawings, diagrams, details and supporting data clearly showing sequence of demolition, removal work of buildings, supporting structures and underpinning. Provide Departmental Representative with copy of such drawings.
- .3 Drawings for structural elements shall be designed by and bear signature and stamp of qualified professional engineer registered in the Province of Alberta.

**1.4 PROTECTION**

- .1 Provide required bracing, shoring and underpinning to prevent movement, settlement or damage of adjacent structures, services, walks, paving, trees, landscaping, adjacent grades.
- .2 Take precautions to support structures. When safety of building being demolished, adjacent structures or services appear to be endangered, cease operations and inform Departmental Representative immediately.
- .3 Cease operations and notify the Departmental Representative immediately for special protective and disposal instructions when asbestos materials [, other than those identified,] and other hazardous materials are uncovered during the work of this project.
- .4 Do not proceed with demolition work when prevailing weather forecasts indicate, or weather conditions constitute, a hazard to the workers and site.
- .5 Temporarily suspended work that is without continuous supervision, shall be closed to prevent entrance of unauthorized persons.

## **1.5 SALVAGEABLE AND RECYCLABLE MATERIALS**

- .1 Except where otherwise specified, all materials indicated or specified to be permanently removed from the Place of the Work shall become Contractor's property. Maximize to the fullest extent possible, salvage and recycling of such materials, consistent with proper economy and expeditious performance of the Work.
- .2 To reduce the quantity of material otherwise destined for disposal at a landfill, the Contractor is encouraged to consider utilizing the services of businesses and non-profit organizations that specialize in salvage and recycling of used building materials, but does so at his own option and risk.
- .3 A current listing of recyclers specializing in specific categories of materials may be obtained during normal office hours from:  
Alberta Environment  
Recycling Branch  
Recycle Info Line  
Phone: (780) 4276982 or 1-800-463-6326  
e-mail: [wastenot@env.gov.ab.ca](mailto:wastenot@env.gov.ab.ca)

## **1.6 CONCRETE RUBBLE**

- .1 Deliver demolished concrete and brick rubble not used for fill material to the municipal facility accepting concrete and masonry rubble. Cut reinforcement and break larger pieces of rubble to conform to maximum allowable dimensions prior to delivery.
- .3 Contractor shall pay for disposal costs.

## **Part 2. Products**

### **2.1 MATERIALS AND EQUIPMENT**

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

## **Part 3. Execution**

### **3.1 EXISTING SERVICES**

- .1 Disconnect electrical and telephone service lines entering buildings to be demolished. Post warning signs on electrical lines and equipment which must remain energized to serve other properties during period of demolition.
- .2 Treat existing piped services as follows:
  - .1 Disconnect and cap mechanical services in accordance with requirements of local authority having jurisdiction.
  - .2 Natural gas supply lines shall be removed by gas company or by qualified tradesman in accordance with gas company instructions.

.3 Remove sewer and water lines to property line and cap to prevent leakage.

.3 Do not disrupt active or energized utilities traversing premises.

### **3.2 DEMOLITION**

.1 Carry out demolition work in accordance with Alberta Building Code and Alberta Fire Code regulations.

.2 Demolition by explosives or other methods to initiate a "Rapid Progressive Failure" of a structure will not be allowed without written permission of the Departmental Representative and all authorities having jurisdiction.

.3 Completely demolish structure and appurtenances in an orderly and careful manner.

.4 At end of each day's work, leave work in safe condition so that no part is in danger of toppling or falling.

.5 Demolish in a manner to minimize dusting. Keep dusty materials wetted. Do not cause flooding, contaminated run-off, or icing.

.6 Employ rodent and vermin exterminators to comply with health regulations.

.7 Dispose of demolished materials off site except where noted otherwise.

### **3.3 RESTORATION**

.1 Immediately as the work progresses, repair all vibration and excavation damages to existing adjacent properties and active underground services.

.2 Adequately protect walls of adjoining structures not exposed prior to demolition.

.3 Upon completion of work, remove debris, trim surfaces and leave work site clean.

.4 Reinstall areas and existing works outside area of demolition to conditions that existed prior to commencement of work.

### **3.4 DISPOSAL**

.1 Remove salvageable materials as the work progresses and transport immediately from the site.

.2 Unless indicated otherwise, dispose of demolished materials off-site.

.3 Selling or burning materials on site is not permitted.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA-A23.1- Concrete Materials and Methods of Concrete Construction.
  - .2 CSA-A23.2- Test Methods and Standard Practices for Concrete
  - .3 CSA-S269.3 – Concrete Formwork
  - .4 CSA O121, Douglas Fir Plywood.
  - .5 CSA-O86 Engineering Design in Wood
  - .6 CSA O151, Canadian Softwood Plywood.
  - .7 CSA O153, Poplar Plywood.
  - .8 CAN3-O188.0, Standard Test Methods for Mat-Formed Wood Particleboards and Waferboard.
  - .9 CSA O437, Standards for OSB and Waferboard.
  - .10 CSA S269.1, Falsework for Construction Purposes.
  - .11 CAN/CSA-S269.3, Concrete Formwork.
- .2 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit shop drawings for formwork and falsework.
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Canada.
- .2 Indicate method and schedule of construction, shoring, stripping and re-shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, liners, and locations of temporary embedded parts.
- .3 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
- .4 Indicate sequence of erection and removal of formwork/falsework.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal].
  - .2 Place materials defined as hazardous or toxic in designated containers.
  - .3 Divert wood materials from landfill to a recycling facility as approved by DCC Representative.

- .4 Divert plastic materials from landfill to a recycling facility as approved by DCC Representative.
- .5 Divert unused form release material from landfill to an official hazardous material collections site as approved by the DCC Representative.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Formwork materials:
  - .1 For concrete without special architectural features, use wood and wood product formwork materials to CSA-O121, CSA-O86.1, CSA O437, Series CSA-O153.
  - .2 For concrete with special architectural features, use formwork materials to CSA-A23.1/A23.2.
  - .3 Rigid insulation board: to CAN/ULC-S701.
- .2 Form ties:
  - .1 For concrete not designated 'Architectural', use removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes larger than 25 mm diameter in concrete surface.
  - .2 For Architectural concrete, use snap ties complete with plastic cones and light grey concrete plugs.
- .3 Form liner:
  - .1 Plywood: Douglas Fir to CSA O121, Canadian Softwood Plywood to CSA O151, Poplar to CSA O153.
  - .2 Waferboard: to CAN/CSA-O325.0.
- .4 Form release agent: non-toxic, biodegradable, low VOC.
- .5 Form stripping agent: colourless mineral oil, non-toxic, biodegradable, low VOC, free of kerosene, with viscosity between 70 and 110s Saybolt Universal at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
- .6 Falsework materials: to CSA-S269.1.
- .7 Sealant: to Section 07 92 00 - Joint Sealants.

## **Part 3 Execution**

### **3.1 FABRICATION AND ERECTION**

- .1 Verify lines, levels and centres before proceeding with formwork/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 Locate horizontal form joints for exposed columns 2400 mm above finished floor elevation.
- .11 Use 25 mm chamfer strips on external corners and/or 25 mm fillets at interior corners, joints, unless specified otherwise.
- .12 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .13 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.
- .14 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.
- .15 Line forms for following surfaces:
  - .1 Outer face of outside girders and vertical edge of bridge sidewalk slab.
  - .2 Soffit of girders and underside of bridge decks if exposed.
  - .3 Exposed faces of abutments, wingwalls, piers and pylons: do not stagger joints of form lining material and align joints to obtain uniform pattern.
  - .4 Secure lining taut to formwork to prevent folds.
  - .5 Pull down lining over edges of formwork panels.
  - .6 Ensure lining is new and not reused material.
  - .7 Ensure lining is dry and free of oil when concrete is poured.
  - .8 Application of form release agents on formwork surface is prohibited where drainage lining is used.
  - .9 If concrete surfaces require cleaning after form removal, use only pressurized water stream so as not to alter concrete's smooth finish.
  - .10 Cost of textile lining is included in price of concrete for corresponding portion of Work.
- .16 Clean formwork in accordance with CSA-A23.1/A23.2, before placing concrete.

- .17 When slip forming, flying forms are used, submit details as indicated in PART 1 - SUBMITTALS.

### **3.2 REMOVAL AND RESHORING**

- .1 Leave formwork in place for following minimum periods of time after placing concrete.
  - .1 1 day for walls and sides of beams.
  - .2 1 day for columns.
  - .3 1 day for footings and abutments.
- .2 Remove formwork when concrete has reached 25% of its design strength or minimum period noted above, whichever comes later, and replace immediately with adequate reshoring.
- .3 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.
- .4 Space reshoring in each principal direction at not more than 3000 mm apart.
- .5 Re-use formwork and falsework subject to requirements of CSA-A23.1/A23.2.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials (ASTM International)
  - .1 ASTM D1751-[99], Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-19.24-[M90], Multicomponent, Chemical-Curing Sealing Compound.
- .3 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-A23.1/A23.2-[14], Concrete Materials and Methods of Concrete Construction/Methods of test for concrete.
  - .2 CSA G30.5-[M1983(R1998)], Welded Steel Wire Fabric for Concrete Reinforcement.
  - .3 CAN/CSA-G30.18-[09(R2014)], Billet-Steel Bars for Concrete Reinforcement.
  - .4 CSA G40.20/G40.21-[13], General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .4 Environmental Choice Program (ECP), Environment Canada, Canadian Environmental Protection Act (CEPA)
  - .1 ECP-40-[97], Building Materials: Thermal Insulation.
  - .2 ECP-45-[95], Sealants and Caulking Compounds.
  - .3 ECP-69-[95], Polyethylene Plastic Film Products.
- .5 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S701-[01], Thermal Insulation, Polystyrene, Boards and Pipe Covering.

**1.2 SYSTEM DESCRIPTION**

- .1 Insulated concrete form (ICF) building system: factory-assembled and site-installed stay-in-place, reusable polystyrene rigid board insulation panels, plastic web spacers, connection ties and inserts, concrete reinforcement, concrete accessories and cast-in-place concrete.

**1.3 PRODUCT DATA**

- .1 Submit product data sheets in accordance with Section [01 33 00 - Submittal Procedures].
- .2 For primers, adhesives and sealants, indicate VOC in g/L during application and curing.
- .3 For insulation, indicate VOC in g/L and other off gassing at time of installation.

**1.4 SHOP DRAWINGS**

- .1 Before fabrication, submit shop drawings of insulated concrete form building system in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Submit shop drawings bearing stamp and signature of a qualified professional engineer registered or licensed in the Province of Alberta.
- .3 Indicate method and schedule of construction, shoring procedures, materials, arrangement of joints, special architectural exposed finishes, ties, corner, intersection and connector ties, braces and locations of temporary embedded parts.
- .4 Indicate sequence of erection of forms as directed by Engineer.

**1.5 SAMPLES**

- .1 Submit samples for verification in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit 305 mm long pieces of insulation and one representative sample of each tie, connector and brace.

**1.6 QUALITY ASSURANCE SUBMITTALS**

- .1 Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and physical requirements in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Test Reports: Submit test reports for thermal resistance, water vapour permeance, flexural and compressive strength in accordance with Section [01 33 00 - Submittal Procedures].

**1.7 ENVIRONMENTAL CHOICE PROGRAM**

- .1 Provide products bearing the 'Ecologo' of the Environmental Choice Program, Product Guidelines ECP-40 Building Materials: Thermal Insulation, ECP-45 Sealants and Caulking Compounds and ECP-69 Polyethylene Plastic Film Products.
- .2 Submit two copies of the licensing criteria statements and the verification of compliance with Sections 3(a) and 3(b) of the Environmental Choice Program to Engineer in accordance with Section [01 33 00 - Submittal Procedures]. Alternatively, material in original containers bearing the 'Ecologo' or products bearing the 'Ecologo' will satisfy this requirement. For primers and sealants, indicate VOC in g/l during application and curing.

**1.8 QUALIFICATIONS**

- .1 Installers, supervisors and inspectors: trained and certified by ICF manufacturer.
- .2 Submit certification letter to Engineer from ICF manufacturer listing ICF installer/supervisor/inspector's name, address, level of certification and certification number.

- .3 Submit inspection schedule to Engineer for each item of work to be inspected prior to placement of concrete and for work to be inspected during and after placement of concrete in accordance with ICF manufacturer's recommendations.

## **1.9 REGULATORY REQUIREMENTS**

- .1 Design insulated concrete forms in accordance with National Building Code of Canada, latest edition.
- .2 Conform to CCMC Evaluation Report specific to ICF manufacturer's system, latest edition.

## **1.10 PRE-INSTALLATION MEETINGS**

- .1 Conduct pre-installation meeting to verify project requirements and conditions, manufacturer's installation instructions and manufacturer's warranty requirements.

## **1.11 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section [01 61 00 - Common Product Requirements].
- .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .3 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- .4 Store materials off ground, protected from direct sunlight with light-coloured opaque polyethylene film and ventilated to prevent excessive temperature.
- .5 Protect Products from exposure to harmful weather conditions. Store at temperature and humidity conditions recommended by manufacturer.
- .6 Remove damaged or deteriorated Products from site.

## **1.12 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction Waste Management And Disposal.
- .2 Place materials defined as hazardous or toxic waste in designated containers.
- .3 Ensure emptied containers are sealed and stored safely for disposal away from children.
- .4 Use sealers that are non-toxic, biodegradable and have zero or low VOC's.

## **1.13 WARRANTY**

- .1 Project Warranty: Refer to General Conditions of the Contract for project warranty provisions.

- .2 Manufacturer's Warranty: Submit properly executed manufacturer's standard warranty. Manufacturer's warranty is in addition to and not a limitation of other rights Owner may have under the Contract.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Insulation: closed cell expanded polystyrene rigid boards to CAN/ULC-S701, Type 2, RSI 0.70 per 25 mm of thickness, 110 Kpa compressive strength.
- .2 Web spacer: Manufacturer's standard polypropylene web spacer, flush with panel interior, flared, snap-in reinforcement bar mounting points, mechanical interlock system.
- .3 Connector Ties: Manufacturer's standard, polypropylene, designed for intended function and to prevent thermal bridging. Provide special one-piece corner ties, T-intersection, and hinged connection ties.
- .4 Inserts: moulded inside panels, spaced 200 m OC, reinforcement against bulging, integral slide for web spacers.
- .5 Bracing: Manufacturer's standard internal alignment brace.
- .6 Anchor Bolts: to CSA G40.20/G40.21, Grade 300W.
- .7 Furring Channels: 0.5 mm core thickness galvanized steel channels.
- .8 Polyurethane Spray Foam: compatible with polystyrene, as and when recommended by ICF manufacturer.
- .9 Concrete: as specified in Section 03 30 00 to CSA-A23.1, 25 MPa at 28 days, Exposure class F-2, 20 mm maximum size aggregate; 75 mm slump at time of deposit, plus or minus 10 mm; 4 to 7 percent air entrainment.
- .10 Welded Wire Fabric: as specified in Section 03 20 00 steel, to CSA G30.5, flat sheets, sizes as noted on Drawings.
- .11 Reinforcing Bars: as specified in Section 03 20 00 to CAN/CSA-G30.18, Grade 400, deformed.
- .12 Joint Filler: preformed, asphalt saturated fibre to ASTM D1751.
- .13 Sealant: multi-component, chemical curing to CAN/CGSB-19.24, Type 1, Class B, with compatible primer for concrete, Ecologo certified.
- .14 Adhesive: As recommended by ICF manufacturer.
- .15 Sealing Tape: As recommended by ICF manufacturer.
- .16 Panel Protective Coating: Parging acrylic stucco, as recommended by ICF manufacturer.

## **2.2 COMPONENTS**

- .1 Pre-assembled Wall Sections: 200 mm thick profiles, comprised of two layers of factory processed rigid board insulation connected with web spacers, connectors, inserts, purpose-made ties and bracing.
- .2 Corner Kits: Manufacturer's standard factory-processed 90 degree corner kits.

## **2.3 FABRICATION**

- .1 Fabricate panels and special shapes in shop to facilitate on-site assembly with mechanically-interlocked joints.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verify that site conditions are ready to receive work.
- .2 Verify lines, levels and centres before proceeding with form erection. Ensure site dimensions agree Shop Drawings.
- .3 Beginning of installation implies acceptance of site conditions.

### **3.2 PREPARATION**

- .1 Align form joints and make watertight. Keep form joints to minimum.
- .2 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated on Drawings.
- .3 Build in anchors, sleeves and other inserts required by other Sections. Ensure anchors and inserts will not protrude beyond surfaces designated to receive applied finishes.

### **3.3 INSTALLATION**

- .1 Install forms to lines and levels, widths and sizes indicated on Shop Drawings, including special shapes.
- .2 Place forms on standard footing or concrete pad as indicated and temporarily brace to prevent displacement during final assembly and concrete pour.
- .3 Provide external bracing as indicated on Shop Drawings.
- .4 Provide vertical braces every 3.0 m along one side of form and anchor with dimensional lumber.
- .5 Provide diagonal bracing to align and support forms in accordance with Shop Drawings.
- .6 Install reinforcing in accordance with CSA-A23.1 Section 03 20 00.
- .7 Reinforce service penetrations exceeding 400 x 400 mm in size.

- .8 Apply adhesive and sealing tape to panel intersections in accordance with ICF manufacturer's instructions.
- .9 Apply protective coating to panel forms in accordance with ICF manufacturer's instructions.
- .10 Install concrete in accordance with CSA-A23.1 Section 03 30 00.

### **3.4 FIELD QUALITY CONTROL**

- .1 Arrange with manufacturer's representative to review work of this Section and submit written reports to verify compliance with Contract Documents.
- .2 Manufacturer's Field Services: consisting of product use recommendations and periodic site visits to review installation, scheduled as follows:
  - .1 After delivery and storage of Products.
  - .2 After preparatory work is complete but before installation commences.
  - .3 Twice during the installation, at 25% and 60% completion stages.
  - .4 Upon completion of installation.
- .3 Submit manufacturer's reports to Consultant within 3 days of manufacturer representative's review.

### **3.5 CLEANING**

- .1 Remove temporary covering and protection of adjacent work areas. Repair or replace damaged Product.
- .2 Clean installed Products in accordance with manufacturer's instructions.
- .3 Remove and dispose of construction debris to requirements of authorities having jurisdiction.

### **3.6 PROTECTION**

- .1 Where rigid polystyrene insulation boards may remain exposed to sunlight for a period greater than 60 days, protect insulation from ultra-violet radiation by installing temporary covers.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Concrete Institute (ACI)
  - .1 SP-66-04, ACI Detailing Manual 2004.
- .2 ASTM International
  - .1 ASTM A82/A82M-[07], Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
  - .2 ASTM A143/A143M-07, Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
  - .3 ASTM A185/A185M 07, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
  - .4 ASTM A775/A775M-07b, Standard Specification for Epoxy-Coated Reinforcing Steel Bars.
- .3 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/G40.21-13 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
  - .5 CAN/CSA-G164-M92(R2003), Hot Dip Galvanizing of Irregularly Shaped Articles.
  - .6 CSA W186-M1990(R2012), Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .4 Reinforcing Steel Institute of Canada (RSIC)
  - .1 RSIC-[2004], Reinforcing Steel Manual of Standard Practice.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Prepare reinforcement drawings in accordance with [RSIC Manual of Standard Practice] [SP-66].
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta.
    - .1 Indicate placing of reinforcement and:
      - .1 Bar bending details.
      - .2 Lists.

- .3 Quantities of reinforcement.
- .4 Sizes, spacings, locations of reinforcement and mechanical splices if approved by Consultant, with identifying code marks to permit correct placement without reference to structural drawings.
- .5 Indicate sizes, spacings and locations of chairs, spacers and hangers.
- .2 Detail lap lengths and bar development lengths to CAN/CSA-A23.3, unless otherwise indicated.
  - .1 Provide type B unless otherwise indicated.
- .4 When Chromate solution is used as replacement for galvanizing non-prestressed reinforcement, provide product description for review by Consultant prior to its use.

### **1.3 QUALITY ASSURANCE**

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

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 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.
- .4 Develop Construction Waste Management Plan related to Work of this Section.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Substitute different size bars only if permitted in writing by Consultant.
- .2 Reinforcing steel: billet steel, grade 400, deformed bars to CSA-G30.18, unless indicated otherwise.
- .3 Reinforcing steel: weldable low alloy steel deformed bars to CSA-G30.18.
- .4 Cold-drawn annealed steel wire ties: to ASTM A82/A82M.



- .5 Deformed steel wire for concrete reinforcement: to ASTM A82/A82M.
- .6 Welded steel wire fabric: to ASTM A185/A185M.
  - .1 Provide in flat sheets only.
- .7 Welded deformed steel wire fabric: to ASTM A82/A82M.
  - .1 Provide in flat sheets only.
- .8 Epoxy Coating of non-prestressed reinforcement: to ASTM A775/A775M.
- .9 Galvanizing of non-prestressed reinforcement: to CAN/CSA-G164, minimum zinc coating [610] g/m<sup>2</sup>.
  - .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.
- .10 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.
- .11 Mechanical splices: subject to approval of Consultant.
- .12 Plain round bars: to CSA-G40.20/G40.21.

## 2.2 FABRICATION

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

**2.3 SOURCE QUALITY CONTROL**

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

**3.2 FIELD BENDING**

- .1 Do not field bend or field weld reinforcement except where indicated or authorized by Consultant.
- .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 placing drawings in accordance with CSA-A23.1/A23.2.
- .2 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.
- .3 Prior to placing concrete, obtain Consultant's approval of reinforcing material and placement.
- .4 Ensure cover to reinforcement is maintained during concrete pour.
- .5 Protect paint coated portions of bars with covering during transportation and handling.

**3.4 FIELD TOUCH-UP**

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

**3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.

- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal] [01 35 21 - LEED Requirements].

**END OF SECTION**

**Part 1 General**

**1.1 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 C309-[07], Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
    - .3 ASTM C494/C494M-[10a], Standard Specification for Chemical Admixtures for Concrete.
    - .4 ASTM C1017/C1017M-[07], Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
    - .5 ASTM D412-[06ae2], Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
    - .6 ASTM D624-[00(2007)], Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
    - .7 ASTM D1751-[04(2008)], Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
    - .8 ASTM D1752-[04a(2008)], 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-37.2-[M88], Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.

- .2 CAN/CGSB-51.34-[M86(R1988)], Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .3 CSA International
  - .1 CSA A23.1/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .2 CSA A283-06 (R2016), Qualification Code for Concrete Testing Laboratories.
  - .3 CSA A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

## 1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: in accordance with Section [01 32 16.07 - Construction Progress Schedules - Bar (GANTT) Chart, convene pre-installation meeting [one] week prior to beginning [concrete works].
  - .1 Ensure [key personnel,] [site supervisor,] [Departmental Representative] [DCC Representative] [Consultant] [speciality contractor - finishing, forming] [concrete producer] [testing laboratories] attend.
    - .1 Verify project requirements.

## 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 At least 4 weeks prior to beginning Work, provide Consultant with samples of materials proposed for use as follows:
  - .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 1 kg of each fine and coarse aggregate.
- .3 Provide testing results for review by Consultant 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 –

## 1.4 FIELD QUALITY CONTROL.

- .1 Concrete hauling time: provide for review by Consultant deviations exceeding maximum allowable time of 120 minutes for concrete to be delivered to site of Work and discharged after batching.
- .2 Provide two copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements.

## 1.5 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Provide [Departmental Representative] [DCC Representative] [Consultant], minimum [4] 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.
- .3 Minimum 4 weeks prior to starting concrete work, provide proposed quality control procedures for review by Consultant on following items:
  - .1 Falsework erection.
  - .2 Hot weather concrete.
  - .3 Cold weather concrete.
  - .4 Curing.
  - .5 Finishes.
  - .6 Formwork removal.
  - .7 Joints.
- .4 Quality Control Plan: provide written report to Consultant verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.

## 1.6 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 concrete producer as described in CSA A23.1/A23.2.
    - .2 Deviations to be submitted for review by Consultant.
  - .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
- .2 Packaging Waste Management: remove for reuse [and return] [by manufacturer] of [pallets,] [crates,] [padding,] [packaging materials] in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal].

## Part 2 Products

### 2.1 DESIGN CRITERIA

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

## 2.2 PERFORMANCE CRITERIA

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

## 2.3 MATERIALS

- .1 Portland Cement: to CSA A3001, Type [GU] [HS].
- .2 Hydraulic cement: Type [GUb] [HSb] to CSA A3001.
- .3 Portland-limestone cement: Type [GUL] to CSA A23.1.
- .4 Supplementary cementing materials: with minimum 20% [N] [GGBFS] [Type [F] [CI] [CH] fly ash replacement], by mass of total cementitious materials to CSA A3001.
- .5 Water: to CSA A23.1.
- .6 Aggregates: to CSA A23.1/A23.2.
- .7 Admixtures:
  - .1 Air entraining admixture: to CAN3-A266.1.
  - .2 Chemical admixture: to CAN3-A266.2
- .8 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.
  - .2 Net shrinkage at 28 days: maximum 0.1 %.
- .9 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 35 MPa at 28 days.
- .10 Curing compound: to CSA A23.1/A23.2.
- .11 Dovetail anchor slots: minimum 0.6 mm thick galvanized steel with insulation filled slots.
- .12 Dampproof membrane:
  - .1 Kraft/polyethylene membrane:
    - .1 Plain: [.05] [.10] [.75] mm thick polyethylene film bonded to asphalt treated creped kraft.
    - .2 Reinforced: two [.05] [.10] [.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.
  - .2 Bitumen impregnated protection board: [\_\_\_\_\_].
  - .3 Cavity drainage board: [\_\_\_\_\_].
- .13 Dampproofing:
  - .1 Emulsified asphalt, mineral colloid type, unfilled: to CAN/CGSB-37.2, [and to Section [07 11 13 - Bituminous Dampproofing]].

- .14 Polyethylene film: [ ] mm thickness to CAN/CGSB-51.34.

## **2.4 MIXES**

- .1 Alternative 1 - Performance Method for specifying concrete: to meet 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 the Performance Alternative outlined in Table 5 of CAN/CSA-A23.1
- .3 Provide concrete mix to meet following hard state requirements:
- .1 Durability and class of exposure: [N] [S-2].
- .2 Compressive strength at [28] [56] age: [25] [32] Mpa minimum.
- .4 Provide quality management plan to ensure verification of concrete quality to specified performance.
- .5 Concrete supplier's certification: both batch plant and materials meet CSA A23.1 requirements.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Obtain Consultant's written approval before placing concrete.
- .1 Provide 24 hours minimum notice prior to placing of concrete.
- .2 Place concrete reinforcing in accordance with Section 03 20 00 - Concrete Reinforcing.
- .3 During concreting operations:
- .1 Development of cold joints not allowed.
- .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Pumping of concrete [will not be permitted] [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 Consultant's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .7 Protect previous Work from staining.
- .8 Clean and remove stains prior to application for concrete finishes.
- .9 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .10 In locations where new concrete is dowelled to existing work, drill holes in existing concrete.
- .1 Place steel dowels of deformed steel reinforcing bars and pack solidly with epoxy grout to anchor and hold dowels in positions as indicated.



- .11 Do not place load upon new concrete until authorized by Consultant.

### **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 Consultant.
  - .2 Where approved by Consultant, 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 Consultant.
  - .4 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Consultant before placing of concrete.
  - .5 Confirm locations and sizes of sleeves and openings shown on drawings.
  - .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 Consultant.
    - .1 Formed holes: [100] mm minimum diameter.
    - .2 Drilled holes: to manufacturers' recommendations.
  - .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
  - .4 Set bolts and fill holes with 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 weep holes:
  - .1 Form weep holes and drainage holes in accordance with Section 03 10 00 - Concrete Forming and Accessories. If wood forms are used, remove them after concrete has set.
  - .2 Install weep hole tubes and drains as indicated.
- .5 Dovetail anchor slots: in accordance with Section 04 05 00 - Common Work Results for Masonry.
  - .1 Install continuous vertical anchor slot to forms where masonry abuts concrete wall or columns.
  - .2 Install continuous vertical anchor slots at 800 mm on centre where concrete walls are masonry faced.
- .6 Grout under base plates [and machinery] using procedures in accordance with manufacturer's recommendations which result in 100 % contact over grouted area.

- .7 Finishing and curing:
  - .1 Finish concrete to CSA A23.1/A23.2.
  - .2 Use procedures as reviewed by 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. Provide written declaration that compounds used are compatible.
  - .4 Provide screed is to be applied.
  - .5 Provide screed finish unless otherwise indicated.
  - .6 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 Consultant.
- .9 Joint fillers:
  - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Consultant.
  - .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 expansion joints as indicated.
  - .4 Install joint filler.
  - .5 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 150 mm 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.

### **3.4 FIELD QUALITY CONTROL**

- .1 Site tests: conduct tests as follows [in accordance with Section 01 45 00 - Quality Control] and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .1 Concrete pours.
  - .2 Slump.
  - .3 Air content.
  - .4 Compressive strength at [7 and 28] [7 and 56] days.
  - .5 Air and concrete temperature.
- .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory designated 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] [DCC Representative] [Consultant].
- .4 [Departmental Representative] [DCC Representative] will pay for costs of tests as specified in Section [01 29 83 - Payment Procedures for Testing Laboratory Services.
- .5 Consultant will take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .6 Non-Destructive Methods for Testing Concrete: to CSA A23.1/A23.2.
- .7 Inspection or testing by Consultant will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

### **3.5 CLEANING**

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

**END OF SECTION**

**PART 1. General**

**1.1 REFERENCES**

- .1 ASTM C472-99 (2009) - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters, and Gypsum Concrete.
- .2 CAN/CSA-A23.1-09/A23.2-09 - Concrete Materials and Methods of Concrete Construction / Methods of Test and Standard Practices for Concrete.

**1.2 ENVIRONMENTAL REQUIREMENTS**

- .1 Do not install underlayment until floor penetrations and peripheral work are complete.
- .2 Maintain minimum ambient temperatures of 10 degrees C minimum 24 hours before, during and 72 hours after installation of underlayment.

**PART 2. Products**

**2.1. MATERIALS**

- .1 Gypsum Cement: GYP-CRETE 2000 floor underlayment compound, manufactured by Maxxon Corporation.
- .2 Acoustic Underlay: Acousti-Mat II, entangle polmeric filament mat, 6mm thickness, manufactured by Maxxon Corporation.

**2.2. MIXES**

- .1 Mix underlay compound with water and sand to the following ratio:
  - .1 16-21 litres of water and 0.035m3 of sand per 25 kg bag of compound.
  - .2 do not overwater. Change amount of water to suit condition of sand.

**PART 3. Execution**

**3.1. PREPARATION**

- .1 Ensure plywood surfaces to receive floor underlay are sound and dry before beginning application.
- .2 Fill any depressions or holes with quick set patching compound.

**3.2. APPLICATION**

- .1 loose lay acoustic mat over subfloor in accordance with manufacturer's instructions. Seal seams self adhesive tape and install isolation strips at perimeters in accordance with manufacturer's instructions.
- .2 Install gypsum cement underlay directly over acoustic mat in accordance with manufacturer's recommendations to maximum thickness indicated.
- .3 Spread and screed slurry to ensure uniform thickness.
- .4 If portions of application obtain initial set before apply adjacent underlay, obtain manufacturer's directions before continuing application in that area.

**3.3. PROTECTION**

- .1 Provide adequate ventilation upon completion of application to allow underlay to set properly.
- .2 Do not allow foot traffic over completed areas until underlay has obtained full set.

**END OF SECTION**

**PART 1        General**

**1.1                      REFERENCES**

- .1        Conform to CAN/CSA-A371- Masonry Construction for Buildings, except as modified by this specification.
- .2        Application company and masons shall have experience in installation of cast (manufactured) stone veneer.
- .3        Manufactured stone veneer shall have current CCMC approval, or manufacturer/supplier shall provide installation shop drawings for Contractors use with the seal of a professional engineer registered in Alberta, in compliance with Alberta Building Code and Standata requirements. In addition, manufacturer of veneer shall provide, to the Consultant, proof that the veneer is suitable for the application intended.

**1.4                      MOCK-UP**

- .1        Erect a mock-up approximately 1m x 1m at a location as directed by the Departmental Representative. Incorporate features as directed. Mock-up shall demonstrate field pattern of stone, field cutting, colours and joint treatment. Make adjustments as requested.
- .2        Accepted mock-up shall represent minimum acceptable standard for the project. Preserve accepted mock-up for duration of project. Mock-up may be incorporated into finished project.

**PART 2        Products**

**2.1                      CAST STONE**

- .1        “Cultured Stone” of texture, colour and type as noted on drawings.
- .2        Product is a non-structural lightweight veneer facing made from Portland cement, lightweight aggregates and iron oxide pigments, cast in moulds with raked back to assist in adhesion. UL 723 test for Fire hazard Classification of Building materials flame spread rating 0 and smoke developed 0. Provide manufactured trim pieces as required.
- .3        Mortar: to CSA-A179-93, Type AN.
- .4        Metal lath: 18 gauge galvanized, woven wire mesh or 2.5 lb. flat galvanized diamond mesh. Metal lath shall be self-furring type.

**PART 3       Execution**

**3.1           PREPARATION**

- .1       Complete installation of air retarder membrane prior to installation of masonry. Refer to Section 07 27 19 for additional information.
- .2       Sheathed Surfaces: Install flashings at heads and sills of all openings. Apply metal lath attached with galvanized nails or screws penetrating panel substrate or studs 25 mm and spaced at 150 mm on centres vertically and 400 mm on centres horizontally. Fasteners shall penetrate studs.
- .2       Concrete and Masonry Surfaces: New, clean and untreated no preparation necessary. Ensure concrete surfaces do not have form release agent on surface which will impair bond. Remove any form release agent by a method directed by the Stone manufacturer.

**3.2           INSTALLATION**

- .1       Apply in accordance with manufacturer's installation instructions. Lay out work to minimize cutting.
- .2       Install control joints where shown on the drawings and at maximum spacing of 7.5 m where not shown otherwise.
- .3       All control joint locations shall be confirmed on site with the Departmental Representative.

**END OF SECTION**

**PART 1.General**

**1.1 SECTION INCLUDES**

- .1 Aluminum handrails and balusters
- .2 Side mount painted steel handrails
- .3 Anchors and support components

**1.2 REFERENCES**

- .1 ANSI A117.1 - Standard on Accessible and Usable Buildings and Facilities.
- .2 ASTM A53/A53M-10 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- .3 ASTM A123/A123M-08 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- .4 ASTM B211M-03 - Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric).
- .5 ASTM B221M-07 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).
- .6 ASTM B241/B241M-02 - Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
- .7 ASTM B483/B483M-03 - Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications.
- .8 ASTM C509-06 - Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
- .9 ASTM C920-10 - Specification for Elastomeric Joint Sealants.
- .10 ASTM C1115-06 - Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories
- .11 ASTM C1172-09 - Specification for Laminated Architectural Flat Glass.
- .12 ASTM E894-88 (2010) - Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Building.
- .13 ASTM E935-00 (2006) - Test Methods for Performance of Permanent Metal Railing Systems and Rails for Building.
- .14 ASTM E985-00 (2006) - Specification for Permanent Metal Railing Systems and Rails for Buildings.
- .15 CAN/CGSB-1.40-97 - Anti-corrosive Structural Steel Alkyd Primer.
- .16 CAN/CGSB-1.181-99 - Ready-Mixed, Organic Zinc-Rich Coating.
- .17 CSA-W59.2-1991 (R2008) - Welded Steel Construction (Metal Arc Welding)
- .18 CSA-W59-03 - Welded Steel Construction (Metal Arc Welding)
- .19 GANA (Glass Association of North America) – Glazing and Sealant Manuals.
- .20 SSPC (The Society for Protective Coatings) (formerly SSPC - Steel Structures Painting Council) - Steel Structures Painting Manual.



**1.3                    PERFORMANCE REQUIREMENTS**

- .1 Conform to ANSI A117.1.
- .2 Railing assembly, balusters, wall rails, and attachments to resist the following when tested in accordance with ASTM E935:
  - .1 A lateral force of 444 N at any point without damage or permanent set.
  - .2 A vertical force of 888 N at any point without damage or permanent set.
- .3 Glass Deflection: Size glass thickness and limit glass deflection to 1/200 or flexure limit of glass, with full recovery of glazing materials, whichever is less.

#### **1.4 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Prepare Shop Drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and registered in the Province of Alberta.
  - .1 Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
  - .2 Provide manufacturer's complete design calculations prepared, stamped and signed by a Professional Engineer registered in the Province of Alberta.
  - .3 Indicate structural attachment of entire assembly back to supporting structure.
  - .4 Indicate welded connections using standard welding symbols. Indicate net weld lengths.
- .3 Samples: Submit two (2) 300 mm long samples of handrail. Submit two (2) samples, of elbow, Tee, wall bracket, escutcheon, and end stop.

#### **1.5 QUALITY ASSURANCE**

- .1 Perform welding to CSA W59.
- .2 Perform railing Work in accordance with ASTM E894, E935, and E985.
- .3 Perform glass baluster Work in accordance with GANA Glazing and Sealant Manuals.
- .4 Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and registered in the Province of Alberta.

#### **1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Transport, handle, store, in a manner that protects the products.
- .2 Protect pre-finished surfaces with sheets of bubble-wrap or plastic wrapping.

### **PART 2. Products**

#### **2.1 ALUMINUM RAILING SYSTEM**

- .1 Rails and Posts: 38mm diameter, extruded tubing, 6063-T6 alloy and temper, conforming to ASTM B211 or B241; factory pre-finished with modified silicone polyester coating, colour as indicated on drawing.
- .2 Flanges, Anchors, and Railing Accessories: to ASTM B 247, finish to match railing

- .3 Bases: manufacturer's standard 6063 alloy cast or solid aluminum, finish to match railing.
- .4 Fittings: Elbows, T-shapes, wall brackets, escutcheons; machined aluminum, finish to match railing.
- .5 Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.
- .6 Splice Connectors: Steel concealed spigots.

**2.2 STEEL RAILING SYSTEM**

- .1 Steel Tubing: to ASTM A500/A500M, Grade B.
- .2 Steel Pipe: to ASTM A53/A53M, Grade B, Schedule 40.
- .3 Fittings: Elbows, T-shapes, wall brackets, escutcheons; machined steel.
- .4 Mounting Brackets: suitable for mounting or embedding onto supporting surfaces.
- .5 Exposed Fasteners: Flush countersunk screws or bolts; consistent with design of railing.
- .6 Splice Connectors: Steel concealed spigots

**2.3 FABRICATION**

- .1 Fit and shop assemble components in largest practical sizes for delivery to site.
- .2 Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- .3 Provide anchors as required for connecting railings to structure.
- .4 Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- .5 Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.
- .6 Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion
- .7 Interior Components: Continuously welded joined pieces
- .8 Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- .9 Accurately form components [to suit stairs and landings,] to each other and to building structure.
- .10 Accommodate for expansion and contraction of members and building movement without damage to connections or members.

**PART 3.Execution**

**3.1 EXAMINATION AND PREPARATION**

- .1 Verify that field conditions are acceptable and are ready to receive work.
- .2 Clean and strip [primed steel items to bare metal] [aluminum] where site welding is required.
- .3 Supply items required to be cast into concrete and/or embedded in masonry, placed in partitions complete with setting templates, to appropriate sections

**3.2 INSTALLATION**

- .1 Install components plumb and level, accurately fitted, free from distortion or defects.
- .2 Anchor railings to structure.
- .3 Field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.
- .4 Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings
- .5 Assemble with spigots and sleeves to accommodate tight joints and secure installation.

**3.3 ERECTION TOLERANCES**

- .1 Maximum Variation From Plumb: 6 mm per storey, non-cumulative.
- .2 Maximum Offset From True Alignment: 6 mm.
- .3 Maximum Out-of-Position: 6 mm.

**3.4 CLEANING AND PROTECTION**

- .1 Remove protective material from surfaces.
- .2 Wash down surfaces as follows:
  - .1 With a solution of mild detergent in warm water applied with soft, clean wiping cloths,
  - .2 Take care to remove dirt from corners and wipe surfaces clean.
- .3 Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.
- .4 Protect finished Work from damage..

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials (ASTM)
  - .1 ASTM D1761, Standard Test Methods for Mechanical Fasteners in Wood.
  - .2 ASTM D5456, Specification for Evaluation of Structural Composite Lumber Products.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-71.26, Adhesive for Field-Gluing Plywood to Lumber Framing for Floor Systems.
- .3 Canadian Standards Association (CSA)
  - .1 CAN/CSA-086 – Engineering Design in Wood.
  - .2 CSA O112 Series, CSA Standards for Wood Adhesives.
  - .3 CSA O121, Douglas Fir Plywood.
  - .4 CAN/CSA-O141, Softwood Lumber.
  - .5 CSA O151, Canadian Softwood Plywood.
  - .6 CAN/CSA-O325, Construction Sheathing.
  - .7 CAN3-O437, Standards on OSB and Waferboard.
  - .8 CSA O80.20, Fire-Retardant Treatment of Lumbering Pressure Processes. This Standard applies to the fire-retardant treatment of lumber by pressure processes. Fire-Retardant Treatment of Lumber by Pressure Processes. This is not a stand alone specification.
  - .9 CSA O80.27, Fire-Retardant Treatment of Plywood by Pressure Processes. This Standard covers the fire-retardant treatment of Douglas Fir, hardwood, softwood, and Poplar plywood by pressure processes. Fire-Retardant Treatment of Plywood by Pressure Processes. This not a stand alone specification.
  - .10 CSA O322, Procedure for Certification of Pressure-Treated Wood Materials for Use in Preserved Wood Foundations.
- .4 National Lumber Grades Authority (NLGA)
  - .1 Standard Grading Rules for Canadian Lumber.
- .5 American Wood-Preservers' Association (AWPA)
  - .1 AWPA M2, Standard Inspection of Treated Wood Products.
  - .2 AWPA M4, Standard for the Care of Preservative-Treated Wood Products.

**1.2 DESIGN REQUIREMENTS**

- .1 Unless otherwise noted, connections shall be designed by the Contractor to the reference Standards by the Specialty Structural Engineer.
- .2 Design details and connections in accordance with requirements of CAN/CSA-O86 to resist forces, moments, shears and allow for movements indicated.

- .3 Where connections are detailed, use connection of the type and detail shown on the drawings. Modifications to the specified connection types and details will not be permitted without prior approval.
- .4 Connections for wind or seismic lateral load-resisting elements, such as bracing and drag struts, and others so noted on the structural drawings may be designed as bearing connections but shall be pre-tensioned.
- .5 Use standard connection types where connections are not detailed on the structural drawings.
- .6 Design shall be for the forces and loads shown on the drawings and shall allow for the effects of beam deflections. If forces or loads are not given, the connection shall be designed for the maximum uniform distributed load that the member can carry for the span shown.
- .7 Structural members spliced for ease of fabrication or transportation shall have splices designed to develop the full strength and stiffness of the member. Splices shall be subject to non-destructive testing. The cost for such testing shall be borne by the Contractor.
- .8 Shear connections: 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.
- .9 Submit sketches and design calculations stamped and signed by qualified professional engineer licensed in Province of Alberta, Canada for non standard connections.

### **1.3 QUALITY ASSURANCE**

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

### **1.4 SHOP DRAWINGS**

- .1 Submit "design" drawings for review summarizing the proposed connection details to be used on the project. These drawings to be prepared by, or under supervision of, the Specialty Structural Engineer and submitted for review before start of shop drawing production. These design drawings shall show the complete connection and:
  - .1 How the connection assembly fits with the connected members.
  - .2 Sizes of engineered wood products and structural composite lumber complete with connection.
  - .3 Capacities of the connection.
  - .4 Assumed eccentricities, lines of action of forces, etc.

- .2 Submit shop drawings prepared under direction of the Specialty Structural Engineer. Drawings of components and connections designed by the Contractor shall be sealed and signed by this Specialty Structural Engineer or a letter shall be submitted at the end of the project signed and sealed by this Specialty Structural Engineer. The letter shall identify what was designed by the Specialty Structural Engineer and list the final shop drawings by number with dates and revision numbers.
- .3 Shop drawings shall show complete shop and erection details necessary for fabrication and erection of the component parts of the structure, including cuts, copes, connections, holes, fasteners, splices and location, type, size and extent of all connections. Splices not shown on the shop drawings will be rejected.
- .4 Provide a shop drawing clearly locating all anchor bolts, embedded plates, baseplates, etc.
- .5 Provide setting drawings, templates and directions for the installation of anchor bolts, plates and other devices.
- .6 Review of the shop drawings is intended as an assistance to the Contractor and does not relieve the Contractor of his responsibility for the completeness or accuracy of his work and its conformance with the contract documents.
- .7 Fabrication that commences prior to shop drawing review is at the risk of the Contractor.
- .8 Clearly identify on the shop drawing all revisions, changes, or modifications.
- .9 Resubmit reviewed shop drawings where noted in the review stamp, or when the Contractor makes revisions for his own purposes.
- .10 Allow at least two (2) weeks for shop drawing review.
- .11 Structural drawings are not prepared to be used as erection or shop drawings.

## **1.5 SUPPLY OF ALTERNATE PRODUCTS**

- .1 Should the sections shown on the drawings not be procurable, or should substitution for those sections be desired, sections of equivalent strength, may be substituted if approved. In such cases full particulars, thereof must be submitted prior to the closing of Bid. Material substitutions after the closing of Bid, if accepted, will be at the Contractor's cost.

## **1.6 FIELD REVIEW**

- .1 The Specialty Structural Engineer responsible for shop drawings, or the Specialty Structural Engineer's representative, shall visit the site to review in place the connections and components designed by that Specialty Structural Engineer. The Specialty Structural Engineer shall be satisfied or take steps to ensure that these connections and components substantially comply with the Specialty Structural Engineer's design. The Specialty Structural Engineer shall then provide a sealed and signed letter to this effect.

- .2 The Contractor shall advise the Specialty Structural Engineer of the scheduling of all field work pertaining to this Project. The Contractor shall permit the Specialty Structural Engineer full access to the site, for the purpose of carrying out his work and he shall provide assistance required to aid in the performance of the inspection.
- .3 Provide safe access and working areas for field review on site, as required by the Specialty Structural Engineer.
- .4 Submit field review reports within 1 week of completion of inspection.

## **Part 2 Products**

### **2.1 BUILDING FRAMING AND STRUCTURAL MATERIALS**

- .1 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% (S-dry) or less in accordance with following standards:
  - .1 CAN/CSA-O141.
  - .2 NLGA Standard Grading Rules for Canadian Lumber.
- .2 Glued end-jointed (finger-jointed) lumber is not acceptable.
- .3 Columns to be 178x178 PSL 1.8E (12,400MPa) c/w base plate and Tie Down Anchor in the locations indicated on the structural drawings. Connect Columns to concrete slab on pool level for Tf = 50kN. Connect Columns through +15 level for Tf = 25kN. See structural drawings for column base connection concepts.
- .4 Laminated Veneer Lumber (LVL) Beams in accordance with ASTM D5456: LVL 1.9E (13,100MPa) with vertical laminations and depths indicated on the structural drawings.
- .5 Floor, Roof, and Exterior Wall Sheathing to be 16mm Tongue and Groove Plywood.
- .6 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:
  - .1 S4S for members receiving finishes, S2S or S4S for members not receiving finishes.
  - .2 Board sizes: Spruce, pine, fir (SPF) species, No. 2 grade or better.
  - .3 Dimension sizes: Spruce, pine, fir (SPF) species, No. 2 grade or better.
  - .4 Post and timbers sizes: Spruce, pine, fir (SPF) species, No. 2 grade or better.

### **2.2 PANEL MATERIALS**

- .1 Plywood, OSB and wood based composite panels: to CAN/CSA-O325.0.
- .2 Douglas fir plywood (DFP): to CSA O121, standard construction.
- .3 Canadian softwood plywood (CSP): to CSA O151, standard construction.
- .4 Poplar plywood (PP): to CSA O153, standard construction.



## **2.3 ACCESSORIES**

- .1 General purpose adhesive: to CSA O112 Series.
- .2 Nails, spikes and staples: galvanized.
- .3 Bolts: Galvanized 15.5 mm diameter unless indicated otherwise, complete with galvanized nuts and washers.
- .4 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. All proprietary fasteners to be galvanized or stainless steel.
- .5 Joist hangers: minimum 1 mm thick sheet steel with galvanized ZF001 coating designation.
- .6 Roof sheathing H-Clips: formed "H" shape, thickness to suit panel material.
- .7 Damp Proofing Membrane: polyethylene film: to CAN/CGSB-51.34, Type 1, 0.15 mm thick.

## **2.4 FASTENER FINISHES**

- .1 Galvanizing: to CAN/CSA-G164, use galvanized fasteners for all interior and exterior work, pressure-preservative treated lumber as indicated on drawings.

## **2.5 WOOD PRESERVATIVE**

- .1 Preservative: to CSA-O80 Series, Alkaline Copper Quaternary (ACQ) tinted green.

# **Part 3 Execution**

## **3.1 PREPARATION**

- .1 Store wood products as to avoid damage and keep clean.

## **3.2 FRAMING MEMBERS**

- .1 Comply with requirements of NBC Part 9 supplemented by following paragraphs.
- .2 Install members true to line, levels and elevations, square and plumb. Erect all framing materials forming subsurfaces for wood finishes, drywall, etc. to be straight in any plain with a tolerance of 6 mm in 3 m non cumulative.
- .3 Construct continuous members from pieces of longest practical length.
- .4 Install spanning members with "crown-edge" up.
- .5 Select exposed framing for appearance. Install lumber and panel materials so that grade-marks and other defacing marks are concealed or are removed by sanding where materials are left exposed.

- .6 Ensure that all members are framed, anchored, tied and braced together to provide the strength and rigidity necessary for their end purposes.
- .7 Ensure that at least 50% of length of fasteners penetrate wood materials to which fasteners are secured.
- .8 Secure exterior stud wall sole plates bolted on foundations in strict accordance with design requirements.
- .9 Brace all framing temporarily in place, until braced by complete framing and sheathing.
- .10 Construct openings in stud walls wider than stud spacing by doubling jamb studs with full length cripples having full bearing at bottom of opening and providing minimum 38 mm full bearing for lintel.
- .11 Construct lintels over openings in stud walls with framing lumber set on edge and continuous solid lumber or fir sheathing plywood spacer, spiked together to make up full stud wall thickness, as indicated on structural drawings.
- .12 Provide built-up stud columns at each bearing for built-up timber beam unless noted otherwise. Each built-up column shall consist of the same number of wood studs as the number of wood framing members in each built-up timber beam, unless otherwise noted.
- .13 Double up sill plates at window and similar openings wider than 800 mm in stud walls, provide bearing cripples at jamb studs for sill plate support similar as specified for lintel support preceding.
- .14 Provide 38 x 38 mm wood bridging between joists at bearing locations and at intervals not exceeding 2 m between supports.
- .15 Provide 38 x 150 solid wood blocking in walls to receive washroom accessories, handrails, upper casework, etc. as shown on drawings

### **3.5**

#### **ROOF FRAMING**

- .1 Set roof framing with crown up, minimum 3" birds mouth cut at wall solid support at intermediate beams, vertical cut at ridge to fit ridge board.
- .2 Cut all eaves plumb vertical and true to line.
- .3 Spike all rafters to wall plates, dwarf walls, trusses, ridges, valleys. Install and secure all blocking, bridging, framing. Provide continuous solid blocking for fascia and soffit.
- .4 Provide a minimum of 2 - 38 x 235 mm timber framing members on each side of roof openings, unless noted otherwise. Extend these framing members on two parallel sides of the opening to bear on the nearest adjacent bearing truss or beam.

### **3.5 ROOF FASCIAS, NAILERS, CURBS**

- .1 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.
- .2 Install furring to support siding applied vertically [where there is no blocking and] where sheathing is not suitable for direct nailing.
- .3 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .4 Install wood fascia backing, nailers, curbs, roof spacers and other wood supports for roofing and sheet metal work, insulation, blocking, as indicated.
- .5 Secure with galvanized nails. Locate fastenings within 300 mm from ends and uniformly spaced between. Space nails at 200 mm centres except where indicated otherwise.

### **3.7 ROUGH BUCKS, NAILERS**

- .1 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .2 Install wood cants, fascia backing, nailers, curbs and other wood supports as required and secure using steel fasteners.
- .3 Install sleepers as indicated.
- .4 Except where indicated otherwise use material at least 38 mm thick secured with 9 mm bolts located within 300 mm from ends of members and uniformly spaced at 1200 mm between.
- .5 Countersink bolts where necessary to provide clearance for other work.

### **3.3 ERECTION**

- .1 Countersink bolts where necessary to provide clearance for other work.
- .2 Use nailing disks for soft sheathing as recommended by sheathing manufacturer.
- .3 Install damp proofing membrane between sole plate of stud walls set on slabs on grade and foundations, 300 mm wide, continuous with 200 mm laps, turned up inside, down on outside of wall, stamped in place both sides to studs, lapped over a vapour barrier where such is applied.
- .4 Obtain permission from Building Inspector of local authority having jurisdiction, before covering fire stop bridging with other materials.
- .5 Limit all other vertically continuous stud spaces exceeding 3 m in height by installing horizontal fire stop bridging of same size as studs at strategic points between studs.
- .6 Install horizontal fire stop bridge of same material as studs, between all studs at springing points of ceiling, where studs wall spaces extend continuously beyond edge of ceiling, and as detailed.

- .7 Use dust collectors and high quality respirator masks when cutting or sanding wood panels.

### 3.4 ROOF SHEATHING

- .1 Install roof sheathing in accordance with requirements of NBC.
- .2 Install roof plywood sheathing across wood trusses, rafters and joists.
- .3 Nail securely to joists, rafters, trusses, blocking. Use approved H clips at horizontal joints where no solid blocking under.
- .4 Stagger vertical joints of sheathing.
- .5 Leave smooth and securely fastened ready to receive shingles on sloped roof.

### 3.5 WALL SHEATHING

- .1 Install wall sheathing in accordance with manufacturer's printed instructions.
- .2 Apply plywood sheathing to walls. Nail securely to studs, plates, blocking and framing.
- .3 Cut sheathing neatly at door, window framed openings.
- .4 Leave smooth and securely fastened ready to receive sheathing paper and finishes.

### 3.6 SURFACE-APPLIED WOOD PRESERVATIVE

- .1 Treat surfaces of material with wood preservative, before installation. Wherever possible, apply preservative after materials have been cut and fit to size.
- .2 Apply preservative by dipping, or by brush or spray to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.
- .3 Re-Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.
- .4 Treat all material as follows:
  - .1 Wood fascia backing, curbs, nailers, on roof deck.
  - .2 Wood in contact with exterior concrete walls.
  - .3 All exposed exterior wood framing.
  - .4 Wood in contact with grade (ie support for crawl space smoke separations).

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 CSA International
  - .1 CAN/CSA O80 Series-08 (R2013), Wood Preservation.
  - .2 CSA O86 Consolidation-14, Engineering Design in Wood.
  - .3 CSA O141-05(R2014), Softwood Lumber.
  - .4 CSA S307-M1980(R2006)], Load Test Procedure for Wood Roof Trusses for Houses and Small Buildings.
  - .5 CSA S347-99(R2014), Method of Test for Evaluation of Truss Plates Used in Lumber Joints.
  - .6 CSA W47.1-09 (R2014), Certification of Companies for Fusion Welding of Steel.
  - .7 CAN/CSA-Z809-08 (R2013), Sustainable Forest Management.
- .2 Forest Stewardship Council (FSC)
  - .1 FSC-STD-01-001-[2004], FSC Principle and Criteria for Forest Stewardship.
- .3 National Lumber Grades Authority (NLGA)
  - .1 Standard Grading Rules for Canadian Lumber [2010].
- .4 National Research Council (NRC)/Institute for Research in Construction (IRC) - Canadian Construction Materials Centre (CCMC)
  - .1 CCMC-[on-line edition], Registry of Product Evaluations.
- .5 Truss Plate Institute of Canada (TPIC)
  - .1 TPIC - 2007, Truss Design Procedures and Specifications for Light Metal Plate Connected Wood Trusses (Limit States Design).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section [01 33 00 - Submittal Procedures].
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for [wood trusses ] 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 Alberta, Canada.
  - .2 Include on drawings:
    - .1 Each shop drawing submission showing connection details.
    - .2 Indicate special structural application and specification as according to local authorities having jurisdiction.

- .3 Indicate TPIC Truss Design Procedure and CSA O86 Engineering Design in Wood and specific CCMC Product Registry number of the truss plates
- .4 Indicate species, sizes, and stress grades of lumber used as truss members. Show pitch, span, camber, configuration and spacing of trusses. Indicate connector types, thicknesses, sizes, locations and design value. Show bearing details. Indicate design load for members.
- .5 Submit stress diagram or print-out of computer design indicating design load for truss members. Indicate allowable load and stress increase.
- .6 Provide certification that trusses meet requirements of CSA S307 and CSA S347.
- .7 Indicate arrangement of webs or other members to accommodate ducts and other specialties.
- .8 Show location of lateral bracing for compression members.
- .9 Test reports: submit certified test reports for prefabricated wood trusses from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
- .10 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .11 Instructions: submit manufacturer's installation instructions.

### **1.3 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Fabricator for trusses to show evidence of quality control program such as provided by regional wood truss associations, or equivalent.
  - .2 Fabricator for welded steel connections to be certified in accordance with CSA W47.1.

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect wood trusses from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
  - .4 Provide bearing supports and bracings. Prevent bending, warping and overturning of trusses.
- .4 Packaging Waste Management: remove for as specified in Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products**

**2.1 DESIGN REQUIREMENTS**

- .1 Design light metal plate connected wood trusses in accordance with TPIC truss design procedures for wood truss chords and webs in accordance with engineering properties in CSA O86.
- .2 Design light metal plate connected wood trusses in accordance with TPIC truss design procedures for truss joint designs to test engineering properties in accordance with CSA S347 and listed in CCMC Registry of Product Evaluations.
- .3 Design trusses, bracing in accordance with CSA O86.1 for building locality as ascertained by NBC, Climatic Information for Building Design in Canada.
- .4 Limit live load deflection to 1/360th of span where gypsum board ceilings are hung directly from trusses.
- .5 Limit live load deflections to 1/240th of span unless otherwise specified or indicated.

**2.2 MATERIALS**

- .1 Lumber: SPF species, #1/2 grade, softwood, with maximum moisture content of 19% at time of fabrication and to following standards:
  - .1 CSA O141.
  - .2 NLGA (National Lumber Grading Association), Standard Grading Rules for Canadian Lumber.
  - .3 CAN/CSA-Z809 or FSC or SFI certified.
- .2 Fastenings: to CSA O86.

**2.3 FABRICATION**

- .1 Fabricate wood trusses in accordance with reviewed shop drawings.
- .2 Provide for design camber and roof slopes when positioning truss members.
- .3 Connect members using metal connector plates.

**2.4 SOURCE QUALITY CONTROL**

- .1 Identify lumber by grade stamp of an agency certified by Canadian Lumber Standards Administration Board.
- .2 Certify by agency accredited by Standards Council of Canada that fire retardant treated wood in accordance with CAN/CSA O80 Series.

**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 Consultant.
- .2 Inform Consultant of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Consultant.

### **3.2 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 ERECTION**

- .1 Erect wood trusses [as indicated] [in accordance with reviewed shop drawings.
- .2 Handling, installation, erection, bracing and lifting in accordance with manufacturers instructions.
- .3 Make adequate provisions for handling and erection stresses.
- .4 Exercise care to prevent out-of-plane bending of trusses.
- .5 Install temporary horizontal and cross bracing to hold trusses plumb and in safe condition until permanent bracing and decking are installed.
- .6 Install permanent bracing in accordance with reviewed shop drawings, prior to application of loads to trusses.
- .7 Do not cut or remove any truss material without approval of Consultant.
- .8 Remove chemical and other surface deposits on treated wood, in preparation for applied finishes.

### **3.4 FIELD QUALITY CONTROL**

- .1 Manufacturer's Field Services:
  - .1 Have manufacturer of products supplied under this Section review work involved in handling, installation/application, protection and cleaning of its products, and submit written reports, in acceptable format, to verify compliance of work with Contract.
  - .2 Manufacturer's field services: provide manufacturer's field services, consisting of product use recommendations and periodic site visits for inspection of product installation, in accordance with manufacturer's instructions.
  - .3 Schedule site visits to review work at stages listed:
    - .1 After delivery and storage of products, and when preparatory work on which work of this Section depends is complete, but before installation begins.
    - .2 [Twice] during progress of work at [25%] and [60%] complete.
- .2 Upon completion of work, after cleaning is carried out.
- .3 Obtain reports within [three] days of review and submit immediately to [Departmental Representative] [DCC Representative] [Consultant].



**3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.

**END OF SECTION**

**Part 1            General**

**1.1            REFERENCES**

- .1 American National Standards Institute (ANSI)
  - .1 ANSI A208.1-[99], Particleboard.
  - .2 ANSI A208.2-[02], Medium Density Fibreboard (MDF).
  - .3 ANSI/HPVA HP-1-[2004], Standard for Hardwood and Decorative Plywood.
- .2 American Society for Testing and Materials International (ASTM)
  - .1 ASTM E1333-[96(2002)], Standard Test Method for Determining Formaldehyde Concentrations in Air and Emissions Rates from Wood Products Using a Large Chamber.
- .3 Architectural Woodwork Manufacturers Association of Canada (AWMAC) and Architectural Woodwork Institute (AWI)
  - .1 Architectural Woodwork Quality Standards Illustrated, latest edition.
- .4 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-11.3-[M87], Hardboard.
- .5 Canadian Plywood Association (CanPly)
  - .1 The Plywood Handbook [2005].
- .6 Canadian Standards Association (CSA International)
  - .1 CSA B111-[74(R2003)], Wire Nails, Spikes and Staples.
  - .2 CAN/CSA-G164-[M92(R2003)], Hot Dip Galvanizing of Irregularly Shaped Articles.
  - .3 CSA O121-[M89(R2003)], Douglas Fir Plywood.
  - .4 CAN/CSA O141-[91(R1999)], Softwood Lumber.
  - .5 CSA O151-[04], Canadian Softwood Plywood.
  - .6 CSA O153-[M1980(R2003)], Poplar Plywood.
  - .7 CSA Z760-[94], Life Cycle Assessment.
- .7 Forest Stewardship Council (FSC)
  - .1 FSC-STD-01-001-[2004], FSC Principle and Criteria for Forest Stewardship.
- .8 National Hardwood Lumber Association (NHLA)
  - .1 Rules for the Measurement and Inspection of Hardwood and Cypress [1998].
- .9 National Lumber Grades Authority (NLGA)
  - .1 Standard Grading Rules for Canadian Lumber [2005].
- .10 South Coast Air Quality Management District (SCAQMD), California State (SCAQMD)
  - .1 SCAQMD Rule 1113-[04], Architectural Coatings.
  - .2 SCAQMD Rule 1168-[05], Adhesives and Sealants Applications.

- .11 Underwriters Laboratories of Canada (ULC)
  - .1 CAN4-S104-[80(R1985)], Standard Method for Fire Tests of Door Assemblies.
  - .2 CAN4-S105-[85(R1992)], Standard Specification for Fire Door Frames, meeting the Performance Required by CAN4-S104.

## 1.2 SUBMITTALS

- .1 Submit Submittal submissions: in accordance with Section [01 33 00 - Submittal Procedures] [\_\_\_\_].
- .2 Shop Drawings Submittals: in accordance with Section [01 33 00 - Submittal Procedures] [\_\_\_\_].
  - .1 Indicate details of construction, profiles, jointing, fastening and other related details.
  - .2 Indicate materials, thicknesses, finishes and hardware.
- .3 Submit samples in accordance with Section [01 33 00 - Submittal Procedures] [\_\_\_\_].
  - .1 Submit duplicate samples: sample size [\_\_\_\_] x [\_\_\_\_] mm or [\_\_\_\_] mm long unless specified otherwise of [\_\_\_\_] materials.

## 1.3 QUALITY ASSURANCE

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

## 1.4 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with Section [01 61 00 - Common Product Requirements] [\_\_\_\_].
  - .1 Protect materials against dampness during and after delivery.
  - .2 Store materials in ventilated areas, protected from extreme changes of temperature or humidity.
- .2 Waste Management and Disposal:
  - .1 Separate waste materials for [reuse] [and] [recycling] in accordance with Section [01 74 21 - Construction/Demolition Waste Management and Disposal] [\_\_\_\_].

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## Part 2 Products

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### 2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Section [01 47 15 - Sustainable Requirements: Construction] [\_\_\_\_].
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### 2.2 LUMBER MATERIAL

- .1 Softwood lumber: unless specified otherwise, S4S, moisture content 19% or less in accordance with following standards:

- .1 CAN/CSA-O141.
- .2 NLGA Standard Grading Rules for Canadian Lumber.
- .3 AWMAC [custom] [premium] grade, moisture content as specified.
- .2 Machine stress-rated lumber is acceptable.
- .3 Hardwood lumber: moisture content [ ] % or less in accordance with following standards:
  - .1 National Hardwood Lumber Association (NHLA).
  - .2 AWMAC [custom] [premium] grade, moisture content as specified.

## **2.3 PANEL MATERIAL**

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- .1 Douglas fir plywood (DFP): to [CSA O121] [ ], standard construction.
  - .1 Urea-formaldehyde free.
- .2 Canadian softwood plywood (CSP): to [CSA O151] [ ], standard construction.
  - .1 Urea-formaldehyde free.
- .3 Hardwood plywood: to [ANSI/HPVA HP-1] [ ].
  - .1 Urea-formaldehyde free.
- .4 Poplar plywood (PP): to [CSA O153] [ ], standard construction.
  - .1 Urea-formaldehyde free.
- .5 Particleboard: to [ANSI A208.1] [ ].
  - .1 Urea-formaldehyde free.
- .6 Hardboard: to [CAN/CGSB-11.3] [ ].
  - .1 Urea-formaldehyde free.
- .7 Medium density fibreboard (MDF): to [ANSI A208.2] [ ], density 640-800 kg/m<sup>3</sup>.
  - .1 Urea-formaldehyde free.
    - .1 Medium density fibreboard [ ].
      - .1 Urea-formaldehyde free.
- .8 Low density fibreboard: to [CSA-A247M] [ ].
  - .1 Urea-formaldehyde free.
- .9 Decorative overlaid composite panels.
  - .1 Decorative overlay, heat and pressure laminated with suitable resin to [thickness indicated] [12.7] [ ]mm thick [particleboard] [MDF] [urea-formaldehyde free] core.
  - .2 Overlay bonded to both faces where exposed two sides, and when panel material require surface on one side only, reverse side to be overlaid with a plain (buff) balancing sheet.
  - .3 Furniture finish: [ ] wood grain pattern [solid colour] [ ] selected by [Departmental Representative] [Engineer] [Consultant] [ ].

- .4 Edge finishing: [matching melamine and polyester overlay edge strip with self-adhesive] [edges dadoed or saw kerfed to take plastic "T" moulding in width and colour to match melamine finish] [edge filler to provide a smooth surface for paint finish].

## 2.4 ACCESSORIES

- .1 Nails and staples: to CSA B111; galvanized to CAN/CSA-G164 for exterior work, interior humid areas and for treated lumber; [plain] [copper] [stainless steel] finish elsewhere.
- .2 Wood screws: [plain] [electroplated] [copper] [brass] [stainless steel] [steel], type and size to suit application.
- .3 Splines: [wood] [plastic] [metal].

- .4 Adhesive: recommended by manufacturer [\_\_\_\_].
  - .1 Adhesives: [maximum VOC limit [30] [\_\_\_\_] g/L] [SCAQMD Rule 1168 - Adhesives and Sealants Applications].

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Do finish carpentry to Quality Standards of the Architectural Woodwork Manufacturers Association of Canada (AWMAC), except where specified otherwise.
- .2 Scribe and cut as required, fit to abutting walls, and surfaces, fit properly into recesses and to accommodate piping, columns, fixtures, outlets, or other projecting, intersecting or penetrating objects.
- .3 Form joints to conceal shrinkage.

### 3.2 CONSTRUCTION

- .1 Fastening:
  - .1 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.
  - .2 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
  - .3 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round smooth cut hole and plug with wood plug to match material being secured.
  - .4 Replace items of finish carpentry with damage to wood surfaces including hammer and other bruises.
- .2 Standing and running trim:
  - .1 Butt and cope internal joints of baseboards to make snug, tight, joint. Cut right angle joints of casing and base with mitred joints.
  - .2 Fit backs of baseboards and casing snugly to wall surfaces to eliminate cracks at junction of base and casing with walls.

- .3 Make joints in baseboard, where necessary using a [45] [ ] degrees scarf type joint.
- .4 Install door and window trim in single lengths without splicing.
- .3 Interior and exterior frames:
  - .1 Set frames with plumb sides [and] [ ] level heads [and sills] [ ] and secure.
- .4 Panelling:
  - .1 Secure panelling and perimeter trim using adhesive recommended for purpose by manufacturer. Fill nail holes caused by temporary fixing with filler matching wood in colour.
  - .2 Secure panelling and perimeter trim using concealed fasteners.
  - .3 Secure panelling and perimeter trim using counter sunk screws plugged with matching wood plugs.
- .5 Stairs:
  - .1 Install stairs to location and details as indicated.
- .6 Handrails, wall rails and bumper rails.
  - .1 Make joints hair line, dowelled and glued.
  - .2 Support brackets provided under Section [ ] for installation under this Section.
  - .3 Install brackets at ends and at [ ] mm on centre maximum at intermediate spacings.
  - .4 Install metal backing plates between studs at bracket locations to ensure proper support for brackets and bolts or self-tapping screws.
  - .5 Secure using counter sunk screws plugged with matching wood plugs.
- .7 Shelving:
  - .1 Install shelving on [ledgers] [shelf brackets].
- .8 Hardware:
  - .1 Install [ ], location [ ].

### 3.3 SCHEDULES

- .1 Standing and running trim:
  - .1 Exterior:
    - .1 Grade: [ ].
    - .2 Solid stock: [ ] species.
  - .2 Interior:
    - .1 Grade: [ ].
    - .2 Solid stock: [ ] species.
    - .3 Veneered stock: [ ] veneer, [ ] grade, [ ] cut.
- .2 Exterior frames:
  - .1 Grade: [ ].
  - .2 Frames to be solid wood [ ] species.

.3 Construction: [AWMAC Design Detail Sheet No. [\_\_\_\_]] [as detailed].

.3 Interior frames:

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.1 Grade: [\_\_\_\_].

.2 Frames to be solid wood [\_\_\_\_] species.

.3 Construction:

.1 Profile: [AWMAC Design Detail Sheet No. [\_\_\_\_], Type [1] [2] [3] [4] [5]] [as detailed].

.2 Corner: [AWMAC Design Detail Sheet No. [\_\_\_\_], Type [1 Rabbet] [2 Blind Dado] [3 Mitre]] [as detailed].

.4 Fire rated frames:

.1 Grade: [\_\_\_\_].

.2 Frames to be solid wood [\_\_\_\_] species.

.3 Construction:

.1 Profile: [AWMAC Design Detail Sheet No. [\_\_\_\_], Type [1] [2] [3] [4] [5]] [as detailed].

.2 Corner: [AWMAC Design Detail Sheet No. [\_\_\_\_] Type [1 Rabbet] [2 Blind Dado] [3 Mitre]] [as detailed].

.4 Fire rating: [\_\_\_\_].

.5 Stile and rail panelling:

.1 Stile and rail panel types.

.1 Solid wood.

.2 Hardwood plywood.

.3 Hardwood.

.4 Particleboard: [\_\_\_\_] mm thick, [\_\_\_\_] finish/overlay.

.5 MDF: [\_\_\_\_] mm thick, [\_\_\_\_] finish/overlay.

.2 Panel face assembly: [running match] [balanced match] [centre match].

.3 Matching of adjacent panels: [warehouse matched sets] [sequence matched sets] [blueprint matched].

.4 Flitch selection: flitches to be selected by [Departmental Representative] [Engineer] [Consultant] [\_\_\_\_] from sample flitches.

.5 Labelling: classified as to surface burning characteristics as follows:

.1 Flame spread: [\_\_\_\_].

.2 Smoke developed: [\_\_\_\_].

.3 Fuel contributed: [\_\_\_\_].

.6 Stairwork and handrails:

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.1 Treads and nosings: [\_\_\_\_] species, [\_\_\_\_] grade.

.2 Risers: [\_\_\_\_] species, [\_\_\_\_] grade.

.3 Stringers: [\_\_\_\_] species, [\_\_\_\_] grade.

.4 Skirts: [\_\_\_\_] species, [\_\_\_\_] grade.

.5 Balusters: [\_\_\_\_] species, [\_\_\_\_] grade.

.6 Handrail: [\_\_\_\_] species, [\_\_\_\_] grade.

.7 Newel posts: [\_\_\_\_] species, [\_\_\_\_] grade.

.7 Wall rails and bumper rails:

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- .1 [ ] species, grade [ ], [solid] [veneer] stock, [grain direction [ ]]
- .2 MDF.

.8 Shelving:

- .1 Softwood and popular plywood [DFP or CSP or PP [ ] grade] [ ], [ ] grade, [square] [ ] edge, [ ] mm thick.
- .2 Hardwood plywood:
  - .1 Thickness: [ ].
  - .2 Number of plies: [ ].
  - .3 Face veneer: [ ] species, [ ] grade, [ ] cut, [matching requirement] [ ].
  - .4 Back veneer: [ ] species, [ ] grade, [ ] cut, [matching requirement] [ ].
  - .5 Core: [ ].
  - .6 Bond: Type II.
  - .7 Sanding: [no sanding] [touch sanding] [regular sanding].
  - .8 Grain direction [ ].
- .3 Particleboard, grade [ ], [[ ]mm thick].
- .4 Solid wood: [ ] species, [ ] grade, [ ] mm thick.
- .5 MDF [ ] grade, [ ] mm thick, [ ] finish/decorative overlay.
- .6 Edge banding: provide [10] [ ]mm thick solid matching wood strip on [plywood] [particleboard] edges [12] [ ] mm or thicker, exposed in final assembly. Strips same width as [plywood] [particleboard].

**END OF SECTION**



**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Cold applied asphalt bitumen dampproofing.
- .2 Protection Board

**1.3 REFERENCES**

- .1 ASTM D41-05 - Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
- .2 ASTM D449-03 (2008) - Asphalt Used in Dampproofing and Waterproofing.
- .3 CGSB-37-GP-9Ma-83 - Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.
- .4 CAN/CGSB-37.2-M88 - Emulsified Asphalt, Mineral-Colloid Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.
- .5 CAN/CGSB-37.16-M89 - Filled, Cutback, Asphalt for Dampproofing and Waterproofing.
- .6 CRCA (Canadian Roofing Contractors Association) Roofing and Waterproofing Manual.

**1.4 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Product Data: Provide properties of primer, bitumen, and mastics.
- .3 Installation Data: Manufacturer's special installation requirements indicating special procedures and perimeter conditions requiring special attention.

**1.6 QUALITY ASSURANCE**

- .1 Perform Work in accordance with the printed requirements of the dampproofing manufacturer, the NRCA Waterproofing Manual and this specification. Advise designer of any discrepancies prior to commencement of the Work.
- .2 Maintain one copy of manufacturer's literature on site throughout the execution of the Work.
- .3 At the beginning of the Work and at all times during the execution of the Work, allow access to site by the dampproofing manufacturer's representative.
- .4 Applicator Qualifications: Company specializing in performing the work of this section approved by the manufacturer.
- .5 Components and materials must be obtained as a single-source from the membrane manufacturer to ensure total system compatibility and integrity.

**1.7 SITE MOCK-UP**

- .1 Apply dampproofing to minimum 3 m x 3 m area, for approval. Locate mock-up where directed.
- .2 Materials and/or installation methods will be rejected if bond coverage or failure occurs.
- .3 Clean rejected test areas free of applied finish, acceptable for new application.

**1.8 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials to the job site in undamaged and original packaging indicating the name of the manufacturer and product.
- .2 Cold applied membrane should be stored in closed containers outdoors.
- .3 Store roll materials horizontally in original packaging.
- .4 Store membrane at temperature of 5 degrees C (40 degrees F) and above to facilitate handling.
- .5 Membrane contains petroleum solvents and is flammable. Keep away from open flame or excessive heat.

**1.9 CO-ORDINATION**

- .1 Ensure continuity of the damproofing membrane throughout the scope of this section.
- .2 Work shall be so scheduled as to provide a watertight seal at the end of each working day on the areas worked upon during the day.

**1.10 SITE CONDITIONS**

- .1 No installation work shall be performed during rainy or inclement weather and on frost or wet covered surfaces.
- .2 Provide adequate protection of materials and work of this section from damage by weather backfilling operations and other causes.
- .3 Protect work of other trades from damage resulting from work of this section. Make good such damage at own expense to satisfaction of the consultant.

**Part 2 Products**

**2.1 MANUFACTURERS**

- .1 Damproofing Membrane for Temperatures Below 5 degrees C (40 degrees F)
  - .1 To CAN/CGSB 37.16.
  - .2 Asphalt Primer for temperatures below 5 degrees C (40 degrees F) shall be 910-01 Penetrating Asphalt Primer manufactured by Bakor.
  - .3 Solvent base asphalt damproofing membrane for temperatures below 5 degrees C (40 degrees F) shall be 710-11 Premium Grade Foundation Coating manufactured by Bakor.
- .2 Damproofing Membrane for Temperatures Above 5 degrees C (40 degrees F)
  - .1 To CAN/CGSB 37.2
  - .2 Asphalt emulsion primer shall be 700-01 Damproofing Asphalt Emulsion manufactured by Bakor diluted 20% with clean water.
  - .3 Asphalt emulsion damproofing membrane conforming to the requirements of CAN/CGSB-37.2 for temperatures above 5 degrees C (40 degrees F) shall be 700-01 Damproofing Asphalt Emulsion manufactured by Bakor.
- .3 Other manufacturers offering products meeting or exceeding specified products and requirements may be considered.

## **2.3 ACCESSORIES**

- .1 Reinforcing Fabric: Open weave glass fabric yarn saturated with synthetic resins conforming to the requirements of CGSB 37-GP-63M shall be 990-06 Yellow Jacket manufactured by Bakor.
- .2 Protection Board: Polypropylene extruded flexible twin-wall 2mm thick protection board with a compressive strength of 0.45 kg/cm<sup>2</sup> shall be 990-31 Polypropylene Protection Board manufactured by Bakor.
- .3 Protection board adhesive shall be 230-21 Adhesive manufactured by Bakor a synthetic rubber base compound having the following characteristics:
  - .1 Compatible with damproofing membrane and substrate,
  - .2 Long term flexibility: Pass CGSB 71-GP-24M,
  - .3 Chemical resistance: Alkalies, mild acid and salt solutions.
- .4 Water: potable.
- .5 Other products meeting or exceeding specified products and requirements may be considered.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verify substrate surfaces are durable, free of matter detrimental to adhesion or application of damproofing system.
- .2 Verify items which penetrate surfaces to receive dampproofing are securely installed.
- .3 Before commencing work, ensure environmental and site conditions are suitable for installation of damproofing membrane.
- .4 The substrate shall be clean and dry, free from surface water, ice, snow or frost, dust, dirt, oil, grease, curing compounds or any other foreign matter detrimental to the adhesion of the damproofing membrane.
- .5 Bakor 700-01 can be applied to green concrete. Bakor 710-11 must be applied to concrete which has been cured for a minimum of 14 days.
- .6 Notify consultant and contractor in writing of unsuitable surfaces and working conditions. Commencement of work shall imply acceptance of surfaces and working conditions.

### **3.2 PREPARATION**

- .1 Protect adjacent surfaces not designated to receive dampproofing.
- .2 Clean and prepare surfaces to receive dampproofing in accordance with manufacturer's written instructions.
- .3 Do not apply dampproofing to surfaces unacceptable to manufacturer or applicator.
- .4 Apply mastic to seal penetrations, small cracks, or minor honeycomb in substrate.

### **3.3 APPLICATION**

- .1 Prime surfaces to manufacturer's instructions.
- .2 Apply a coat of primer as recommended at rate as recommended and allow to cure until touch dry.
- .3 Apply first bedding coat of damproofing membrane at a minimum rate of 1.0 l/m<sup>2</sup> (2 gal./100ft.<sup>2</sup>) and embed fabric reinforcement immediately eliminating air pockets, wrinkles, buckles or fishmouths, ensure full adhesion and allow to dry.
- .4 Apply successive plies of membrane reinforcement in further bedding coats in the same manner. Offset joints at least 25 mm (1") from joints of preceding ply of membrane reinforcement.
- .5 At all corners and angles, and at the junctions of damproofing on foundation walls with footings, reinforce membrane with two additional coats of damproofing membrane and two plies of fabric reinforcement extending at least 100 mm (4") each side of the junction.
- .6 Apply seal coat of damproofing membrane over entire surface at rate of 1.0 l/m<sup>2</sup> (2 gal./100ft.<sup>2</sup>) and permit to cure thoroughly.

### **3.4 INSTALLATION - PROTECTION BOARD**

- .1 Protection Boards shall be installed over the damproofing membrane to prevent damage from materials used in backfilling.
- .2 Place protection board directly against membrane; butt joints.
- .3 Apply protection board adhesive in 12mm wide strips spaced at 450 mm o/c to cured damproofing membrane. Immediately embed protection board and press into adhesive to ensure full contact. Do not backfill until adhesive has cured and dried. Do not use excessive levels of adhesive.

**END OF SECTION**

**Part 1. General**

**1.1 REFERENCES**

- .1 ASTM C20808 Cellulosic Fibre, Insulating Board.
- .2 ASTM C55207 Cellular Glass Thermal Insulation.
- .3 ASTM C57808 Rigid, Cellular Polystyrene Thermal Insulation.
- .4 ASTM C59108 Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- .5 ASTM C61204e1 Mineral Fibre Block and Board Thermal Insulation.
- .6 ASTM C112604 Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- .7 ASTM C128907 Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- .8 ASTM E8408a Test Method for Surface Burning Characteristics of Building Materials.
- .9 ASTM E96/E96M05 Test Methods for Water Vapor Transmission of Materials.
- .10 CAN/ULCS10207 Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .11 CAN/ULCS70105 Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .12 CAN/ULCS70297 Thermal Insulation, Mineral Fibre, for Buildings.
- .13 CAN/ULCS70301 Cellulose Fibre Insulation (CFI) for Buildings.
- .14 CAN/ULCS70403 Thermal Insulation, Polyurethane and Polyisocyanurate Boards, Faced.
- .15 CAN/ULCS70602 Wood Fibre Thermal Insulation for Buildings.

**1.2 SEQUENCING**

- .1 Sequence work to ensure air barrier materials are in place before beginning the Work of this section.

**1.3 ENVIRONMENTAL REQUIREMENTS**

- .1 Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

**Part 2. Products**

**2.1 BELOW GRADE INSULATING MATERIALS**

- .1 Perimeter Wall Insulation: Polystyrene, extruded type, in accordance with CAN/ULC S701, Type 4, thermal resistance not less than RSI 0.87/25 mm; square edges, board size 610 mm x 2440 mm x thickness as indicated on Drawings; minimum compressive strength 170 kPa at 10% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in conformation with ASTM D2842:
- .2 Load Bearing Insulation: Polystyrene, high density extruded type in accordance with CAN/ULC S701, Type 4, thermal resistance not less than RSI 0.87/25 mm; square edges, board size 610 mm x 2440 mm x thickness as indicated on Drawings; minimum compressive strength 275 kPa at 5% deformation in accordance with ASTM D1621, water absorption (% by volume) maximum 0.7% in conformation with ASTM D2842.
- .3 Protected Insulation: Extruded polystyrene as specified in 2.1.1; complete with minimum 13mm thick cementitious protection board applied to one side.

## ACCESSORIES

- .4 Insulation Fasteners:
  - .1. Perimeter Insulation Fasteners: Concrete faced insulation manufacturer's standard concealed fasteners with groove mounting plate and fastening spline.
- .5 Insulation Adhesive:
  - .1. Trowelable Polystyrene Insulation Adhesive: Trowel consistency, synthetic rubber based insulation adhesive compatible with polystyrene insulation in accordance with CGSB 71GP24M; suitable for application in temperatures down to 12°C.
  - .2. Acceptable Materials:
    - .1. [Bakor](#), 23021 Rigid Insulation Adhesive
    - .2. Alternates will be considered for this material.
- .6 Perimeter Insulation Flashings: Coordinate supply of end closures and flashings for perimeter insulation system with Section 07 62 00.

## Part 3. Execution

### 3.1 EXAMINATION

- .1 Examine substrates and conditions for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
- .2 Verify that all surfaces which are to receive rigid insulation are clean, free of deleterious matter and are sufficiently level to allow the proper installation of insulation.
- .3 Verify that all flashings provided under other Sections are installed and that they divert moisture to exterior of insulated systems.

### 3.2 PREPARATION

- .1 Clean substrates of substances harmful to insulations; remove projections that interfere with insulation attachment.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION, GENERAL

- .1 Comply with insulation and accessory manufacturer's written instructions applicable to products and application indicated.
- .2 Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice and snow.
- .3 Install insulation to maintain continuous thermal insulation, vapour barrier and air tightness for building spaces and elements, and as follows:
- .4 Saw cut and trim insulation neatly to fit spaces; fill voids with foamed-in-place insulation compatible with installed insulation, refer **to Section 07 21 19**.
- .5 Butt edges and ends tight.
- .6 Fit insulation tight against mechanical, electrical and other items protruding through the plane of insulation.
- .7 Use insulation free of broken or chipped edges.
- .8 Apply single layer of insulation to produce thickness indicated, unless multiple layers are otherwise specifically shown or required to make up total thickness.

- .9 Fit insulation firmly against substrate using mechanical fasteners spaced in accordance with manufacturers recommended spacing and pattern; in addition, adhere insulation to uneven substrate surfaces and provide additional fasteners to eliminate air spaces between insulation and substrate.
- .10 Mechanically fasten insulation boards 50 mm in from edges at 305 mm centres.
- .11 Leave insulation joints un-bonded over line of expansion and control joints; bond a continuous 150 mm wide 150 µm thick polyethylene strip over expansion and control joints using compatible adhesive before application of insulation.
- .12 Protect insulation from damage until it is covered; replace any broken, sunburned, crushed or dented insulation immediately prior to covering; coordinate with backfilling operations.

### **3.4 INSTALLATION, PERIMETER AND UNDER SLAB INSULATION**

- .1 Perimeter Insulation: Adhere board insulation to vertical surfaces with adhesive applied in accordance with manufacturer's written instructions, and as follows:
  - .1. Exterior Application: Extend boards a minimum of 1220 mm below finish grade, as indicated on Drawings, installed on exterior face of perimeter foundation wall.
  - .2. Apply adhesive to the substrate by the "dab" method not less than 10 mm x 19 mm size at 150 mm centres; bed the insulation in the adhesive before the adhesive loses its tack or skins over.
  - .3. Protect below grade insulation on vertical surfaces from damage during backfilling by applying protection board; set in adhesive according to insulation manufacturer's written instructions.
  - .4. Install protected insulation board to locations indicated on Drawings..

### **3.5 INSTALLATION, BELOW GRADE INSULATION**

- .1 Load Bearing Insulation: Install board insulation horizontally having a minimum compressive strength to locations indicated on Drawings.

### **3.6 PROTECTION**

- .1 Protect installed board insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- .2 Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION**

**Part 1. General**

**1.1 REFERENCES**

- .1 ASTM C66506 MineralFibre Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .2 ASTM E84 10 Test Method for Surface Burning Characteristics of Building Materials.
- .3 CAN/ULCS10203 Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 CAN/ULCS70209 Thermal Insulation, Mineral Fibre, for Buildings.
- .5 NFPA 255 Test of Surface Burning Characteristics of Building Materials.
- .6 UL 723 Tests for Surface Burning Characteristics of Building Materials.

**Part 2. Products**

**2.1 MATERIALS**

- .1 Batt Insulation: Un-faced, flexible, preformed GreenGuard™ or formaldehyde free fibrous insulation in accordance with CAN/ULC S702, Type 1; having a nominal RSI of 0.55/25 mm, thickness as required to meet design insulation values indicated on drawings or as required to fill insulated spaces where not indicated.
- .2 Fibrous Mineral Wool Wall Insulation: Un-faced, preformed mineral slag batt insulation in accordance with CAN/ULC S702, Type 1; having a nominal RSI of 0.67/25 mm; rated noncombustible in accordance with CAN/ULC S114 and having a flame spread rating of 5 or less in accordance with CAN/ULC S102; density 32 kg/m<sup>3</sup>; square edges, thickness as required to meet design insulation values indicated on drawings or as required to fill insulated spaces where not indicated.
- .3 Acoustic Insulation: CAN/ULC S702; preformed glass or mineral fibre, friction fit type, unfaced, in thicknesses to fill wall cavities.

**Part 3. Execution**

**3.1 INSTALLATION**

- .1 Install insulation where indicated in accordance with ASTM A1320, and as follows:
  - .1. Utilize either fibrous or mineral wool insulation for exterior wall applications at the option of the Contractor and acoustic insulation for all interior wall applications, unless specifically noted otherwise on Drawings.
  - .2. Where required to maintain continuity of thermal insulation of the building envelope.
  - .3. Cut and trim insulation neatly to fit spaces; butt ends and edges tight; fit insulation tightly to framing members and around pipes, conduits, and projecting structural members within insulated spaces.
  - .4. Fill stud space of exterior framed walls with insulation full depth of stud only where no insulation/vapour retardant indicated on exterior face of stud walls.
  - .5. Do not compress insulation to fit into spaces.
  - .6. Fill stud space of temporary partitions with insulation.



- .7. Hold insulation in position with clips, wires or as recommended by manufacturer when insulation is installed in horizontal locations.
- .8. Place acoustic insulation in interior walls tight within spaces, around cut openings, behind and around electrical and mechanical items within or behind walls, and tight to items passing through walls.

### **3.2 PROTECTION**

- .1 Protect installed insulation from damage arising from harmful weather exposures, physical abuse, and other causes.
- .2 Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION**

**Part 1 General**

**1.1 INTENT**

- .1 Foam-in-place insulation to exterior hollow metal doorframes and aluminum door and window frames.
- .2 Foam-in-place insulation around protrusions through the exterior wall envelope and juncture of different cladding materials.

**1.2 REFERENCES**

- .1 American Society for Testing and Materials (ASTM):
  - .1 ASTM C273-00e1, Standard test method for shear properties of sandwich core materials
  - .2 ASTM D1622-03, Standard test methods for apparent density of rigid cellular plastics
  - .3 ASTM D1621-04, Standard test methods for compressive properties of rigid cellular plastics
  - .4 ASTM D1623-03, Standard test methods for tensile and tensile adhesion properties of rigid cellular plastics
  - .5 ASTM D2842-01, Standard test methods for water absorption of rigid cellular plastics
  - .6 ASTM E96-00e1, Standard test method for water vapour transmission of materials

**1.3 QUALITY ASSURANCE**

- .1 Cooperate and coordinate with the requirements of other units of work specified in other sections.

**1.4 PROJECT CONDITIONS**

- .1 Apply foam-in-place insulation only when substrate and ambient temperatures are within the prescribed limits.
- .2 Ensure that temperature is maintained throughout the curing period.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Insulation: One component rigid urethane foam with the following physical properties:

Density (ASTM D1622):	30.3 kg/m <sup>3</sup>
Compressive Strength (ASTM D1621):	57.5 kPa
Compressive Modulus (10% deflection):	848 kPa
Tensile Strength (ASTM D1623):	133.5 kPa
Flatwise Shear (ASTM C273):	58.5 kPa
Thermal Resistance:	1.41 RSI/25 mm thickness
Water Absorption (ASTM D2842):	3.0 kg/H2O/m <sup>2</sup>
Water Vapour Transmission (ASTM E96):	2.327 perms

**Part 3 Execution**

**3.1 SURFACE PREPARATION/EXISTING CONDITIONS**

- .1 Clean spaces that are to receive insulation, of dirt, dust, grease, loose material or other foreign matter that may inhibit adhesion.
- .2 Provide sufficient ventilation during and until insulation has cured, to ensure safe working conditions. Introduce fresh air and exhaust air continuously during the 24-hour period after application.
- .3 Protect adjacent surfaces from overspray and dusting.
- .4 Prior to application, slightly moisten surfaces to which foam-in-place insulation is being applied, to accelerate curing.
- .5 Temporarily brace frames as may be required to prevent possible bowing of frames due to over expansion of the foam-in-place insulation.

**3.2 INSTALLATION STEEL DOOR FRAMES**

- .1 Fill exterior hollow metal door frames 75% full with foam-in-place insulation prior to installation of frames. Fill the remainder of the frame after installation, through the gap between the frame and the wall construction.

**3.3 INSTALLATION/AIR SEAL AROUND EXTERIOR WINDOW AND DOOR FRAMES**

- .1 Install foam-in-place insulation around all exterior window frames to maintain continuity of the thermal barrier, after air barrier has been installed and sealed to window frames.
- .2 Ensure that foam completely fills spaces, without voids, and that voids, and that foam is continuous at corners.

**3.4 INSTALLATION/AROUND PROTRUSIONS THROUGH AIR SEAL**

- .1 Install foam-in-place insulation around all protrusions through the exterior building envelope to achieve and maintain continuity of air/vapour seal.

**3.5 CLEAN UP**

- .1 Cut back excess foam-in-place insulation once cured, flush with surrounding surfaces, or recess back for application of sealant as specified in Section 07 90 00.
- .2 Upon completion of foam-in-place insulation work, clean adjacent surfaces of overspray and dusting to the satisfaction of the Consultant.

**END OF SECTION**

**Part 1. General**

**1.1. PRODUCT DELIVERY, STORAGE AND HANDLING**

- .1 Deliver sheet air and vapour retarder materials in factory wrapped rolls with labels indicating:
  - .1 Manufacturer or trade name.
  - .2 Compliance with CGSB standard and type or CMHC Acceptance Number.
  - .3 Material type, thickness, roll width and area.
- .2 Protect materials from direct exposure to sunlight and physical damage.

**1.2. COORDINATION**

- .1 Coordinate installation of sheet air and vapour retarders with work of other Sections to achieve an air and vapour retarder tight building envelope.

**Part 2. Products**

**2.1. MATERIALS**

- .1 Sheet Vapour Retarder: to CAN/CGSB-51.34-M86, 6 mil. thick polyethylene film.
- .2 Staples: hot-dipped galvanized, type and size to suit application, minimum 6 mm leg
- .3 Sheet Air Retarder: asphalt saturated breather type sheathing paper to CAN2-51.32M, 11.34 kg, meeting the requirements of Federal Specification UU-B-790a, Grade D
- .4 Sheathing Joint Tape: specially formulated self adhesive permanent acrylic type with oriented polypropylene backing, 50mm wide, red colour.
- .5 Flexible Sealant: non-hardening, non-skinning permanently flexible, polyurethane sealant to CAN/CGSB 19-GP-13M.
- .6 Polyethylene Pans: 18 mil black polyethylene pans moulded to fit between framing members to accommodate recessed equipment and electrical outlet boxes.

**Part 3. Execution**

**3.1. INSTALLATION OF VAPOUR RETARDER.**

- .1 Install continuous sheet vapour retarder at exterior insulated framing elements.
- .2 Place vapour retarder on warm side (inside) of thermal insulation as indicated on drawings.
- .3 Installed vapour retarder shall form a complete and continuous envelope at exterior building elements, properly sealed at all joints, fastenings and penetrations, effectively resisting moisture migration.
- .4 All penetrations through the vapour retarder, unless clearly detailed on drawings, must be approved by the Departmental Representative. Install polyethylene pans at all electrical penetrations.

- .5 To ensure continuity of vapour retarder at all locations, install strips of vapour retarder material of sufficient widths, at all intersecting walls, at tops of walls at joist bearings and all other locations where subsequent work would prevent installation of a continuous vapour retarder membrane.
- .6 Mechanically fasten vapour retarder joints over solid backing, lap minimum one full stud or joist space, and seal with flexible sealant between sheets. Ensure that no gaps exist in sealant bead. Seal joints with tape.
- .7 Seal perimeter of vapour retarder as follows:
  - .1 Apply continuous bead of sealant to substrate at perimeter of sheet vapour retarder.
  - .2 Lap sheet into sealant and press into sealant bead.
  - .3 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
  - .4 Seal joints with tape.
- .8 Seal around all penetrations through membrane with flexible sealant.
- .9 After completion, inspect entire installation and repair or replace damaged material. Do not conceal any areas until the Departmental Representative has inspected and accepted installation of vapour retarder.
- .10 Inspect vapour retarder for continuity. Repair punctures, rips and tears with sealing tape.
- .11 Where punctures and tears are extensive replace entire damaged section.
- .12 Seal penetrations through polyethylene pans and outlet box covers with acoustical sealant.

### **3.2. INSTALLATION OF AIR RETARDER.**

- .1 Install air retarder to exterior face of wall sheathing.
- .2 Offset joints with those of sheathing minimum 300mm. Overlap joints of membrane minimum 300mm. Ensure no joints occur at corners.
- .3 Pull air retarder tight against wall sheathing and around perimeter of openings.
- .4 At window openings, lap air retarder over vapour retarder and seal with joint tape.
- .5 Staple air retarder to substrate and cover staples and all joints with joint tape.
- .6 Repair all rips, tears, punctures or holes in air retarder with joint tape.

### **3.3. SEALING AROUND EXTERIOR DOOR AND WINDOW OPENINGS**

- .1 Fill gap between rough opening and aluminum window frames with batt insulation.
- .2 Apply foam rod and sealant in accordance with manufacturer's instructions.
- .3 Install foam sealant around door frames, electrical chases, exhaust systems, lintels, sheathing, sill plates, sole plates, top plates, wall penetrations, wood window frames and as shown on drawings.
- .4 Seal in and around main power supply conduit where it enters building.

- .5 Seal where electrical wires and plumbing stacks penetrate the top plates of partition walls intersecting insulated ceilings, or the first stud of an interior partition wall intersects an exterior perimeter insulated wall.

**END OF SECTION**

**PART 1 General**

**1.1 SUMMARY**

- .1 This Section includes the following:
  - .1 Asphalt shingles.
  - .2 Felt underlayment.
  - .3 Self adhering sheet underlayment.

**1.2 REFERENCES**

- .1 Alberta Roofing Contractor's Association (ARCA):
  - .1 Roofing Application Standards Manual: Part 3 – Steep Slope Roofing.
- .2 American Society for Testing and Materials ([ASTM](#)):
  - .1 ASTM B74903, Standard Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products
  - .2 ASTM D197001, Standard Specification for Self Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
  - .3 ASTM D486904, Standard Specification for Asphalt Saturated Organic Felt Underlayment Used in Steep Slope Roofing
  - .4 ASTM D638103b, Standard Test Method for Measurement of Asphalt Shingle Tab Mechanical Uplift Resistance
- .3 Canadian Standards Association ([CSA](#)):
  - .1 CAN/CSA A123.198/A123.598 (R2004), Asphalt Shingles Made From Organic Felt and Surfaced With Mineral Granules / Asphalt Shingles Made From Glass Felt and Surfaced With Mineral Granules
  - .2 CSA A123.398 (R2004), Asphalt or Tar Saturated Roofing Felt
  - .3 CAN3 A123.51M85 (R2001), Asphalt Shingle Application on Roof Slopes 1:3 and Steeper
  - .4 CAN3 A123.52M85 (R2001), Asphalt Shingle Application on Roof Slopes 1:6 to Less Than 1:3
- .4 Canadian General Standards Board ([CGSB](#)):
  - .1 CAN/CGSB 37.5M89, Cutback Asphalt Plastic Cement
- .5 Underwriters Laboratories of Canada ([ULC](#)):
  - .1 CAN/ULC S1072003, Fire Tests of Roof Coverings

### 1.3 SUBMITTALS

- .1 Comply with requirements of Section 01 33 00.
- .2 Provide product data for each type of product specified.
- .3 Provide the following samples:
  - .1 Samples for Verification: For the following products, of sizes indicated, to verify colour selected, as follows:
    - .1 Asphalt Shingle: Full size asphalt shingle strip.
    - .2 Ridge and Hip Cap Shingles: Full size ridge and hip cap asphalt shingle.
    - .3 Ridge Vent: 305 mm (12") long Sample.
    - .4 Exposed Valley Lining: 305 mm (12") square.
    - .5 Self Adhering Underlayment: 305 mm (12") square.
- .4 Provide qualification data for Installer, including certificate signed by asphalt shingle manufacturer stating that Installer is approved, authorized, or licensed to install roofing system indicated.

### 1.4 QUALITY ASSURANCE

- .1 Fire Test Response Characteristics:
  - .1 Provide asphalt shingle and related roofing materials with the fire test response characteristics indicated, as determined by testing identical products in accordance with test method below.
  - .2 Exterior Fire Test Exposure: accordance with ULC S107 for application and roof slopes indicated.
  - .3 UL or another testing and inspecting agency acceptable to authorities having jurisdiction may be considered where products are marked with either a cUL or cUL<sub>US</sub> or similar marking from other testing agencies.
  - .4 Identify materials with appropriate markings of applicable testing and inspecting agency.

### 1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Store roofing materials in a dry, well ventilated, weather tight location in accordance with asphalt shingle manufacturer's written instructions.
- .2 Store underlayment rolls on end on pallets or other raised surfaces; do not double stack rolls.
- .3 Handle, store, and place roofing materials in a manner to avoid significant or permanent damage to roof deck or structural supporting members.
- .4 Protect unused underlayment from weather, sunlight, and moisture when left overnight or when roofing work is not in progress.

### 1.6 PROJECT CONDITIONS

- .1 Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit asphalt shingle roofing to be performed in accordance with manufacturer's written instructions and warranty requirements.



- .2 Install self adhering sheet underlayment within the range of ambient and substrate temperatures recommended by manufacturer.

## 1.7 WARRANTY

- .1 Provide an ARCA 5 year Warranty Certificate effective from date of Substantial Performance of the project.
- .2 Manufacturer's Warranty: Provide manufacturer's standard product warranty indicating that they will be responsible to repair or replace asphalt shingles that fail in materials or workmanship for a period of 30 years. Materials failures include manufacturing defects and failure of asphalt shingles to self seal after a reasonable time.

## PART 2 Products

### 2.1 ACCEPTABLE MANUFACTURERS

- .1 Provide materials manufactured by one of the following:
  - .1 [IKO](#), Telephone: (403) 510 4414, (780) 940 7004, or (800) 661 1034 ext 373
  - .2 [Malarkey Roofing Company](#), Telephone: (403) 207 3400 or (780) 439 9300
  - .3 [Atlas Roofing Corporation](#), Telephone: (403) 277 5347 or (780) 474 5491
  - .4 [Elk Corporation](#), Telephone: (403) 720 0600 or (780) 437 7003.
  - .5 [GAF Materials Corporation](#), Telephone: (403) 207 3400 or (780) 439 9300.

### 2.2 ORGANIC FELT REINFORCED ASPHALT SHINGLES

- .1 Three Tab Strip Asphalt Shingles: Fibreglass reinforced roof shingles manufactured in accordance with CAN/CSA A123.1 or ASTM D225, granule surfaced, and self sealing asphalt shingles having a minimum applied weight of 124 kg/10 m<sup>2</sup> (254#/100 ft<sup>2</sup>), A fire rating; and as follows:
  - .1 Strip Size: Manufacturer's standard.
  - .2 Colour and Blends: as indicated on drawings.
- .2 Hip and Ridge Shingles: Manufacturer's standard units to match asphalt shingles.

### 2.3 UNDERLAYMENT MATERIALS

- .1 Felts: In accordance with CSA A123.3, Type I, 15# asphalt saturated organic felts, nonperforated.
- .2 Ice Dam Protection: Self Adhering Sheet Underlayment, Granular Surfaced in accordance with ASTM D1970, minimum of 1.4 mm (0.055") thick sheet; glass fibre mat reinforced, SBS modified asphalt; mineral granule surfaced; with release paper backing; cold applied.
  - .1 Acceptable materials:
    - .1 CertainTeed Corporation; WinterGuard.
    - .2 GAF Materials Corporation; Weather Watch.
    - .3 IKO; ArmourGuard.
    - .4 Johns Manville International, Inc.; Roof Defender.

## 2.4 ACCESSORIES

- .1 Asphalt Roofing Cement: CGSB 37.5, Type II, asbestos free.
- .2 Staples: Standard wire shingle hot dipped zinc coated steel type, of sufficient length to penetrate into roof sheathing
- .3 Roofing Nails: Aluminum, stainless steel, copper, or hot dip galvanized steel wire shingle nails, minimum 3 mm (1/8") diameter, barbed shank, sharp pointed, with a minimum 10 mm (3/8") diameter flat head and of sufficient length to penetrate 3 mm (1/8") through OSB or plywood sheathing.
- .4 Where nails are in contact with metal flashing, use nails made from same metal as flashing.

## 2.5 METAL FLASHING AND TRIM

- .1 Sheet Metal Flashing and Trim: In accordance with Section 07 62 00 Sheet Metal Flashings and Trim.
- .2 Fabricate sheet metal flashing and trim in accordance with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item, and as follows:
  - .1 Apron Flashings: Fabricate with lower flange a minimum of 100 mm (4") over and 100 mm (4") beyond each side of down slope asphalt shingles and 150 mm (6") up the vertical surface.
  - .2 Step Flashings: Fabricate with a head lap of 50 mm (2") and a minimum extension of 100 mm (4") over the underlying asphalt shingle and up the vertical surface.
  - .3 [Cricket] [Backer] [Saddle] Flashings: Fabricate with concealed flange extending a minimum of 450 mm (18") beneath upslope asphalt shingles and 150 mm (6") beyond each side of [chimney] [skylight] and 150 mm (6") above the roof plane.
  - .4 Open Valley Flashings: Fabricate in lengths not exceeding 3050 mm (10' 0") with 25 mm (1") high inverted V profile at centre of valley and equal flange widths of 305 mm (12"), 610 mm (24") total.
  - .5 Drip and Rake Edges: Fabricate in lengths not exceeding 3050 mm (10' 0") with 50 mm (2") roof deck flange and 38 mm (1 1/2") fascia flange with 10 mm (3/8") drip at lower edge.
- .3 Vent Pipe Flashings: ASTM B749, Type L51121, at least 1.5 mm (1/16") thick. Provide lead sleeve sized to slip over and turn down into pipe, soldered to skirt at slope of roof and extending at least 100 mm (4") from pipe onto roof.

## PART 3 Execution

### 3.1 EXAMINATION

- .1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
  - .1 Examine roof sheathing to verify that sheathing joints are supported by framing and blocking or metal clips and that installation is within flatness tolerances.

- .2 Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and completely anchored; and that provision has been made for flashings and penetrations through asphalt shingles.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 UNDERLAYMENT INSTALLATION

- .1 Single Layer Felt Underlayment: Install single layer of felt underlayment on roof deck perpendicular to roof slope in parallel courses. Lap sides a minimum of 50 mm (2") over underlying course. Lap ends a minimum of 100 mm (4"). Stagger end laps between succeeding courses at least 1830 mm (6').
  - .1 Install felt underlayment on roof deck not covered by self adhering sheet underlayment. Lap sides of felt over self adhering sheet underlayment not less than 76 mm (3") in direction to shed water. Lap ends of felt not less than 150 mm (6") over self adhering sheet underlayment.
- .2 Self Adhering Ice Dam Protection Sheet: Install self adhering sheet, wrinkle free, on roof deck. Comply with low temperature installation restrictions of underlayment manufacturer if applicable. Install at locations indicated below, lapped in direction to shed water. Lap sides not less than 89 mm (3 ½"). Lap ends not less than 150 mm (6") staggered 610 mm (24") between courses. Roll laps with roller. Cover underlayment within seven days.
  - .1 Eaves: Extend from edges of eaves 610 mm (24") beyond interior face of exterior wall.
  - .2 Rakes: Extend from edges of rake 610 mm (24") beyond interior face of exterior wall.
  - .3 Valleys: Extend from lowest to highest point 450 mm (18") on each side.
  - .4 Hips: Extend 450 mm (18") on each side.
  - .5 Ridges: Extend 900 mm (36") on each side without obstructing continuous ridge vent slot.
  - .6 Sidewalls: Extend beyond sidewall 450 mm (18") and return vertically against sidewall not less than 100 mm (4").
  - .7 Dormers, Chimneys, Skylights, and other Roof Penetrating Elements: Extend beyond penetrating element 450 mm (18") and return vertically against penetrating element not less than 100 mm (4").
  - .8 Roof Slope Transitions: Extend 450 mm (18") on each roof slope.
- .3 Metal Flashed Open Valley Underlayment: Install two layers of 900 mm (36") wide felt underlayment centred in valley. Stagger end laps between layers at least 1830 mm (6'). Lap ends of each layer at least 305 mm (12") in direction to shed water, and seal with asphalt roofing cement. Fasten each layer to roof deck with felt underlayment nails.
- .4 Lap roof deck felt underlayment over first layer of valley felt underlayment at least 150 mm (6").

### 3.3 METAL FLASHING INSTALLATION

- .1 General: Install metal flashings and other sheet metal in accordance with requirements in Section 07 62 00 – Metal Flashing and Trim.
- .2 Install metal flashings in accordance with recommendations in ARCA's Steep Roofing Division, Requirements for 5 Year Certificate of Assurance.
- .3 Apron Flashings: Extend lower flange over and beyond each side of down slope asphalt shingles and up the vertical surface.
- .4 Step Flashings: Install with a head lap of 50 mm (2") and extend over the underlying asphalt shingle and up the vertical surface. Fasten to roof deck only.
- .5 Cricket, Backer and Saddle Flashings: Install against the roof penetrating element extending concealed flange beneath upslope asphalt shingles and beyond each side.
- .6 Open Valley Flashings:
  - .1 Adhere one ply of 900 mm (36") wide self adhering ice dam protection material, centred in valley.
  - .2 Install 610 mm (24") wide flashing centred in valley, lapping ends at least 203 mm (8") in direction to shed water.
  - .3 Fasten upper end of each length to roof deck beneath overlap.
  - .4 Secure hemmed flange edges into metal cleats spaced 305 mm (12") apart and fastened to roof deck.
  - .5 Adhere 225 mm (9") wide strip of self adhering sheet to metal flanges and to self adhering sheet underlayment.
- .7 Rake Drip Edges: Install rake drip edge flashings over underlayment and fasten to roof deck.
- .8 Eave Drip Edges: Install eave drip edge flashings below underlayment and fasten to roof sheathing; maintain a minimum of 6 mm (¼") spacing between vertical flashing flange and fascia.
- .9 Pipe Flashings: Form flashing around pipe penetrations and asphalt shingles. Fasten and seal to asphalt shingles as recommended by manufacturer.

### 3.4 ASPHALT SHINGLE INSTALLATION

- .1 Install asphalt shingles in accordance with manufacturer's written instructions, recommendations in ARCA's, Steep Roofing Division, requirements for ARCA 5 Year Certificate of Assurance.
- .2 Install starter strip along lowest roof edge, consisting of an asphalt shingle strip with tabs removed with self sealing strip face up at roof edge.
  - .1 Extend asphalt shingles 19 mm (¾") over fascia at eaves and rakes.
  - .2 Install starter strip along rake edge.
- .3 Install first and remaining courses of asphalt shingles stair stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.

- .4 Install first and remaining courses of asphalt shingles stair stepping diagonally across roof deck with manufacturer's recommended offset pattern at succeeding courses, maintaining uniform exposure.
- .5 Fasten asphalt shingle strips with staples in accordance with manufacturer's written instructions.
- .6 Open Valleys: Cut and fit asphalt shingles at open valleys, trimming upper concealed corners of shingle strips. Maintain uniform width of exposed open valley, and as follows:
  - .1 Set valley edge of asphalt shingles in a 76 mm (3") wide bed of asphalt roofing cement.
  - .2 Do not secure shingles to open valley metal flashings.
- .7 Ridge and Hip Cap Shingles:
  - .1 Maintain same exposure of cap shingles as roofing shingle exposure.
  - .2 Lap cap shingles at ridges to shed water away from direction of prevailing winds.

**END OF SECTION**

## **PART 1.General**

### **1.1 SUMMARY**

- .1 This Section includes requirements for supply and installation of factory formed, site assembled, non-structural, exposed fastener, metal roofing system; including accessories required for weather tight installation; job site manufactured materials will not be acceptable for this project.
- .2 Drawings indicate size, profiles, and dimensional requirements of metal roofing system and are based on the specific system indicated; do not modify intended aesthetic effects.

### **1.2 DEFINITIONS**

- .1 Metal Roofing System Assembly: Metal roofing system, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weather tight roofing system.
- .2 Core Metal Thickness: Minimum thickness of base metal without metallic coatings or painted finishes.

### **1.3 REFERENCE STANDARDS**

- .1 ASTM A653/A653M-07, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .2 ASTM A755/A755M-03, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products
- .3 ASTM A792/A792M-06 Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
- .4 ASTM C1396/C1396M-06a, Standard Specification for Gypsum Board
- .5 CGSB 37-GP-56M-85, Membrane, Modified, Bituminous, Prefabricated and Reinforced for Roofing
- .6 CSA A123.3-05, Asphalt or Tar Saturated Roofing Felt
- .7 CSA S136-94 (R2001), Cold Formed Steel Structural Members
- .8 CSSBI 20M-99, Sheet Steel Cladding for Architectural, Industrial and Commercial Building Applications
- .9 SMACNA Architectural Sheet Metal Manual.

### **1.4 SYSTEM REQUIREMENTS**

- .1 Refer to Drawings for loads and deflections.
  - .1. Design to provide for movement of components without damage, failure of joint seals, undue stress on fasteners, or other detrimental effects when subject to seasonal or cyclic day/night temperature ranges.
  - .2. Design assembly to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.
  - .3. Design assembly to accommodate live and dead loads, drag, wind loads, thermal effects, rainfall, snow load, and curved deck application.

- .4. Seismic Loads: Design and size components to withstand seismic loads and sway displacement as calculated in accordance with code applicable at place of the Work.

## 1.5 COORDINATION:

- .1 Coordinate metal roofing system with rain drainage work, flashing, trim, and construction of decks, parapets, walls, and other adjoining work to provide a leak proof, secure, and non-corrosive installation.

## 1.6 SUBMITTALS

- .1 Comply with requirements of Section 01 33 00.
- .2 Product Data: Submit product data including; but not limited to, construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roofing system and accessory.
- .3 Shop Drawings: Submit shop drawings indicating fabrication and installation layouts of metal roofing system; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details, identify between factory and site assembled work, include details for the following:
  - .1. Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
  - .2. Shop Drawings shall bear the seal and stamp of a Professional Engineer experienced in design of this work and licensed in the province of British Columbia and shall indicate:
    - .1. calculations for loadings and stresses.
    - .2. member sizes.
    - .3. materials.
    - .4. design thickness exclusive of coatings, coating specifications.
    - .5. layout.
    - .6. screw sizes and spacing.
    - .7. anchors.
    - .8. maximum sizes of cut-outs.
    - .9. flashing details and accessories.
    - .10. weather barriers and self-adhesive membrane.
    - .11. seal to penetrations.
  - .3. Submit complete with seal of a Professional Engineer registered to practice in Alberta certifying that the work of this Section meets or exceeds the snow and wind loading requirements of the Alberta Building Code, latest editions.
- .4 Accessory details drawn at minimum 1:10 scale including; but not limited to, the following:
  - .1. Flashing and trim
  - .2. Roof curbs
  - .3. Snow guards
- .5 Samples: Submit one (1) sample for each type of exposed finish required for Consultant's verification of finishes, prepared in sizes as follows:

- .1. Metal roofing system: 300 mm long by actual panel width; include fasteners, clips, closures, and other metal roofing system accessories.
- .2. Trim and Closures: 300 mm long; include fasteners and other exposed accessories.
- .3. Vapour Retarders: 150 mm square samples.
- .4. Accessories: 300 mm long samples for each type of accessory.
- .6 Informational Submittals: Provide the following submittals when requested by the Consultant:
- .7 Coordination Drawings: Coordination drawings drawn at minimum 1:100 indicating locations of penetrations and roof mounted items including; but not limited to, the following:
  - .1. Roof systems and attachments.
  - .2. Roof hatches
  - .3. Equipment supports
  - .4. Pipe supports and penetrations
  - .5. Lighting fixtures
  - .6. Snow guards
  - .7. Items mounted on roof curbs

#### **1.7 PROJECT CLOSEOUT SUBMISSIONS**

- .1 Operation and Maintenance Data: Submit manufacturers written maintenance data for metal roofing system, include name of original installer and contact information for inclusion in maintenance manuals in accordance with Section 01 78 00.

#### **1.8 QUALITY ASSURANCE**

- .1 Qualifications: Provide proof of qualifications when requested by Consultant:
- .2 Manufacturer: Obtain each type of metal roofing system through one source from a single manufacturer.
- .3 Perform work in accordance with ARCA standard details and requirements unless modified by this Section to exceed minimum 10 year warranty.
- .4 Fabricator Qualifications: Company specializing in manufacturing the Products specified in this section.
- .5 Installer Qualifications: Company specializing in performing the work of this section approved by the manufacturer. Installer: Use only installers that are trained and qualified by factory formed roofing panel manufacturer, and who have experience in projects of similar complexity and scope.
- .6 Contractors Field Supervision: Maintain dedicated full time supervisor/ foreman on site while roofing work in progress. Supervisor must have roofing trade certification in roofing work similar in nature and scope of specified roofing. Roofing crew makeup shall be trade qualified journeyman roofers and registered apprentices in ratio of no more than 1 to 1 (at least one journeyman to one apprentice). Qualifications may be reviewed prior to award of contract or on site by the Consultant and/or roofing inspector.



## **1.9 DELIVERY, STORAGE, AND HANDLING**

- .1 Delivery and Acceptance Requirements: Deliver components, sheets, metal roofing system, and other manufactured items to prevent damage or deformation; package metal roofing system for protection during transportation and handling.
- .2 Storage and Handling Requirements: Unload, store, and erect metal roofing system in a manner to prevent bending, warping, twisting, and surface damage, and as follows:
  - .1. Protect metal roofing system to prevent wetting of materials, and as follows:
  - .2. Stack metal roofing system on platforms or pallets, covered with suitable weather tight and ventilated covering.
- .3 Do not store metal roofing system in contact with other materials that might cause staining, denting, or other surface damage.
- .4 Protect strippable protective covering on metal roofing system from exposure to sunlight and high humidity, except to extent necessary for period of metal roofing system installation.
- .5 Protect foam plastic insulation from surface degradation, and as follows:
- .6 Do not expose to sunlight, except to extent necessary for period of installation and concealment.
- .7 Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
- .8 Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## **1.10 SITE CONDITIONS**

- .1 Site Measurements: Verify locations of roof framing and roof opening dimensions by site measurements before metal roofing system fabrication and indicate measurements on shop drawings.
- .2 Established Dimensions: Establish framing and opening dimensions and proceed with fabricating metal roofing system without site measurements where site measurements cannot be made without delaying the Work, or allow for site trimming of panels; coordinate roof construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.
- .3 Ambient Conditions: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roofing system in accordance with manufacturers' written instructions and warranty requirements.

## **1.11 WARRANTY**

- .1 Provide manufacturer's standard form of warranty stating that manufacturer agrees to repair or replace components of metal roofing system that fail in materials or workmanship within specified warranty period; failures will be considered to include; but are not limited to, the following:
  - .2 Structural failures, including rupturing, cracking, or puncturing.
  - .3 Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - .4 Deterioration of finishes, peeling or cracking of coating, failure to adhere to bare metal, colour fading and chalking.

- .5 Warranty Period:
  - .1. Metal Roof System: Two (2) years from date of Substantial Performance.
  - .2. Finishes: Forty (40) years from date of Substantial Performance.
  - .3. Weather Tightness: Five (5) years from date of Substantial Performance stating that manufacturer agrees to repair or replace metal roofing system failing to remain weather tight; including leaks, within specified warranty period.

## **PART 2.Products**

### **2.1 MANUFACTURERS**

- .1 Basis-of-Design products are named in this Section; additional manufacturers offering similar setting systems may be incorporated into the work provided they meet the performance requirements established by the named products.
- .2 Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - .1. [Behlen Industries](#)
  - .2. [Berridge Manufacturing Company](#)
  - .3. [Canadian Metal Rolling Mills](#)
  - .4. [Vicwest Steel Inc.](#)

### **2.2 METAL ROOFING SYSTEM**

- .1 Performance Requirements: Provide metal roofing system in accordance with performance requirements specified in this Section and as follows:
  - .1. Design and construct roof so that completed installation will not leak.
  - .2. Provide maximum deflection not exceeding 1/180 under system weight plus snow load and build-up, and wind and suction loads acting normal to the plane in accordance with the Building Code Climatic Data, wind load for 1:50 years.
  - .3. Provide movement of components without causing buckling, failure of joint seals, undue stress on fasteners when subject to seasoned temperature range, from -40°C to +50°C, and preceding noted wind and suction loads.
  - .4. Provide expansion joints to accommodate movement in wall system and between wall system and building structure where these movements are caused by deflection of building structure, without permanent distortion, damage to in-fills, racking of joints, breakage of seals, or water penetration into system.
  - .5. Provide for positive drainage to the exterior of all water entering or condensation occurring within the system.
- .2 Panel Materials: Coated steel sheet with coil coating having galvanized finish using hot dip process and pre-coated using coil coating process in accordance with ASTM A755M, factory pre-finished using Silicone Modified Polyester; colour as indicated on drawings and as follows:
  - .1. Galvanized Steel Sheet: ASTM A653M, having Z275 coating designation; structural quality.
  - .2. Surface: smooth finish.
  - .3. Core Metal Thickness: Nominal 0.76 mm.
  - .4. Profile: as indicated on Drawings
  - .5. Panel Width: 762 mm.

- .3 Ice and Water Shield Membrane: Self adhering, granular faced sheet manufactured in accordance with CGSB 37-GP-56M, minimum 1.4 mm thick, consisting of glass fibre mat reinforcing and SBS modified asphalt, granule faced, with release paper backing; cold applied; provide primer when recommended by ice and water shield manufacturer.
- .4 Felts: CSA A123.36, Type II (No. 30), asphalt saturated organic felts.
- .5 Slip Sheet: Building paper, minimum 0.24 kg/m<sup>2</sup>, rosin sized.
- .6 Metal Framing Fasteners: Type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates as recommended by manufacturer.

## 2.3 ACCESSORY MATERIALS

- .1 Provide components required for complete metal roofing system assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items; match material and finish of metal roofing system.
- .2 Fasteners: Self tapping screws, bolts, nuts, self locking rivets and bolts, end welded studs, and other suitable fasteners designed to withstand design loads, and as follows:
- .3 Provide exposed fasteners with heads matching colour of metal roofing system by means of plastic caps or factory applied coating.
- .4 Fasteners for Roof systems: Self drilling or self tapping, zinc plated, hex head carbon steel screws, with a stainless-steel cap or zinc aluminum alloy head and EPDM or neoprene sealing washer.
- .5 Fasteners for Flashing and Trim: Blind fasteners or self drilling screws with hex washer head; no exposed fastenings on exposed faces.
- .6 Blind Fasteners: High strength stainless steel rivets.
- .7 Bituminous Coating: Cold applied asphalt mastic, SSPC-Paint 12, compounded for 0.4 mm dry film thickness per coat; inert type non-corrosive compound free of asbestos fibres, sulphur components, and other deleterious impurities.
- .8 Flashing, Roof Curbs, and Trim: Pre-finished flashing materials to match roofing materials in accordance with Section 07 62 00.
- .9 Surface Mounted, Plastic, Stop Type Snow Guards: Integral colour polycarbonate stops designed for attachment to pan surface of metal roofing system using construction adhesive, silicone or polyurethane sealant, or adhesive tape.
  - .1. Acceptable Materials:
    - .1. [Glacier Snow Guard](#)
    - .2. [Polar Blox Standing Seam Guards](#)
    - .3. [Snoblox Snow Guards](#)
    - .4. [Zaleski Snow Guards for Roofs Inc.](#)

## 2.4 FABRICATION

- .1 Fabricate and finish metal roofing system and accessories at the factory to greatest extent possible, using manufacturer's standard procedures and processes to obtain the indicated profiles and meeting dimensional and structural requirements for the Project.
- .2 Fabricate flashing and trim in accordance with SMACNA recommendations that apply to the design, dimensions, metal, and other characteristics of item indicated.

## **2.5 FINISHES, GENERAL**

- .1 Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- .2 Variations in appearance of abutting or adjacent pieces are acceptable if they are within ½ the range of reviewed samples:
- .3 Noticeable variations in the same piece are not acceptable.
- .4 Variations in appearance of other components are acceptable if they are within the range of reviewed samples and are assembled or installed to minimize contrast.

## **PART 3.Execution**

### **3.1 EXAMINATION**

- .1 Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roofing system supports, and other conditions affecting performance of work.
- .2 Examine primary and secondary roof framing to verify that angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roofing system manufacturer.
- .3 Examine roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roofing system manufacturer.
- .4 Examine roughing-in for components and systems penetrating metal roofing system to verify actual locations of penetrations relative to seam locations of metal roofing system before metal roofing system installation.
- .5 Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- .1 Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- .2 Install auxiliary levelling substrate boards over steel deck; attach with mechanical fasteners into top flutes of steel to prevent wind uplift.
- .3 Install flashings and other sheet metal in accordance with requirements specified in Section 07 62 00.
- .4 Install fasciae and copings in accordance with requirements specified in Section 07 62 00.
- .5 Install eave angles, furring, and other miscellaneous roof system support members and anchorage in accordance with metal roofing system manufacturer's written recommendations.

### **3.3 ICE AND WATER SHIELD INSTALLATION**

- .1 Install self adhering sheet ice and water shield, wrinkle free, on roof sheathing under metal roofing system.
- .2 Apply primer if required by manufacturer and install in accordance with temperature restrictions of ice and water shield manufacturer; use primer rather than nails for installing ice and water shield at low temperatures.

- .3 Apply over entire roof in shingle fashion to shed water, with end laps of not less than 150 mm staggered 600 mm between courses and as follows:
- .4 Overlap side edges not less than 90 mm.
- .5 Extend ice and water shield into gutter trough.
- .6 Roll laps with roller.
- .7 Cover ice and water shield within 14 days.
- .8 Install flashings to cover ice and water shield in accordance with requirements specified in Section 07 62 00.
- .9 Apply slip sheet over ice and water shield before installing metal roofing system.

### **3.4 METAL ROOFING SYSTEM INSTALLATION**

- .1 Install metal roofing system in accordance with manufacturer's written instructions and as modified by this Section.
- .2 Provide metal roofing system of full length from eave to ridge, unless restricted by shipping limitations.
- .3 Anchor metal roofing system and other components of the Work securely in place, with provisions for thermal and structural movement:
- .4 Site cutting of metal roofing system by torch is not permitted.
- .5 Rigidly fasten eave end of metal roofing system and allow ridge end free movement due to thermal expansion and contraction; pre-drill panels before installing fasteners.
- .6 Provide metal closures at peaks, rake edges, rake walls and each side of ridge and hip caps.
- .7 Flash and seal metal roofing system with weather closures at eaves, rakes, and at perimeter of all openings; fasten with self tapping screws.
- .8 Locate and space fastenings in uniform vertical and horizontal alignment.
- .9 Locate panel splices over, but not attached to, structural supports.
- .10 Stagger panel splices and end laps to avoid a four-panel lap splice condition.
- .11 Lap metal flashing over metal roofing system to allow moisture to run over and off the material.
- .12 Protect against galvanic action where dissimilar metals contact each other or corrosive substrates, by painting contact surfaces with bituminous coating, by applying rubberized asphalt ice and water shield to each contact surface, or by other permanent separation as recommended by metal roofing system manufacturer.
- .13 Install gaskets, joint fillers, and sealants where required for weatherproof performance of metal roofing system; include types of gaskets, fillers, and sealants recommended by metal roofing system manufacturer, and as follows:
- .14 Seal metal roofing system end laps with double beads of tape or sealant, full width of panel.
- .15 Seal side joints where recommended by metal roofing system manufacturer.
- .16 Prepare joints and apply sealants in accordance with requirements in Section 07 90 00.

- .17 Fasten metal roofing system to supports with exposed fasteners as recommended by manufacturer.
- .18 Align bottom of fascia panels and fasten with blind rivets, bolts, or self tapping screws; flash and seal panels with weather closures where fascia meet soffits, along lower panel edges, and at perimeter of all openings.

### **3.5 ACCESSORY INSTALLATION**

- .1 Install accessories with positive anchorage to building and weather tight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
- .2 Install components required for a complete metal roofing system assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- .3 Install flashing and trim in accordance with performance requirements, manufacturer's written installation instructions, and SMACNA recommendations; provide concealed fasteners where possible, and set units true to line and level; install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- .4 Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
- .5 Provide for thermal expansion of exposed flashing and trim:
- .6 Space movement joints at equally spaced intervals to a maximum of 3 metres o.c. with no joints allowed within 600 mm of corner or intersection.
- .7 Form expansion joints of intermeshing hooked flanges, not less than 25 mm deep, filled with mastic sealant concealed within joints where lapped or bayonet type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof.
- .8 Install roof curbs at locations indicated on Drawings; install flashing around bases where they meet metal roofing system.
- .9 Attach snow guards to metal roofing system with adhesive, sealant, or adhesive tape, as recommended by snow guard manufacturer; do not use fasteners that will penetrate metal roofing system. Install two snow guards per panel width in a staggered arrangement and carry up roof for four rows spaced at 600mm o.c..
- .10 Form flashing around pipe penetration and metal roofing system; fasten and seal to metal roofing system as recommended by manufacturer.

### **3.6 ERECTION TOLERANCES**

- .1 Shim and align metal roofing system units within installed tolerance of 6 mm in 6 metres on slope and location lines as indicated and within 3 mm offset of adjoining faces and of alignment of matching profiles.

### **3.7 CLEANING AND PROTECTION**

- .1 Remove temporary protective coverings and strippable films, if any, as metal roofing system is installed, unless otherwise indicated in manufacturer's written installation instructions.

- .2 Clean finished surfaces as recommended by metal roofing system manufacturer upon completion of metal roofing system installation; maintain in a clean condition during remainder of construction.
- .3 Replace metal roofing system components that become damaged or have deteriorated beyond successful repair by finish touch-up or similar minor repair procedures.

**END OF SECTION**

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## **Part 1. General**

### **1.1 SUMMARY**

- .1 This Section includes requirements for supply and installation of fibre reinforced cement siding and panels.

### **1.2 REFERENCE STANDARDS**

- .1 ASTM C118602 Standard Specification for Flat Non Asbestos Fiber Cement Sheets
- .2 CAN/ULC S10203, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies
- .3 CAN/ULC S11405, Standard Method of Test for Determination of Non Combustibility in Building Materials

### **1.3 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00 – Submittals.
- .2 Product Data: Submit product data for each type of product indicated.
- .3 Samples: Submit samples for verification for each type, colour, texture, and pattern required, as follows:
  - .1. 300 mm long x actual width sample of siding.
  - .2. 300 mm long x actual width sample of trim.
- .4 Shop Drawings:
  - .1. Indicate flashings, jointing methods and locations, fastening methods and locations, and installation details.
  - .2. Engineer and include in shop drawings support girts and fastenings.
  - .3. All shop drawings shall be signed and sealed by an Engineer registered in the Province where the work is located.

### **1.4 QUALITY ASSURANCE**

- .1 Source Limitations: Obtain each type, colour, texture, and pattern of siding including related accessories, through one source from a single manufacturer.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Store materials in a dry, well ventilated, weather tight location in accordance with manufacturers written instructions.

### **1.6 SITE CONDITIONS**

- .1 Proceed with siding installation when substrate is completely dry and where existing and forecasted weather conditions permit siding to be installed according to manufacturer's written instructions.



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**1.7 SEQUENCING**

- .1 Coordinate installation with flashings and other adjoining construction to ensure proper sequencing

**1.8 WARRANTY**

- .1 General Warranty: Special warranties specified in this Article shall not deprive the Departmental Representative of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.
- .2 Manufacturers Defect Warranty: Submit a written warranty, signed by manufacturer, covering manufacturer defects in the siding within the specified warranty period and agreeing to repair or replace siding that show evidence of defects.
- .3 Defect Warranty Period: 50 years from date of Substantial Performance.

**Part 2. Products**

**2.1 SIDING**

- .1 Horizontal Fibre Cement Siding: Siding made from fibre reinforced cement board, free from asbestos fibres; in accordance with ASTM C1186, Type A, Grade II; classified as non-combustible in accordance with ULC S114; and having flame spread index of 25 or less in accordance with ULC S102, having the following characteristics:
  - .1. Nominal Face Exposure: as indicated on Drawings.
  - .2. Edge Style: Plain Lap
  - .3. Texture: Textured.
  - .4. Factory Finish: Prefinished acrylic, colour as indicated on Drawings.

**2.2 ACCESSORIES**

- .1 Soffits: fibre reinforced cement board, free from asbestos fibres; in accordance with ASTM C1186, Type A, Grade II; classified as non-combustible in accordance with ULC S114; and having flame spread index of 25 or less in accordance with ULC S102, vented and non-vented
- .2 Siding Accessories: Provide starter strips, edge trim, corner cap, and other items as recommended by siding manufacturer for building configuration, and as follows:
- .3 Provide accessories made from same material as adjacent siding, unless otherwise indicated.
- .4 Provide accessories matching color and texture of adjacent siding, unless otherwise indicated.
- .5 Flashing: Provide prefinished, galvanized sheet steel flashing and trims in accordance with Section 07 62 00, at window and door heads and where indicated.
- .6 Elastomeric Joint Sealant: Two part multicomponent sealant joint sealant in accordance with Section 07 90 00.

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- .7 Fasteners:
  - .1 Fastening to Wood: ribbed, hot-dipped galvanized bugle head screws of sufficient length to penetrate a minimum of 25mm into substrate.
  - .2 Metal Framing: length to accommodate three turns into substrate, No. 8-18 x 0.323" head self-drilling, corrosion resistant S-12 ribbed buglehead screws Trim and moulding.

### Part 3. Execution

#### 3.1 EXAMINATION

- .1 Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of siding.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- .1 Clean substrates of projections and substances detrimental to application.

#### 3.3 INSTALLATION- SIDING

- .1 Starting: Install a minimum 6 mm (¼") thick lath starter strip at the bottom course of the wall. Apply planks horizontally with minimum 32 mm (1¼") wide laps at the top. The bottom edge of the first plank overlaps the starter strip.
- .2 Allow minimum 25 mm (1") vertical clearance between roofing and bottom edge of siding.
- .3 Align vertical joints of the siding over framing members.
- .4 Maintain clearance between siding and adjacent finished grade.
- .5 Locate splices at least one stud cavity away from window and door openings.
- .6 Use off stud metal joiner when vertical joints occur between framing members. Position metal joiner so that the bottom lip is resting on the solid course of planks. Fasten plank to the framing. Position and fasten abutting plank into place insuring that the lower edges of the two planks align. Locate metal joiner centrally behind the joint. Locate off stud splices a minimum of two stud cavities from wall corners and stagger all subsequent course splices at minimum 610 mm (24") intervals when located in the same wall cavity.
- .7 Wind Resistance: Where a specified level of wind resistance is required install siding to framing members and secure with fasteners described in Table No. 2 in National Evaluation Service Report No. NER405.

#### 3.4 INSTALLATION - MOULDING

- .1 Install flashing around all wall openings.
- .2 Fasten through trim into structural framing or code complying sheathing. Fasteners must penetrate minimum 19 mm (¾") or full thickness of sheathing. Additional fasteners may be required to ensure adequate security.

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- .3 Place fasteners no closer than 19 mm ( $\frac{3}{4}$ " ) and no further than 50 mm (2") from side edge of trim board and no closer than 25 mm (1") from end. Fasten maximum 406 mm (16") on centre.
- .4 Maintain clearance between trim and adjacent finished grade.
- .5 Trim inside corner with single board.
- .6 Install single board of outside corner board then align second corner board to outside edge of first corner board. Do not fasten trim board to trim board.
- .7 Allow 3 mm ( $\frac{1}{8}$ " ) gap between trim and siding.
- .8 Seal gap with sealant as specified in Section 07 92 00.
- .9 Shim frieze board as required to align with corner trim.
- .10 Install filler board behind trim boards to ensure trim boards are proud of siding.

### **3.5 ADJUSTING AND CLEANING**

- .1 Remove damaged, improperly installed, or otherwise defective siding materials and replace with new materials complying with specified requirements.
- .2 Clean finished surfaces according to siding manufacturer's written instructions and maintain in a clean condition during construction.

**END OF SECTION**

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**PART 1. General**

**1.1 INTENT**

- .1 Work of this section includes: pre-fabricated aluminum gutters, downspouts and accessories.

**1.2 REFERENCE STANDARDS**

- .1 American Architectural Manufacturers Association:
  - .1. AAMA 2605: Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- .2 ASTM International:
  - .1. ASTM B209: Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate.
- .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Inc. Architectural Sheet Metal Manual.

**1.3 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Shop Drawings: Clearly indicate the following:
  - .1. Manufacturer of pre-finished coating application for gutters.
  - .2. Type and thickness of pre-finished aluminum components.
  - .3. Type and thicknesses of pre-finished colour coating system and special coating system.
  - .4. Typical profiles of formed metal systems.
  - .5. Typical details of jointing profiles.
  - .6. Manufacturer and type of sealants and gaskets.
  - .7. Typical sectional details showing locations of fasteners.

**1.4 HANDLING AND PROTECTION**

- .1 Stack preformed and pre-finished materials in a manner to prevent permanent deformation and marring of finished surfaces.
- .2 Prevent contact with dissimilar metals during storage and protect from acids and other corrosive materials and elements.
- .3 Deliver, handle and store all accessory materials to job site, in original packages and containers with manufacturer's seals and labels intact.
- .4 Store materials requiring protection from the weather in weatherproof shelters having floors.
- .5 Protect installed work and materials from damage.

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- .6 In the event of materials being damaged by the elements, improper handling, or other causes, such materials will be rejected, and shall be replaced at no increase in Contract Price. Promptly remove rejected materials from site.

## **PART 2. Products**

### **2.1 MATERIALS**

- .1 Pre-finished Sheet Aluminum: to ASTM B209, manufacturer's standard alloy and temper for specified finish; shop finished with three coat PVDF (polyvinylidene fluoride) coating.
  - .1. Gutters: minimum 1.78mm (14 gauge) base metal thickness.
  - .2. Downspouts: 0.76mm (22 gauge) base metal thickness
  - .3. Colours: as indicated on drawings.
  - .4. Sizes and Profiles: 150mm x 150mm (6" x 6") Jogee profile for gutters; downspouts sized to suit gutters.
- .2 Anchors and Supports: profiled to suite gutters and downspouts and as follows:
  - .1. Anchoring Devices: in accordance with SMACNA requirements.
  - .2. Gutter Supports, Brackets and Straps: sized in accordance with SMACNA Table 1B.
  - .3. Downspout Supports: to SMACNA Figure 1-35E.
- .3 Strainers: 0.76mm (14 gauge) stainless steel wire baskets.
- .4 Fasteners: aluminum or stainless steel complete with EPDM washers.
- .5 Sealant: type and quality specified in Section 07 90 00. Sealants are acceptable in non-visible locations only.
- .6 Splashpads: Precast concrete splashpad from 24 Mpa concrete, 310 mm (12 1/4") wide x 75 mm (3") deep x 610 mm (24") long, to CAN/CSA A23.1.

### **2.2 FABRICATION**

- .1 Fabricate gutters and downspouts to profiles detailed to maximum practical lengths. Joints in gutters must correspond with joints in eave edge fascias.
- .2 Fabricate all corners as one piece with joints mitred and welded watertight.
- .3 Fabricate gutters with ends closed off, with caps welded in place watertight.
- .4 Form spill-outs as detailed, welded in place watertight.
- .5 At expansion joints, gutters are to be end capped and separated by 25mm (1"). End caps are to be welded in place watertight.
- .6 Fabricate gutter sections with flush butt joints. All joints are to be backed with alignment splines which are to have a face width of 65 mm (2 1/2").
- .7 Alignment splines are to be full welded to one side of each gutter section so that when gutters are installed each and every joint will be backed with an alignment spline.
- .8 Lap Alignment splines 25 mm (1") over the gutter sections to which they are to be welded.

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- .9 Fabricate shapes free of distortion, ripples, dents, and other visible non-repairable surface damage. Grind all welds smooth and flush with adjacent surfaces.

**PART 3. Execution**

**3.1 INSTALLATION OF GUTTERS**

- .1 Install eave edge gutters well secured in place and rigid, and with all sections in-line with each other. All joints must correspond with joints in metal fascias. All anchorage's must penetrate back up Z-bars and channels.
- .2 Maintain 10 mm (3/8") wide joints between gutter sections to allow for expansion and contraction. Seal lapped edges as work progresses. Clean all visible traces of sealant at lapped joints as work progresses.
- .3 Match building expansion joints with gutters..

**3.2 INSTALLATION OF DOWNSPOUTS**

- .1 Secure downspouts using 0.76-mm (0.029") (22 gauge) thick straps at 600 mm (24") on centre. Secure straps using corrosion resistant screws.

**3.3 SPLASH PADS**

- .1 Install splash pads to locations indicated.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Underwriter's Laboratories of Canada (ULC)
- .1 CAN-S115, Fire Tests of Firestop Systems.

**1.2 DEFINITIONS**

- .1 Fire Stop Material: device intended to close off opening or penetration during fire or materials that fill openings in wall or floor assembly where penetration is by cables, cable trays, conduits, ducts and pipes and poke-through termination devices, including electrical outlet boxes along with their means of support through wall or floor openings.
- .2 Single Component Fire Stop System: fire stop material that has Listed Systems Design and is used individually without use of high temperature insulation or other materials to create fire stop system.
- .3 Multiple Component Fire Stop System: exact group of fire stop materials that are identified within Listed Systems Design to create on site fire stop system.
- .4 Tightly Fitted: penetrating items that are cast in place in buildings of noncombustible construction or have "0" annular space in buildings of combustible construction.
  - .1 Words "tightly fitted" should ensure that integrity of fire separation is such that it prevents passage of smoke and hot gases to unexposed side of fire separation.

**1.3 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Submit duplicate 300 x 300 mm samples showing actual firestop material proposed for project.
- .3 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.
- .4 Submit manufacturer's engineering judgement identification number and drawing details when no ULC or cUL system is available. Engineering judgement must include both project name and contractor's name who will install firestop system as described in drawing.

- .5 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site. Include manufacturer's printed instructions for installation. Include manufacturer's specifications, training letter, and technical data for each material including the composition and limitations, documentation of ULC or CUL firestop systems to be used.
- .6 Submit material safety data sheets provided with product delivered to job site.

## **1.4 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Installer: person specializing in fire stopping installations approved by the fire stopping manufacturer.
  - .2 Manufacturer: company with experience in producing of material used for work required for this project, with sufficient production capacity to produce and deliver required units without causing delay in work.
- .2 All fire stopping materials for this project to be supplied by a single manufacturer.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Use only firestop products that have been ULC or cUL tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements and fire-rating involved for each separate instance.
- .2 Fire stopping and smoke seal systems: in accordance with CAN-S115.
  - .1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of CAN-S115 and not to exceed opening sizes for which they are intended.
  - .2 Firestop system rating: as indicated on drawings.
- .3 Service penetration assemblies: certified and tested by ULC or cUL in accordance with CAN-S115.
- .4 Service penetration firestop components: certified and tested by ULC or cUL in accordance with CAN-S115.
- .5 Fire-resistance rating of installed fire stopping assembly in accordance with ABC.
- .6 Non-curing, re-penetrable intumescent sealants, caulking or putty material for use with flexible cables or cable bundles.



- .7 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .8 Intumescent sealants or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe. No silicone based firestop are allowed to be applied on plastic pipes.
- .9 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .10 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .11 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .12 Sealants for vertical joints: non-sagging.

### **Part 3 Execution**

#### **3.1 PREPARATION**

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

#### **3.2 INSTALLATION**

- .1 Install fire stopping and smoke seal material and components in accordance with ULC certification or UL Products Certified for Canada (CUL) and manufacturer's instructions.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.

- .4 Tool or trowel exposed surfaces to a neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

### **3.3 SCHEDULE**

- .1 Firestop and smoke seal at:
  - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
  - .2 Edge of floor slabs at curtain wall and precast concrete panels.
  - .3 Top of fire-resistance rated masonry and gypsum board partitions.
  - .4 Intersection of fire-resistance rated masonry and gypsum board partitions.
  - .5 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
  - .6 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
  - .7 Openings and sleeves installed for future use through fire separations.
  - .8 Around mechanical and electrical assemblies penetrating fire separations.
  - .9 Rigid ducts: greater than 129 cm<sup>2</sup>: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

### **3.4 CLEAN UP**

- .1 Remove excess materials and debris and clean adjacent surfaces immediately after application.
- .2 Remove temporary dams after initial set of fire stopping and smoke seal materials.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-19.13, Sealing Compound, One-component, Elastomeric, Chemical Curing.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for joint sealants and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Manufacturer's product to describe:
    - .1 Caulking compound.
    - .2 Primers.
    - .3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.
  - .3 Submit 2 copies of WHMIS MSDS.
- .3 Manufacturer's Instructions:
  - .1 Submit instructions to include installation instructions for each product used.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturers 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 and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

**1.4 SITE CONDITIONS**

- .1 Ambient Conditions:
  - .1 Proceed with installation of joint sealants only when:
    - .1 Ambient and substrate temperature conditions are within limits permitted by joint sealant manufacturer or are above 4.4 degrees C.
    - .2 Joint substrates are dry.

- .3 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.
- .2 Joint-Width Conditions:
  - .1 Proceed with installation of joint sealants only where joint widths are more than those allowed by joint sealant manufacturer for applications indicated.
- .3 Joint-Substrate Conditions:
  - .1 Proceed with installation of joint sealants only after contaminants capable of interfering with adhesion are removed from joint substrates.

## **1.5 ENVIRONMENTAL REQUIREMENTS**

- .1 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (MSDS) acceptable to Health Canada.

## **Part 2 Products**

### **2.1 SEALANT MATERIAL DESIGNATIONS**

- .1 Polysulfide one part, self-levelling: to CAN/CGSB-19.13, MC-1-40-B-N, colour to match adjacent surfaces
- .2 Preformed compressible and non-compressible back-up materials:
  - .1 Polyethylene, urethane, neoprene or vinyl foam:
    - .1 Extruded closed cell foam backer rod.
    - .2 Size: oversize [30 to 50 %].
  - .2 Neoprene or butyl rubber:
    - .1 Round solid rod, Shore A hardness 70.
  - .3 High density foam:
    - .1 Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m<sup>3</sup> 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.

### **2.2 JOINT CLEANER**

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

## **Part 3 Execution**

**3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for joint sealants installation 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 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 manufacturers 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 and 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.

### **3.7 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.
  - .2 Clean adjacent surfaces immediately.
  - .3 Remove excess and droppings, using recommended cleaners as work progresses.
  - .4 Remove masking tape after initial set of sealant.

### **3.8 PROTECTION**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Architectural Woodwork Manufacturers Association of Canada (AWMAC).
  - .1 “Architectural Woodwork Standards”, First Edition 2009, published by the Architectural Woodwork Institute of the U.S. and jointly copyrighted with the Architectural Woodwork Manufacturer's Association of Canada (AWMAC).
- .2 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-71.19-[M88], Adhesive, Contact, Sprayable.
  - .2 CAN/CGSB-71.20-[M88], Adhesive, Contact, Brushable.
- .3 Canadian Standards Association (CSA International).
  - .1 CSA A440.2-[98], Energy Performance of Windows and Other Fenestration Systems.
  - .2 CSA O115-[M1982(R2001)], Hardwood and Decorative Plywood.
  - .3 CAN/CSA O132.2 Series-[90(R1998)], Wood Flush Doors.
  - .4 CAN/CSA-O132.5-[M1992(R1998)], Stile and Rail Wood Doors.
  - .5 CAN/CSA-Z808-[96], A Sustainable Forest Management System: Guidance Document.
  - .6 CSA Certification Program for Windows and Doors [00].
- .4 Environmental Choice Program (ECP).
  - .1 CCD-045-[92], Sealants and Caulking Compounds.
  - .2 CCD-046-[92], Adhesives.
- .5 National Fire Protection Association (NFPA).
  - .1 NFPA 80-[1999], Standard for Fire Doors and Fire Windows.
  - .2 NFPA 252-[1999], Standard Method of Fire Tests of Door Assemblies.
- .6 Underwriters' Laboratories of Canada (ULC).
  - .1 CAN-4S104M-[80(R1985)], Fire Tests of Door Assemblies.
  - .2 CAN4-S105M-[85 (R1992)], Fire Door Frames Meeting the Performance Required by CAN4-S104.

**1.2 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Submit shop drawings showing large scale construction details, service outlets, connections and anchoring, sizes and species of stiles, top rails, bottom rails and lock blocks:
  - .1 Show construction and materials used in cores, size and species of edge strip, thickness and species of cross-banding, and thickness and species of face veneer.
  - .2 Show details of openings and mouldings for glazing.

- .3 Show locations, sizes and types of all doors to be supplied, referenced to the Door and Hardware Schedule.
  - .4 Indicate elevation of each kind of door, details of construction, location and extent of hardware blocking, fire ratings, requirements for factory finishing and other pertinent data.
  - .5 Include finishing specifications for doors to receive factory-applied finish.
  - .6 Include certifications as might be required to show compliance with specifications.
- 
- .3 Provide the Consultant with a certificate from the door manufacturer declaring that doors meet AWMAC Architectural Grade Standards.

### **1.3 QUALITY ASSURANCE**

- .1 Fabricate doors in accordance with Architectural Woodwork Manufacturers Association of Canada (AWMAC) Quality Standards for Architectural Woodwork, Part 4 Wood Doors, as a minimum, or such higher standards as specified herein.
- .2 Telegraphing will not be considered as a defect unless the face of the door varies from a true plane in excess of 0.25 mm in any 75 mm (1/100" in any 3") span.

### **1.4 DELIVERY, STORAGE, AND HANDLING**

- .1 Doors to be delivered to the site when all gypsum board and concrete work is dry and the building is closed to the weather.
- .2 Stack doors flat on carefully levelled supports consisting of three 2 x 4's placed the full width of the doors, one across the centre and the other two 305 mm (12") in from each end, covered with a sheet of plywood or heavy cardboard to protect the face of the bottom door. Cover the top door in a similar manner. Keep doors entirely covered as partially covered doors may be "sunburned" (stained) by the light or warped.
- .3 Storage space to be dry and well ventilated. Doors not to be subject to rapid humidity and temperatures changes. Humidity over 60% or under 30% may cause permanent damage and will void manufacturer's warranty. Keep doors a minimum of 1220 mm (4') away from heating sources or direct sunlight.
- .4 Condition doors to the average humidity of the site before hanging. If doors are to be stored more than a few days, all edges shall be sealed with moisture sealer, **NOT** sanding sealer.
- .5 When moving doors, lift straight up. Do not drag them one across another.

### **1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .2 Dispose of packaging material in appropriate on-site bin for recycling in accordance with site waste management program.
- .3 Unused or damaged glazing materials are not recyclable and must not be diverted to municipal recycling programs.



- .4 Divert unused adhesive material from landfill to official hazardous material collections site approved by Departmental Representative.
- .5 Do not dispose of unused paint materials into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

## **Part 2 Products**

### **2.1 Materials**

- .1 Dry lumber to an average moisture content of between 6 and 12% maximum at time of manufacture.
- .2 Wood door frames and stops: Refer to Section 06 20 00 – Finish Carpentry.
- .3 Metal door frames: Refer to Section 08 11 00 – Hollow Metal Doors and Frames.
- .4 Wood Veneer Faced Doors: 45 mm (1 ¾") thick 7 Ply, Premium Grade, Anti-Warping Door having AWMAC No. 3 edge constructed in accordance with CAN/CSA O132.2 as a minimum, and as follows:
  - .1 Solid Core: Particleboard core having minimum density of 449 kg/m<sup>3</sup> (28#/ft<sup>3</sup>) in accordance with CSA O188.
  - .2 Stiles and Rails: Structural Composite Lumber (SCL) bonded to core and as follows:
    - .1 Side Stiles: 108 mm (4 ¼") SCL with 16 mm (5/8") hardwood edge, to match face veneers; no finger jointed materials permitted.
    - .2 Top and Bottom Rails: 57 mm (2 ¼") SCL with 16 mm (5/8") soft wood cap.
  - .3 Cross Ply: 3 mm (1/8"), 3-ply birch plywood, glued to core and stiles, cold pressed Type 1 PVA cross-linked glue.
  - .4 Wood Veneer Faces: Joint occurring in the centre of the face panel, parallel to the door edges, veneers supplied from same source manufacturer:
    - .1 Finish: Three coat transparent stained factory applied system, A veneer grade both sides of door, matched veneers, no end matching allowed within face of door species, match and face symmetry as follows:
      - .1 Natural Maple, plain sliced, book matched, centre balanced, maximum 8 flitches for each face of door, no exceptions.
    - .2 Veneer: Minimum 0.50 mm (1/50") Clear and bright in colour with minimum of pin knots, mineral or sugar streaks, no open defects, heartwood, or wild grain, and minimal colour variation between flitches, meeting the requirements for Canadian Hardwood Plywood Association (CHPA) or Hardwood Plywood and Veneer Association (HPVA) quality grade and hardwood species as indicated.
  - .5 Glass: Clear tempered safety glass as specified under Section 08 80 00.
  - .6 Glazing Stops: Solid hardwood with mitred corners, to match veneers.
  - .7 Edge Finish: Paint hardwood edge and cross ply, colour to match face finish, submit for acceptance by Consultant; provide touch-up materials to repair edges after site trimming.

- .8 Edge Profile: Single Acting Swing Doors: bevel 3 mm ( $\frac{1}{8}$ " in 50 mm (2").

## 2.2 FABRICATION

- .1 Provide factory-made cut-outs for glass as indicated in door schedule, with edges reinforced and stops pre-cut to fit.
- .2 No cut-outs permitted within 127 mm (5") of sides and top of door or 254 mm (10") from bottom of door.
- .3 Doors shall be pre-fitted, bevelled and machined at the factory for all mortise hardware items as per templates and approved hardware schedules provided.
- .4 Clearance between the door and frame shall be minimum 1.5 mm ( $\frac{1}{16}$ ") on the hinge side and 3 mm ( $\frac{1}{8}$ ") on the lock set side and top edge.
- .5 Bevel door edge so that door does not bind in frame.

## 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 INSTALLATION

- .1 All doors shall be inspected thoroughly by the installer before installation or finishing.
- .2 Install doors and hardware in accordance with manufacturer's printed instructions.
- .3 Refer to Section 08 71 00 – Door Hardware and Hardware Schedule for hardware types and groups.
- .4 Trim doors as required for proper fit and function; refinish all cut or planed surfaces immediately to match factory finish.
- .5 Do not impair the structural strength during application of hardware, cutting and altering the door for lights, louvres or other special details.
- .6 Use three hinges for all interior doors:
  - .1 Full mortise hinges: use No. 12 by 32 mm ( $\frac{1}{4}$ ") flat, threaded-to-the-head, steel wood screws; drill 3.6 mm ( $\frac{9}{64}$ ") Ø pilot holes for No. 12 screws.
  - .2 Surface hinges: attached with steel through bolts.
- .7 Install cylindrical locks for latch using No. 8 flat, threaded-to-the-head, steel wood screws drill 2.8 mm ( $\frac{7}{64}$ ") Ø pilot holes for No. 8 screws.
- .8 Failure to pre-drill or drill correct size pilot holes will likely result in stile splitting or structural impairment, and cause the Consultant ask for replacement of the door.

- .9 Arrange to have cut edges sealed the same day they are cut.
- .10 Adjust operable hardware parts for correct function.

**3.3 ADJUSTMENT**

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

**3.4 CLEANING**

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

**END OF SECTION**

**Part 1. General**

**1.2. SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Shop Drawings: clearly indicate sizes, description of components, materials, finishes, fabrication details and attachment methods.

**Part 2. Products**

**2.1 MANUFACTURED PRODUCT**

- .1 Ceiling Access Hatch. Nystrom Model HS, complete with removable, keyed access handle, security screws and perimeter gaskets; 610mm x 610mm size; prime-painted finish.

**Part 3. Execution**

**3.1. INSTALLATION**

- .1 Install ceiling access hatch in accordance with manufacturer's instructions to location indicated on Drawings.
- .2 Clean and adjust completed assembly to ensure correct function.

**END OF SECTION**

**Part 1. General**

**1.1 SYSTEM DESCRIPTION**

- .1 Window system composed of metal clad wood casement and fixed window units complete with hardware, glazing, weather-stripping, screens, jamb extensions, and installation accessories.

**1.2 REFERENCE STANDARDS**

- .1 AAMA/WDMA/CSA/101/I.S.2/A440 - Standard/Specification for Windows, Doors, and Unit Skylights.
- .2 AAMA/WDMA/CSA/101/I.S.2/A440 - Canadian Supplement to Standard/Specification for Windows, Doors, and Unit Skylights.
- .3 AAMA 1503 - Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors, and Glazed Wall Sections.
- .4 ASTM E283 - Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- .5 ASTM E330 - Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
- .6 ASTM E331 - Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
- .7 ASTM F588 - Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact.

**1.3 DESIGN & PERFORMANCE REQUIREMENTS**

- .1 Materials, fabrication, attachments, accessories, assembly and performance, other than thermal performance, shall meet or exceed applicable requirements of AAMA/WDMA/CSA/101/I.S.2/A440, the following appendices, and as specified herein:1
- .2 Thermal performance shall be determined in conformance with AAMA/WDMA/CSA/101/I.S.2/A440, Thermal Performance Evaluation of Windows and Sliding Glass Doors, and Appendix A – Overview of the Procedure for Determining the U-Value by Computer Simulation.1
- .3 Design windows to equalize both positive and negative pressure between outside air and:
  - .1 cavities surrounding insulating glass units, and
  - .2 cavities surrounding operable sash. 1
- .4 Meet or exceed requirements of AAMA/WDMA/CSA/101/I.S.2/A440, and the following performance requirements:
  - .1 Product Type: AP – Awning, BW – Basement and FW - Fixed
  - .2 Primary Designation: LC - Light Commercial
  - .3 Performance Category: 25 psf (1200 Pa
  - .4 Overall Window UValue: maximum 2.20 W/m<sup>2</sup>°C.
- .5 Make provisions to drain to the exterior, any water entering at joints and /or condensation occurring withinthe assembly.
- .6 Design windows to provide drainage from spaces around operable sash and around insulating glass units to exterior.
- .7 Design windows to protect drainage openings from direct entrance of wind-driven rain by use of baffles or other protection.

- .8 Design frames and sashes for interior glazing methods. Exterior glazing methods are not acceptable.
- .9 Design main frame for exterior surface of frame to be mounted flush with the exterior sheathing.
- .10 Design windows for strap anchorage or through jamb anchorage to withstand minimum wind load based on Climatic Data in the NBC and to distribute wind load along frames to window manufacturer's recommendations.
- .11 Design components to accommodate thermally induced movement.
- .12 Combination and composite windows:
  - .1 Meet or exceed requirements of AAMA/WDMA/CSA/101/I.S.2/A440 for combination and composite windows, and the performance requirements for single unit windows
  - .2 Where composite and combination windows specified have not been tested, individual lights shall meet the performance requirements for the applicable single unit window types specified.
  - .3 Air and water tightness of joints along frames mullied together, and at mullions where lites within one main frame join, shall meet or exceed performance ratings specified for adjacent single unit windows.
  - .4 Lateral deflection of mullied frames shall not exceed 1/175 of span when subjected to loading equivalent to wind load resistance of the adjacent single unit windows.2

#### **1.4 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Shop Drawings: Clearly indicate, in large scale, the following:
  - .1 Sections details showing all window perimeter conditions.
  - .2 Mullion and muntin details and frame corner connections, including reinforcement and its fastening if applicable.
  - .3 Sill flashing terminations, in isometric view, including coordination with wall cladding materials.
  - .4 Details showing frame anchorage to wall structure.
  - .5 Details showing air sealing within and around perimeter of framing and operable sash.
  - .6 Required sizes and tolerances of openings.2
  - .7 Connection to building sheet membrane air and vapour seal.
- .3 Submit duplicate 200 mm x 200 mm sample of fabrication of the following:
  - .1 Window frame corners at sills.
  - .2 Typical insulating glass unit and glazing accessories including shims, installed in a frame and sash.
  - .3 Typical anchoring devices and connection to frame.
  - .4 Mullion intersecting head and sill frame.
  - .5 Operable sash installed in typical frame, c/w hardware.
  - .6 Insect screens, in sash.
  - .7 Non-standard conditions.2
- .4 Samples shall be square cut through frame and sash and be finished as specified, with thermal unit cut at 45 degrees.

- .5 Coordinate with section 08 80 50 and submit glazing samples for review.
- .6 Submit evaluation reports and test data indicating glazing centre of glass U-value, solar heat gain coefficient and visible light transmission values.
- .7 Provide a stress analysis on all tinted heat/absorbing glass and light and heat reflecting glass. Submit prior to ordering glass.
- .8 Provide a letter from window manufacturer identifying the CSA-A440.1 performance classification ratings for the windows to be supplied under this Contract, compliance with ASTM D4216 and ASTM D4726.
- .9 Upon request, submit test reports from an independent testing agency acceptable to the Owner, indicating windows to be supplied for project meet specified requirements, including compliance with ASTM D4216 and ASTM D4726.
- .10 Reports shall include complete description of window assemblies and components tested.
- .11 Provide operation and maintenance data for windows for incorporation into manual specified in Section 01 78 00.

## **1.5 PRODUCT HANDLING**

- .1 Deliver materials to the job site in original undamaged packaging with manufacturer's labels and seals intact.

## **1.6 WARRANTY**

- .2 Insulated Glass: All insulated glass units warranted against seal failure of the spacer bar for a period of (10) years.
- .3 Frames: Ten (10) year warranty against defects in workmanship or materials that render the product unserviceable.
- .4 Should any defects develop during the warranty period, manufacturer may repair or replace defective products with current products at no cost to the Owner.

## **Part 2. Products**

### **2.1 COMPONENTS**

- .1 Frames & Sash: Fabricated from clear pine or fir species preservative treated to WDMA I.S.4 of type suitable for transparent or opaque exterior and interior finish.
- .2 Metal Cladding (Exterior Surface): Formed aluminum, factory finished; factory fit to profile of wood members, and exterior exposed surfaces
- .3 Glazing: in accordance with Section 08 80 00.
- .4 Glazing Stops: pultruded fiberglass with neoprene glazing gasket
- .5 Weatherstripping at Operable Sash: neoprene, thermoplastic rubber or EPDM, flexible at minimum design temperature, and as follows:
  - .1 Profiled to mechanically key into window frame and operable sash.
  - .2 Removable without special tools and without dismantling of sash or frame.

- .3 Designed to maintain pressure contact against sash through design temperature range.<sup>4</sup>
- .6 Operator Hardware: Factory installed roto gear hardware, high-pressure zinc die cast housing and steel base plate, hardened steel drive work and gear arms, cam locks.
- .7 Screens: White baked-on enamel finish, aluminum roll form frames with corner keys, black fiberglass 14 x 18 charcoal mesh.
- .8 Steel Clips, Supports and Anchors: minimum 1.5 mm bare sheet thickness, hot-dip galvanized to CAN/CSA G164. Provide anchors that permit sufficient adjustment for accurate alignment.
- .9 Steel Reinforcement: sheet steel to ASTM A653M, hot dip galvanized, minimum Z275 coating designation.
- .10 Insulating Foam Sealant: one-part polyurethane, closed cell foam, skin-forming type, expanding maximum 25%.
- .11 Foam Backer Rod: extruded closed cell backer rod, oversize 30 to 50%.
- .12 Flashing: prefinished sheet aluminum, brake formed as indicated on drawings, 0.60 to 1.3 mm thick, or extruded FRP matching window framing, concealed fastened.

### **2.3 FABRICATION**

- .1 Fabricate framing, mullions and sash members with mortise and tenon joints. Glue and steel pin joints to hairline fit, weather tight.
- .2 Finger joints permitted if wood matches in colour and grain texture.
- .3 Form sills in one piece. Slope sills for wash.
- .4 Form glass stops of solid wood sloped for wash.
- .5 Provide weather stop flange for perimeter of unit.
- .6 Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet allowing installation and dynamic movement of perimeter seal.
- .7 Arrange fasteners to be concealed from view.
- .8 Assemble insect screen frame, mitre and reinforced frame corners. Fit mesh taut into frame and secure. Fit frame with four spring loaded steel pin retainers.
- .9 Double weatherstrip operable units.
- .10 Factory glaze units in accordance with Section 08 80 50.



**Part 3. Execution**

**3.1 PREPARATION**

- .1 Inspect openings to receive aluminum windows for the following:
  - .1 Rough opening plumb and square.
  - .2 Correct rough opening dimensions.
  - .3 Adequate supports and indicated backing materials are in place.
- .2 Report frame defects or unsuitable substrate conditions to the General Contractor before proceeding. Proceeding with installation will mean acceptance of existing conditions.
- .3 Ensure continuity of air/vapor barrier with adjacent construction.

**3.2 INSTALLATION**

- .1 Install windows in accordance with manufacturer's instructions and reviewed shop drawings.
- .2 Maintain dimensional tolerances stated herein after installation. Maintain alignment with adjacent work.
- .3 Secure work adequately and accurately to the structure in the required position, in a manner not restricting thermal and wind movement of windows.
- .4 Make allowance for deflection of structure. Ensure that structural loads are not transmitted to window frames.
- .5 Transfer window dead load to wall construction by anchors alone or in combination with plastic shims. Wood shims are not acceptable.
- .6 Place shims under sill frame at setting block locations, and as recommended by window frame manufacturer.
- .7 Anchor using metal strap anchors or concealed fasteners through frames. Use of nailing fins or splines is not acceptable.
- .8 All anchors and fasteners must be concealed. Exposed heads of fasteners not permitted.
- .9 Erect and secure window units in prepared openings plumb and square, free from warp, twist or superimposed loads.
- .10 Ensure that positive connection is made with air and vapour barriers and frame. Install to achieve weather tight installation.
- .11 Install necessary sills, drips, joint covers and other trim components using concealed anchors and fasteners. Exposed heads of fasteners are not permitted.
- .12 Install matching aluminum flashing at window heads and sills and as indicated on drawings to provide a complete and weather tight installation.

**3.3 SEALANT**

- .1 Provide seal around interior perimeter of window frame using foam joint sealant or foam backer rod, size as required to lightly compress between frame and rough opening, and sealant.
- .2 Provide seal at head and jamb of exterior perimeter of window frame using foam joint sealant or foam backer rod, size as required to lightly compress between frame and rough opening, and sealant. Do not seal sill at exterior.
- .3 Seal joints between windows, jamb extensions, and window sills with sealant. Bed expansion joint cover plates and drip deflectors in bedding sealant. Apply sealant in accordance with section 07 92 00 and manufacturer's recommendations.

**3.4 ADJUSTING & CLEANING**

- .1 Adjust operating sash to work freely with all hardware functioning properly. Re-adjust at completion of the project if directed.
- .2 Remove all visible labels.
- .3 Leave job site and windows in a clean condition. Clean interior and exterior surfaces as soon as adjacent contaminating activities are completed, to recommendations of window manufacturer. Final cleaning of glass will be done under Section 1740 and according to manufacturer's recommended cleaning method.6

**3.5 PROTECTION**

- .1 Cover windows during spray painting or other construction operation that might cause damage.

**END OF SECTION**

**Part 1            General**

**1.1            SECTION INCLUDES**

- .1      Hardware for wood and residential metal doors, including templates required to make proper provisions in other work to receive the Finish Hardware.
- .2      Thresholds.
- .3      Weatherstripping, seals, and door gaskets.

**1.2            REFERENCES**

- .1      AWMAC (Architectural Woodwork Manufacturers Association of Canada) - Quality Standards.
- .2      BHMA (Builders Hardware Manufacturers Association) - A156 series.
- .3      CSDMA (Canadian Steel Door Manufacturers Association).
- .4      DHI (Door and Hardware Institute Canada) - AHC and EHC certification programs.
- .5      DHI (Door Hardware Institute) - A115 series.
- .6      DHI (Door Hardware Institute) - WDHS.3 - Hardware Locations for Wood Flush Doors.

**1.3            SUBMITTALS**

- .1      Comply with requirements of Section 01 33 00.
- .2      Shop Drawings:
  - .1          Indicate locations and mounting heights of each type of hardware, schedules, catalogue cuts, electrical characteristics and connection requirements.
  - .2          Submit manufacturer's parts lists, and templates.
- .3      Samples:
  - .1          Submit one (1) sample of hinge, latch-set, lockset, closer, illustrating style, colour, and finish.
  - .2          Samples, where accepted, will be incorporated into the Work.
- .4      Installation Data: Manufacturer's special installation requirements.

**1.4            CLOSEOUT SUBMITTALS**

- .1      Operation and Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- .2      Warranty Documentation: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- .3      Record Documentation:
  - .1          Record actual locations of installed cylinders and their master key code.
  - .2          Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

**1.5 QUALITY ASSURANCE**

- .1 Finish Hardware: to A.N.S.I. standard dimensions.
- .2 Perform Work in accordance with the following requirements:
  - .1 BHMA A156 series.
  - .2 CSDMA.
- .3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section.
- .4 Installer Qualifications: Company specializing in performing the work of this section approved by the manufacturer.
- .5 Hardware Supplier Personnel: Employ an Architectural Hardware Consultant (AHC) to assist in the work of this section.
- .6 Hardware Supplier Personnel: Employ an Electrified Hardware Hardware Consultant (EHC) to assist in the electronics and controls work of this section.

**1.6 DELIVERY, STORAGE, AND PROTECTION**

- .1 Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

**Part 2 Products**

**2.1 PRODUCT REQUIREMENTS**

- .1 These products are listed in the BHMA Certified Product Directory, Product Qualification; Products listed in this Schedule have been selected to achieve a minimum standard based upon Quality, Design, Finish, Performance and localized support.
- .2 Supply all like products from one manufacturer.

**2.2 LOCKS AND LATCHES**

- .1 Bored Locks And Latches: to ANSI/BHMA A156.2-1996 designed for function, grade and keyed as stated in hardware schedule
- .2 Provide all lock sets installed in wood doors or frames with wrought boxes.

**2.3 DOOR HANGING DEVICES**

- .1 Butts And Hinges, and Pivots: to ANSI/BHMA A156.1-2000 as specified in Hardware Schedule.

**2.4 ARCHITECTURAL DOOR TRIM**

- .1 to ANSI/BHMA A156.6-2001, as specified in Hardware Schedule.
- .2 Door Protection Plates: kick plate construction stainless steel beveled 4 edge:
- .3 Push/Pull Plates: stainless steel construction beveled 4 edges, as specified in Hardware Schedule.

**2.5 AUXILIARY HARDWARE**

- .1 to ANSI/BHMA A156.16-2002, as specified in Hardware Schedule.

**2.6 WEATHERSTRIPPING AND DOOR SEALS**

- .1 Head and Jamb Seal:
  - .1 Extruded aluminum frame and neoprene as specified in Hardware Schedule.
  - .2 Adhesive backed as specified in Hardware Schedule.

- .2 Door Bottom Seal:
  - .1 Extruded aluminum frame and closed cell neoprene, nylon brush as specified in Hardware Schedule.

## **2.7 MISCELLANEOUS HARDWARE**

- .1 Thresholds: to ANSI/BHMA A156.21-2001, as specified in Hardware Schedule.

## **2.8 KEYING**

- .1 Door Locks: Incorporate new door locks into Owner's existing keying system.

## **2.9 MATERIALS AND FASTENERS**

- .1 Furnish hardware with all necessary fasteners, mounting brackets, and special tools required for the proper installation as recommended by the manufacturer.
- .2 Provide machine screws and lead anchors for floor stops toggle bolts for wall stops. Provide sex bolts or through bolts where required on rated mineral core doors. Provide wall stops in lieu of floor stops wherever possible. Where wall stops are not suitable provide floor stops.
- .3 All flatware shall be .050" Type 304 satin stainless steel with radius corners, and fastened with self tapping sheet metal screws or wood screws. Generally protective plates on single doors shall be 50mm less than door width on push side and 25mm less than door width on pull side. Plates on pairs of doors shall be 25mm less than door width on both sides. Refer to door schedule for flatware requirements.
- .4 Provide 114 x 101mm hinges for doors up to 950mm and 127 x 101mm hinges for doors over 950mm wide. Provide 3 hinges per leaf for doors up to 2200mm in height and one additional hinge for each additional 600mm in door height. Exterior out swinging doors shall have non removable pins.
- .5 Thresholds shall be constructed of high quality aluminum oxide with silicon carbon grains integrally cast into the fluted surface and fastened with stainless steel machine screws and lead anchors.

## **2.10 FINISHES**

- .1 Finishes shall be as listed herein except where noted otherwise.

Butts and Hinges:	marine grade stainless steel
Exit devices:	630 Satin Stainless Steel.
Door Closers and Accessories:	689
Architectural door trim:	marine grade stainless steel

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verify that doors and frames are ready to receive work and dimensions are as indicated on shop drawings.

### **3.2 INSTALLATION**

- .1 Install hardware to manufacturer instructions.
- .2 Use templates provided by hardware item manufacturer.
- .3 Where hardware items are required to be installed onto or into surfaces that are to be later painted or finished, install hardware completely to ensure proper fit, remove and store until finishing is complete, and then re-install.
- .4 Drill and countersink units which are pre-prepared for anchorage of fasteners. Space fasteners and anchors to manufacturer's recommendations. Use only fasteners supplied by hardware manufacturers.

- .5 Where hardware items are required to be installed onto or into surfaces that are to be later painted or finished, install hardware completely to ensure proper fit, remove and store until finishing is complete, and then re-install.
- .6 Protect doors and frames from damage due to installation of hardware.
- .7 Finish Hardware to be installed as per manufacturers instructions in accordance with D.H.I. document "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" which list all mounting heights and locations.

**3.3 ADJUSTING AND PROTECTION OF INSTALLED HARDWARE**

- .1 Adjust hardware for smooth operation.
- .2 Do not permit adjacent work to damage hardware or finish.

**3.4 HARDWARE SCHEDULE**

- .1 Refer to Drawings for specific door hardware requirements.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board ([CGSB](#)):
  - .1 CAN/CGSB12.1M90, Tempered or Laminated Safety Glass.
  - .2 CAN/CGSB12.3M91, Flat, Clear Float Glass.
  - .3 CAN/CGSB12.897, Insulating Glass Units.
  - .4 CAN/CGSB12.11M90, Wired Safety Glass.
  - .5 CAN/CGSB19.2M87, Glazing Compound, Non-hardening, Modified Oil Type.

**1.3 QUALITY ASSURANCE**

- .1 Manufacturer's technical recommendations:
  - .1 Perform glazing work in accordance with written recommendations from the glass manufacturer or glass fabricator.
  - .2 Certify glass compatibility with glazing materials (i.e. insulating glass sealants, structural sealants and silicones, gaskets, setting blocks, etc.)
  - .3 Designs to be analyzed for thermal stress.
  - .4 Provide shop inspection for glass.
- .2 Window fabricator shall be a member in good standing of the Northern Alberta Glass Trades Association and adhere to the rules and regulations for workmanship, training and personnel as set forth by the association.

**1.4 PERFORMANCE REQUIREMENTS**

- .1 Provide continuity of building enclosure vapour and air barrier using glass and glazing materials utilizing inner light of multiple light sealed units for continuity of air and vapour seal.
- .2 Size glass to withstand wind loads, deck loads and positive and negative live loads acting normal to plane of glass to a design pressure of 75 kPa as measured in accordance with ANSI/ASTM E330.
- .3 Limit glass deflection to 1/200 with full recovery glazing materials.

**1.5 SUBMITTALS**

- .1 Comply with requirements of Division 01 30 00.
- .2 Samples: Submit 300mm x 300mm sized samples of each type of glass, clearly labeled with manufacturer's name and glass type. Reference glass types to those scheduled and specified herein.
- .3 Stress Analysis: Prepare a stress analysis on all tinted heat/absorbing glass and light and heat reflecting glass. Submit prior to ordering glass.

**1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver and store packaged materials in their original containers with manufacturer's labels and seals intact.
- .2 Store vertically, blocked off the floor in a weatherproof enclosure.
- .3 Install glass as soon as possible after delivery to site.

- .4 Handle glass carefully to its place of installation. Prevent damage to glass, adjacent materials and surfaces.

#### **1.7 SITE CONDITIONS**

- .1 Coordinate the Work of this Section with the installation of frames to ensure a continuous, uninterrupted sequence, and to prevent the undue exposure of unprotected frames to the weather.
- .2 Do not install any glazing until all nearby welding is completed.
- .3 As each light of glass installed, mark it in a manner to make it visible and obvious to all persons. Do not use materials which may permanently mar, discolour or disfigure the glass.

#### **1.8 ENVIRONMENTAL REQUIREMENTS**

- .1 Install glazing when ambient temperature is 4°C minimum. Maintain ventilated environment for 24 hours after application.
- .2 Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

#### **1.9 WARRANTY**

- .1 Provide manufacturers guarantee for the following types of glass listed, against defects in materials and workmanship for the period indicated, commencing from the date of Substantial Performance of Work.
- .2 Sealed glass units against misting, dusting, seal failure, thermal shock breakers: or other impairments: 5 Years.

### **Part 2 Products**

#### **2.3 GLASS**

- .1 Clear Tempered Glass: to CAN/CGSB12.1 and as follows:
  - .1 Type: 2 Tempered.
  - .2 Class: B Float Glass.
  - .3 Category: II 540 J impact resistance.
- .2 Low Emissivity (Low E) Glass: to CAN/CGSB12.10, thickness as indicated, clear, sputtered titanium providing an emissivity rating 0.03 or less for 2<sup>nd</sup> glass surface installation.
  - .1 Acceptable materials: Solarban 60
- .3 Wired Glass: to CAN/CGSB12.11, as follows:
  - .1 Type 1 Polished both sides (transparent.
  - .2 Wire mesh styles 3 Square.

#### **2.4 INSULATING GLASS**



- .1 Insulating Glass Units: Provide sealed insulating glass units in accordance with CAN/CGSB12.8 in configurations indicated, and as specified herein.
  - .1 Double Glazing:
    - .1 Manufacture sealed insulating Low E coated glass units triple glazed without edge channels or tape, that is, with bare glass edges.
    - .2 Use two stage seal method of manufacture, as follows:
      - .1 Primary Seal: polyisobutylene sealing compound between glass and metal spacer/separator.
      - .2 Secondary Seal: polyurethane, silicone or polysulphide base sealant, filling gap between the two lites of glass at the edge up to the spacer/separator and primary seal.
    - .3 Spacer/separator to provide continuous vapour barrier between interior of sealed unit and secondary seal.
    - .4 Sealants for Insulating Glass Units shall be silicone based and compatible with Structural Silicone and as follows:
      - .1 Silicone Base Sealants: to CAN/CGSB19.13M87, one component, elastomeric, chemical curing.
      - .2 Rheological Properties: Class 2 nonsag.
      - .3 Substrate Class: G Glass.
      - .4 Glazing Suitability: Class A resists ultraviolet through glass.
      - .5 Temperature Class: L low temperature
      - .6 Movement Class: 40.
      - .7 Colour: Black.

## **2.5 ACCESSORY MATERIALS**

- .1 Sealants: Silicone, one component clear, with primers, sealers, cleaners all as specified in Section 07 92 00.
- .2 Glazing Tape: 100 percent polybutene vehicle. Extruded in ribbon form with paper separator. Tape shall have an integral shim strip where required.
- .3 Setting Blocks: Neoprene, shore A" hardness 7090; shims shore A" hardness 4050.
- .4 Glazing Compound: For glazing to metal, to CAN/CGSB19.2.

## **2.6 FABRICATION GENERAL**

- .1 Cut all glass to field measurement with proper clearances. Cut to produce clean, straight edges with no chips, cracks or flaws, round over and polish all edges of security glass.
- .2 Make any cutouts, openings to approved drawings. Grind and polish exposed edges smooth roundoff corners.

## **Part 3 Execution**

### **3.3 EXAMINATION**

- .1 Verify that openings for glazing are correctly sized and within tolerance.
- .2 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.

### **3.4 PREPARATION**

- .1 Ensure all glazing rebates smooth and true, free of projections nails, screws, fastenings properly set to prevent contact with glass.

- .2 Ensure all stops, splines, glazing accessories provided by others accurately cut to length and proper size and type for specific glazing.
- .3 Clean contact surfaces with solvent and wipe dry.
- .4 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .5 Prime surfaces scheduled to receive sealant.

**3.5 INSTALLATION**

- .1 Install in accordance with the manufacturer's written instructions and the contract documents, plumb, true, level and rigid.
- .2 Do not glaze when ambient or surface temperatures are less than 4°C. Glazing rebates, stops and glass shall be dry, free from ice, frost slick, grease, oil, dust, rust, or other matter detrimental to adhesion of tape, glazing compounds and sealant.
- .3 Installation of glass shall be by workmen skilled in this trade in strict accordance with manufacturer's directions.
- .4 Centre and support glass on setting blocks at quarter points, as required shim sides.
- .5 Glass shall be free from contact with the frames and stops.
- .6 Label each light to show manufacturer's name or trade mark, quality and thickness.
- .7 Use sealant at exterior doors, sealing water and weather tight.

**3.6 GLASS SCHEDULE**

- .1 Refer to Drawings for types and sizes of glass required.

**END OF SECTION**

**PART 1 General**

**1.1 SUMMARY**

- .1 This Section includes the following:
  - .1 Interior gypsum board for walls, ceilings and bulkheads

**1.2 REFERENCES**

- .1 American Society for Testing and Materials ([ASTM](#)):
  - .1 ASTM A653/A653M04a Steel Sheet, ZincCoated (Galvanized) or ZincIron AlloyCoated (Galvannealed) by the HotDip Process, General Requirements
  - .2 ASTM C1103d Standard Terminology Relating to Gypsum and Related Building Materials and Systems
  - .3 ASTM C47504 Joint Compound and Joint Tape for Finishing Gypsum Board
  - .4 ASTM C104799 (2004) Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
  - .5 ASTM C1396/C1396M04 Standard Specification for Gypsum Board
- .2 Canadian General Standards Board ([CGSB](#)):
  - .1 CAN/CGSB19.21M87 Sealing and Bedding Compound for Acoustic Purposes
- .3 Northwest Wall and Ceiling Bureau ([NWCB](#)):
  - .1 Specification Standards Manual
- .4 Underwriters Laboratories of Canada ([ULC](#)):
  - .1 CAN/ULC S10104 Fire Endurance Tests of Building Construction and Materials
  - .2 CAN/ULCS10203 Surface Burning Characteristics of Building Materials and Assemblies
  - .3 CAN/ULC S1141980 (R1997) Test for Determination of NonCombustibility in Building Materials
  - .4 CAN/ULC S70297 Mineral Fibre Thermal Building Insulation
  - .5 List of Equipment and Materials

**1.3 DEFINITIONS**

- .1 **Levels of Finish:** Standard levels of finish defined by NWCB Manual apply to products of this Section as follows, and are used in Section 09 99 10 Room Finish Schedule to designate required finish levels for indicated areas:
  - .1 **L0 – Level 0:** No tape or joint compound in joints.
  - .2 **L1 – Level 1:** Embed tape at joints in ceiling plenum areas, concealed areas, unless a higher level of finish is required for fire resistance rated assemblies and sound rated assemblies.
  - .3 **L2 – Level 2:** Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile.
  - .4 **L4 – Level 4:** Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view.
- .2 Refer to ASTM C11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

**1.4 QUALITY ASSURANCE**

- .1 Install gypsum board in accordance with the Northwest Wall and Ceiling Bureau (NWCBC), except as specified otherwise herein.
- .2 Conform to product manufacturer's written instruction and ULC Design Requirements to provide STC and fire ratings indicated.

**1.5 SITE SUPERVISION**

- .1 Site supervision for work of this section shall be full time. Supervisor shall be directly employed by the installer and shall have the authority to receive, represent and make decisions on behalf of the Trade Contractor.

**1.6 DELIVERY, STORAGE AND HANDLING**

- .1 Comply with requirements of Section 01 65 00.
- .2 Deliver materials in undamaged, original factory wrappings with labels and seals intact, and stored on job site in a dry, weatherproof, heated area.
- .3 Store metal furring and accessories flat and protected from moisture and damage.
- .4 Store boards flat, in piles, without overhanging boards, protected from moisture and physical damage.
- .5 Waste Management and Disposal: separate waste materials for re-use and recycling in accordance with Section 01 35 41.

**1.7 ENVIRONMENTAL CONDITIONS**

- .1 Maintain room, surface and material between 15°C and 21°C for a period of at least 72 hours before and during application, and continuously after.

**1.8 SUPERIMPOSED LOADS**

- .1 Determine the superimposed loads which will be applied to suspended ceiling systems and ensure that adequate hangers are installed to safely support the additional loads in conjunction with the normal loads of the system.

**PART 2 Products**

**2.1 GYPSUM BOARD MATERIALS**

- .1 Gypsum Board: meeting the requirements of ASTM C1396/C1396M and as follows:
  - .1. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system as indicated on drawings.
  - .2. Regular Gypsum Board:
    - .1. Thickness: As indicated.
    - .2. Long Edges: Tapered.
    - .3. Location: Vertical surfaces, unless otherwise indicated.

- .3. Fire Resistant Type (Type C or X):
  - .1. Thickness: As indicated, 16 mm minimum.
  - .2. Long Edges: Tapered.
  - .3. Location: Where required for fire resistance rated assembly.
- .4. Sag Resistant Gypsum Board: ceiling board manufactured to have more sag resistance than regular type gypsum board:
  - .1. Thickness: As indicated.
  - .2. Long Edges: Tapered.
  - .3. Location: Ceiling surfaces.
- .5. Mould Resistant Gypsum Board, for use on ceilings and wall in washroom, wet work stations, and janitor areas: To ASTM C1396, and mould resistance to ASTM D3273.
  - .1. Thickness: As indicated, 13 mm minimum.
  - .2. Long Edges: Tapered.
  - .3. Location: Vertical surfaces, unless otherwise indicated.
- .6. Glass Mat Water Resistant Gypsum Backer Board (Interior Applications Only): Manufactured in accordance with ASTM C1178 to produce greater resistance to water penetration and to provide improved surface bonding characteristics for ceramic tile than standard gypsum board:
  - .1. Thickness: As indicated, minimum 13 mm x manufacturers maximum length and widths.
  - .2. Location: Substrate for ceramic tile.
- .2 Joint Tape: To ASTM C475, perforated paper with tapered edges as recommended by gypsum board manufacturer, or glass fibre mesh tape
- .3 Joint Compound: To ASTM C475, bedding and finishing types recommended by gypsum board manufacturer; casein, vinyl or latex base.
- .4 Corner and Casing Beads, Edge Trim: To ASTM 1047, Minimum 0.455 mm metal core thickness (0.017") (26 gauge) galvanized sheet steel with Z275 zinc finish to ASTM A525M86, type with perforated flanges, of type to be finished with joint compound
- .5 Control/Expansion Joints: To ASTM C1047, 3 m (10 foot) lengths, roll formed zinc with a tape protected 6 mm (1/4") opening, 11 mm (7/16") deep
- .6 Adhesive: Type as recommended by gypsum board manufacturers
- .7 Acoustic Insulation: To ULC S702, mineral fibre sound control batts, steel stud friction fit insulation (un faced), thickness 76 mm (3"), density 40 kg/m<sup>3</sup> minimum STC 50 for wall assembly. Acceptable material: Roxul AFB, substitutions shall submit product data to the Consultant prior to close of bid with all supporting information
- .8 Sealant (acoustic purposes only): To CAN/CGSB19.21, non-skinning, non-hardening as specified in Section 07 90 00
- .9 Sealant (fire rated for rated walls): ULC labelled, as specified in Section 07 90 00
- .10 Insulating Strip: Rubberized, moisture resistant 3 mm thick closed cell neoprene strip 90 mm wide with self sticking permanent adhesive on one face lengths as required

**PART 3 Execution**

**3.1 INSPECTION AND PREPARATION**

- .1 Inspect areas and surfaces and ensure all required metal backing for equipment is in place before commencing gypsum board application.
- .2 Verify stud framing securely and rigidly erected, all services, lines, outlets and insulation.
- .3 Prepare existing walls with wall metal backing ready for installation of new or relocated cabinet as indicated on drawings. Coordinate with Section 06 40 00 Architectural Wood work for backing requirements.
- .4 Inspect all pressed steel frames and correct out-of-plumb frames for true alignment.

**3.2 RESTORATION AND REPAIRS**

- .1 Skim coat all existing affected gypsum board walls and columns to make ready for new finishes. Repair all dents and gouges to provide smooth and even appearance. Cut and repair any gypsum board that has broken front and backer face.
- .2 Repair existing drywall surfaces where existing abutting partitions have been removed. Review conditions on site during bid period.

**3.3 CONTROL JOINTS**

- .1 Erect control joints at maximum 7.5 metre (25 feet) centres to divide large ceiling and wall areas into panels, over junction of structural members and non structural members where gypsum board is continuous, over control joints in masonry walls, at junction of ceilings and partitions with furred exterior wall.
- .2 Control joints shall be laid out to coincide as far as possible with metal door, window or screen frames, but not necessarily to occur at every individual frame. Obtain Architect's approval for location, prior to installation.

**3.4 ACCESSORIES**

- .1 Secure corner beads rigidly at all external angles of walls and ceilings.
- .2 Install casing beads where gypsum board terminates against surface having no trim concealing the junction or where junction is not taped.
- .3 Install casing beads where gypsum board butts to windows, frames or where interior partitions butt to exterior walls.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window exterior door frames and ceilings to provide thermal break and air seal.

**3.5 GYPSUM BOARD APPLICATION**

- .1 Erect gypsum board and tape joints to NWCB except where specified otherwise herein.
- .2 Kerf cut gypsum board at curved walls follows by plaster fill system to present smooth even curve showing no faceting and blending smoothly into adjacent straight wall sections.
- .3 Install fire rated and labelled gypsum board at all locations indicated on Drawings, utilizing type "C" or "X" as indicated by ULC rating for assembly and as required by authority having jurisdiction. Continue fire and smoke rated wall construction behind and around fire hose cabinet recesses and other recessed items larger than a double gang switch box to maintain wall fire rating.

- .4 Stop gypsum board 25 mm (1") from underside of roof deck. Attach gypsum board to vertical studs, not to ceiling track, to allow for deflection.
- .5 Tile Backing Panels:
  - .1 Construct shower and bath surround partitions of glass mat reinforced water resistant gypsum backing board only, in strict accordance with manufacturer's current recommended installation procedures.
  - .2 Shim surfaces to produce a uniform plane across panel surfaces where tile backing panels abut other types of panels in the same plane.

### 3.6 SEALANT SOUND RATINGS

- .1 Caulk sound rated partitions strictly in accordance with gypsum board manufacturer's instructions for the specific sound rating requirements. Locate sealant to ensure it is covered at completion of partition when finishes applied. Seal top and bottom tracks, and seal studs where they abut adjacent wall construction to ensure that no sound flanking occurs.
- .2 Seal around mechanical and electrical work and other work in walls to ensure proper sound ratings. Provide gaskets where partitions abut a finished surface or material as per details and where partitions meet exterior wall furring.
- .3 Build in all door, borrowed light frames and equipment to best practice to provide a neat, cleanly finished system.
- .4 In fire rated partitions install fire stopping sealant before installing acoustic sealant.

### 3.7 INSULATION ACOUSTIC

- .1 Install insulation within metal stud space to top of wall construction as indicated for sound or fire rating. Insulation to extend full height of partitions. Fill behind electrical outlet boxes, fire hose cabinets, washroom accessories and other openings with at least 150 mm (6") lap around perimeter of opening, packed tight in layers (to approximately 50% of nominal thickness).
- .2 Coordinate with Electrical and Mechanical Subcontractors to ensure that no back-to-back openings are formed, whether or not so indicated on drawings. All electrical and mechanical openings shall be separated by one stud space and lined all around with gypsum board and sealed with acoustic sealant.
- .3 Installation to comply with manufacturer's current written recommendations.

### 3.8 SEALANT FIRE RATINGS

- .1 Coordinate requirements for fire sealants with General Contractor.
- .2 Caulking and sealing of fire and smoke rated partitions and separations specified under Section 07 84 00 Fire stopping and Smoke Seals.

### 3.9 CEILINGS AND SOFFITS

- .1 Apply no-sag gypsum board to ceiling suspension system with end joints occurring over supports. Allow 1.5 mm (1/16") to 3 mm (1/8") space between butting ends.
- .2 Cut board to fit within 6 mm (1/4") of fixtures and other surfaces.
- .3 Screw attach to furring channels at spacing recommended by gypsum board manufacturer but in no case less than 150 mm (6") on centre.

- .4 Coordinate cutouts, trim and opening details and location with mechanical and electrical subcontractors.
- .5 Finish gypsum board to heights and profiles indicated. Trim all corners and edges with proper corner and casing beads.
- .6 Install moisture resistant gypsum board ceiling in washrooms and housekeeping rooms.
- .7 Build bulkheads for drop ceilings as detailed. Carry gypsum board a minimum 50 mm (2") above finished acoustic board ceiling. Provide furring behind for attachment of acoustic board perimeter track.
- .8 Maintain surface flatness and level of ceiling within 3 mm (1/8") in 3 metres (10 feet).

**3.10 FINISHING**

- .1 Finish gypsum wallboard in accordance with the Northwest Wall and Ceiling Bureau (NWCBC), Section 9.6 Part 3, Item 12.2, Levels of Finish No. 4.

**3.11 ACCESS DOORS**

- .1 Install flush mounted access doors in locations as indicated on drawings in accordance with manufacturers instructions. Ensure that installation occurs prior to taping and finishing of gypsum board surfaces.
- .2 Install all access doors provided by other trades. Exact locations of these doors will be verified on site.

**3.12 CLEAN UP**

- .1 All gypsum board debris and dust shall be cleaned up and disposed of daily.
- .2 Cleaning shall consist of brushing down wall and ceiling and sweeping floors daily.
- .3 As areas are completed, thoroughly vacuum ceilings, walls and floors of all dust.

**END OF SECTION**



**Part 1 General**

**1.1 SECTION INCLUDES**

- .1 Provide labour, materials, tools and other equipment, services and supervision required to complete all interior and exterior (including above roof) painting and decorating work as indicated on Finish Schedules and to the full extent of the drawings and specifications.
- .2 Surface preparation to receive painting and finishing is not included under this section of work, except for priming and back-priming and specific pre-treatments noted herein or specified in the Master Painters Institute (MPI) Painting Specification Manual.

**REFERENCES**

- .3 AWWA (American Water Works Association) - C218 - Standard for Coating the Exterior of Aboveground Steel Water Pipelines & Fittings.
- .4 AWWA (American Water Works Association) - D102 - Coating Steel Water Storage Tanks.
- .5 NACE (National Association of Corrosion Engineers) - Industrial Maintenance Painting.
- .6 MPI (Master Painters Institute) - Specifications Manual.
- .7 SSPC (The Society for Protective Coatings) (formerly SSPC - Steel Structures Painting Council) - Steel Structures Painting Manual.

**SUBMITTALS**

- .8 Comply with requirements of Section 01 33 00.
- .9 Product Data: Provide data on all finishing products.
  - .1 Provide VOC information for all sealants, adhesives, paints, and finishes.
- .10 Samples: Submit two samples (drawdowns), 100 x 100 mm in size illustrating each colour and finish as selected by Departmental Representative.
  - .1 Submit samples of all finishes specified to Departmental Representative for review and acceptance prior to ordering materials.
- .11 Installation Data: Manufacturer's special installation requirements indicating special surface preparation procedures, substrate conditions requiring special attention.
  - .1 Provide percentage of recycled content for each Product used.
  - .2 Provide number of litres used for each product.

**1.2 SYSTEM DESCRIPTION**

- .1 Paint exposed surfaces in new construction affected by new work whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural.
    - .1 Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces.
    - .2 If color or finish is not designated, Departmental Representative will select from standard colors or finishes available.
-

- .3 Painting includes field painting exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
  - .2 Painting is not required on prefinished items, finished metal surfaces, concealed surfaces, operating parts, and labels.
  - .3 Prefinished items not to be painted include the following factory-finished components:
    - .1 Shower enclosures.
    - .2 Acoustic materials.
    - .3 Architectural woodwork and casework.
    - .4 Finished mechanical and electrical equipment. Rooftop mechanical equipment to be painted uniform colour.
    - .5 Light fixtures.
    - .6 Switchgear.
    - .7 Distribution cabinets.
    - .8 Cladding materials.
  - .4 Concealed surfaces not to be painted include wall or ceiling surfaces in the following generally inaccessible areas:
    - .1 Foundation spaces.
    - .2 Furred areas.
    - .3 Utility tunnels.
    - .4 Pipe spaces.
    - .5 Duct shafts.
    - .6 Elevator shafts.
  - .5 Finished metal surfaces not to be painted include:
    - .1 Anodized aluminium.
    - .2 Copper and copper alloys.
    - .3 Stainless steel.
    - .4 Chromium plate.
  - .6 Operating parts not to be painted include moving parts of operating equipment such as the following:
    - .1 Valve and damper operators.
    - .2 Linkages.
    - .3 Sensing devices.
    - .4 Motor and fan shafts.
    - .5 Door and window handles.
  - .7 Labels: Do not paint over CSA, Underwriter's Laboratories, Factory Mutual or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
  - .8 Coordination of Work: Review other sections in which primers are provided to ensure compatibility of the total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
-

### **1.3 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Stock Materials:
  - .1 Provide four (4) L of each colour, type, and surface texture to Departmental Representative.
  - .2 Label each container with colour, type, texture, room locations, in addition to the manufacturer's label.

### **1.4 QUALITY ASSURANCE**

- .1 Conform to MPI - Specification Manual.
- .2 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section.
- .3 Installer Qualifications: Company specializing in performing the work of this section.
- .4 Single Source Responsibility: Obtain materials from a single manufacturer for the complete system.
- .5 Pre-Installation Meetings: Conduct meetings at Project site.
- .6 Only qualified journeymen who have a "Tradesman Qualification Certificate of Proficiency" shall be engaged in painting and decorating work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.
- .7 Surfaces shall receive Premium grade finish systems, 3 coats, except where MPI Manual indicates no Premium system in which case a 2 coat Custom system is acceptable.

### **1.5 PROJECT CONDITIONS**

- .1 Painting and decorating work shall be inspected by a Paint Inspection Agency (inspector) acceptable to the specifying authority and the local MPDA Accredited Quality Assurance Association. Notify the Paint Inspection Agency a minimum of one week prior to commencement of work and provide a copy of the project painting specification, plans and elevation drawings (including pertinent details) as well as a Finish Schedule.
- .2 Surfaces requiring painting shall be inspected by the Paint Inspection Agency who shall notify the Departmental Representative and Contractor in writing of defects or problems, prior to commencing painting work, or after the prime coat shows defects in the substrate.
- .3 Do not apply paint finishes in areas where dust is being generated.
- .4 Conform to MPI and manufacturer's requirements.

### **1.6 REGULATORY REQUIREMENTS**

- .1 Conform to applicable code for flame and smoke rating requirements for finishes.

### **1.7 DELIVERY, STORAGE, AND PROTECTION**

- .1 Section 01 61 00: Transport, handle, store, and protect products.
  - .2 Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
  - .3 Container label to include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, colour designation, and written instructions for mixing and reducing.
-

- .4 Store paint materials at minimum ambient temperature of <7 degrees C> <<45 degrees F>> and a maximum of <32 degrees C> <<90 degrees F>>, in ventilated area, and as required by manufacturer's written instructions.

## **1.8 COORDINATION**

- .1 Coordinate the work of this section closely with the work of Section 05 50 00 Metal Fabrications and 07 92 00 Joint Sealants to ensure compatibility of primers and finish systems.

## **1.9 ENVIRONMENTAL REQUIREMENTS**

- .1 Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
- .2 Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the paint product manufacturer.
- .3 Minimum Application Temperatures for Latex Paints: <7 degrees C> << 45 degrees F>> for interiors; <10 degrees C> << 50 degrees F>> for exterior; unless required otherwise by manufacturer's written instructions.
- .4 Minimum Application Temperature for Varnish and Clear Finishes: <18 degrees C> << 65 degrees F >>for interior or exterior, unless required otherwise by manufacturer's written instructions.
- .5 Provide lighting level of <860 lx> <<80 ft candles>> measured mid-height at substrate surface.

## **Part 2 Products**

### **2.1 MATERIALS - GENERAL**

- .1 Provide paints and coatings that comply with Green Seal Standards GS-03, and GS-11.
- .2 Provide paints and coatings that comply with the South Coast Air Quality Management District (SCAQMD) rule #1113 limits on volatile organic compounds.
- .3 Paints and coatings, used on the interior of the building (defined as inside of the weatherproofing system and applied on-site) shall comply with the following criteria:
  - .1 Architectural paints, coatings and primers applied to interior walls and ceiling: do not exceed VOC content limits established in green seal standard GS-11, paints, first edition, May 20, 1993.
    - .1 Flats: 50 g/L.
    - .2 Non-Flats: 150 g/L.
  - .2 Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates: Do not exceed the VOC content limit of 250 g/L established in green seal standard GC-03, anti-corrosive paints, second edition, January 7, 1997.
  - .3 Clear wood finishes, floor coatings, stains and shellacs applied to interior elements: Do not exceed the VOC content limits established in South Coast Air Quality Management District (SCAQMD) Rule 1113, Architectural coatings, rules in effect on January 1, 2004.
    - .1 Clear Wood Finishes: Varnish 350 g/L; lacquer 550 g/L.
    - .2 Floor Coating: 100 g/L.

- .3 Sealers: Waterproofing sealers 250 g/L; sanding sealers 275 g/L; all other sealers 200 g/L.
- .4 Shellacs: Clear 730 g/L; Pigmented 550 g/L.
- .5 Stains: 250 g/L. Surface preparation and field application of paints and coatings.

## 2.2 MATERIALS

- .1 All the materials must meet the Green Approved Products List of the Master Painters Institute.
- .2 Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.
- .3 Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified, of commercial quality.
- .4 Patching Materials: Latex filler.
- .5 Fastener Head Cover Materials: Latex filler.

## 2.3 GLOSS LEVELS

- .1 Specified gloss levels are based on the MPI standard, which is as follows:
  - .1 Level G1 – Matte or Flat: gloss rating of 0 to 5 units at 60 degrees and sheen rating of a maximum of 10 units at 85 degrees.
  - .2 Level G2 - Velvet: gloss rating of 0 to 10 units at 60 degrees and a sheen rating of 10 to 35 units at 85 degrees.
  - .3 Level G3 - Eggshell: gloss rating of 10 to 25 units at 60 degrees and a sheen rating of 10 to 35 units at 85 degrees.
  - .4 Level G4 - Satin: gloss rating of 20 to 35 units at 60 degrees and a sheen rating of 35 units minimum at 85 degrees.
  - .5 Level G5 - Semi-gloss: gloss rating of 35 to 70 units at 60 degrees.
  - .6 Level G6 - Gloss: gloss rating of 70 to 85 units at 60 degrees.
  - .7 Level G7 – High-gloss: gloss rating of more than 85 units at 60 degrees.

## 2.4 Finishes

- .1 Refer to schedules at end of section for surface finishes.

## Part 3 Execution

### EXAMINATION

- .1 Verify existing conditions before starting work.
  - .2 Verify that surfaces and substrate conditions are ready to receive work as instructed by the product manufacturer.
  - .3 Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
-

- .4 Test shop applied primer for compatibility with subsequent cover materials.
- .5 Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
  - .1 Plaster and Gypsum Wallboard: 12 percent.
  - .2 Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
  - .3 Interior Wood: 15 percent, measured in accordance with ASTM D2016.
  - .4 Concrete Floors: 8 percent.

#### **PREPARATION**

- .6 Remove electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.
- .7 Correct defects and clean surfaces which affect work of this section.
- .8 Seal with shellac and seal marks which may bleed through surface finishes.
- .9 Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
- .10 Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
- .11 Concrete Floors: Remove contamination, acid etch, and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.
- .12 Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
- .13 Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
- .14 Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
- .15 Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.
- .16 Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. [Prime metal items including shop primed items.]
- .17 Interior Wood Items Scheduled to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats.
- .18 Wood and Metal Doors Scheduled for Painting: Seal top and bottom edges with primer.

#### **APPLICATION**

- .19 Apply products to manufacturer instructions.
  - .20 Do not apply finishes to surfaces that are not dry.
-

- .21 Apply each coat to uniform finish.
- .22 Apply each coat of paint slightly darker than preceding coat unless otherwise approved.
- .23 Sand wood and metal lightly between coats to achieve required finish.
- .24 Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
- .25 Allow applied coat to dry before next coat is applied.
- .26 Where clear finishes are required, tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.
- .27 Prime concealed surfaces of interior woodwork with primer paint.
- .28 Prime concealed surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.

### **3.2 ROOM IDENTIFICATION SIGNAGE**

- .1 Thoroughly clean all surfaces designated for signage and leave the work ready for painting.
- .2 Use paint system compatible with surface below.
- .3 Clearly mark all doors with alphanumeric characters to schedule as provided by Departmental Representative. Allow for 5 characters per room.

### **3.3 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT**

- .1 Refer to Mechanical and Electrical Specifications for schedule of colour coding and identification banding of equipment, duct work, piping, and conduit.
- .2 Paint shop primed equipment.
- .3 Remove unfinished louvres, grilles, covers, and access panels on mechanical and electrical components and paint separately. Paint to match adjacent surface.
- .4 Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, except where items are prefinished.
- .5 Paint interior surfaces of air ducts, that are visible through grilles and louvres with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvres, grilles, to match face panels.
- .6 Paint exposed conduit and electrical equipment occurring in finished areas.
- .7 Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
- .8 Colour code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated.
- .9 Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

### **CLEANING**

- .10 Section 01 74 11: Cleaning installed work.
  - .11 Collect waste material which may constitute a fire hazard, place in closed metal containers and remove daily from site.
-

**SCHEDULE - SHOP PRIMED ITEMS FOR SITE FINISHING**

- .12 Metal Fabrications (Section 05 50 00): Exposed surfaces of lintels, elevator pit ladders, doors and frames.
- .13 Metal Stairs (Section 05 51 00): Exposed surfaces of stringers, exposed vertical risers.

**3.4 SCHEDULE - EXTERIOR SURFACES**

- .1 Steel - Galvanized:
  - .1 EXT 5.3B Alkyd semi gloss finish.
  - .2 Primer: AFM MetalCoat Acrylic Metal Primer.
  - .3 First and Second Coats: "All Purpose Exterior Satin" satin gloss.
  - .4 Colours: colour to be selected by Departmental Representative.
- .2 Wood - Transparent:
  - .1 EXT 6.3G Polyurethane, Clear, 2 Component, 3 coats.

**COLOUR SCHEDULES:**

- .3 Where specific products are available in a restricted range of colours, selection will be based on the limited range.
- .4 Second coat in a three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.
- .5 Colour Scheme: For bidding purposes, colour scheme will be generally as follows:
  - .1 Maximum 4 colours for exterior.
  - .2 Maximum 7 field colours and 2 accent colours for interior.
  - .3 Generally, no more than 3 colours to be used in any one area.
  - .4 Allow approximately 10% of interior painted surfaces for deep colour tones.

**3.5 SCHEDULE - INTERIOR SURFACES**

- .1 Concrete walls:
  - .1 INT 3.1C High performance architectural latex G2 finish.
- .2 Concrete Masonry walls:
  - .1 INT 3.1C High performance architectural latex G2 finish.
- .3 Metal doors, frames, exposed steel columns, beams and miscellaneous metal items.
  - .1 INT 5.1R High performance architectural latex coating G4 gloss level.
- .1 Gypsum Board wall surfaces for Office Areas:
  - .1 INT 9.2A Latex G3 finish (over latex sealer).
- .2 Gypsum Board wall surfaces for Bedrooms, Kitchen, and living areas in Residential Pod:
  - .1 INT 9.2A Latex G4 finish (over latex sealer).
- .3 Gypsum Board wall surfaces:
  - .23680 INT 9.2A Latex G5 finish (over latex sealer).
- .30464 Gypsum Board ceilings surfaces:



- .1 INT 9.2A Latex G1 finish (over latex sealer).

**SCHEDULE – EXTERIOR SURFACES**

- .30465 Exterior steel doors and frames:

- .1 EXT 5.3B - Alkyd G4 gloss level finish.

- .30466 Galvanized metal:

- .1 EXT 5.3G - Water based light industrial G1 gloss level coating.

**END OF SECTION**

**PART 1. General**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM A653/A653M[01a], Standard Specification for Steel Sheet, ZincCoated, (Galvanized) or ZincIron AlloyCoated (Galvannealed) by the HotDip Process.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB1.81[M90], Air Drying and Baking Alkyd Primer for Vehicles and Equipment.
  - .2 CAN/CGSB1.88[92], Gloss Alkyd Enamel, Air Drying and Baking.
  - .3 CAN/CGSB1.104[M91], Semigloss Alkyd, Air Drying and Baking Enamel.
- .3 Canadian Standards Association (CSA International)
  - .1 CSAG40.20-[04]/G40.21[02], General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
  - .2 CAN/CSAG164[M92(R2003)], Hot Dip Galvanizing of Irregularly Shaped Articles.
  - .3 CSA W59[03], Welded Steel Construction (Metal Arc Welding).
- .4 Green Seal Environmental Standards
  - .1 Standard GC-03-[93], Anti-Corrosive Paints.
  - .2 Standard GS-11-[97], Architectural Paints.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .6 South Coast Air Quality Management District (SCAQMD), California State
  - .1 SCAQMD Rule 1113-[04], Architectural Coatings.
- .7 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual [February 2004].
    - .1 MPI # 76, Quick Dry Alkyd Metal Primer.
    - .2 MPI # 81, Machinery Enamel.
    - .3 MPI # 96, Quick Dry Enamel Gloss.

**1.2 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature for wire mesh partitions or components, specifications and data sheet and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Indicate partition panel modules and types, materials, gauges, finishes, door and other openings, hardware, fastening methods to adjacent structure, ceiling details, and assembly methods.

- .4 Samples:
  - .1 Submit duplicate 300 x 300mm samples of partition and colour and finish on actual base metal.
  - .2 Sample to show basic construction, door construction, hardware, and finishes.

## **PART 2. Products**

### **2.1 MATERIALS**

- .1 Partition mesh: PVC coated welded mesh.
- .2 Steel sections and plates: to CAN/CSAG40.20, type 44W.
  - .1 Posts: minimum 1.6 mm thick hollow steel tubing, round 90 mm diameter, galvanized bolted construction, designed to secure to floors.
  - .2 Extension posts: 44 x 44mm hollow steel tubing, minimum wall thickness 1.6mm.
  - .3 Angle frame: 32 x 32 x 3mm.
  - .4 Post caps: manufacturer's standard formed cap; finish to match other components.
- .3 Bolts, fasteners and fastening hardware: manufacturer's standard to suit design and application.

### **2.2 FABRICATION**

- .1 Panels:
  - .1 Fabricate panels sizes or shapes as required for proposed installation and as indicated on Drawings.
  - .2 Mitre and weld frame corners.
  - .3 Provide 20 x 6 mm flat bars across panels at third points on 2400 mm dimension.
  - .4 Provide wire mesh panel ceilings for lockers.
- .2 Posts:
  - .1 2400 mm high with floor plates for fixing and post cap.
  - .2 Include corner, wall, door and other special posts to manufacturer's standard.
- .3 Post extensions:
  - .1 Length required to telescope 300 mm into post and extend posts to ceiling.
  - .2 Weld ceiling plate on upper end for fixing.
  - .3 Supply extension posts where indicated.
- .4 Swing doors: standard doors:
  - .1 750 x 2100mm.
  - .2 Construct doors and transom above of angle frame to match panels.
  - .3 Reinforce door with 40 x 5 mm or equivalent flat bar centre rail and 20 x 6 mm or equivalent flat bar bracing from centre rail to opposite corners on hinge side.

- .5 Swing door hardware:
  - .1 Equip doors with stops, keeper, hasp for padlock.
  - .2 Equip standard doors with 1 1/2 pair of butts.
  - .3 Equip dutch doors with 2 pair of butts.

**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 ERECTION**

- .1 Install mesh enclosures and doors in accordance with manufacturer's printed instructions.
- .2 Erect enclosures plumb, level, straight, rigidly supported, and securely fastened to abutting surfaces, free from superimposed loads.
- .3 Fix to masonry and concrete using lag bolts and shields; to hollow walls using bolts and toggle type anchors; to steel supports with bolts in threaded holes or spot welds.
- .4 Install doors and adjust for proper closing, locking and smooth operation.
- .5 Install ceilings to lockers to maintain minimum 300mm clearance from underside of structure for sprinkler operation.

**3.3 CLEANING**

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

**END OF SECTION**

**PAR 1. General**

**1.1. SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00
- .2 Shop Drawings: Indicate size, description of components, base materials, surface finishes, inside and out, hardware components, attachment and anchorage methods for all components.

**PART 2. Products**

**2.1. MANUFACTURED PRODUCTS**

- .1 The following manufacturers' products are acceptable for use for this project:
  - .1 Bobrick Washroom Equipment of Canada Ltd.
  - .2 Taymor Industries Ltd.
  - .3 The Bradley Corporation
  - .4 Hubert Industries
  - .5 Frost Metal Products Ltd.
  - .6 Twin-Cee Ltd. Architectural Division of G.H. Wood & Co. Ltd.
- .2 The following manufacturer's products are the basis for the attached washroom accessory schedule
  - .1 Taymor Industries Ltd., Sunglow Collection

**2.2. MATERIALS**

- .1 Sheet Metal: Commercial quality, stretcher levelled to ASTM A526-80, zinc coated to ASTM A525-81, G90 coating designation
- .2 Fasteners & Anchors: Screws and bolts hot dipped galvanized to CSA G164-M1981, expansion shields fibre, lead or rubber to suit intended installation and as recommended by fixture manufacturer

**2.3. FINISHES**

- .1 Chrome & Nickel Plating: To ASTM B456-79, satin finish
- .2 Baked Enamel: Condition metal by applying one coat metal conditioner to CGSB 31-GP-107a, apply one coat primer to CGSB 1-GP-81M - Type 2, apply two coats Type 2 enamel to CGSB 1-GP-88e and bake to a hard durable finish, colour as selected by the Consultant from manufacturer's standard range

**2.4. FABRICATION**

- .1 Weld and grind joints of fabricated components flush and smooth. Use mechanical fasteners only where it is impractical to weld.
- .2 Wherever possible form exposed surfaces from one piece or sheet of material, free of joints.
- .3 Form surfaces flat without distortion, scratches or dents, radius corners.
- .4 Back paint surfaces of components coming in contact with building finishes.

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- .5 Shop assemble components and package complete with all anchors and fittings.
- .6 Deliver templates, inserts and rough-in frames to site at appropriate time for building in.
- .7 Provide anchorage devices and concealed plates for installation into building framing.

**3. Execution**

**3.1. PREPARATION**

- .1 Verify with Consultant exact locations of all components before beginning installation.
- .2 Examine areas to receive components and notify Consultant of any conflicts detrimental to installation or operation of components.
- .3 Ensure all concealed backup and anchorage has been installed in correct locations.

**3.2. INSTALLATION**

- .1 Install all fixtures, accessories and other items in accordance with manufacturer's written instructions.
- .2 Install level and plumb, rigidly anchor to substrate.
- .3 Use tamperproof fasteners for installation of all components.
- .4 Provide necessary supplies for components and install in units when directed by the Consultant.

**3.3. SCHEDULE OF ACCESSORIES**

- .1 Provide and install the following components and accessories in locations indicated:
  - .1 Toilet Paper Rolls: 101S; chrome-plated recessed toilet tissue dispenser complete with chrome-plated spindle
  - .2 Towel Bars: 9400-18 (457mm length) or 9400-24 (610mm length) as indicated on drawings; square towel bar set; 19mm, chrome-plated steel complete with connected mounting bracket
  - .3 Shower Rods: 9789; standard chrome-plated steel shower rod 25mm ø x 1524mm long complete with flange and exposed fasteners, chrome-plated hooks, hold-back chain and hook

**END OF SECTION**

**1. General**

**1.1 RELATED REQUIREMENTS**

- .1 Mechanical General Requirements: Section 20 00 13.

**1.2 REFERENCE DOCUMENTS**

- .1 National Fire Protection Association (NFPA):  
.1 NFPA (Fire) 10 Portable Fire Extinguishers, 2010 Edition  
.2 Underwriters Laboratories of Canada (ULC):  
.1 CAN/ULC-S508-02 Standard for the Rating and Fire Testing of Fire Extinguishers, Including Amendments 1 and 2

**1.4 PRODUCT OPTIONS AND SUBSTITUTIONS**

- .1 Refer to Division 01 for requirements pertaining to product options and substitutions.

**1.5 SUBMITTALS**

- .1 Product Data:  
.1 Submit manufacturer's printed product literature, specifications and data sheets in accordance with Section 01 33 00 - Submittal Procedures.  
.2 Shop Drawings:  
.1 Submit shop drawings, clearly indicating fabrication details, plans, elevations, edge details, hardware, and installation details.  
.2 Submit large scale details of all anchorages, clearly indicating components, materials, and finishes, and related work.

**1.6 CLOSEOUT SUBMITTALS**

- .1 Operation and Maintenance Data:  
.1 Provide data describing maintenance of product for incorporation into Maintenance and Operation Manual.

**1.7 DELIVERY, STORAGE, AND HANDLING**

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

**2. Products**

**2.1 RATING OF PORTABLE FIRE EXTINGUISHERS**

- .1 Provide hand portable extinguishers rated in accordance with CAN/ULC S508 and bearing ULC label.

**2.2 PORTABLE FIRE EXTINGUISHERS**

- .1 Multi-Purpose Dry Chemical - Pressure Type:
  - .1 Description: ammonium phosphate, powder type, heavy duty steel cylinder, baked enamel finish, squeeze grip handle with positive on/off valve, hose and nozzle, mounting brackets, ULC labeled.
  - .2 Capacity: 4.5 kg.
  - .3 ULC Rating: 2A, 2 to 10BC
  - .4 Classification: Class A, B, and C fires.
- .2 Carbon Dioxide:
  - .1 Description: carbon dioxide charged heavy duty steel cylinder, baked enamel finish, positive on/off squeeze grip handle, impact resistance discharge horn, mounting bracket, ULC labeled.
  - .2 Capacity: 4.5 kg.
  - .3 ULC Rating: 10 BC.
  - .4 Classification: Class B and C fires.

**3. Execution**

**3.1 INSTALLATION**

- .1 Provide extinguishers where indicated on drawings.
- .2 Where exact location is not indicated, mount in location as directed by the Minister.

**END OF SECTION**



**PART 1. General**

**1.1 SECTION INCLUDES**

- .1 Cabinets and countertops, trim, attachment accessories.
- .2 Finish hardware.

**1.2 REFERENCES**

- .1 ANSI/NPA A208.1-1999 - Particleboard.
- .2 ANSI/NPA A208.2-2002 - Medium Density Fibreboard (MDF) for Interior Applications.
- .3 APA (The Engineered Wood Association).
- .4 ASTM E84-08a - Test Method for Surface Burning Characteristics of Building Materials.
- .5 NEMA LD3-2005 - High-Pressure Decorative Laminates.

**1.3 ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination:
  - .1 Coordinate with other work having a direct bearing on work of this section.
  - .2 Coordinate the Work of this section and directly related sections, with installation of adjacent work, utility and service outlets.
- .2 Pre-installation Meetings: Convene one (1) week before starting work of this section.

**1.4 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, finishes.
  - .1 Indicate location of countertop seams.
  - .2 Indicate locations and types of service fittings, exposed conduit and associated service supply connections.
  - .3 Indicate required clearance from adjacent building components and other laboratory equipment.
- .3 Samples:
  - .1 Submit 300mm x 600mm size samples, illustrating cabinet finish.
  - .2 Submit 300mm x 300mm size samples, illustrating countertop finish.
  - .3 Submit two (2) samples each of typical hardware, illustrating hardware finish.
- .4 Installation Data: Manufacturer's special installation requirements.

**1.5 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section.
- .2 Installer Qualifications: Company specializing in performing the work of this section approved by the manufacturer.

**1.6 REGULATORY REQUIREMENTS**

- .1 Conform to applicable code for fire retardant requirements.

**1.7 DELIVERY, STORAGE, AND PROTECTION**

- .1 Protect units from moisture damage.

**1.8 ENVIRONMENTAL REQUIREMENTS**

- .1 Maintain ambient temperature between 15-25 or as recommended by manufacturer, during and after installation of casework.

**1.9 WARRANTY**

- .1 Provide a two (2) year warranty to include coverage for failure to meet specified requirements.

**PART 2. Products**

**2.1 MATERIALS**

- .1 Medium Density Fibreboard (MDF): ANSI A208.2; composed of wood fibres, medium density, of grade to suit application; sanded faces.
- .2 High Pressure Laminate: NEMA LD3, high pressure laminate, Grade VGS or VGL
- .3 Post-formed Laminate: NEMA LD3, high pressure laminate, Grade HGP.
- .4 Thermofused Decorative Overlay (Melamine): to NEMA LD3, melamine-impregnated decorative paper thermally fused to MDF core; white colour.
- .5 Laminate Backing Sheet: NEMA LD3, BKL, not less than 0.5 mm thick, undecorated.
- .6 Cabinet Liner: NEMA LD3, Grade CLS, not less than 0.5 mm thick, [white] [ ] colour.

**2.2 ACCESSORIES**

- .1 Contact Adhesives: Water base type.
- .2 Bolts, Nuts, Washers, Blind fasteners, Lags, and Screws: Size and type to suit application; plain finish.
- .3 Plastic Edge Trim: Extruded convex shaped; smooth finish; self-locking serrated tongue; of width to match panel thickness; same colour as exposed finish.

**2.3 HARDWARE**

- .1 Hardware: Manufacturer's standard hardware.

**2.4 PLASTIC LAMINATE CASEWORK**

- .1 Cabinet Construction: Flush overlay, adjustable shelving MDF core.
- .2 Exposed Surfaces:
  - .1 Drawers and Drawer Fronts: High pressure laminate.
  - .2 Edges: PVC.

- .3 Semi-exposed Surfaces:
  - .1 Surfaces (other than drawer bodies): Thermofused melamine.
  - .2 Shelves: Thermofused melamine.
  - .3 Edges: PVC.
  - .4 Drawer Units: manufacturer's standard.

## **2.5 PLASTIC LAMINATE COUNTERTOPS**

- .1 Postformed Laminate: NEMA LD3, high pressure laminate, Grade [HGP].
  - .1 Edge Treatment: Same as laminate cladding on horizontal surfaces.
  - .2 Core Material: Medium density fiberboard].

## **2.6 FABRICATION**

- .1 Fabricate cabinets to manufacturer's standard construction.

## **PART 3. Execution**

### **3.1 EXAMINATION**

- .1 Verify openings and adjoining materials are ready to receive work of this section.

### **3.2 INSTALLATION**

- .1 Install to manufacturer instructions.
- .2 Set and secure materials and components in place, plumb and level.
- .3 Install components and trim, with screws and bolts with blind fasteners.
- .4 Cover exposed edges of shelving and site made casework with plastic edging. Width of edging to match shelving.
- .5 Apply plastic laminate finishes where indicated.
  - .1 Cap exposed edges with plastic laminate of same finish and pattern.
  - .2 Apply laminate backing sheet on reverse side of plastic laminate finished surfaces.

### **3.3 ADJUSTING**

- .1 Adjust doors and drawers for smooth operation.

### **3.4 CLEANING**

- .1 Wash down surfaces:
  - .1 with a solution of mild detergent in warm water,
  - .2 applied with soft, clean wiping cloths,
  - .3 take care to remove dirt from corners, and
  - .4 wipe surfaces clean.

- .2** Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant manufacturer.

**END OF SECTION**

**Part 1 General****1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for boilers, pumps, and HRV, 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 Alberta, Canada.
  - .2 Drawings to show:
    - .1 Mounting arrangements.
    - .2 Operating and maintenance clearances.
  - .3 Drawings and product data accompanied by:
    - .1 Detailed drawings of bases, supports, and anchor bolts.
    - .2 Acoustical sound power data, where applicable.
    - .3 Points of operation on performance curves.
    - .4 Manufacturer to certify current model production.
    - .5 Certification of compliance to applicable codes.
  - .4 In addition to transmittal letter referred to in Section 01 33 00 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.
- .4 Sustainable Design Submittals:
  - .1 Construction Waste Management:
    - .1 Submit project Waste Management Plan highlighting recycling and salvage requirements.

**1.2 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for boilers, pumps, and HRV for incorporation into manual.
  - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .2 Operation data to include:
    - .1 Control schematics for systems including environmental controls.
    - .2 Description of systems and their controls.
    - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.

- .4 Operation instruction for systems and component.
- .5 Description of actions to be taken in event of equipment failure.
- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.
- .3 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
  - .1 Submit 2 copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
  - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
  - .1 Departmental Representative will provide 1 set of reproducible mechanical drawings. Provide sets of [white] prints as required for each phase of work. Mark changes as work progresses and as changes occur.
  - .2 Transfer information weekly to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .8 As-Built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.

- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

### **1.3 MAINTENANCE MATERIAL SUBMITTALS**

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

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan.

**Part 2 Products****2.1 N/A****Part 3 Execution****3.1 EXAMINATION**

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

**3.2 PAINTING REPAIRS AND RESTORATION**

- .1 Do painting in accordance with Section 09 91 10 - Interior Painting.
- .2 Prime and touch up marred finished paintwork to match original.
- .3 Restore to new condition, finishes which have been damaged.

**3.3 SYSTEM CLEANING**

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

**3.4 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .1 Hydronic heating system
  - .2 Plumbing systems.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.



**3.5 DEMONSTRATION**

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 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 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for [reuse] [recycling] in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.7 PROTECTION**

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

**END OF SECTION**

**Part 1****1.1 RELATED REQUIREMENTS**

- .1 Section 21 05 01 Common Work Results - Mechanical.

**1.2 REFERENCES**

- .1 National Fire Prevention Association (NFPA)
  - .1 NFPA 13R-2015, Standard for the Installation of Sprinkler Systems.
- .2 Underwriter's Laboratories of Canada (ULC)
  - .1 CAN4 S543-M984, Standard for Internal Lug Quick Connect Couplings for Fire Hose.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and data sheets, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Preliminary Design Drawings: Submit preliminary layout showing only head locations for review by Consultant a minimum of eight (8) weeks prior to starting work of this Section; Consultant may move location of sprinkler heads indicated on preliminary layout to account for coordination with other ceiling mounted elements, include interference drawings indicating detailed piping layouts in areas having congestion arising from structure, ductwork, plumbing systems and electrical systems.
- .4 Shop Drawings: Submit sprinkler and fire protection systems shop drawings and calculations in accordance with applicable standards and requirements of the Authorities Having Jurisdiction, and as follows:
  - .1 Stamp shop drawings with review mark from the Authority Having Jurisdiction.
  - .2 Stamp shop drawings and calculations with seal of delegated design professional engineer.
- .5 Informational Submittals: Provide the following submittals during the course of the work;
  - .1 Hydrostatic Test Certificate: Submit completed hydrostatic test certificates to Owner's insurance underwriter; submit addition certification of testing that may be requested by the Consultant and submit to the Owner's insurance underwriter.
  - .2 .Site Quality Control Submission: Submit sprinkler system certification as required by applicable codes and standards, and Authorities Having Jurisdiction; certification sealed by delegated design engineer registered in the province of the Work
- .6 Samples:
  - .1 Submit samples of following:

- .1 Each type of sprinkler head.
  - .2 Signs.
- .7 Test reports:
  - .1 Submit certified test reports for wet pipe fire protection sprinkler systems from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
- .8 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .9 Manufacturers' Instructions:
  - .1 Provide manufacturer's installation instructions.
- .10 Field Quality Control Submittals:
  - .1 Manufacturer's Field Reports: manufacturer's field reports specified.

#### **1.4 CLOSEOUT SUBMITTALS**

- .1 Provide operation, maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Manufacturer's Catalog Data, including specific model, type, and size for:
  - .1 Pipe and fittings.
  - .2 Alarm valves.
  - .3 Valves, including gate, check, and globe.
  - .4 Water motor alarms.
  - .5 Sprinkler heads.
  - .6 Pipe hangers and supports.
  - .7 Pressure or flow switch.
  - .8 Fire department connections.
  - .9 Excess pressure pump.
  - .10 Mechanical couplings.
- .3 Drawings:
  - .1 Sprinkler heads and piping system layout.
    - .1 Prepare 760 mm by 1050 mm detail working drawings of system layout in accordance with NFPA 13R, "Working Drawings (Plans)".
    - .2 Show data essential for proper installation of each system.
    - .3 Show details, plan view, elevations, and sections of systems supply and piping.
    - .4 Show piping schematic of systems supply, devices, valves, pipe, and fittings. Show point to point electrical wiring diagrams.
  - .2 Electrical wiring diagrams.
- .4 Design Data:

- .1 Calculations of sprinkler system design.
- .2 Indicate type and design of each system and certify that each system has performed satisfactorily in the manner intended for not less than 18 months.
- .5 Field Test Reports:
  - .1 Preliminary tests on piping system.
- .6 Records:
  - .1 As-built drawings of each system.
    - .1 After completion, but before final acceptance, submit complete set of as-built drawings of each system for record purposes.
    - .2 Submit 760 mm by 1050 mm drawings on reproducible Mylar film with title block similar to full size contract drawings.
- .7 Operation and Maintenance Manuals:
  - .1 Provide detailed hydraulic calculations including summary sheet, and Contractors Material and Test Certificate for piping and other documentation for incorporation into manual in accordance with NFPA 13R.

## **1.5 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Installer: company or person specializing in wet sprinkler systems with documented experience.
- .2 Supply grooved joint couplings, fittings, valves, grooving tools and specialties from a single manufacturer. Use date stamped castings for coupling housings, fittings, valve bodies, for quality assurance and traceability.

## **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Provide spare sprinklers and tools in accordance with NFPA 13R.

## **1.7 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Storage and Protection:
  - .1 Store materials in dry location.
  - .2 Store and protect materials from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

## **Part 2 Products**

### **2.1 DESIGN REQUIREMENTS**

- .1 Design automatic wet pipe fire suppression sprinkler systems in accordance with required and advisory provisions of NFPA 13R, by hydraulic calculations for uniform distribution of water over design area pipe schedules for light hazard occupancy.
- .2 Include with each system materials, accessories, and equipment inside and outside building to provide each system complete and ready for use.
- .3 Design and provide each system to give full consideration to blind spaces, piping, electrical equipment, ducts, and other construction and equipment in accordance with detailed shop drawings.
- .4 Locate sprinkler heads in consistent pattern with ceiling grid, lights, and air supply diffusers.
- .5 Devices and equipment for fire protection service: ULC approved for use in wet pipe sprinkler systems.
- .6 Location of Sprinkler Heads:
  - .1 Locate heads in relation to ceiling and spacing of sprinkler heads not to exceed that permitted by NFPA 13R.
- .7 Water Distribution:
  - .1 Make distribution uniform throughout the area in which sprinkler heads will open.
  - .2 Discharge from individual heads in hydraulically most remote area to be 100 % of specified density.
- .8 Friction Losses:
  - .1 Calculate losses in piping in accordance with Hazen-Williams formula with 'C' value of 120 for steel piping, 150 for copper tubing, and 140 for cement-lined ductile-iron piping.
- .9 Water Supply:
  - .1 Conduct flow and pressure test of water supply in vicinity of project to obtain criteria for bases of design in accordance with NFPA 13R.

### **2.2 PIPE, FITTINGS AND VALVES**

- .1 Pipe:
  - .1 Ferrous: to NFPA 13R.
  - .2 Copper tube: to NFPA 13R.
- .2 Fittings and joints to NFPA 13R:

- .1 Ferrous: screwed, welded, flanged or roll grooved.
  - .1 Grooved joints designed with two ductile iron housing segments, pressure responsive gasket, and zinc-electroplated steel bolts and nuts. Cast with offsetting angle-pattern bolt pads for rigidity and visual pad-to-pad offset contact.
- .2 Copper tube: screwed, soldered, brazed, grooved.
- .3 Provide welded, threaded, or grooved-end type fittings into which sprinkler heads, sprinkler head riser nipples, or drop nipples are threaded.
- .4 Plain-end fittings with mechanical couplings and fittings which use steel gripping devices to bite into pipe when pressure is applied will not be permitted.
- .5 Rubber gasketed grooved-end pipe and fittings with mechanical couplings are permitted in pipe sizes 32 mm and larger.
- .6 Fittings: ULC approved for use in wet pipe sprinkler systems.
- .7 Ensure fittings, mechanical couplings, and rubber gaskets are supplied by same manufacturer.
- .8 Side outlet tees using rubber gasketed fittings are not permitted.
- .9 Sprinkler pipe and fittings: metal.
- .3 Valves:
  - .1 ULC listed for fire protection service.
  - .2 Gate valves: open by counter clockwise rotation.
  - .3 Provide gate valve in piping protecting machine rooms.
- .4 Pipe hangers:
  - .1 ULC listed for fire protection services in accordance with NFPA.

## 2.3 SPRINKLER HEADS

- .1 General: to NFPA 13R and ULC listed for fire services.
- .2 Sprinkler Head Type:
  - .1 For suspended ceilings, provide surface mount pendant type sprinkler heads with chrome plated finish and chrome plated escutcheon.
  - .2 For exposed areas, provide standard upright type with chrome plated finish.
  - .3 For sidewall application, provide sidewall type with chrome plated finish and chrome plated escutcheon.
- .3 Provide nominal 1.2 cm orifice sprinkler heads.
  - .1 Release element of each head to be of intermediate temperature rating or higher as suitable for specific application.
  - .2 Provide corrosion-resistant sprinkler heads and sprinkler head guards in accordance with NFPA 13.
  - .3 Deflector: not more than 75 mm below suspended ceilings.
  - .4 Ceiling plates: not more than 25 mm deep.
  - .5 Ceiling cups: not permitted.

**2.4 ALARM CHECK VALVE**

- .1 Alarm check valve to NFPA 13 and ULC listed for fire service.
- .2 Provide valve complete with internal components that are replaceable without removing the valve from the installed position.
- .3 Provide a ULC approved alarm valve complete with all necessary trim and drain valves. Drain piping shall be piped to exterior of building or to a suitably sized floor drain.

**2.5 WATER MOTOR ALARMS**

- .1 Provide alarms approved weatherproof and guarded type, to sound locally on flow of water in each corresponding sprinkler system.
- .2 Mount alarms on outside of outer walls of each building at location as directed.
- .3 Provide separate drain piping directly to exterior of building.

**2.6 SUPERVISORY SWITCHES**

- .1 General: to NFPA 13 and ULC listed for fire service.
- .2 Valves:
  - .1 Mechanically attached to valve body, with normally open and normally closed contacts and supervisory capability.
- .3 Pressure or flow switch type:
  - .1 With normally open and normally closed contacts and supervisory capability.
  - .2 Provide switch with circuit opener or closer for automatic transmittal of alarm over facility fire alarm system.
  - .3 Connect into building fire alarm system.
  - .4 Connection of switch: Section 28 31 00 - Fire Detection and Alarm.
  - .5 Alarm actuating device: mechanical diaphragm controlled retard device adjustable from 10 to 60 seconds and instantly recycle.
- .4 Pressure alarm switch:
  - .1 With normally open and normally closed contacts and supervisory capability.

**2.7 WATER GONG**

- .1 To NFPA 13R and ULC listed for fire service. Location as indicated.

**2.8 FIRE DEPARTMENT CONNECTION**

- .1 Provide connections approximately 1.5 m above finish grade, location as indicated.
- .2 To NFPA 13R and ULC S543 listed, Siamese type.
- .3 Polished bronze recessed of approved two-way type with 2.5 inch National Standard female hose threads with plug, chain, and identifying fire department connection escutcheon plate.
- .4 Thread specifications: compatible with local fire department.

- .5 Install a 90-degree elbow with drain connection at the low-point near each fire department connection to allow for system drainage to prevent freezing.

## 2.9 PRESSURE GAUGES

- .1 ULC listed and to Section 23 05 19.01 - Thermometers and Pressure Gauges - Piping Systems.
- .2 Maximum limit of not less than twice normal working pressure at point where installed.
- .3 A pressure gauge with a connection not smaller than 6mm shall be installed at the system main drain, at each main drain associated with a floor control valve, and on the inlet and outlet side of each pressure-reducing valve. Each gauge connection shall be equipped with a shutoff valve and provisions for draining.

## 2.10 PIPE SLEEVES

- .1 Provide pipe sleeves where piping passes through walls, floors, roofs.
- .2 Secure sleeves in position and location during construction.
- .3 Provide sleeves of sufficient length to pass through entire thickness of walls, floors, roofs.
- .4 Provide 2.5 cm minimum clearance between exterior of piping and interior of sleeve or core-drilled hole.
  - .1 Firmly pack space with mineral wool insulation.
  - .2 Seal space at both ends of sleeve or core-drilled hole with plastic waterproof cement which will dry to firm but pliable mass, provide mechanically adjustable segmented elastomeric seal.
  - .3 In fire walls and fire floors, seal both ends of pipe sleeves or core-drilled holes with ULC listed fill, void, or cavity material.
- .5 Sleeves in Masonry and Concrete Walls, Floors, and Roofs:
  - .1 Provide ductile-iron sleeves.
  - .2 Core drilling of masonry and concrete may be provided in lieu of pipe sleeves when cavities in core-drilled hole are completely grouted smooth.
- .6 Sleeves in Other Than Masonry and Concrete Walls, Floors, and Roofs:
  - .1 Provide 0.61 mm thick galvanized steel sheet.

## 2.11 ESCUTCHEON PLATES

- .1 Provide one piece split hinge type metal plates for piping passing through walls, floors, ceilings in exposed spaces.
- .2 Provide polished chromium-plated finish on copper alloy plates in finished spaces.
- .3 Provide paint finish on metal plates in unfinished spaces.



**2.12 INSPECTOR'S TEST CONNECTION**

- .1 Locate inspector's test connection at hydraulically most remote part of each system, provide test connections approximately 3 m above floor for each sprinkler system or portion of each sprinkler system equipped with alarm device.
- .2 Provide test connection piping to location where discharge will be readily visible and where water may be discharged without property damage.
- .3 Provide discharge orifice of same size as corresponding sprinkler orifice.

**2.13 SIGNS**

- .1 Attach properly lettered Bilingual and approved metal signs to each valve and alarm device to NFPA 13R.
- .2 Permanently fix hydraulic design data nameplates to riser of each system.

**2.14 ANTIFREEZE**

- .1 Antifreeze loops to NFPA 13R, locations as indicated.

**2.15 SPARE PARTS CABINET**

- .1 Provide metal cabinet with extra sprinkler heads and sprinkler head wrench adjacent to each alarm valve. Number and types of extra sprinkler heads as specified in NFPA 13R.

**Part 3 Execution****3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Install, inspect and test to acceptance in accordance with NFPA 13R.

**3.3 PIPE INSTALLATION**

- .1 Install piping straight and true to bear evenly on hangers and supports. Do not hang piping from plaster ceilings.
- .2 Keep interior and ends of new piping and existing piping thoroughly cleaned of water and foreign matter.
- .3 Keep piping systems clean during installation by means of plugs or other approved methods. When work is not in progress, securely close open ends of piping to prevent entry of water and foreign matter.
- .4 Inspect piping before placing into position.

**3.4 ELECTRICAL CONNECTIONS**

- .1 Provide electrical work associated with this section under Section 26 05 00 - Common Work Results for Electrical.
- .2 Provide fire alarm system under Section 28 31 00 - Fire Detection and Alarm.
- .3 Provide control wiring, including connections to fire alarm systems, in accordance with National Electrical Code.
- .4 Provide wiring in rigid metal conduit or intermediate metal conduit.

**3.5 DISINFECTION**

- .1 Disinfect new piping.
- .2 Fill piping systems with solution containing minimum of 50 parts per million of chlorine and allow solution to stand for minimum of 24 hours.
- .3 Flush solution from systems with clean water until maximum residual chlorine content is not greater than 0.2 part per million or residual chlorine content of domestic water supply.
- .4 Obtain at least two consecutive satisfactory bacteriological samples from piping, analyzed by certified laboratory, and submit results prior to piping being placed into service.

**3.6 BURIED PIPING SYSTEM**

- .1 Bury tape with printed side up at depth of 30 cm below the top surface of earth or top surface of subgrade under pavements.

**3.7 FIELD PAINTING**

- .1 Clean, pretreat, prime, and paint new systems including valves, piping, conduit, hangers, supports, miscellaneous metalwork, and accessories.
- .2 Apply coatings to clean, dry surfaces, using clean brushes.
- .3 Clean surfaces to remove dust, dirt, rust, and loose mill scale.
- .4 Immediately after cleaning, provide metal surfaces with [1] coat of pretreatment primer applied to minimum dry film thickness of [0.3] ml, and one coat of zinc chromate primer applied to minimum dry film thickness of [1.0] ml.
- .5 Shield sprinkler heads with protective covering while painting is in progress.
- .6 Upon completion of painting, remove protective covering from sprinkler heads.
- .7 Remove sprinkler heads which have been painted and replace with new sprinkler heads.
- .8 Provide primed surfaces with following:
  - .1 Piping in Finished Areas:
    - .1 Provide primed surfaces with [2] coats of paint to match adjacent surfaces.
    - .2 Provide valves and operating accessories with [1] coat of red alkyd gloss enamel applied to minimum dry film thickness of [1.0] mil.

- .3 Provide piping with self-adhering red plastic bands [50] mm wide red enamel bands spaced at maximum of [6] m intervals throughout piping systems.
- .2 Piping in Unfinished Areas:
  - .1 Provide primed surfaces with [one] coat of red alkyd gloss enamel applied to minimum dry film thickness of [1.0] mil in spaces above suspended ceilings, mechanical equipment room, spaces where walls or ceiling are not painted or not constructed of a prefinished material.
  - .2 Provide piping with self-adhering red plastic bands [50] mm wide red enamel bands spaced at maximum of [6] m intervals.

### 3.8 FIELD QUALITY CONTROL

- .1 Site Test, Inspection:
  - .1 Perform test to determine compliance with specified requirements in presence of Departmental Representative.
  - .2 Test, inspect, and approve piping before covering or concealing.
  - .3 Preliminary Tests:
    - .1 Hydrostatically test each system at [200] psig for a [2] hour period with no leakage or reduction in pressure.
    - .2 Flush piping with potable water in accordance with NFPA 13R.
    - .3 Piping above suspended ceilings: tested, inspected, and approved before installation of ceilings.
    - .4 Test alarms and other devices.
    - .5 Test water flow alarms by flowing water through inspector's test connection. When tests have been completed and corrections made, submit signed and dated certificate in accordance with NFPA 13R.
  - .4 Formal Tests and Inspections:
    - .1 Do not submit request for formal test and inspection until preliminary test and corrections are completed and approved.
    - .2 Submit written request for formal inspection at least [15] days prior to inspection date.
    - .3 Repeat required tests as directed.
    - .4 Correct defects and make additional tests until systems comply with contract requirements.
    - .5 Furnish appliances, equipment, instruments, connecting devices, personnel for tests.
    - .6 Authority of Jurisdiction, will witness formal tests and approve systems before they are accepted.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.

- .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
- .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .3 CLEANING
  - .1 Clean in accordance with Section 01 74 11 - Cleaning.
    - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
  - .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for domestic water heaters and domestic hot water recirculating pump 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 Alberta, 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 - Submittal Procedures: use MCAC "Shop Drawing Submittal Title Sheet". Identify section and paragraph number.

**1.2 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals].
- .2 Operation and Maintenance Data: submit operation and maintenance data for incorporation into manual.
  - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .2 Operation data to include:
    - .1 Control schematics for systems including environmental controls.
    - .2 Description of systems and their controls.
    - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4 Operation instruction for systems and component.
    - .5 Description of actions to be taken in event of equipment failure.
    - .6 Valves schedule and flow diagram.
    - .7 Colour coding chart.

- .3 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
  - .1 Submit [2] copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
  - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
  - .1 Departmental Representative will provide [1] set of reproducible mechanical drawings. Provide sets of [white] prints as required for each phase of work. Mark changes as work progresses and as changes occur.
  - .2 Transfer information [weekly] to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.
  - .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

**1.3 MAINTENANCE MATERIAL SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements] [with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 NOT USED**

- .1 Not used.

**Part 3 Execution****3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.

- .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
- .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

### **3.2 PAINTING REPAIRS AND RESTORATION**

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

### **3.3 SYSTEM CLEANING**

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

### **3.4 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

### **3.5 DEMONSTRATION**

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 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 - Cleaning.
  - .1 Leave Work area clean at end of each day.



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

**3.7 PROTECTION**

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

**END OF SECTION**

**Part 1 General****1.1 SUMMARY****.1 Section Includes:**

- .1 Materials and installation for plumbing pumps.

**1.2 REFERENCES**

- .1 Material Safety Data Sheets (MSDS).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS****.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.****.2 Product Data:**

- .1 Submit manufacturer's printed product literature, specifications and data sheet for fixtures and equipment.

**.3 Shop Drawings.**

- .1 Submit shop drawings to indicate:

- .1 Equipment, including connections, fittings, control assemblies and ancillaries. Identify whether factory or field assembled.
  - .2 Wiring and schematic diagrams.
  - .3 Dimensions and recommended installation.
  - .4 Pump performance and efficiency curves.

**.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.****.5 Instructions: submit manufacturer's installation instructions.****.6 Manufacturers' Field Reports: manufacturers' field reports specified.****.7 Closeout submittals: submit maintenance and engineering data for incorporation into manual specified in Section 01 78 00 - Closeout Submittals, include:**

- .1 Manufacturers name, type, model year, capacity and serial number.
- .2 Details of operation, servicing and maintenance.
- .3 Recommended spare parts list with names and addresses.

**1.4 QUALITY ASSURANCE****.1 Pre-Installation Meeting:**

- .1 Convene pre-installation meeting one week prior to beginning work of this Section in accordance with Section 01 32 16.07 - Construction Progress Schedule:

- .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordination with other building subtrades.

- .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Waste Management and Disposal:
  - .1 Separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .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 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
  - .5 Unused 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.
  - .6 Fold up metal plastic banding, flatten and place in designated area for recycling.

## **Part 2 Products**

### **2.1 DOMESTIC HOT WATER CIRCULATING PUMPS**

- .1 Capacity: refer to schedule.
- .2 Construction: closed-coupled, in-line centrifugal, all bronze construction, stainless steel or bronze shaft sleeve, two oil lubricated bronze sleeves or ball bearings.
- .3 Motor: drip-proof, with thermal overload protection.
- .4 Supports: provide as recommended by manufacturer.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 INSTALLATION**

- .1 Make piping and electrical connections to pump and motor assembly and controls as indicated.

- .2 Ensure pump and motor assembly do not support piping.
- .3 Align vertical pit mounted pump assembly after mounting and securing cover plate.
- .4 Place [150] mm sand under sump pit tank.

### 3.3 FIELD QUALITY CONTROL

- .1 Site Tests/Inspection:
  - .1 Check power supply.
  - .2 Check starter protective devices.
- .2 Start-up, check for proper and safe operation.
- .3 Check settings and operation of hand-off-auto selector switch, operating, safety and limit controls, audible and visual alarms, over-temperature and other protective devices.
- .4 Adjust flow from water-cooled bearings.
- .5 Adjust impeller shaft stuffing boxes, packing glands.

### 3.4 START-UP

- .1 General:
  - .1 In accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC and 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
  - .2 Procedures:
    - .1 Check power supply.
    - .2 Check starter O/L heater sizes.
    - .3 Start pumps, check impeller rotation.
    - .4 Check for safe and proper operation.
    - .5 Check settings, operation of operating, limit, safety controls, over-temperature, audible/visual alarms, other protective devices.
    - .6 Test operation of hands-on-auto switch.
    - .7 Test operation of alternator.
    - .8 Adjust leakage through water-cooled bearings.
    - .9 Adjust shaft stuffing boxes.
    - .10 Adjust leakage flow rate from pump shaft stuffing boxes to manufacturer's recommendations.
    - .11 Check base for free-floating, no obstructions under base.
    - .12 Run-in pumps for 12 continuous hours.
    - .13 Check installation, operation of mechanical seals, packing gland type seals. Adjust as necessary.
    - .14 Adjust alignment of piping and conduit to ensure full flexibility.
    - .15 Eliminate causes of cavitation, flashing, air entrainment.
    - .16 Measure pressure drop across strainer when clean and with flow rates as finally set.

- .17 Replace seals if pump used to degrease system or if pump used for temporary heat.
- .18 Verify lubricating oil levels.

### **3.5 REPORTS**

- .1 In accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC and 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.
- .2 Include:
  - .1 Product Information report forms.
  - .2 Pump performance curves (family of curves) with final point of actual performance.

### **3.6 TRAINING**

- .1 In accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC and 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

**END OF SECTION**

**Part 1            General****1.1            RELATED REQUIREMENTS**

- .1      Section 21 05 01 - Common Work Results for Mechanical.
- .2      Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .3      Section 23 05 23.01 - Valves – Bronze.
- .4      Section 23 05 05 - Installation of Pipework.

**1.2            REFERENCES**

- .1      American National Standards Institute (ANSI)/American Society of Mechanical Engineers International (ASME)
  - .1      ANSI/ASME B16.15, Cast Bronze Threaded Fittings, Classes 125 and 250.
  - .2      ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
  - .3      ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - .4      ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings, Class 150, 300, 400, 600, 900, 1500 and 2500.
- .2      ASTM International Inc.
  - .1      ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .2      ASTM A536, Standard Specification for Ductile Iron Castings.
  - .3      ASTM B88M, Standard Specification for Seamless Copper Water Tube (Metric).
- .3      American National Standards Institute/American Water Works Association (ANSI)/ (AWWA)
  - .1      ANSI/AWWA C111/A21.11-[07], Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .4      Canadian Standards Association (CSA International)
  - .1      CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
- .5      Department of Justice Canada (Jus)
  - .1      Canadian Environmental Protection Act, 1999, c. 33 (CEPA).
- .6      Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1      Material Safety Data Sheets (MSDS).
- .7      Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS).
  - .1      MSS-SP-67, Butterfly Valves.
  - .2      MSS-SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.
  - .3      MSS-SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
  - .4      MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

- .8 National Research Council (NRC)/Institute for Research in Construction
  - .1 NRCC 38728, National Plumbing Code of Canada (NPC) - [1995].
- .9 Transport Canada (TC)
  - .1 Transportation of Dangerous Goods Act, 1992, c. 34 (TDGA).

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

### 1.4 DELIVERY, STORAGE AND HANDLING

- .1 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
- .2 Place materials defined as hazardous or toxic in designated containers.
- .3 Handle and dispose of hazardous materials in accordance with Regional and Municipal regulations.

## Part 2 Products

### 2.1 PIPING

- .1 Domestic hot, cold and recirculation systems, within building.
  - .1 Above ground: copper tube, hard drawn, type [K] [L] [M]: to ASTM B88M.
  - .2 Buried or embedded: copper tube, soft annealed, type [K] [L]: to ASTM B88M, in long lengths and with no buried joints.

### 2.2 FITTINGS

- .1 Bronze pipe flanges and flanged fittings, Class [150]: to ANSI/ASME B16.24.
- .2 Cast bronze threaded fittings, Class [125]: to ANSI/ASME B16.15.
- .3 Cast copper, solder type: to ANSI/ASME B16.18.
- .4 Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
- .5 NPS 2 and larger: ANSI/ASME B16.18 or ANSI/ASME B16.22 roll grooved to CSA B242.

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

## 2.3 JOINTS

- .1 Rubber gaskets, latex-free 1.6 mm thick: to AWWA C111.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: [95/5] [tin copper alloy].
- .4 Teflon tape: for threaded joints.
- .5 Grooved couplings: designed with angle bolt pads to provide rigid joint, complete with EPDM gasket.
- .6 Dielectric connections between dissimilar metals: dielectric fitting, complete with thermoplastic liner.

## 2.4 GATE VALVES

- .1 NPS 2 and under, soldered:
  - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
  - .1 Rising stem: to MSS-SP-80, Class 125, 860 kPa, bronze body, screw-in bonnet, solid wedge disc as specified Section 23 05 23.01 - Valves - Bronze.

## 2.5 GLOBE VALVES

- .1 NPS2 and under, soldered:
  - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, renewable composition disc, screwed over bonnet as specified Section 23 05 23.01 - Valves - Bronze.
  - .2 Lockshield handles: [as indicated].
- .2 NPS 2 and under, screwed:
  - .1 To MSS-SP-80, Class 150, 1 MPa, bronze body, screwed over bonnet, renewable composition disc as specified Section 23 05 23.01 - Valves - Bronze.
  - .2 Lockshield handles: [as indicated].

## 2.6 SWING CHECK VALVES

- .1 NPS 2 and under, soldered:
  - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, screwed:
  - .1 To MSS-SP-80, Class 125, 860 kPa, bronze body, bronze swing disc, screw in cap, regrindable seat as specified Section 23 05 23.01 - Valves - Bronze.



**2.7 BALL VALVES**

- .1 NPS 2 and under, screwed:
  - .1 Class 150.
  - .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle as specified Section 23 05 23.01 - Valves - Bronze.
- .2 NPS 2 and under, soldered:
  - .1 To ANSI/ASME B16.18, Class 150.
  - .2 Bronze body, stainless steel ball, PTFE adjustable packing, brass gland and PTFE seat, steel lever handle, with NPT to copper adaptors as specified Section 23 05 23.01 - Valves - Bronze.

**Part 3 Execution****3.1 APPLICATION**

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

**3.2 INSTALLATION**

- .1 Install in accordance with NPC local authority having jurisdiction.
- .2 Install pipe work in accordance with Section 23 05 05 - Installation of Pipework, supplemented as specified herein.
- .3 Assemble piping using fittings manufactured to ANSI standards.
- .4 Install CWS piping below and away from HWS and HWC and other hot piping so as to maintain temperature of cold water as low as possible.
- .5 Connect to fixtures and equipment in accordance with manufacturer's written instructions unless otherwise indicated.
- .6 Buried tubing:
  - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
  - .2 Bend tubing without crimping or constriction. Minimize use of fittings.

**3.3 VALVES**

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

**3.4 PRESSURE TESTS**

- .1 Conform to requirements of Section 21 05 01 - Common Work Results for Mechanical.
- .2 Test pressure: greater of 1 time maximum system operating pressure or 860 kPa.

**3.5 FLUSHING AND CLEANING**

- .1 Flush entire system for 8 h. Ensure outlets flushed for 2 hours. Let stand for 24 hours, then draw one sample off longest run. Submit to testing laboratory to verify that system is clean copper to Provincial potable water guidelines. Let system flush for additional 2 hours, then draw off another sample for testing.

**3.6 PRE-START-UP INSPECTIONS**

- .1 Systems to be complete, prior to flushing, testing and start-up.
- .2 Verify that system can be completely drained.
- .3 Ensure that pressure booster systems are operating properly.
- .4 Ensure that air chambers, expansion compensators are installed properly.

**3.7 DISINFECTION**

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction.
- .2 Coordinate with Section 33 11 16- Site Water Utility Distribution Piping and Section 33 11 16.01 - Incoming Site Water Utility Distribution Piping.
- .3 Upon completion, provide laboratory test reports on water quality for Departmental Representative approval.

**3.8 START-UP**

- .1 Timing: start up after:
  - .1 Pressure tests have been completed.
  - .2 Disinfection procedures have been completed.
  - .3 Certificate of static completion has been issued.
  - .4 Water treatment systems operational.
- .2 Provide continuous supervision during start-up.
- .3 Start-up procedures:
  - .1 Establish circulation and ensure that air is eliminated.
  - .2 Check pressurization to ensure proper operation and to prevent water hammer, flashing and/or cavitation.
  - .3 Commission water conditioning specified Section 22 31 13 - Residential Domestic Water Softeners.
  - .4 Bring HWS storage tank up to design temperature slowly.
  - .5 Monitor piping HWS and HWC piping systems for freedom of movement, pipe expansion as designed.
  - .6 Check control, limit, safety devices for normal and safe operation.
- .4 Rectify start-up deficiencies.

**3.9 PERFORMANCE VERIFICATION**

- .1 Scheduling:

- .1 Verify system performance after pressure and leakage tests and disinfection are completed, and Certificate of Completion has been issued by authority having jurisdiction.
- .2 Procedures:
  - .1 Verify that flow rate and pressure meet Design Criteria.
  - .2 TAB HWC in accordance with Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .3 Adjust pressure regulating valves while withdrawal is maximum and inlet pressure is minimum.
  - .4 Sterilize HWS and HWC systems for Legionella control.
  - .5 Verify performance of temperature controls.
  - .6 Verify compliance with safety and health requirements.
  - .7 Check for proper operation of water hammer arrestors. Run [one] outlet for 10 seconds, then shut of water immediately. If water hammer occurs, replace water hammer arrestor or re-charge air chambers. Repeat for outlets and flush valves.
  - .8 Confirm water quality consistent with supply standards, and ensure no residuals remain as result of flushing or cleaning.
- .3 Reports:
  - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Reports, using report forms as specified in Section 01 91 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
  - .2 Include certificate of water flow and pressure tests conducted on incoming water service, demonstrating adequacy of flow and pressure.

### **3.10 OPERATION REQUIREMENTS**

- .1 Co-ordinate operation and maintenance requirements including, cleaning and maintenance of specified materials and products with Section 23 05 05 - Installation of Pipework.

### **3.11 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 ASTM International Inc.
  - .1 ASTM B32, Standard Specification for Solder Metal.
  - .2 ASTM B306, Standard Specification for Copper Drainage Tube (DWV).
  - .3 ASTM C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .2 Canadian Standards Association (CSA International).
  - .1 CSA B67, Lead Service Pipe, Waste Pipe, Traps, Bends and Accessories.
  - .2 CAN/CSA-B70, Cast Iron Soil Pipe, Fittings and Means of Joining.
  - .3 CAN/CSA-B125.3, Plumbing Fittings.
- .3 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-36, Commercial Adhesives.
- .4 South Coast Air Quality Management District (SCAQMD), California State
  - .1 SCAQMD Rule 1168, Adhesive and Sealant Applications.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products****2.1 COPPER TUBE AND FITTINGS**

- .1 Above ground sanitary storm and vent Type DWV to: ASTM B306.

- .1 Fittings.
  - .1 Cast brass: to CAN/CSA-B125.3.
  - .2 Wrought copper: to CAN/CSA-B125.3.
- .2 Solder: tin-lead, 50:50, type 50A to ASTM B32.

## 2.2 CAST IRON PIPING AND FITTINGS

- .1 Buried sanitary storm and vent] minimum NPS 3, to: CAN/CSA-B70, with one layer of protective coating.
  - .1 Joints:
    - .1 Mechanical joints:
      - .1 Neoprene or butyl rubber compression gaskets: to CAN/CSA-B70.
    - .2 Hub and spigot:
      - .1 Caulking lead: to CSA B67.
      - .2 Cold caulking compounds.
  - .2 Above ground sanitary storm and vent: to CAN/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 05 - Installation of Pipework.
- .2 Install in accordance with National Plumbing Code local authority having jurisdiction.

### 3.3 TESTING

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

### 3.4 PERFORMANCE VERIFICATION

- .1 Cleanouts:

- .1 Ensure accessible and that access doors are correctly located.
- .2 Open, cover with linseed oil and re-seal.
- .3 Verify 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 - Cleaning.
- .2 Waste Management: separate waste materials for reuse recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 05 - Installation of Pipework.

**1.2 REFERENCES**

- .1 ASTM International Inc.
  - .1 ASTM D2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
  - .2 ASTM D2564, Standard Specification for Solvent Cements for Poly(Vinyl-Chloride) (PVC) Plastic Piping Systems.
- .2 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-Series B1800, Thermoplastic Nonpressure Pipe Compendium - B1800 Series.
- .3 Green Seal Environmental Standards (GSES)
  - .1 Standard GS-36, Commercial Adhesives.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .5 South Coast Air Quality Management District (SCAQMD), California State
  - .1 SCAQMD Rule 1168, Adhesive and Sealant Applications.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for piping and adhesives, and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Provide two copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products**

**2.1 PIPING AND FITTINGS**

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

**2.2 JOINTS**

- .1 Solvent weld for PVC: to ASTM D2564.
- .2 Solvent weld for ABS: to ASTM D2235.

**Part 3 Execution****3.1 APPLICATION**

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

**3.2 INSTALLATION**

- .1 In accordance with Section 23 05 05 - Installation of Pipework.
- .2 Install in accordance with National Plumbing Code local authority having jurisdiction.

**3.3 TESTING**

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

**3.4 PERFORMANCE VERIFICATION**

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

**3.5 CLEANING**

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



- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 American National Standards Institute/Canadian Standards Association (ANSI/CSA)
  - .1 ANSI Z21.10.3A/CSA 4.3, Gas Water Heaters - Volume III - Storage Water Heaters, with Input Ratings Above 75,000 Btu Per Hour, Circulating and Instantaneous.
- .2 Canadian Standards Association (CSA International)
  - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
  - .2 CAN/CSA-B149.1, Natural Gas and Propane Installation Code.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for domestic water heater, and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Alberta, Canada.
  - .2 Indicate:
    - .1 Equipment, including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**1.5 WARRANTY**

- .1 For the Work of this Section, 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to number of years specified for each product.

**Part 2 Products****2.1 DHW HEATER AND STORAGE TANK**

- .1 DHW heater:
  - .1 General: packaged unit to ASME standards, stamped for 1100 kPa WP. Provide CGA certification.
  - .2 Capacity: refer to schedule.
  - .3 Heat exchanger: multi-tube, 2 pass, copper and bronze, with NPS 1 extruded and finned tubes rolled into heavy tube sheets. Inlet and outlet headers to include drain valves and thermowells.
  - .4 Combustion chamber: line with 50 mm insulating refractory.
  - .5 Burners: high chromium stainless steel, die stamped, raised port, fixed primary air.
  - .6 Cabinet: baked enamel, welded steel, insulated with foil-faced fiberglass.
  - .7 Trim:
    - .1 Self-actuated modulating valves with 2 ply thermostatic bellows, copper capillary tubing, separate built-in well, tight disc shut-off removable composition disc stem with lubricator temperature adjustment setting reference scale, maximum, pressure differential of 28 kPa, temperature range 25-60 degrees C.
  - .8 Controls:
    - .1 Main gas shut-off valve.
    - .2 Approved gas train including pressure regulator, motorized electric shut-off valve, downstream block/test valve, test connection, pressure gauge.
    - .3 Thermopilot safety with 100% shut-off, adjustable electric high limit control.
    - .4 Gas modulating valve adjusted for 100% to 20% input.
    - .5 Minimum input valve, on-off.
    - .6 Flow switch, interlocked with ignition system to prevent operation in event of low flow.
- .2 Storage tank:
  - .1 Sizes, capacity: refer to schedule.
  - .2 Shell: vertical, steel to CSA B51, ANSI/ASME Unfired Pressure Vessel Code and Province of Alberta standards, WWP/WSP [700] kPa. Provide certificates.
  - .3 Lining: glass.
  - .4 Service Hole: [280 x 380] mm ASME, with gasketed cover.

- .5 Cathodic protection: magnesium anodes, number and size to provide for [20] years protection of tank material.
- .6 Cradles: steel, minimum of [2].
- .7 Thermal insulation: see Section 23 07 14 - Thermal Insulation for Equipment.
- .8 Extended warranty: [10] years. Provide certificate.

## **2.2 TRIM AND INSTRUMENTATION**

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

## **2.3 ANCHOR BOLTS AND TEMPLATES**

- .1 Supply anchor bolts and templates for installation in concrete support pad in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Size anchor bolts to withstand seismic zone [4] acceleration and velocity forces].

## **Part 3 Execution**

### **3.1 APPLICATION**

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

### **3.2 INSTALLATION**

- .1 Install in accordance with manufacturer's recommendations and authority having jurisdiction.
- .2 Provide insulation between tank and supports.
- .3 Install oil burning domestic water heaters in accordance with CAN/CSA-B139.
- .4 Install natural gas fired domestic water heaters in accordance with CAN/CSA-B149.1.
- .5 Install propane gas fired domestic water heaters in accordance with CAN/CSA-B149.2.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer's factory trained, certified Engineer to start up and commission DHW heaters.

**3.4 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 CSA Group
  - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for water softeners 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 Alberta, Canada.
  - .2 Indicate:
    - .1 Equipment including connections, fittings, control assemblies and ancillaries, identifying factory and field assembled.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Provide Departmental Representative with:
    - .1 One spare regenerating valve.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse and return by manufacturer of packaging materials padding, crates, pallets, as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 WATER SOFTENER**

- .1 General: to include softener tanks, brine tanks, brine distribution system, regenerating manifold and control system, ready for piping and wiring connections as indicated.
- .2 Capacity: refer to schedule.
- .3 Mineral tank: FRP, tested to 1-1/2 times working pressure or minimum 860 kPa.
- .4 Salt storage tank: moulded plastic, complete with lid.
- .5 Control:
  - .1 Fully automatic; five cycle regeneration controller of nickel plated bronze; timing motor operated control valve; time clock and brine system; 12 day time clock controlled regeneration frequency; timed brine cycle and salt dosage controller; and manual regeneration switch.

## **Part 3 Execution**

### **3.1 EXAMINATION**

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

### **3.2 MANUFACTURER'S INSTRUCTIONS**

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

### **3.3 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations and as indicated.

### **3.4 CLEANING**

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

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

### **3.5 CLOSEOUT ACTIVITIES**

- .1 Demonstration
  - .1 Water softeners:
    - .1 Demonstrate softener effectiveness.
    - .2 Demonstrate equipment operation as directed by Departmental Representative using manufacturer's soap test kit.

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 ASTM International
  - .1 ASTM A126-, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
  - .2 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .2 American Water Works Association (AWWA)
  - .1 ANSI/AWWA C700, Standard for Cold Water Meters-Displacement Type, Bronze Main Case.
- .3 CSA International
  - .1 CSA-B64 Series, Backflow Preventers and Vacuum Breakers.
  - .2 CSA B79, Commercial and Residential Drains and Cleanouts.
  - .3 CAN/CSA-B356, Water Pressure Reducing Valves for Domestic Water Supply Systems.
- .4 Plumbing and Drainage Institute (PDI)
  - .1 PDI-WH201, Water Hammer Arresters Standard.

**1.2 ADMINISTRATIVE REQUIREMENTS**

- .1 Pre-installation Meetings:
  - .1 Convene pre-installation meeting [1] week prior to beginning work of this Section on-site installation, with Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:
    - .1 Verify project requirements.
    - .2 Review installation and substrate conditions.
    - .3 Co-ordination with other building construction subtrades.
    - .4 Review manufacturer's written installation instructions and warranty requirements.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for plumbing products and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit [2] copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures. Indicate VOC's.

- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
  - .2 Indicate on drawings to indicate materials, finishes, method of anchorage, and number of anchors, dimensions construction.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Instructions: submit manufacturer's installation instructions.
- .6 Manufacturers' Field Reports: manufacturers' field reports specified.

#### **1.4 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for plumbing specialties and accessories for incorporation into manual.
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
  - .2 Details of operation, servicing and maintenance.
  - .3 Recommended spare parts list.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

### **Part 2 Products**

#### **2.1 FLOOR DRAINS**

- .1 Floor Drains and Trench Drains: to CSA B79.
- .2 Refer to schedule.

**2.2 CLEANOUTS**

- .1 Cleanout Plugs: heavy cast iron male ferrule with brass screws and threaded brass or bronze plug. Sealing-caulked lead seat or neoprene gasket.
- .2 Access Covers:
  - .1 Wall Access: face or wall type, polished nickel bronze round cover with flush head securing screws, bevelled edge frame complete with anchoring lugs.
  - .2 Floor Access: rectangular cast iron body and frame with adjustable secured nickel bronze top and:
    - .1 Plugs: bolted bronze with neoprene gasket.
    - .2 Cover for Unfinished Concrete Floors: cast iron round, gasket, vandal-proof screws.
    - .3 Cover for Terrazzo Finish: polished nickel bronze with recessed cover for filling with terrazzo, vandal-proof locking screws.
    - .4 Cover for Tile and Linoleum Floors: polished nickel bronze with recessed cover for linoleum or tile infill, complete with vandal-proof locking screws.
    - .5 Cover for Carpeted Floors: polished nickel bronze with deep flange cover for carpet infill, complete with carpet retainer vandal-proof locking screws.

**2.3 NON-FREEZE WALL HYDRANTS**

- .1 Surface mount with integral vacuum breaker, NPS [3/4] hose outlet, Chrome plated finish.

**2.4 WATER HAMMER ARRESTORS**

- .1 Copper construction, piston type: to PDI-WH201.

**2.5 BACK FLOW PREVENTERS**

- .1 Preventers: to CSA-B64, double check valve type assembly, consisting of two (2) positive sealing replaceable check valves with stainless steel or bronze seats. Provide strainer on units 50 mm and smaller. All interior surfaces of iron double check valve assemblies to be epoxy coated.

**2.6 VACUUM BREAKERS**

- .1 Breakers: to CSA-B64 Series, vacuum breaker atmospheric.

**2.7 BACKWATER VALVES**

- .1 Galvanized body with bronze seat, revolving bronze flapper and threaded cover.
- .2 Access:
  - .1 Surface access.
  - .2 Access pipe with cover: maximum [300] mm depth.
  - .3 Steel housing with gasketed steel cover.
  - .4 Concrete access pit with cover, as indicated.

**2.8 HOSE BIBBS AND SEDIMENT FAUCETS**

- .1 Bronze construction complete with integral back flow preventer, hose thread spout, replaceable composition disc, and chrome plated in finished areas.

**2.9 WATER MAKE-UP ASSEMBLY**

- .1 Complete with backflow preventer pressure gauge on inlet and outlet, pressure reducing valve to CAN/CSA-B356, pressure relief valve on low pressure side and gate valves on inlet and outlet.

**2.10 WATER METERS**

- .1 Displacement type to ANSI/AWWA C700.
- .2 Capacity: as indicated.
- .3 Accessories: remote readout device.

**2.11 TRAP SEAL PRIMERS**

- .1 Brass, with integral vacuum breaker, NPS 1/2 solder ends, NPS 1/2 drip line connection.

**2.12 STRAINERS**

- .1 860 kPa, Y type with 20 mesh, monel, bronze or stainless steel removable screen.
- .2 NPS 2 and under, bronze body, screwed ends, with [brass] cap.
- .3 NPS 2 1/2 and over, cast iron body, flanged ends, with bolted cap.

**Part 3 Execution****3.1 EXAMINATION**

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

**3.2 MANUFACTURER'S INSTRUCTIONS**

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

**3.3 INSTALLATION**

- .1 Install in accordance with National Plumbing Code of Canada, local authority having jurisdiction.
- .2 Install in accordance with manufacturer's instructions and as specified.

**3.4 CLEANOUTS**

- .1 Install cleanouts at base of soil and waste stacks, and rainwater leaders, at locations required code, and as indicated.
- .2 Bring cleanouts to wall or finished floor unless serviceable from below floor.
- .3 Building drain cleanout and stack base cleanouts: line size to maximum NPS 4.

**3.5 NON-FREEZE WALL HYDRANTS**

- .1 Install [600] mm above finished grade and as indicated.

**3.6 WATER HAMMER ARRESTORS**

- .1 Install on branch supplies to fixtures or group of fixtures.

**3.7 BACK FLOW PREVENTERS**

- .1 Install in accordance with CSA-B64 Series, where indicated and elsewhere as required by code.
  - .1 Drains.
  - .2 Backwater Valves.
  - .3 Water Make-up Assembly.
- .2 Pipe discharge to terminate over nearest drain.

**3.8 BACKWATER VALVES**

- .1 Install in main sewer lines where indicated and at weeping tile connection in pit provided at building cleanout.

**3.9 HOSE BIBBS AND SEDIMENT FAUCETS**

- .1 Install at bottom of risers, at low points to drain systems, and as indicated.

**3.10 TRAP SEAL PRIMERS**

- .1 Install for floor drains and elsewhere, as indicated.
- .2 Install on cold water supply to nearest frequently used plumbing fixture, in concealed space, to approval of Departmental Representative.
- .3 Install soft copper tubing to floor drain.

**3.11 STRAINERS**

- .1 Install with sufficient room to remove basket for maintenance.

**3.12 WATER METERS**

- .1 Install water meter provided by local water authority.
- .2 Install water meter as indicated.

**3.13 WATER MAKE-UP ASSEMBLY**

- .1 Install on valved bypass.
- .2 Pipe discharge from relief valve to nearest floor drain.

**3.14 START-UP**

- .1 General:
  - .1 In accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: General Requirements, supplemented as specified herein.
- .2 Timing: start-up only after:
  - .1 Pressure tests have been completed.
  - .2 Disinfection procedures have been completed.
  - .3 Certificate of static completion has been issued.
  - .4 Water treatment systems operational.
- .3 Provide continuous supervision during start-up.

**3.15 TESTING AND ADJUSTING**

- .1 General:
  - .1 Test and adjust plumbing specialties and accessories in accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC and 01 91 13- General Commissioning (Cx) Requirements : General Requirements, supplemented as specified.
- .2 Timing:
  - .1 After start-up deficiencies rectified.
  - .2 After certificate of completion has been issued by authority having jurisdiction.
- .3 Application tolerances:
  - .1 Pressure at fixtures: +/- [70] kPa.
  - .2 Flow rate at fixtures: +/- 20%.
- .4 Adjustments:
  - .1 Verify that flow rate and pressure meet design criteria.
  - .2 Make adjustments while flow rate or withdrawal is (1) maximum and (2) 25% of maximum and while pressure is (1) maximum and (2) minimum.
- .5 Floor drains:
  - .1 Verify operation of trap seal primer.
  - .2 Prime, using trap primer. Adjust flow rate to suit site conditions.
  - .3 Check operations of flushing features.
  - .4 Check security, accessibility, removability of strainer.
  - .5 Clean out baskets.
- .6 Vacuum breakers, backflow preventers, backwater valves:

- .1 Test tightness, accessibility for O M of cover and of valve.
- .2 Simulate reverse flow and back-pressure conditions to test operation of vacuum breakers, backflow preventers.
- .3 Verify visibility of discharge from open ports.
- .7 Access doors:
  - .1 Verify size and location relative to items to be accessed.
- .8 Cleanouts:
  - .1 Verify covers are gas-tight, secure, yet readily removable.
- .9 Water hammer arrestors:
  - .1 Verify proper installation of correct type of water hammer arrester.
- .10 Wall hydrants:
  - .1 Verify complete drainage, freeze protection.
  - .2 Verify operation of vacuum breakers.
- .11 Pressure regulators, PRV assemblies:
  - .1 Adjust settings to suit locations, flow rates, pressure conditions.
- .12 Strainers:
  - .1 Clean out repeatedly until clear.
  - .2 Verify accessibility of cleanout plug and basket.
  - .3 Verify that cleanout plug does not leak.
- .13 Hose bibbs, sediment faucets:
  - .1 Verify that flow and pressure meet design criteria.
  - .2 Check for leaks, replace compression washer if required.
- .14 Hydronic system water Make-up Assembly:
  - .1 Verify flow, pressure, and connection.
- .15 Water meters:
  - .1 Verify location and accessibility.
  - .2 Test meter reading accuracy.

**3.16 CLOSEOUT ACTIVITIES**

- .1 Commissioning Reports: in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: reports, supplemented as specified.
- .2 Training: provide training in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements: Training of O M Personnel, supplemented as specified.

**3.17 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Leave Work area clean at end of each day.

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

**3.18 PROTECTION**

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

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 CSA Group
  - .1 CAN/CSA-B45 Series, Plumbing Fixtures, (Consists of B45.0, B45.1, B45.2, B45.3, B45.4, B45.5, B45.6, B45.7, B45.8 and B45.9).
  - .2 CSA B125.3, Plumbing Fittings.
  - .3 CSA B651, Accessible Design for the Built Environment.
- .2 Green Seal (GS)
  - .1 GS-36, Adhesives for Commercial Use.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for washroom fixtures and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate fixtures and trim:
    - .1 Dimensions, construction details, roughing-in dimensions.
    - .2 Factory-set water consumption per flush at recommended pressure.
    - .3 For water closets: minimum pressure required for flushing.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Include:
  - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
  - .2 Details of operation, servicing, maintenance.
  - .3 List of recommended spare parts.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section with manufacturer's written instructions 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse by manufacturer of packaging materials padding, crates, pallets, as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 MANUFACTURED UNITS**

- .1 Fixtures: manufacture in accordance with CAN/CSA-B45 series.
- .2 Trim, fittings: manufacture in accordance with CSA B125.3.
- .3 Exposed plumbing brass to be chrome plated.
- .4 Number, locations: [as indicated].
- .5 Fixtures in any one location to be product of one manufacturer and of same type.
- .6 Trim in any one location to be product of one manufacturer and of same type.
- .7 Water closets: refer to schedule.
- .8 Washroom Lavatories: refer to schedule.
- .9 Chair carriers:
  - .1 Factory manufactured floor-mounted carrier systems for wall-mounted fixtures.

## **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 washroom fixtures 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 Mounting heights: refer to schedule.
  - .1 Barrier-free: to most stringent CSA B651, NBC.

### **3.3 ADJUSTING**

- .1 Conform to water conservation requirements specified this section.
- .2 Adjustments:
  - .1 Adjust water flow rate to design flow rates.

- .2 Adjust pressure to fixtures to ensure no splashing at maximum pressures.
- .3 Adjust flush valves to suit actual site conditions.
- .4 Adjust urinal flush timing mechanisms.
- .3 Checks:
  - .1 Water closets, urinals: flushing action.
  - .2 Aerators: operation, cleanliness.
  - .3 Vacuum breakers, backflow preventers: operation under all conditions.
- .4 Thermostatic controls:
  - .1 Verify temperature settings, operation of control, limit and safety controls.

**3.4 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-B45 Series, Plumbing Fixtures.
  - .2 CAN/CSA-B125.3, Plumbing Fittings.
  - .3 CAN/CSA-B651, Accessible Design for the Built Environment.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products****2.1 MANUFACTURED UNITS**

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

- .5 Fixtures to be product of one manufacturer.
- .6 Trim to be product of one manufacturer.
- .7 Mop sinks:
  - .1 Refer to schedule.
- .8 Stainless steel counter-top sinks.
  - .1 Refer to schedule
- .9 Chair carriers:
  - .1 Factory manufactured floor-mounted carrier systems for all wall-mounted fixtures.

### **Part 3 Execution**

#### **3.1 APPLICATION**

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

#### **3.2 INSTALLATION**

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

#### **3.3 ADJUSTING**

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

#### **3.4 CLEANING**

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

- .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-B45 Series, Plumbing Fixtures.
  - .2 CAN/CSA-B125.3, Plumbing Fittings.
  - .3 CAN/CSA-B651, Accessible Design for the Built Environment.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.
- .2 Include:
  - .1 Description of fixtures and trim, giving manufacturer's name, type, model, year, capacity.
  - .2 Details of operation, servicing, maintenance.
  - .3 List of recommended spare parts.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products****2.1 MANUFACTURED UNITS**

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

- .4 Number, locations: architectural drawings to govern.
- .5 Fixtures in any one location to be product of one manufacturer and of same type.
- .6 Trim in any one location to be product of one manufacturer and of same type.
- .7 Baths: refer to schedule.

**Part 3 Execution****3.1 APPLICATION**

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

**3.2 INSTALLATION**

- .1 Mounting heights:
  - .1 Standard: to comply with manufacturer's recommendations unless otherwise indicated or specified.
  - .2 Physically handicapped: to comply with most stringent of either NBCC or CAN/CSA B651.

**3.3 ADJUSTING**

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

**3.4 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 Definitions:
  - .1 HVAC System: complete air duct system from outside air intake louvers to furthest air supply terminal unit and including:
    - .1 Rigid supply and return ductwork;
    - .2 Flexible ductwork;
    - .3 Mixing plenum boxes;
    - .4 Return air plenums including ceiling plenums;
    - .5 Condensate drain pans;
    - .6 Fans, fan blades and fan housing;
    - .7 Filter housing and frames;
    - .8 Acoustically insulated duct linings;
    - .9 Diffusers, registers and terminal units;
    - .10 Dampers and controls;
- .2 Reference Standards:
  - .1 National Air Duct Cleaners Association (NADCA)
    - .1 ACR Standard: Assessment, Cleaning and Restoration of HVAC Systems.
  - .2 North American Insulation Manufacturers Association (NAIMA)
    - .1 NAIMA, Cleaning Fibrous Glass Insulated Duct Systems - Recommended Practices.

**1.2 ADMINISTRATIVE REQUIREMENTS**

- .1 Site Evaluation: conduct site visit [2] weeks before start of work to establish specific co-ordinated video survey and cleaning plan to establish specific co-ordinated video survey and cleaning plan determining how areas of facility and HVAC systems will be protected during cleaning operations.
  - .1 Organize and lay out plan for video survey and identify camera and cleaning apparatus insertion points.
  - .2 Ensure plan identifies sequence and schedule of survey and cleaning operations for each individual HVAC system and for complete facility.
    - .1 Take account of elbows, bends, turning vanes, dampers, transitions, take-offs, and other internal features.
  - .3 Departmental Representative to review video survey and cleaning plan [1] week minimum prior to start of work.
    - .1 Proceed with survey and cleaning work only after receiving written approval from Departmental Representative.
- .2 Project Co-ordination: assign Project Co-ordinator to oversee air duct cleaning processes.

- .1 Provide Departmental Representative with contact information of Project Co-ordinator including: name, telephone number, cell phone number.
- .3 Security: Departmental Representative will pay costs and provide security escort at times requested on Contractor's submitted work schedule.
  - .1 Cancellation of security escort requires [72] hours minimum written notice.
  - .2 Failure to cancel security escort requirements [72] hours minimum before scheduled event will result in Contractor paying for security costs.
- .4 Damaged or broken equipment and components found during initial testing and inspection will be repaired or replaced by Departmental Representative.

### 1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit video survey and cleaning plan developed during site evaluation.
  - .1 Ensure plan includes sequence of operation, identification of camera and cleaning apparatus insertion points and schedule for work.
- .3 Product Data:
  - .1 Submit manufacturer's printed product literature and data sheets for antimicrobial agents and include product characteristics, performance criteria and limitations.
  - .2 Provide [two] copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements for antimicrobial agents or coatings.
- .4 Submit verification of delivery of hazardous or toxic waste materials to contaminated waste facility, as described in PART 3 - CLEANING - Waste Management.

### 1.4 CLOSEOUT SUBMITTALS

- .1 Provide submittals in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Post Cleaning Inspection Report: submit [4] copies of Final Inspection Report, including data collected, observations and recommendations as well as following information:
  - .1 Name and address of facility;
  - .2 Name and address of HVAC cleaning contractor;
  - .3 Description of HVAC systems with drawings identifying systems cleaned;
  - .4 Identification scheme for location points in systems that were inspected with accompanying notes describing methods of inspection or tests used;
  - .5 Identification of points where samples were collected and type of analysis used for each collection;
  - .6 Identification of each sample collected;
  - .7 Comments complete with photographs of each sampling location and other observed system features;
  - .8 Identify systems tested, observations, actions taken and recommendations for future maintenance.

- .3 Record post cleaning video survey: submit [2] copies of video survey USB Drive media, and include on video survey following:
  - .1 Areas tested for particulate analysis or microbial growth evaluation;
  - .2 Areas of special interest and location;
  - .3 Special internal features;
  - .4 Problems such as broken or damaged controls or components;
  - .5 Ensure system tested, locations, observations, actions taken and recommendations are clearly identified in [English] [French] on video using text or voice over.
- .4 Submit verification of delivery of hazardous or toxic waste materials to contaminated waste facility.

## 1.5 EXTRA MATERIALS

- .1 Extra Stock Materials:
  - .1 Supply [4] extra filters for each HVAC System cleaned.
  - .2 Ensure filters are correct match, size, type and configuration of existing HVAC Systems.

## Part 2 Products

### 2.1 ACCESS DOORS AND PANELS

- .1 Equipment Access Doors and Panels: construct from same materials as equipment panelling complete with sealing gasket and positive locking device.
  - .1 Size access doors and panels in equipment to allow for inspection and cleaning.
- .2 Ductwork Access Doors: construct access doors from [1.27] mm minimum galvanized sheet steel with gasketed seal.
  - .1 Ensure access door is [25] mm greater in every dimension than access opening.
  - .2 Access door size [200] mm x [200] mm minimum.
  - .3 Secure access doors with sheet metal screws on 75 mm centres minimum. Ensure [3] screws per side minimum.
- .3 Access Doors and Panels Acoustic Lining:
  - .1 Install acoustic lining to match existing.
  - .2 Self-adhesive glass fibre tape capable of adhering to both acoustic lining and metal access door or panel materials.
  - .3 Water-based duct sealer for repairing cut acoustic lining.

### 2.2 SYSTEM FILTERS

- .1 Supply and install new filters for each HVAC System cleaned.

### 2.3 AIR DUCT CLEANING EQUIPMENT

- .1 Manually propelled full contact brushes:

- .1 Ensure brushes are specifically manufactured and shaped to fit individual ducts, equipment and components of HVAC system.
  - .1 Ensure brushes are sized to fit various duct sizes in HVAC system.
- .2 Ensure brushes make scrubbing motion and full contact with HVAC system interior surfaces to be cleaned.
- .2 Brushes: manually propelled with integrally-mounted motor drive and nylon bristles.
  - .1 Ensure motor drive has capacity to continue to push brush after bristles are distorted.
  - .2 Replace worn and ineffective brushes when required.

### Part 3 Execution

#### 3.1 PREPARATION

- .1 Close down HVAC system.
- .2 Locate and identify externally visible HVAC system features which may affect cleaning process including:
  - .1 Control devices;
  - .2 Fire and smoke control dampers;
  - .3 Balancing dampers: indicate and record positions for resetting;
  - .4 Air volume control boxes: indicate and record positions for resetting;
  - .5 Fire alarm devices;
  - .6 Monitoring devices and controls;
- .3 Cut openings in equipment panels and ductwork for access to system interior.
  - .1 Square or rectangular opening sizes: [200] mm minimum each side.
  - .2 Circular opening sizes: [200] mm minimum diameter.
- .4 Installation of Access Doors and Panels: install access doors and panels for equipment where required instructed by Departmental Representative to facilitate system inspection and cleaning.
  - .1 Install access doors and panels for inspection and cleaning of equipment as follows:
    - .1 Heating and cooling coils;
    - .2 Fan units;
    - .3 Filters;
    - .4 Dampers;
    - .5 Sensors;
- .5 Installation of Access Doors in Ductwork: install access doors in ductwork where required by Departmental Representative to facilitate system inspection and cleaning.
  - .1 Access door installation is not permitted in flexible ductwork.
    - .1 Inspect flexible ductwork only by disconnecting from main duct and inspecting from open end.

- .6 When acoustically lined duct is cut for access, repair cut edges of acoustic lining using self-adhesive fibre glass tape and water based duct sealer.
  - .1 Adhere new acoustic lining to match existing to inside of access panel or door to ensure continuity of acoustic properties of system.
- .7 Remove and reinstall ceiling panels to gain access to HVAC system as required.
  - .1 Replace ceiling panels damaged or soiled by air duct cleaning procedures.

### 3.2 EXAMINATION / PRE-CLEANING INSPECTION

- .1 Verification of Conditions:
  - .1 Make visual inspection of interior of HVAC system using remote controlled robotic camera.
  - .2 Insert camera at pre-established strategic locations to evaluate condition and cleanliness of HVAC systems and components.
- .2 Evaluation and Assessment:
  - .1 Identify location and type of internal components.
  - .2 Identify extent of potential problems.
  - .3 If toxic or hazardous materials or deposits are suspected after initial inspection immediately stop work and inform Departmental Representative.
    - .1 Do not proceed further with inspection operations until written approval from Departmental Representative.

### 3.3 DUCT CLEANING

- .1 Do duct cleaning in accordance with NADCA ACR Standard.
- .2 Isolate and clean sections in zones to ensure that dirt deposits and debris from zone being cleaned does not pass through another zones which has already been cleaned.
- .3 Ensure vacuum units and evacuation fans are securely in place before starting cleaning operation of isolated section of HVAC air duct system.
- .4 Clean HVAC supply air duct system and components where particulate sample collected from surfaces is greater than [75] mg of particulate per [0.01] square metres.
- .5 Clean exhaust, return, transfer ductwork and plenums, equipment and components where particulate sample collected from surfaces is greater than [75] mg of particulate per [0.01] square metres.
- .6 Clean equipment, components and other features in isolated zone before moving to next zone of HVAC air duct system.
- .7 Clean diffusers, registers, louvers, and other terminal units.
- .8 Advise Departmental Representative [72] hours minimum before deactivation of fire alarm and smoke detectors duct cleaning operations.
  - .1 Departmental Representative will pay for costs of deactivation of fire alarm and smoke detector system.

**3.4 ACOUSTICALLY LINED DUCTWORK CLEANING**

- .1 Clean glass fibre acoustically insulated ducts to NAIMA recommended practices.
  - .1 Use specifically designed robotic apparatus that has been demonstrated not to damage acoustic glass fibre lining.
  - .2 Monitor cleaning process progress by onboard camera.

**3.5 COMPONENTS AND EQUIPMENT CLEANING**

- .1 Brush and vacuum coils, humidifiers, air handling unit enclosures, and heat exchanger surfaces to achieve required cleanliness.
- .2 When cleaning equipment and components by brushing and vacuuming is inappropriate or insufficient, dismantle and remove equipment or component and move to area designated by Departmental Representative for cleaning.
  - .1 Pressure wash with water and cleaning solution until required cleanliness is achieved.
  - .2 Clean equipment and components in place only if there is no hazard to adjacent materials.
- .3 Proceed to next section in cleaning sequence only after written approval from Departmental Representative.
- .4 Compressed air and manual cleaning is acceptable only for cleaning individual components and small areas as follows and only after written approval from Departmental Representative:
  - .1 Fan blades;
  - .2 Dampers;
  - .3 Turning vanes;
  - .4 Controls;
  - .5 Sensor bulbs;
  - .6 Fire alarms;
  - .7 Smoke detectors;

**3.6 FIELD QUALITY CONTROL/FINAL INSPECTIONS**

- .1 Post Cleaning Inspection: carry out final inspection using robotic camera and other visual inspection methods after final cleaning has been completed.
  - .1 Carry out video survey as directed by Departmental Representative.
  - .2 Include in final survey areas inspected by Contractor Departmental Representative prior to cleaning.
  - .3 Identify on HVAC system record drawings access points used for inspection and cleaning.
  - .4 Re-collect and analyze particulates collected at same locations where original samples were collected before cleaning.
  - .5 Reset components including dampers and sensors, which have been disturbed during cleaning operations.

**3.7 SYSTEM STARTUP**

- .1 Install new system filters after cleaning operations are completed.
- .2 Cover each inspection opening with access door or panel and secure in place after inspection and cleaning are completed.
- .3 Restart each HVAC system.

**3.8 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Dispose of hazardous or toxic waste materials extracted from ductwork system to landfill appropriate contaminated waste facility and provide proof.
  - .2 Dispose of existing HVAC filter materials to landfill appropriate contaminated waste facility.

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for major equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, 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 - Submittal Procedures: 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 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance for incorporation into manual.
  - .1 Operation and maintenance manual approved by, and final copies deposited with, Departmental Representative before final inspection.
  - .2 Operation data to include:
    - .1 Control schematics for systems including environmental controls.
    - .2 Description of systems and their controls.
    - .3 Description of operation of systems at various loads together with reset schedules and seasonal variances.
    - .4 Operation instruction for systems and component.
    - .5 Description of actions to be taken in event of equipment failure.



- .6 Valves schedule and flow diagram.
- .7 Colour coding chart.
- .3 Maintenance data to include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
- .4 Performance data to include:
  - .1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .5 Approvals:
  - .1 Submit [2] copies of draft Operation and Maintenance Manual to Departmental Representative for approval. Submission of individual data will not be accepted unless directed by Departmental Representative.
  - .2 Make changes as required and re-submit as directed by Departmental Representative.
- .6 Additional data:
  - .1 Prepare and insert into operation and maintenance manual additional data when need for it becomes apparent during specified demonstrations and instructions.
- .7 Site records:
  - .1 Departmental Representative will provide [1] set of reproducible mechanical drawings. Provide sets of [white] prints as required for each phase of work. Mark changes as work progresses and as changes occur. Include changes to existing mechanical systems, control systems and low voltage control wiring.
  - .2 Transfer information [weekly] to reproducibles, revising reproducibles to show work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection.
- .8 As-built drawings:
  - .1 Prior to start of Testing, Adjusting and Balancing for HVAC, finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
  - .3 Submit to Departmental Representative for approval and make corrections as directed.

- .4 Perform testing, adjusting and balancing for HVAC using as-built drawings.
- .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .9 Submit copies of as-built drawings for inclusion in final TAB report.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

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

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

#### **Part 2 Products**

##### **2.1 N/A**

#### **Part 3 Execution**

**3.1 EXAMINATION**

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

**3.2 PAINTING REPAIRS AND RESTORATION**

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

**3.3 SYSTEM CLEANING**

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

**3.4 FIELD QUALITY CONTROL**

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.

**3.5 DEMONSTRATION**

- .1 Departmental Representative will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.
- .2 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 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**3.7 PROTECTION**

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

**END OF SECTION**

**Part 1            General****1.1            RELATED REQUIREMENTS**

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

**1.2            REFERENCES**

- .1            Canadian General Standards Board (CGSB)
  - .1            CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
- .2            Canadian Standards Association (CSA International)
  - .1            CSA B149, Natural Gas and Propane Installation Code.
  - .2            CSA B139, Installation Code for Oil Burning Equipment.
- .3            Green Seal Environmental Standards (GSES)
  - .1            Standard GS-11, Environmental Standard for Paints and Coatings.
- .4            National Fire Code of Canada
- .5            South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1            SCAQMD Rule 1113, Architectural Coatings.
  - .2            SCAQMD Rule 1168, Adhesive and Sealant Applications.

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4            DELIVERY, STORAGE AND HANDLING**

- .1            Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2            Delivery and Acceptance Requirements:
  - .1            Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3            Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products****2.1 MATERIAL**

- .1 Paint: zinc-rich to CAN/CGSB-1.181.
  - .1 Primers Paints Coating: in accordance with manufacturer's recommendations for surface conditions.
  - .2 Primer: maximum VOC limit 250 g/L to Standard GS-11.
  - .3 Paints: maximum VOC limit 150 g/L to Standard GS-11.
- .2 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
  - .1 Sealants: maximum VOC limit to GSES GS-36.
- .3 Sealants: maximum VOC limit to GSES GS-36.
- .4 Adhesives: maximum VOC limit to GSES GS-36.
- .5 Fire Stopping: in accordance with Section 07 84 00 - Fire Stopping.

**Part 3 Execution****3.1 APPLICATION**

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

**3.2 CONNECTIONS TO EQUIPMENT**

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

**3.3 CLEARANCES**

- .1 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and National Fire Code of Canada.
- .2 Provide space for disassembly, removal of equipment and components as recommended by manufacturer without interrupting operation of other system, equipment, and components.

**3.4 DRAINS**

- .1 Install piping with grade in direction of flow except as indicated.
- .2 Install drain valve at low points in piping systems, at equipment and at section isolating valves.
- .3 Pipe each drain valve discharge separately to above floor drain.

.1 Discharge to be visible.

.4 Drain valves: NPS 3/4 gate or globe valves unless indicated otherwise, with hose end male thread, cap and chain.

### **3.5 AIR VENTS**

.1 Install air vents to CSA B139 at high points in piping systems]

.2 Install isolating valve at each automatic air valve.

.3 Install drain piping to approved location and terminate where discharge is visible.

### **3.6 DIELECTRIC COUPLINGS**

.1 General: compatible with system, to suit pressure rating of system.

.2 Locations: where dissimilar metals are joined.

.3 NPS 2 and under: isolating unions or bronze valves.

.4 Over NPS 2: isolating flanges.

### **3.7 PIPEWORK INSTALLATION**

.1 Install pipework to CSA B139.

.2 Screwed fittings jointed with Teflon tape.

.3 Protect openings against entry of foreign material.

.4 Install to isolate equipment and allow removal without interrupting operation of other equipment or systems.

.5 Assemble piping using fittings manufactured to ANSI standards.

.6 Saddle type branch fittings may be used on mains if branch line is no larger than half size of main.

.1 Hole saw (or drill) and ream main to maintain full inside diameter of branch line prior to welding saddle.

.7 Install exposed piping, equipment, rectangular cleanouts and similar items parallel or perpendicular to building lines.

.8 Install concealed pipework to minimize furring space, maximize headroom, conserve space.

.9 Slope piping, except where indicated, in direction of flow for positive drainage and venting.

.10 Install, except where indicated, to permit separate thermal insulation of each pipe.

.11 Group piping wherever possible.

.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 gate or ball valves at branch take-offs for isolating purposes except where specified.
- .7 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 in vertical pipes with downward flow and as indicated.
  - .2 Install swing check valves in horizontal lines on discharge of pumps and as indicated.

### 3.8 SLEEVES

- .1 General: install where pipes pass through masonry, concrete structures, fire rated assemblies, and as indicated.
- .2 Material: schedule 40 black steel pipe.
- .3 Construction: use annular fins continuously welded at mid-point at foundation walls and where sleeves extend above finished floors.
- .4 Sizes: [6] mm minimum clearance between sleeve and uninsulated pipe or between sleeve and insulation.
- .5 Installation:
  - .1 Concrete, masonry walls, and concrete floors on grade: terminate flush with finished surface.
  - .2 Other floors: terminate 25 mm above finished floor.
  - .3 Before installation, paint exposed exterior surfaces with heavy application of zinc-rich paint to CAN/CGSB-1.181.
- .6 Sealing:
  - .1 Foundation walls and below grade floors: fire retardant, waterproof non-hardening mastic.
  - .2 Elsewhere:
    - .1 Provide space for firestopping.
    - .2 Maintain fire rating integrity.
  - .3 Sleeves installed for future use: fill with lime plaster or other easily removable filler.
  - .4 Ensure no contact between copper pipe or tube and sleeve.

### 3.9 ESCUTCHEONS

- .1 Install on pipes passing through walls, partitions, floors, and ceilings in finished areas.



- .2 Construction: one piece type with set screws.
  - .1 Chrome or nickel plated brass or type 302 stainless steel..
- .3 Sizes: outside diameter to cover opening or sleeve.
  - .1 Inside diameter to fit around pipe or outside of insulation if so provided.

### **3.10 PREPARATION FOR FIRE STOPPING**

- .1 Install firestopping within annular space between pipes, ducts, insulation and adjacent fire separation in accordance with Section 07 84 00 - Fire Stopping.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit pipe movement without damaging firestopping material or installation.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barriers.

### **3.11 FLUSHING OUT OF PIPING SYSTEMS**

- .1 Flush system in accordance with Section 23 08 02 - Cleaning and Start-up of Mechanical Piping Systems.
- .2 Before start-up, clean interior of piping systems in accordance with requirements of Section 01 74 11 - Cleaning supplemented as specified in relevant mechanical sections.
- .3 Preparatory to acceptance, clean and refurbish equipment and leave in operating condition, including replacement of filters in piping systems.

### **3.12 PRESSURE TESTING OF EQUIPMENT AND PIPEWORK**

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

### **3.13 CLEANING**

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

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

**END OF SECTION**

**Part 1        General****1.1        SUMMARY**

- .1    Section Includes:
  - .1    Electrical motors, drives and guards for mechanical equipment and systems.
  - .2    Supplier and installer responsibility indicated in Motor, Control and Equipment Schedule on electrical drawings and related mechanical responsibility is indicated on Mechanical Equipment Schedule on mechanical drawings.
  - .3    Control wiring and conduit is specified in Division 26 except for conduit, wiring and connections below 50 V which are related to control systems specified in Division 22 and 23. Refer to Division 26 for quality of materials and workmanship.

**1.2        REFERENCES**

- .1    American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1    ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA cosponsored; ANSI approved; Continuous Maintenance Standard).
  - .2    NECB 2011
- .2    Electrical Equipment Manufacturers' Association Council (EEMAC)
- .3    Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1    Material Safety Data Sheets (MSDS).

**1.3        ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1    Submit [two] copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
  - .2    Shop Drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta.
- .3    Quality Control: in accordance with Section 01 45 00 - Quality Control.
  - .1    Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2    Instructions: submit manufacturer's installation instructions.

- .1 Departmental Representative will make available [1] copy of systems supplier's installation instructions.
  - .4 Closeout Submittals
    - .1 Provide maintenance data for motors, drives and guards for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- 1.4 QUALITY ASSURANCE**
  - .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, TDGA, and applicable Provincial regulations.
  - .2 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- 1.5 DELIVERY, STORAGE, AND HANDLING**
  - .1 Packing, shipping, handling and unloading:
    - .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
    - .2 Deliver, store and handle materials in accordance with manufacturer's written instructions.
  - .2 Waste Management and Disposal:
    - .1 Construction Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
- Part 2 Products**
  - 2.1 GENERAL**
    - .1 Motors: high efficiency, in accordance with ASHRAE 90.1. or NECB 2011.
  - 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, 208 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 - Closeout Submittals.

**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                FIELD QUALITY CONTROL**

- .1        Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - SUBMITTALS.
- .2        Manufacturer's Field Services:
  - .1        Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
  - .2        Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3        Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

**3.4                CLEANING**

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

**END OF SECTION**

**Part 1            General****1.1               RELATED REQUIREMENTS**

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

**1.2               REFERENCES**

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

**1.3               ACTION AND INFORMATIONAL SUBMITTALS**

- .1       Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2       Product Data:
  - .1       Provide manufacturer's printed product literature and datasheets for 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 - Closeout Submittals.
  - .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 - Common Product Requirements.
- .2       Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3       Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

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

**2.2 GROOVED END EXPANSION JOINTS**

- .1 Packless, Gasketed, Slip, Expansion Joints:
  - .1 [2413] kPa maximum working pressure.
  - .2 Steel pipe fitting consisting of telescoping body and slip-pipe sections.
  - .3 PTFE modified polyphenylene sulfide coated slide section.
  - .4 Suitable for axial end movement to 75 mm.
- .2 Expansion joint consisting of series of grooved end pipe nipples joined in tandem with flexible couplings. Total joint movement dependent on number of couplings and nipples used.

**2.3 FLEXIBLE CONNECTION**

- .1 Application: to suit motion.
- .2 Minimum length in accordance with manufacturer's recommendations to suit offset.



- .3 Inner hose: stainless steel corrugated.
- .4 Braided wire mesh stainless steel outer jacket.
- .5 Diameter and type of end connection: as indicated.
- .6 Operating conditions:
  - .1 Working pressure: 1034 kPa.
  - .2 Working temperature: 200 degrees C.
  - .3 To match system requirements.
- .7 Three flexible grooved couplings placed in close proximity to vibration source for vibration attenuation and stress relief.

## 2.4 ANCHORS AND GUIDES

- .1 Anchors:
  - .1 Provide as indicated.
  - .2 Concrete: to Section 03 30 00 - Cast-in-Place Concrete.
  - .3 Reinforcement: to Section 03 20 00 - Concrete Reinforcing.
- .2 Alignment guides:
  - .1 By conduit manufacturer.
  - .2 To accommodate specified thickness of insulation.
  - .3 Vapour barriers, jackets to remain uninterrupted.

## Part 3 Execution

### 3.1 APPLICATION

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

### 3.2 INSTALLATION

- .1 Install expansion joints with cold setting, as indicated Departmental Representative. Make record of cold settings.
- .2 Install expansion joints and flexible connections in accordance with manufacturer's instructions.
- .3 Install pipe anchors and guides as indicated. Anchors to withstand 150 % of axial thrust.
- .4 Do welding in accordance with section 23 05 17 - Pipe Welding.

### 3.3 PIPE CLEANING AND START-UP

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

**3.4 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**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, Power Piping.
  - .2 ANSI/ASME B31.3, Process Piping.
  - .3 ANSI/ASME Boiler and Pressure Vessel Code-[2007]:
    - .1 BPVC 2007 Section I: Power Boilers.
    - .2 BPVC 2007 Section V: Nondestructive Examination.
    - .3 BPVC 2007 Section IX: Welding and Brazing Qualifications.
- .2 American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - .1 ANSI/AWWA C206, Field Welding of Steel Water Pipe.
- .3 American Welding Society (AWS)
  - .1 AWS C1.1M/C1.1, Recommended Practices for Resistance Welding.
  - .2 AWS Z49.1, Safety in Welding, Cutting and Allied Process.
  - .3 AWS W1, Welding Inspection Handbook..
- .4 Canadian Standards Association (CSA International)
  - .1 CSA W47.2, Certification of Companies for Fusion Welding of Aluminum.
  - .2 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding.
  - .3 CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.
  - .4 CSA-W117.2, Safety in Welding, Cutting and Allied Processes.
  - .5 CSA W178.1, Certification of Welding Inspection Organizations.
  - .6 CSA W178.2, Certification of Welding Inspectors.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**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 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

### **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] [B31.3], 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:
  - .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 10 % of welds in accordance with "Inspection and Test Plan" by non-destructive visual examination [magnetic particle (hereinafter referred to as "particle") tests spot gamma ray radiographic (hereinafter referred to as "radiography") 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 of total of up to 10 radiographic tests.
- .5 Full radiographic tests for 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.

.6 Magnetic particle tests for piping systems.

**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 - Cleaning.

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

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and components for metering steam and chilled/hot water including installation.

**1.2 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME Fluid Meter's Handbook: Their Theory and Application, Sixth Edition [1971].
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
    - .1 Submit [two] copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
    - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
- .3 Submittals to include:
  - .1 Piping configuration and sizing - straight pipe upstream and downstream, distances to first weld, protrusion, thermowell, pressure tap.
  - .2 Service conditions.
  - .3 Full details of primary element - standard of design and construction, materials, type serial number, flow rate, differential pressure, irrecoverable head loss (IHL), calculation sheets.
  - .4 Accuracy statements for each component at specified flow rates and other conditions.
  - .5 Flow and temperature ranges.
  - .6 Signal processor calibration data.
  - .7 Minimum turndown ratio.
- .4 Samples:

- .1 Submit sample in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Samples to include:
  - .1 Full size samples of recorder charts, integrator readings.
- .5 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .2 Instructions: submit manufacturer's installation instructions.
    - .1 Departmental Representative will make available [1] copy of systems supplier's installation instructions.
- .6 Closeout Submittals:
  - .1 Submit maintenance data including monitoring requirements for incorporation into manuals specified in Section 01 78 00 - Closeout Submittals.

#### 1.4 QUALITY ASSURANCE

- .1 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Waste Management and Disposal:
  - .1 Construction Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

### Part 2 Products

#### 2.1 ACCURACY

- .1 Calculate overall accuracy of each installation using following expression: Overall accuracy =  $(E (\text{accuracy of individual components of system})^2)^{1/2}$ .
- .2 Components to include:
  - .1 Primary flow measuring elements.
  - .2 Transmitters: flow, differential pressure, pressure, temperature, temperature difference.
  - .3 RTD's.
  - .4 Signal processors, recorders.
  - .5 Calibration of signal processors: assume 0.20% per processor.



- .6 Installation tolerances: assume 1% for concentricity of pipe, difference in height of transmitter piping.
- .3 Show in proposal overall accuracy at 100%, 70%, 10%, minimum specified design flow rate.
- .4 Indicate minimum measurable flow rate.

### **Part 3 Execution**

#### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

#### **3.2 PREPARATION**

- .1 Before final calculations for orifice diameter, and before purchase of orifice plate, nozzle, venturi, measure:
  - .1 Internal diameter of main at the primary element to +/-0.01 mm accuracy.
  - .2 For concentricity of pipe.

#### **3.3 INSTALLATION OF PRIMARY ELEMENT**

- .1 Follow manufacturer's instructions.

#### **3.4 INSTALLATION OF DIFFERENTIAL PRESSURE TAPS AND PIPING**

- .1 Differential pressure taps horizontal and level with each other to within +/- 1.5 mm.
- .2 Tubing: straight, supported throughout its length, sloped 5%-10% upward to main for drainage and venting, without air pockets, with blowdown valves at bottom.

#### **3.5 INSTALLATION OF TRANSMITTERS NOT FORMING INTEGRAL PART OF PRIMARY ELEMENT**

- .1 Mount on pipe stand installed and located to ensure no damage by passing traffic.

#### **3.6 INSTALLATION OF SIGNAL TRANSMISSION CABLE**

- .1 Ground shielding at one point only.
- .2 Protect against RF interference.
- .3 Cross electrical cables, conduits at 90 degrees leaving at least 150 mm space between.

#### **3.7 START-UP**

- .1 Follow manufacturer's recommendations.

#### **3.8 CLEANING**

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

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 American Society of Mechanical Engineers (ASME)
  - .1 ASME B31.1, Power Piping.
- .2 ASTM International
  - .1 ASTM A125, Standard Specification for Steel Springs, Helical, Heat-Treated.
  - .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
  - .3 ASTM A563, Standard Specification for Carbon and Alloy Steel Nuts.
- .3 Factory Mutual (FM)
- .4 Manufacturer's Standardization Society of the Valves and Fittings Industry (MSS)
  - .1 MSS SP58, Pipe Hangers and Supports - Materials, Design and Manufacture.
  - .2 MSS SP69, Pipe Hangers and Supports - Selection and Application.
  - .3 MSS SP89, Pipe Hangers and Supports - Fabrication and Installation Practices.
- .5 Underwriter's Laboratories of Canada (ULC)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 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 Alberta, Canada.
  - .2 Submit shop drawings for:
    - .1 Bases, hangers and supports.
    - .2 Connections to equipment and structure.
    - .3 Structural assemblies.
- .4 Certificates:
  - .1 Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Manufacturers' Instructions:
  - .1 Provide manufacturer's installation instructions.

- .1 Departmental Representative will make available [1] copy of systems supplier's installation instructions.

### **1.3 CLOSEOUT SUBMITTALS**

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

### **1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements] [with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates padding, packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

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

### **2.2 GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with MSS SP58.

### **2.3 PIPE HANGERS**

- .1 Finishes:
  - .1 Pipe hangers and supports: galvanized.
  - .2 Use electro-plating galvanizing process.
  - .3 Ensure steel hangers in contact with copper piping are copper plated.

- .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, UL listed 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, UL listed to MSS SP69].
  - .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 UL listed.
- .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 UL listed to MSS SP69.
- .5 Shop and field-fabricated assemblies:
  - .1 Trapeze hanger assemblies.
  - .2 Steel brackets.
- .6 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.
- .7 Pipe attachments: material to MSS SP58:
  - .1 Attachments for steel piping: carbon steel black.
  - .2 Attachments for copper piping: copper plated black steel.
  - .3 Use insulation shields for hot pipework.
  - .4 Oversize pipe hangers and supports.
- .8 Adjustable clevis: material to MSS SP69 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.
- .9 Yoke style pipe roll: carbon steel yoke, rod and nuts with cast iron roll, to MSS SP69.
- .10 U-bolts: carbon steel to MSS SP69 with 2 nuts at each end to ASTM A563.
  - .1 Finishes for steel pipework: black.
  - .2 Finishes for copper, glass, brass or aluminum pipework: black.

- .11 Pipe rollers: cast iron roll and roll stand with carbon steel rod to MSS SP69.

## 2.4 RISER CLAMPS

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS SP58, type 42, UL listed.
- .2 Copper pipe: carbon steel copper plated to MSS SP58, type 42.
- .3 Bolts: to ASTM A307.
- .4 Nuts: to ASTM A563.

## 2.5 INSULATION PROTECTION SHIELDS

- .1 Insulated cold piping:
  - .1 64 kg/m<sup>3</sup> density insulation plus insulation protection shield to: MSS SP69, galvanized sheet carbon steel. Length designed for maximum 3 m span.
- .2 Insulated hot piping:
  - .1 Curved plate 300 mm long, with edges turned up, welded-in centre plate for pipe sizes NPS 12 and over, carbon steel to comply with MSS SP69.

## 2.6 CONSTANT SUPPORT SPRING HANGERS

- .1 Springs: alloy steel to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with Certified Mill Test Report (CMTR).
- .2 Load adjustability: 10% minimum adjustability each side of calibrated load. Adjustment without special tools. Adjustments not to affect travel capabilities.
- .3 Provide upper and lower factory set travel stops.
- .4 Provide load adjustment scale for field adjustments.
- .5 Total travel to be actual travel + 20%. Difference between total travel and actual travel 25 mm minimum.
- .6 Individually calibrated scales on each side of support calibrated prior to shipment, complete with calibration record.

## 2.7 VARIABLE SUPPORT SPRING HANGERS

- .1 Vertical movement: 13 mm minimum, 50 mm maximum, use single spring pre-compressed variable spring hangers.
- .2 Vertical movement greater than 50 mm: use double spring pre-compressed variable spring hanger with [2] springs in series in single casing.
- .3 Variable spring hanger complete with factory calibrated travel stops. [Provide certificate of calibration for each hanger].
- .4 Steel alloy springs: to ASTM A125, shot peened, magnetic particle inspected, with +/-5% spring rate tolerance, tested for free height, spring rate, loaded height and provided with CMTR.

**2.8 EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports not provided by equipment manufacturer from structural grade steel meeting requirements of Section 05 12 23 - Structural Steel for Buildings. Submit calculations with shop drawings.

**2.9 EQUIPMENT ANCHOR BOLTS AND TEMPLATES**

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

**2.10 PLATFORMS AND CATWALKS**

- .1 To Section 05 50 00 - Metal Fabrications.

**2.11 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 - Cast-in-Place Concrete.

**2.12 OTHER EQUIPMENT SUPPORTS**

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

**Part 3 Execution****3.1 MANUFACTURER'S INSTRUCTIONS**

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

**3.2 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, and as indicated.
- .3 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt-tightening torques to industry standards.
  - .3 Steel pipes: install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: install below joint.

- .4 Clevis plates:
  - .1 Attach to concrete with [4] minimum concrete inserts, [one] at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
  - .1 Vertical movement of pipework is 13 mm or more,
  - .2 Transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
  - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
  - .2 Variation in supporting effect does not exceed 25 % of total load.

### 3.3 HANGER SPACING

- .1 Plumbing piping: to Canadian Plumbing Code authority having jurisdiction.
- .2 Fire protection: to applicable fire code.
- .3 Gas and fuel oil piping: up to NPS 1/2: every 1.8 m.
- .4 Copper piping: up to NPS 1/2: every 1.5 m.
- .5 Flexible joint roll groove pipe: in accordance with table below for steel, but not less than one hanger at joints. Table listings for straight runs without concentrated loads and where full linear movement is not required.
- .6 Within [300] mm of each elbow.

Maximum Pipe Size : NPS	Maximum Spacing Steel	Maximum Spacing Copper
up to 1-1/4	2.4 m	1.8 m
1-1/2	3.0 m	2.4 m
2	3.0 m	2.4 m
2-1/2	3.7 m	3.0 m
3	3.7 m	3.0 m
3-1/2	3.7 m	3.3 m
4	3.7 m	3.6 m
6	4.3 m	

- .7 Pipework greater than NPS 12: to MSS SP69.

### 3.4 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.

### 3.5 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4 degrees from vertical.



- .2 Where horizontal pipe movement is less than 13 mm, offset pipe hanger and support so that rod hanger is vertical in the hot position.

### 3.6 FINAL ADJUSTMENT

- .1 Adjust hangers and supports:
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis:
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps:
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.

### 3.7 FIELD QUALITY CONTROL

- .1 Site Tests: conduct following tests in accordance with Section 01 45 00 - Quality Control and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .2 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
  - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.

### 3.8 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling] in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 TAB is used throughout this Section to describe the process, methods and requirements of testing, adjusting and balancing for HVAC.
- .2 TAB means to test, adjust and balance to perform in accordance with requirements of Contract Documents and to do other work as specified in this section.

**1.2 QUALIFICATIONS OF TAB PERSONNEL**

- .1 Submit names of personnel to perform TAB to Departmental Representative within 90 days of award of contract.
- .2 Provide documentation confirming qualifications, successful experience.
- .3 TAB: performed in accordance with the requirements of standard under which TAB Firm's qualifications are approved:
  - .1 Associated Air Balance Council, (AABC) National Standards for Total System Balance.
  - .2 National Environmental Balancing Bureau (NEBB) TABES, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.
  - .3 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing.
- .4 Recommendations and suggested practices contained in the TAB Standard: mandatory.
- .5 Use TAB Standard provisions, including checklists, and report forms to satisfy Contract requirements.
- .6 Use TAB Standard for TAB, including qualifications for TAB Firm and Specialist and calibration of TAB instruments.
- .7 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.
- .8 TAB Standard quality assurance provisions such as performance guarantees form part of this contract.
  - .1 For systems or system components not covered in TAB Standard, use TAB procedures developed by TAB Specialist.
  - .2 Where new procedures, and requirements, are applicable to Contract requirements have been published or adopted by body responsible for TAB Standard used (AABC, NEBB, or TABB), requirements and recommendations contained in these procedures and requirements are mandatory.

**1.3 PURPOSE OF TAB**

- .1 Test to verify proper and safe operation, determine actual point of performance, evaluate qualitative and quantitative performance of equipment, systems and controls at design, average and low loads using actual or simulated loads

- .2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.
- .3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

#### **1.4 EXCEPTIONS**

- .1 TAB of systems and equipment regulated by codes, standards to satisfaction of authority having jurisdiction.

#### **1.5 CO-ORDINATION**

- .1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.
- .2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

#### **1.6 PRE-TAB REVIEW**

- .1 Review contract documents before project construction is started confirm in writing to Departmental Representative adequacy of provisions for TAB and other aspects of design and installation pertinent to success of TAB.
- .2 Review specified standards and report to Departmental Representative in writing proposed procedures which vary from standard.
- .3 During construction, co-ordinate location and installation of TAB devices, equipment, accessories, measurement ports and fittings.

#### **1.7 START-UP**

- .1 Follow start-up procedures as recommended by equipment manufacturer unless specified otherwise.
- .2 Follow special start-up procedures specified elsewhere in Division 23.

#### **1.8 OPERATION OF SYSTEMS DURING TAB**

- .1 Operate systems for length of time required for TAB and as required by Departmental Representative for verification of TAB reports.

#### **1.9 START OF TAB**

- .1 Notify Departmental Representative [7] days prior to start of TAB.
- .2 Start TAB when building is essentially completed, including:
- .3 Installation of ceilings, doors, windows, other construction affecting TAB.
- .4 Application of weatherstripping, sealing, and caulking.
- .5 Pressure, leakage, other tests specified elsewhere Division 23.
- .6 Provisions for TAB installed and operational.

- .7 Start-up, verification for proper, normal and safe operation of mechanical and associated electrical and control systems affecting TAB including but not limited to:
  - .1 Proper thermal overload protection in place for electrical equipment.
  - .2 Air systems:
    - .1 Filters in place, clean.
    - .2 Duct systems clean.
    - .3 Ducts, air shafts, ceiling plenums are airtight to within specified tolerances.
    - .4 Correct fan rotation.
    - .5 Fire, smoke, volume control dampers installed and open.
    - .6 Coil fins combed, clean.
    - .7 Access doors, installed, closed.
    - .8 Outlets installed, volume control dampers open.
  - .3 Liquid systems:
    - .1 Flushed, filled, vented.
    - .2 Correct pump rotation.
    - .3 Strainers in place, baskets clean.
    - .4 Isolating and balancing valves installed, open.
    - .5 Calibrated balancing valves installed, at factory settings.
    - .6 Chemical treatment systems complete, operational.

**1.10 APPLICATION TOLERANCES**

- .1 Do TAB to following tolerances of design values:
  - .1 HVAC systems: plus [5] %, minus [5] %.
  - .2 Hydronic systems: plus or minus [10] %.

**1.11 ACCURACY TOLERANCES**

- .1 Measured values accurate to within plus or minus [2] % of actual values.

**1.12 INSTRUMENTS**

- .1 Prior to TAB, submit to Departmental Representative list of instruments used together with serial numbers.
- .2 Calibrate in accordance with requirements of most stringent of referenced standard for either applicable system or HVAC system.
- .3 Calibrate within [3] months of TAB. Provide certificate of calibration to Departmental Representative.

**1.13 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit, prior to commencement of TAB:

- .2 Proposed methodology and procedures for performing TAB if different from referenced standard.

#### **1.14 PRELIMINARY TAB REPORT**

- .1 Submit for checking and approval of Departmental Representative, prior to submission of formal TAB report, sample of rough TAB sheets. Include:
  - .1 Details of instruments used.
  - .2 Details of TAB procedures employed.
  - .3 Calculations procedures.
  - .4 Summaries.

#### **1.15 TAB REPORT**

- .1 Format in accordance with referenced standard.
- .2 TAB report to show results in SI units and to include:
  - .1 Project record drawings.
  - .2 System schematics.
- .3 Submit [6] copies of TAB Report to Departmental Representative for verification and approval, in English in D-ring binders, complete with index tabs.

#### **1.16 VERIFICATION**

- .1 Reported results subject to verification by Departmental Representative.
- .2 Provide personnel and instrumentation to verify up to [30] % of reported results.
- .3 Number and location of verified results as directed by Departmental Representative.
- .4 Pay costs to repeat TAB as required to satisfaction of Departmental Representative.

#### **1.17 SETTINGS**

- .1 After TAB is completed to satisfaction of Departmental Representative, replace drive guards, close access doors, lock devices in set positions, ensure sensors are at required settings.
- .2 Permanently mark settings to allow restoration at any time during life of facility. Do not eradicate or cover markings.

#### **1.18 COMPLETION OF TAB**

- .1 TAB considered complete when final TAB Report received and approved by Departmental Representative.

#### **1.19 AIR SYSTEMS**

- .1 Standard: TAB to most stringent of this section TAB standards of AABC SMACNA ASHRAE.
- .2 Do TAB of systems, equipment, components, controls specified Division 23 following systems, equipment, components, controls:

- .1 Heating system.
- .2 Air systems.
- .3 Boilers.
- .4 Pumps.
- .5 HRVs.
- .3 Qualifications: personnel performing TAB qualified to standards of AABC.
- .4 Quality assurance: perform TAB under direction of supervisor qualified to standards of AABC.
- .5 Measurements: to include as appropriate for systems, equipment, components, controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, vibration.
- .6 Locations of equipment measurements: to include as appropriate:
  - .1 Inlet and outlet of dampers, filter, coil, humidifier, fan, other equipment causing changes in conditions.
  - .2 At controllers, controlled device.
- .7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, run-out (or grille, register or diffuser).

**1.20 OTHER TAB REQUIREMENTS**

- .1 General requirements applicable to work specified this paragraph:
  - .1 Qualifications of TAB personnel: as for air systems specified this section.
  - .2 Quality assurance: as for air systems specified this section.
- .2 Building pressure conditions:
  - .1 Adjust HVAC systems, equipment, controls to ensure specified pressure conditions at all times.
- .3 Measurement of noise from equipment specified in Division 23.
- .4 Measurement of spatial noise

**Part 2 Products****2.1 NOT USED****Part 3 Execution****3.1 NOT USED****END OF SECTION**

**Part 1            General****1.1                REFERENCES**

- .1 Definitions:
  - .1 For purposes of this section:
    - .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
    - .2 "EXPOSED" - means "not concealed" as previously defined.
    - .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.
  - .2 TIAC Codes:
    - .1 CRD: Code Round Ductwork,
    - .2 CRF: Code Rectangular Finish.
- .2 Reference Standards:
  - .1 NECB 2011
  - .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
    - .1 ANSI/ASHRAE/IESNA 90.1, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .3 ASTM International Inc.
    - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
    - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Pipe Insulation.
    - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
    - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
    - .5 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.
    - .6 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
    - .7 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
    - .8 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
    - .9 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  - .4 Canadian General Standards Board (CGSB)
    - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .5 Green Seal Environmental Standards (GSES)

- .1 Standard GS-36-[00], Commercial Adhesives.
- .6 South Coast Air Quality Management District (SCAQMD), California State
  - .1 SCAQMD Rule 1168-[A2005], Adhesive and Sealant Applications.
- .7 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (2005).
- .8 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102-[03], Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701-[05], Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

## **1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for duct insulation, and include product characteristics, performance criteria, physical size, finish and limitations.
    - .1 Description of equipment giving manufacturer's name, type, model, year and capacity.
    - .2 Details of operation, servicing and maintenance.
    - .3 Recommended spare parts list.
- .3 Shop Drawings:
  - .1 Provide drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
- .4 Samples:
  - .1 Submit for approval: complete assembly of each type of insulation system, insulation, coating, and adhesive proposed.
  - .2 Mount sample on 12 mm plywood board.
  - .3 Affix typewritten label beneath sample indicating service.
- .5 Manufacturers' Instructions:
  - .1 Provide manufacture's written duct insulation jointing recommendations, and special handling criteria, installation sequence, cleaning procedures.

## **1.3 QUALITY ASSURANCE**

- .1 Qualifications:
  - .1 Installer: specialist in performing work of this section, and qualified to standards member of TIAC.

## **1.4 DELIVERY, STORAGE AND HANDLING**

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



- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address and ULC markings.
- .3 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 FIRE AND SMOKE RATING**

- .1 To CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### **2.2 INSULATION**

- .1 Mineral fibre: as specified includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24 degrees C mean temperature when tested in accordance with ASTM C335.
- .3 TIAC Code C-1: Rigid mineral fibre board to ASTM C612, with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this Section).
- .4 TIAC Code C-2: Mineral fibre blanket to ASTM C553 faced with factory applied vapour retarder jacket to CGSB 51-GP-52Ma (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to ASTM C553.

### **2.3 JACKETS**

- .1 Canvas:
  - .1 [220] gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .2 Lagging adhesive: compatible with insulation.
  - .1 Maximum VOC limit 250 g/L to SCAQMD Rule 1168.
- .3 Aluminum:
  - .1 To ASTM B209 with moisture barrier as scheduled in PART 3 of this section.
  - .2 Thickness: [0.50] mm sheet.
  - .3 Finish: Smooth.
  - .4 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.
    - .1 Stainless steel:
  - .5 Type: 304.
  - .6 Thickness: 0.25 mm sheet.
  - .7 Finish: Smooth.

- .8 Jacket banding and mechanical seals: 12 mm wide, 0.5 mm thick stainless steel.

## 2.4 ACCESSORIES

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: [hydraulic] setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
  - .1 [220] gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
- .5 Outdoor Vapour Retarder Mastic:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
  - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup>.
- .6 Tape: self-adhesive, aluminum, plain, 50 mm wide minimum.
- .7 Contact adhesive: quick-setting
  - .1 Maximum VOC limit 50 g/L [to SCAQMD Rule 1168] [GSES GS-36].
- .8 Canvas adhesive: washable.
  - .1 Maximum VOC limit 50 g/L [to SCAQMD Rule 1168] [GSES GS-36].
- .9 Tie wire: [1.5] mm stainless steel.
- .10 Banding: [12] mm wide, [0.5] mm thick stainless steel.
- .11 Facing: [25] mm galvanized steel hexagonal wire mesh stitched on one face of insulation with expanded metal lath on other face of insulation.
- .12 Fasteners: [2] mm diameter pins with [35] mm diameter clips, length to suit thickness of insulation.

## Part 3 Execution

### 3.1 APPLICATION

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

### 3.2 PRE-INSTALLATION REQUIREMENTS

- .1 Pressure test ductwork systems complete, witness and certify.
- .2 Ensure surfaces are clean, dry, free from foreign material.

**3.3 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and as indicated.
- .3 Use [2] layers with staggered joints when required nominal thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Ensure hangers, and supports are outside vapour retarder jacket.
- .5 Hangers and supports in accordance with [Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment].
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .6 Fasteners: install at 300 mm on centre in horizontal and vertical directions, minimum [2] rows each side.

**3.4 DUCTWORK INSULATION SCHEDULE**

- .1 Insulation types and thicknesses: conform to following table:

	TIAC Code	Vapour Retarder	Thickness (mm)
Rectangular cold and dual temperature supply air ducts	[C-1]	[yes]	[50]
Round cold and dual temperature supply air ducts	[C-2]	[yes]	[50]
Rectangular warm air ducts	[C-1]	[no]	[25]
Round warm air ducts	[C-1]	[no]	[25]
Supply, return and exhaust ducts exposed in space being served	[none]		
Outside air ducts to mixing plenum	[C-1]	[yes]	[25]
Mixing plenums	[C-1]	[yes]	[25]
Exhaust duct between dampers and louvres	[C-1]	[no]	[25]
Rectangular ducts outside	[C-1]	[special]	[50]
Acoustically lined ducts	[none]		

- .2 Exposed round ducts 600 mm and larger, smaller sizes where subject to abuse:
  - .1 Use TIAC code C-1 insulation, scored to suit diameter of duct.
  - .1 Finishes: conform to following table:

	TIAC Code	TIAC Code
Rectangular/ Round		
Indoor, concealed	none	none
Indoor, exposed within	CRF/1	CRD/2

mechanical room		
Indoor, exposed elsewhere	CRF/2	CRD/3
Outdoor, exposed to precipitation	CRF/3	CRD/4
Outdoor, elsewhere	CRF/4	CRD/5

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 NECB 2011.
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 90.1-SI Edition, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 ASTM International Inc.
  - .1 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .2 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .3 ASTM C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  - .4 ASTM C547, Standard Specification for Mineral Fiber Pipe Insulation.
  - .5 ASTM C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
  - .6 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
  - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
  - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .4 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52MA, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2 CAN/CGSB 51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts.
- .5 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).
- .6 South Coast Air Quality Management District (SCAQMD), California State
  - .1 SCAQMD Rule 1168-[A2005], Adhesive and Sealant Applications.
- .7 Thermal Insulation Association of Canada (TIAC)
  - .1 National Insulation Standards.
- .8 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Provide manufacturer's printed product literature and datasheets for insulation and adhesives, include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Provide [two] copies WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 35 29.06 - Health and Safety Requirements.
- .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.
- .5 Qualifications:
  - .1 Installer to be specialist in performing work of this section, and qualified to standards member of TIAC.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .3 Store at temperatures and conditions recommended by manufacturer.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets crates padding packaging materials in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**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 A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C547.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C547.
- .5 TIAC Code C-1: rigid mineral fibre board, unfaced.
  - .1 Mineral fibre: ASTM C612.
  - .2 Maximum "k" factor: ASTM C612.
- .6 TIAC Code C-4: rigid mineral fibre board faced with factory applied vapour retarder jacket.
  - .1 Mineral fibre: ASTM C612.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C612.
- .7 TIAC Code C-2: mineral fibre blanket unfaced or faced with factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: ASTM C553.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor: ASTM C553.
- .8 TIAC Code A.6: flexible unicellular tubular elastomer.
  - .1 Insulation: with vapour retarder jacket.
  - .2 Jacket: to CGSB 51-GP-52MA.
  - .3 Maximum "k" factor.
  - .4 Certified by manufacturer free of potential stress corrosion cracking corrodents.
- .9 TIAC Code A-2: rigid moulded calcium silicate in sections and blocks, and with special shapes to suit project requirements.
  - .1 Insulation: ASTM C533.
  - .2 Maximum "k" factor: ASTM C533.
  - .3 Design to permit periodic removal and re-installation.

## 2.3 JACKETS

- .1 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type [and sheet] to CAN/CSG 51.53 with pre-formed shapes as required.
  - .2 Colours: selected by Departmental Representative.
  - .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.
- .7 Special requirements:
  - .1 Outdoor: UV rated material at least [0.5] mm thick.
- .8 Covering adhesive: compatible with insulation.
  - .1 Maximum VOC limit 30 g/L [to SCAQMD Rule 1168] [GSES GS-36] and in accordance with Section 01 35 21 - LEED Requirements.
- .2 Aluminum:
  - .1 To ASTM B209.
  - .2 Thickness: [0.50] mm sheet.
  - .3 Finish: smooth.
  - .4 Joining: longitudinal and circumferential slip joints with [50] mm laps.
  - .5 Fittings: [0.5] mm thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, [19] mm wide, [0.5] mm thick at [300] mm spacing.

## 2.4 INSULATION SECUREMENTS

- .1 Tape: self-adhesive, aluminum, plain, [50] mm wide minimum.
- .2 Contact adhesive: quick setting.
  - .1 Maximum VOC limit 30 g/L [to SCAQMD Rule 1168] [GSES GS-36] and in accordance with Section 01 35 21 - LEED Requirements.
- .3 Tie wire: [1.5] mm diameter stainless steel.
- .4 Bands: Stainless steel, [19] mm wide, [0.5] mm thick.
- .5 Facing: 25 mm galvanized steel hexagonal wire mesh on one face of insulation with expanded metal lath on other face of insulation.
- .6 Fasteners: [2] [4] mm diameter pins with [35] mm square clips. Length of pin to suit thickness of insulation.

## 2.5 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.
  - .1 Maximum VOC limit 30 g/L to SCAQMD Rule 1168.

## 2.6 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

## 2.7 OUTDOOR VAPOUR RETARDER MASTIC

- .1 Vinyl emulsion type acrylic, compatible with insulation.



- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup>.

### **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.

#### **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 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.

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

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 Thermal insulation for piping and piping accessories in commercial type applications.

**1.2 REFERENCES**

- .1 NECB 2011
- .2 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - .1 ASHRAE Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings (IESNA co-sponsored; ANSI approved; Continuous Maintenance Standard).
- .3 American Society for Testing and Materials International (ASTM)
  - .1 ASTM B209M, Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate [Metric].
  - .2 ASTM C335, Standard Test Method for Steady State Heat Transfer Properties of Horizontal Pipe Insulation.
  - .3 ASTM C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
  - .4 ASTM C449/C449M, Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.
  - .5 ASTM C533, Calcium Silicate Block and Pipe Thermal Insulation.
  - .6 ASTM C547, Mineral Fiber Pipe Insulation.
  - .7 ASTM C795, Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
  - .8 ASTM C921, Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
- .4 Canadian General Standards Board (CGSB)
  - .1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .2 CAN/CGSB-51.53, Poly (Vinyl Chloride) Jacketing Sheet, for Insulated Pipes, Vessels and Round Ducts
- .5 Department of Justice Canada (Jus)
  - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
  - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
  - .3 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.
- .6 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

- .7 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards (Revised 2004).
- .8 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
  - .2 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
  - .3 CAN/ULC-S702, Thermal Insulation, Mineral Fibre, for Buildings
  - .4 CAN/ULC-S702.2, Thermal Insulation, Mineral Fibre, for Buildings, Part 2: Application Guidelines.

### 1.3 DEFINITIONS

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as specified.
- .2 TIAC ss:
  - .1 CRF: Code Rectangular Finish.
  - .2 CPF: Code Piping Finish.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures Include product characteristics, performance criteria, and limitations.
    - .1 Submit [two] copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Section 01 33 00 - Submittal Procedures.
- .3 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
    - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
- .4 Samples:
  - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .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 - Submittal Procedures.

- .1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .2 Instructions: submit manufacturer's installation instructions.
  - .1 Departmental Representative will make available [1] copy of systems supplier's installation instructions.

## 1.5 QUALITY ASSURANCE

- .1 Qualifications:
- .2 Installer: specialist in performing work of this Section, and qualified to standards member of TIAC.
- .3 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

## 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Packing, shipping, handling and unloading:
  - .1 Deliver, store and handle in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
  - .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 Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.
  - .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] [ASTM C547].
  - .2 Maximum "k" factor: to CAN/ULC-S702.
- .4 TIAC Code A-3: rigid moulded mineral fibre with factory applied vapour retarder jacket.
  - .1 Mineral fibre: to [CAN/ULC-S702] [ASTM C547].
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to [CAN/ULC-S702] [ASTM C547].
- .5 TIAC Code C-2: mineral fibre blanket faced [with] [without] factory applied vapour retarder jacket (as scheduled in PART 3 of this section).
  - .1 Mineral fibre: to [CAN/ULC-S702] [ASTM C547].
  - .2 Jacket: to CGSB 51-GP-52Ma.
  - .3 Maximum "k" factor: to [CAN/ULC-S702] [ASTM C547].

## 2.3 INSULATION SECUREMENT

- .1 Tape: self-adhesive, aluminum, plain, [50] mm wide minimum.
- .2 Contact adhesive: quick setting.
- .3 Canvas adhesive: washable.
- .4 Tie wire: [1.5] mm diameter stainless steel.
- .5 Bands: stainless steel, [19] mm wide, [0.5] mm thick.

## 2.4 VAPOUR RETARDER LAP ADHESIVE

- .1 Water based, fire retardant type, compatible with insulation.

## 2.5 INDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.

## 2.6 OUTDOOR VAPOUR RETARDER FINISH

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: fibrous glass, untreated 305 g/m<sup>2</sup>.

## 2.7 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] [by [Departmental Representative] [DCC Representative] [Consultant]].
- .3 Minimum service temperatures: -20 degrees C.
- .4 Maximum service temperature: 65 degrees C.
- .5 Moisture vapour transmission: 0.02 perm.
- .6 Fastenings:
  - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
  - .2 Tacks.
  - .3 Pressure sensitive vinyl tape of matching colour.
- .7 Special requirements:
  - .1 Outdoor: UV rated material at least [0.5] mm thick.
- .2 Canvas:
  - .1 [220] [and 120] gm/m<sup>2</sup> cotton, plain weave, treated with dilute fire retardant lagging adhesive to ASTM C921.
  - .2 Lagging adhesive: compatible with insulation.
- .3 Aluminum:
  - .1 To ASTM B209.
  - .2 Thickness: [0.50] mm sheet.
  - .3 Finish: [smooth].
  - .4 Joining: longitudinal and circumferential slip joints with [50] mm laps.
  - .5 Fittings: [0.5] mm thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, [19] mm wide, [0.5] mm thick at [300] mm spacing.

## **2.8 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS**

- .1 Caulking to: Section 07 92 00 - Joint Sealants.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 PRE-INSTALLATION REQUIREMENT**

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.

- .2 Surfaces clean, dry, free from foreign material.

### 3.3 INSTALLATION

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturers instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm.
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Install hangers, supports outside vapour retarder jacket.
- .5 Supports, Hangers:
  - .1 Apply high compressive strength insulation, suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.

### 3.4 REMOVABLE, PRE-FABRICATED, INSULATION AND ENCLOSURES

- .1 Application: at expansion joints, valves, primary flow measuring elements flanges and unions at equipment.
- .2 Design: to permit movement of expansion joint without damage to adjacent insulation.
- .3 Insulation:
  - .1 Insulation, fastenings and finishes: same as system.
  - .2 Jacket: aluminum PVC high temperature fabric.

### 3.5 INSTALLATION OF ELASTOMERIC INSULATION

- .1 Insulation to remain dry. Overlaps to manufacturers instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

### 3.6 PIPING INSULATION SCHEDULES

- .1 Includes valves, valve bonnets, strainers, flanges and fittings unless otherwise specified.
- .2 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.

Piping	Pipe Sizes mm	Insulation Thickness mm	Recovery Jacket
Domestic Cold Water Piping	13 to 20 25 to 150 200 and over	15 25 38	[Canvas] [Aluminum] [Stainless Steel] [PVC]



Piping	Pipe Sizes mm	Insulation Thickness mm	Recovery Jacket
Domestic Hot Water Supply and Recirculation Piping	13 to 30 40 and over	25 38	[Canvas] [Aluminum] [Stainless Steel] [PVC]
Domestic Hot Water Supply and Recirculation Piping (through unconditioned spaces)	13 to 50 65 to 100 125 and over	50 65 75	[Canvas] [Aluminum] [Stainless Steel] [PVC]
Irrigation Piping Inside Building	All sizes	25	[Canvas] [Aluminum] [Stainless Steel] [PVC]
Hot Water Heating Piping; Do not insulate within Radiation Enclosures except for mains	13 to 30 40 and Over	25 50	[Canvas] [Aluminum] [Stainless Steel] [PVC]
Vents within 3 m of Roof Outlet	All sizes	38	[Canvas] [Aluminum] [Stainless Steel] [PVC]
Stainless Steel Water Softener Tanks		38	[Aluminum] [Stainless Steel]
Air Separators		38	[Aluminum] [Stainless Steel]
Note: Pipe insulation for piping installed in partitions within conditioned spaces can be reduced by 25mm but not to thickness below 25mm.			

**3.7****CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 Procedures and cleaning solutions for cleaning mechanical piping systems.
- .2 Related Requirements
  - .1 Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
  - .2 Section 23 25 00 - HVAC Water Treatment Systems.

**1.2 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Section 01 33 00 - Submittal Procedures. Include product characteristics, performance criteria, and limitations.
- .2 Quality assurance submittals: submit following in accordance with Section 01 33 00 - Submittal Procedures.
  - .1 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 29.06 - Health and Safety Requirements.

**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 - Common Product Requirements.
- .2 Waste Management and Disposal:

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

## **Part 2 Products**

### **2.1 CLEANING SOLUTIONS**

- .1 Tri-sodium phosphate: 0.40 kg per 100 L water in system.
- .2 Sodium carbonate: 0.40 kg per 100 L water in system.
- .3 Low-foaming detergent: 0.01 kg per 100 L water in system.

## **Part 3 Execution**

### **3.1 MANUFACTURER'S INSTRUCTIONS**

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

### **3.2 CLEANING HYDRONIC AND STEAM SYSTEMS**

- .1 Timing: systems operational, hydrostatically tested and with safety devices functional, before cleaning is carried out.
- .2 Cleaning Agency:
  - .1 Retain qualified water treatment specialist to perform system cleaning.
- .3 Install instrumentation such as flow meters, orifice plates, pitot tubes, flow metering valves only after cleaning is certified as complete by water treatment specialist.
- .4 Cleaning procedures:
  - .1 Provide detailed report outlining proposed cleaning procedures at least [4] weeks prior to proposed starting date. Report to include:
    - .1 Cleaning procedures, flow rates, elapsed time.
    - .2 Chemicals and concentrations used.
    - .3 Inhibitors and concentrations.
    - .4 Specific requirements for completion of work.
    - .5 Special precautions for protecting piping system materials and components.
    - .6 Complete analysis of water used to ensure water will not damage systems or equipment.
- .5 Conditions at time of cleaning of systems:
  - .1 Systems: free from construction debris, dirt and other foreign material.

- .2 Control valves: operational, fully open to ensure that terminal units can be cleaned properly.
- .3 Strainers: clean prior to initial fill.
- .4 Install temporary filters on pumps not equipped with permanent filters.
- .5 Install pressure gauges on strainers to detect plugging.
- .6 Report on Completion of Cleaning:
  - .1 When cleaning is completed, submit report, complete with certificate of compliance with specifications of cleaning component supplier.
- .7 Hydronic Systems:
  - .1 Fill system with water, ensure air is vented from system.
  - .2 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] [82 degrees C minimum]. Circulate for 12 h, ensuring flow in all circuits. Remove heat, continue to circulate until temperature is below 38 degrees C. Drain as quickly as possible. Refill with clean water. Circulate for 6 h at design temperature. Drain and repeat procedures specified above. Flush through low point drains in system. Refill with clean water adding to sodium sulphite (test for residual sulphite).

### 3.3 START-UP OF HYDRONIC SYSTEMS

- .1 After cleaning is completed and system is filled:
  - .1 Establish circulation 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 - HVAC Water Treatment Systems.
  - .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 slowly over a [48] hour period.
- .11 Perform TAB as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .12 Adjust pipe supports, hangers, springs as necessary.
- .13 Monitor pipe movement, performance of expansion joints, loops, guides, anchors.
- .14 If sliding type expansion joints bind, shut down system, re-align, repeat start-up procedures.
- .15 Re-tighten bolts using torque wrench, to compensate for heat-caused relaxation. Repeat several times during commissioning.
- .16 Check operation of drain valves.
- .17 Adjust valve stem packings as systems settle down.
- .18 Fully open balancing valves (except those that are factory-set).
- .19 Check operation of over-temperature protection devices on circulating pumps.
- .20 Adjust alignment of piping at pumps to ensure flexibility, adequacy of pipe movement, absence of noise or vibration transmission.

### 3.4 CLEANING

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 ASME
  - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.
- .2 ASTM International
  - .1 ASTM A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A278/A278M, Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 650 degrees F (350 degrees C).
  - .3 ASTM A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536-, Standard Specification for Ductile Iron Castings.
  - .5 ASTM B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
- .3 CSA Group
  - .1 CSA B51-[09], Boiler, Pressure Vessel, and Pressure Piping Code.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic specialties for incorporation into manual.
- .3 Submit 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 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect hydronic specialties from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 DIAPHRAGM TYPE EXPANSION TANK**

- .1 Vertical steel pressurized diaphragm type expansion tank.
- .2 Capacity: refer to schedule.
- .3 Diaphragm sealed in EPDM suitable for 115 degrees C operating temperature.
- .4 Working pressure: 860 kPa with ASME stamp and certification.
- .5 Air precharged to [84] kPa (initial fill pressure of system).
- .6 Base mount for vertical installation.
- .7 Supports: provide supports with hold down bolts and installation templates [incorporating seismic restraint systems].
- .8 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 Float: solid material suitable for 115 degrees C working temperature].

### **2.3 AIR SEPARATOR - BOILER MOUNTED**

- .1 Complete with dip tube.
- .2 Working pressure: [860] kPa.

### **2.4 AIR SEPARATOR - EXPANSION TANK FITTING**

- .1 Complete with adjustable vent tube and built-in manual vent valve.
- .2 Working pressure: [860] kPa.

### **2.5 AIR SEPARATOR - IN-LINE**

- .1 Working pressure: [860] kPa.
- .2 Size: NPS 1 ½ or as indicated.

**2.6 COMBINATION SEPARATORS/STRAINERS**

- .1 Steel, tested and stamped in accordance with ASME BPVC, for [860] kPa operating pressure, with galvanized steel integral strainer with [5] mm perforations, tangential inlet and outlet connections, and internal stainless steel air collector tube.

**2.7 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 Blowdown connection: NPS [1].
- .4 Screen: stainless steel with [1.19] mm perforations.
- .5 Working pressure: [860] kPa.

**2.8 SUCTION DIFFUSER**

- .1 Body: cast iron with flanged connections.
- .2 Strainer: with built-in, disposable [1.19] mm mesh, low pressure drop screen and NPS [1] blowdown connection.
- .3 Permanent magnet particle trap.
- .4 Full length straightening vanes.
- .5 Pressure gauge tapings.
- .6 Adjustable support leg.

**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.

**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.

**3.6 EXPANSION TANKS**

- .1 Adjust expansion tank pressure to suit design criteria.
- .2 Install lockshield type valve at inlet to tank.

**3.7 PRESSURE SAFETY RELIEF VALVES**

- .1 Run discharge pipe to terminate above nearest drain.

**3.8 SUCTION DIFFUSERS**

- .1 Install on inlet to pumps having suction size greater than 50.

**3.9 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 NECB 2011
- .2 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE/IES Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- .3 CSA Group
  - .1 CAN/CSA-B214-[12], Installation Code for Hydronic Heating Systems.
- .4 Electrical Equipment Manufacturers Association of Canada (EEMAC)
- .5 National Electrical Manufacturers' Association (NEMA)
  - .1 NEMA MG 1-2011, Motors and Generators.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for 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 Alberta, Canada.
  - .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 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for hydronic pumps for incorporation into manual.
- .3 Submit copies of operation and maintenance manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

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

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect hydronic pumps from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 EQUIPMENT**

- .1 Size and select components to: CAN/CSA-B214.

### **2.2 VERTICAL IN-LINE CIRCULATORS**

- .1 Volute: cast iron radially split, with tapped openings for venting, draining and gauge connections, with screwed or flanged suction and discharge connections.
- .2 Impeller: cast iron.
- .3 Shaft: stainless steel with bronze sleeve bearing, integral thrust collar.
- .4 Seal assembly: mechanical for service to 135 degrees C.
- .5 Coupling: rigid self-aligning.
- .6 Motor: to NEMA MG 1 resilient mounted, drip proof, sleeve bearing, 1800 r/min.
- .7 Capacity: refer to 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 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 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.
- .4 Pipe drain tapping to floor drain.
- .5 Install volute venting pet cock in accessible location.
- .6 Check rotation prior to start-up.
- .7 Install pressure gauge test cocks.

**3.4 START-UP**

- .1 General:
  - .1 In accordance with Section 23 05 93 – Testing, Adjusting and Balancing for HVAC and 01 91 13 - General Commissioning (Cx) Requirements: General Requirements; 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 - General Commissioning (Cx) Requirements: General Requirements, 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 - General Commissioning (Cx) Requirements.
  - .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 - General Commissioning (Cx) Requirements 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 13 - General Commissioning (Cx) Requirements: Report Forms and Schematics.
  - .3 Pump performance curves (family of curves).

### 3.6 CLEANING

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .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 - Submittal Procedures].
- .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 29.06 - Health and Safety Requirements. 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 Alberta, Canada.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for HVAC water treatment systems for incorporation into manual.
- .3 Include following:
  - .1 Log sheets as recommended by manufacturer.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials 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 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products****2.1 MANUFACTURER**

- .1 Equipment, chemicals, and service provided by one supplier.

**2.2 POT FEEDER**

- .1 150 mm diameter x 550 mm long feeder, suitable for 861 kPa operating pressure complete with isolation valves on 20 mm inlet and outlet lines. 20 mm drain valve 40 mm fill complete with filling funnel.

**2.3 WATER TREATMENT FOR HYDRONIC SYSTEMS**

- .1 Hot water heating system: pot feeder, 19 L, operating pressure 860 kPa.
- .2 Micron filter for each pot feeder:
  - .1 Capacity 2% of pump recirculating rate at operating pressure.
  - .2 Six (6) sets of filter cartridges for each type, size of micron filter.

**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 system[s] 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 WATER TREATMENT SERVICES**

- .1 Provide water treatment monitoring and consulting services for period of 1 year after system start-up. Service to include:
  - .1 Initial water analysis and treatment recommendations.
  - .2 System start-up assistance.
  - .3 Operating staff training.
  - .4 Visit plant every 7 days during period of operation and as required until system stabilizes, and advise on treatment system performance.
  - .5 Provide necessary recording charts and log sheets for [1 year] operation.
  - .6 Provide necessary laboratory and technical assistance.
  - .7 Provide clear, concise, written instructions and advice to operating staff.

**3.7 FIELD QUALITY CONTROL**

- .1 Start-up:
  - .1 Start up water treatment systems in accordance with manufacturer's instructions.
- .2 Commissioning:
  - .1 Commissioning Agency: to be water treatment supplier.
  - .2 Timing:
    - .1 After start-up deficiencies rectified.
    - .2 After start-up and before TAB of connected systems.
  - .3 Pre-commissioning Inspections: verify:
    - .1 Presence of test equipment, reagents, chemicals, details of specific tests performed, and operating instructions.
    - .2 Suitability of log book.
    - .3 Currency and accuracy of initial water analysis.
    - .4 Required quality of treated water.
  - .4 Commissioning procedures - applicable to Water Treatment Systems:
    - .1 Establish, adjust as necessary and record automatic controls and chemical feed rates.
    - .2 Monitor performance continuously during commissioning of connected systems and until acceptance of project.
    - .3 Establish test intervals, regeneration intervals.
    - .4 Record on approved report forms commissioning procedures, test procedures, dates, times, quantities of chemicals added, raw water analysis, treated water analysis, test results, instrument readings, adjustments made, results obtained.
    - .5 Establish, monitor and adjust automatic controls and chemical feed rates as necessary.
    - .6 Visit project at specified intervals after commissioning is satisfactorily completed to verify that performance remains as set during commissioning (more often as required until system stabilizes at required level of performance).
    - .7 Advise Departmental Representative in writing on matters regarding installed water treatment systems.
  - .5 Commissioning procedures - Closed Circuit Hydronic Systems:
    - .1 Analyze water in system.
    - .2 Based upon an assumed rate of loss approved by Departmental Representative, establish rate of chemical feed.
    - .3 Record types, quantities of chemicals applied.
  - .6 Training:
    - .1 Commission systems, perform tests in presence of, and using assistance of, assigned O M personnel.
    - .2 Train O M personnel in softener regeneration procedures.
  - .7 Certificates:

- .1 Upon completion, furnish certificates confirming satisfactory installation and performance.
- .8 Commissioning Reports:
  - .1 To include system schematics, test results, test certificates, raw and treated water analyses, design criteria, other data required by Departmental Representative.
- .9 Commissioning activities during Warranty Period:
  - .1 Check out water treatment systems on regular basis and submit written report to Departmental Representative.

**3.8 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

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

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for air duct accessories and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate:
    - .1 Flexible connections.
    - .2 Duct access doors.
    - .3 Turning vanes.
    - .4 Instrument test ports.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect air duct accessories from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**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 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/m<sup>2</sup>.

## 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.
  - .2 [301 to 450] mm: four sash locks.
  - .3 [451 to 1000] mm: piano hinge and minimum two sash locks.
  - .4 Doors over [1000] mm: piano hinge and two handles operable from both sides.
  - .5 Hold open devices.

## 2.4 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.

## 2.5 SPIN-IN COLLARS

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

## Part 3 Execution

### 3.1 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 Size:
    - .1 [600] x [600] mm for servicing entry.
    - .2 [300] x [300] mm for viewing.
    - .3 As indicated.
  - .2 Locations:
    - .1 Fire and smoke dampers.
    - .2 Control dampers.
    - .3 Devices requiring maintenance.
    - .4 Required by code.
    - .5 Reheat coils.
    - .6 Elsewhere as indicated.
- .3 Instrument Test Ports:
  - .1 General:
    - .1 Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
  - .2 Locate to permit easy manipulation of instruments.
  - .3 Install insulation port extensions as required.
  - .4 Locations:
    - .1 For traverse readings:
      - .1 Ducted inlets to roof and wall exhausters.
      - .2 Inlets and outlets of other fan systems.
      - .3 Main and sub-main ducts.
      - .4 And as indicated.
    - .2 For temperature readings:
      - .1 At outside air intakes.

- .2 In mixed air applications in locations as approved by Departmental Representative.
- .3 At inlet and outlet of coils.
- .4 Downstream of junctions of two converging air streams of different temperatures.
- .5 And as indicated.

### **3.3 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

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

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect dampers from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**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 Single 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.

### **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 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for recycling in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE)
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
  - .2 NFPA 90B, Standard for Installation of Warm Air Heating and Air-Conditioning Systems.
- .3 Sheet Metal and Air-Conditioning Contractors' National Association (SMACNA)
  - .1 SMACNA HVAC Duct Construction Standards - Metal and Flexible.
  - .2 SMACNA IAQ Guideline for Occupied Buildings under Construction.
- .4 Underwriters' Laboratories (UL)
  - .1 UL 181, Standard for Factory-Made Air Ducts and Air Connectors.
- .5 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S110, Standard Methods of Tests for Air Ducts.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for [flexible ducts] and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate:
    - .1 Thermal properties.
    - .2 Friction loss.
    - .3 Acoustical loss.
    - .4 Leakage.
    - .5 Fire rating.
- .3 Test and Evaluation Reports:
  - .1 Catalogue or published ratings to be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect flexible ducts from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **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 METALLIC - UNINSULATED**

- .1 Type 1: spiral wound flexible aluminum, as indicated.
- .2 Performance:
  - .1 Factory tested to [2.5] kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: [3].

### **2.3 METALLIC - INSULATED**

- .1 Type 2: 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 Thermal R value: RSI-1.

### **2.4 NON-METALLIC - UNINSULATED**

- .1 Type 3: non-collapsible, coated aluminum foil mylar type, mechanically bonded to, and helically supported by, external steel wire, as indicated.
- .2 Performance:
  - .1 Factory tested to [2.5] kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: [3].

**2.5 NON-METALLIC - INSULATED**

- .1 Type 4: non-collapsible, coated aluminum foil/mylar type mechanically bonded to, and helically supported by, external steel wire with factory applied, [37] mm thick flexible mineral 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 Thermal R value: RSI-1.

**2.6 NON-METALLIC - ACOUSTIC INSULATED**

- .1 Type 7: non-collapsible, coated mineral base perforated fabric type helically supported by and mechanically bonded to steel wire with factory applied flexible mineral fibre acoustic insulation and encased in aluminum foil/mylar laminate vapour barrier.
- .2 Performance:
  - .1 Factory tested to [2.5] kPa without leakage.
  - .2 Maximum relative pressure drop coefficient: [3].
  - .3 Acoustical performance: Minimum attenuation (dB/m) to following table:

	Frequency (Hz)				
Duct Diam:	125	250	500	1000	2000
[100]	[0.6]	[3]	[12]	[27]	[0]
[150]	[1.2]	[3]	[12]	[22]	[27]
[200]	[2.0]	[5]	[12]	[19]	[20]
[300]	[2.4]	[5]	[12]	[16]	[15]

**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: CAN/ULC-S110 NFPA 90A NFPA 90B SMACNA.

**3.3 CLEANING**

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

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 ASTM International
  - .1 ASTM C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - .2 ASTM C916, Standard Specification for Adhesives for Duct Thermal Insulation.
  - .3 ASTM C1071, Standard specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
  - .4 ASTM C1338, Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
  - .5 ASTM G21, Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .2 National Fire Protection Association (NFPA)
  - .1 NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
  - .2 NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- .3 North American Insulation Manufacturers Association (NAIMA)
  - .1 NAIMA AH116, Fibrous Glass Duct Construction Standards.
- .4 Sheet Metal and Air Conditioning Contractor's National Association (SMACNA)
  - .1 SMACNA, HVAC Duct Construction Standards, Metal and Flexible-[2005].
  - .2 SMACNA IAQ Guideline for Occupied Buildings Under Construction-[2007].
- .5 Underwriter's 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 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for duct liners and include product characteristics, performance criteria, physical size, finish and limitations.

**1.3 CLOSEOUT SUBMITTALS**

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

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect duct liners from nicks, scratches, and blemishes
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products****2.1 DUCT LINER**

- .1 General:
  - .1 Mineral Fibre duct liner: air surface coated mat facing.
  - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102 NFPA 90A NFPA 90B.
  - .3 Fungi resistance: to ASTM C1338.
- .2 Rigid:
  - .1 Use on flat surfaces.
  - .2 25 mm thick, to ASTM C1071 Type 2, fibrous glass rigid board duct liner.
  - .3 Density: 48 kg/m<sup>3</sup> minimum.
  - .4 Thermal resistance to be minimum 0.76 (m<sup>2</sup>.degrees C)/W for 25 mm thickness, 1.15 (m<sup>2</sup>.degrees C)/W for 38 mm thickness, and 1.53 (m<sup>2</sup>.degrees C)/W for 50 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.
  - .5 Maximum velocity on faced air side: 10 m/s.
  - .6 Minimum NRC of 0.70 at 25 mm]thickness based on Type A mounting to ASTM C423.
- .3 Flexible:
  - .1 Use on round surfaces.
  - .2 25 mm thick, to ASTM C1071 Type 1, fibrous glass blanket duct liner.
  - .3 Density: 24 kg/m<sup>3</sup> minimum.
  - .4 Thermal resistance to be minimum 0.37 (m<sup>2</sup>.degrees C)/W for 12 mm thickness, 0.74 (m<sup>2</sup>.degrees C)/W for 25 mm thickness, 1.11 (m<sup>2</sup>.degrees C)/W for 38 mm

thickness, and 1.41 (m<sup>2</sup>.degrees C)/W to 50 mm thickness when tested in accordance with ASTM C177, at 24 degrees C mean temperature.

- .5 Maximum velocity on coated air side: 25.4 m/s.
- .6 Minimum NRC of 0.65 at 25 mm thickness based on Type A mounting to ASTM C423.

## **2.2 ADHESIVE**

- .1 Adhesive: to NFPA 90B and ASTM C916.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 29 degrees C to plus 93 degrees C.
- .3 Water-based fire retardant type.

## **2.3 FASTENERS**

- .1 Weld pins 2.0 mm diameter, length to suit thickness of insulation. Metal retaining clips, [32] mm square.

## **2.4 JOINT TAPE**

- .1 Poly-Vinyl treated open weave fiberglass membrane [50] mm wide.

## **2.5 SEALER**

- .1 Meet requirements of NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range minus 68 degrees C to plus 93 degrees C.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for duct liner 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 HVAC Duct Construction Standard except as specified otherwise.
- .2 Line inside of ducts where indicated.
- .3 Duct dimensions, as indicated, are clear inside duct lining.



**3.3 DUCT LINER**

- .1 Install in accordance with manufacturer's recommendations, and as follows:
  - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive to ASTM C916.
    - .1 Exposed leading edges and transverse joints to be factory coated or coated with adhesive during fabrication.

**3.4 JOINTS**

- .1 Seal butt joints, exposed edges, weld pin and clip penetrations and damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's written recommendations, and as follows:
  - .1 Bed tape in sealer.
  - .2 Apply [2] coats of sealer over tape.
- .2 Replace damaged areas of liner at discretion of Departmental Representative.
- .3 Protect leading [and trailing] edges of duct sections with sheet metal nosing having [15] mm overlap and fastened to duct.

**3.5 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 23 05 13 - Common Motor 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 NECB 2011.
- .2 American National Standards Institute/Air Movement and Control Association (ANSI/AMCA)
  - .1 ANSI/AMCA Standard 99, Standards Handbook.
  - .2 ANSI/AMCA Standard 210/(ANSI/ASHRAE 51), Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - .3 ANSI/AMCA Standard 300, Reverberant Room Method for Sound Testing of Fans.
  - .4 ANSI/AMCA Standard 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .3 The Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual.
    - .1 MPI #18, Primer, Zinc Rich, Organic.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
  - .1 Provide:
    - .1 Matched sets of belts.
    - .2 Furnish list of individual manufacturer's recommended spare parts for equipment, include:
      - .1 Bearings and seals.
      - .2 Addresses of suppliers.
      - .3 List of specialized tools necessary for adjusting, repairing or replacing.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect HVAC fans from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **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, total pressure, W, efficiency, revolutions per minute, power, model, size, sound power data and as indicated on schedule.
  - .3 Fans: statically and dynamically balanced, constructed in conformity with ANSI/AMCA Standard 99.
  - .4 Sound ratings: comply with ANSI/AMCA Standard 301, tested to ANSI/AMCA Standard 300..
  - .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 - Common Motors Requirements for HVAC Equipment supplemented as specified herein.
  - .2 For use with variable speed controllers.
  - .3 Sizes as indicated.
- .2 Accessories and hardware: matched sets of V-belt drives, adjustable slide rail motor bases, belt guards, coupling guards fan inlet outlet safety screens as indicated and as specified in Section 23 05 13 - Common Motor Requirements for HVAC Equipment, inlet outlet dampers and vanes and as indicated.
- .3 Factory primed before assembly in colour standard to manufacturer.
- .4 Scroll casing drains: as indicated.
- .5 Bearing lubrication systems plus extension lubrication tubes where bearings are not easily accessible.
- .6 Vibration isolation: to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- .7 Flexible connections: to Section 23 33 00 - Air Duct Accessories.

**2.3 BATHROOM EXHAUST FANS**

- .1 Provide multi-blade, forward curved wheel in steel housing for between stud mounting.
- .2 Resiliently mount direct driven fan and motor. Motor shall be plug-in type with permanently lubricated bearings.
- .3 Provide one-piece plastic intake grille.

**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 - Vibration and Seismic Controls for HVAC Piping and Equipment, flexible electrical

leads and flexible connections in accordance with Section 23 33 00 - Air Duct Accessories.

- .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 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for diffusers, registers and grilles and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate following:
    - .1 Capacity.
    - .2 Throw and terminal velocity.
    - .3 Noise criteria.
    - .4 Pressure drop.
    - .5 Neck velocity.
- .3 Samples:
  - .1 Samples are required for following:
    - .1 Submit duplicate [300 x 300] mm samples of [each type].

**1.2 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Extra Materials:
  - .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
  - .2 Include:
    - .1 Keys for volume control adjustment.
    - .2 Keys for air flow pattern adjustment.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location 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 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 SYSTEM DESCRIPTION**

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

### **2.2 GENERAL**

- .1 To meet capacity, pressure drop, terminal velocity, throw, noise level, neck velocity.
- .2 Frames:
  - .1 Full perimeter gaskets.
  - .2 Plaster frames where set into plaster or gypsum board and as specified.
  - .3 Concealed fasteners.
- .3 Concealed manual volume control damper operators.
- .4 Colour: as directed by Departmental Representative.

### **2.3 MANUFACTURED UNITS**

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

### **2.4 SUPPLY GRILLES AND REGISTERS**

- .1 Refer to schedule.

### **2.5 RETURN AND EXHAUST GRILLES AND REGISTERS**

- .1 Refer to 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 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 manufacturer's 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.
- .4 Provide concealed safety chain on each grille, register and diffuser in gymnasium and similar game rooms [and elsewhere as indicated].

### **3.3 CLEANING**

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

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 ASTM International
  - .1 ASTM E90, Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for louvers, intakes and vents and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Indicate following:
    - .1 Pressure drop.
    - .2 Face area.
    - .3 Free area.
- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test Reports: submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect louvers, intakes and vents from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

**Part 2 Products****2.1 SYSTEM DESCRIPTION**

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

**2.2 FIXED LOUVRES - ALUMINUM**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy [6063-T5].
- .3 Blade: [stormproof pattern with centre watershed in blade], reinforcing bosses and maximum blade length of [1500] mm.
- .4 Frame, head, sill and jamb: [100] [150] mm deep one piece extruded aluminum, minimum [3] mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at [1500] mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, ss washer and aluminum body.
- .7 Screen: [12] mm exhaust] [19] mm intake mesh, [2] mm diameter wire aluminum birdscreen on [inside] face of louvres in formed U-frame.
- .8 Finish: factory applied enamel, Colour: to Departmental Representative's approval.

**2.3 ADJUSTABLE LOUVRES**

- .1 Construction: welded with exposed joints ground flush and smooth.
- .2 Material: extruded aluminum alloy [6063-T5].
- .3 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of [1500] mm.
- .4 Frame, head, sill and jamb: [100] [150] mm deep one piece extruded aluminum, minimum [3] mm thick with approved caulking slot, integral to unit.
- .5 Mullions: at [1500] mm maximum centres.
- .6 Fastenings: stainless steel SAE-194-8F with SAE-194-SFB nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, stainless steel washer and aluminum body.
- .7 Screen: [12] mm exhaust] [19] mm intake mesh, [2] mm diameter wire aluminum birdscreen on [inside] face of louvres in formed U-frame.
- .8 Finish: factory applied enamel. Colour: to Departmental Representative's DCC Representative's approval.

**Part 3 Execution****3.1 EXAMINATION**

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

**3.2 INSTALLATION**

- .1 In accordance with manufacturer's and SMACNA recommendations.
- .2 Reinforce and brace as indicated.
- .3 Anchor securely into opening. Seal with caulking to ensure weather tightness.

**3.3 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 American National Standard Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
  - .1 ANSI/ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size (ANSI approved).
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-115.10, Disposable Air Filters for the Removal of Particulate Matter from Ventilating Systems.
- .3 Underwriters' Laboratories of Canada (ULC)
  - .1 ULC -S111, Standard Method of Fire Tests for Air Filter Units.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for HVAC 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 Alberta, Canada.
- .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 - Closeout Submittals.
  - .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as frames and filters, addresses of suppliers, list of specialized tools necessary for adjusting, repairing or replacing for inclusion in operating manual.
  - .3 Spare filters: in addition to filters installed immediately prior to acceptance by Departmental Representative, supply [1] complete set of filters for each.

**1.4 DELIVERY, STORAGE AND HANDLING**

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

- .3 Storage and Handling Requirements:
  - .1 Store materials 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 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **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.
- .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.

### **2.3 FIBROUS GLASS PANEL FILTERS**

- .1 Disposable fibrous glass media: to CAN/CGSB-115.10 with adhesive.
- .2 Holding frame: 1.2 mm minimum thick galvanized steel with [3] mm diameter hinged wire mesh screen.
- .3 Performance: to ANSI/ASHRAE 52.2 [70] %.
- .4 Fire rated: to ULC -S111.
- .5 Nominal thickness: 25 mm.

## **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 system, at time of acceptance.

### **3.4 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
- .2 Underwriters' Laboratories of Canada (ULC)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for chimneys and stacks 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 Alberta, Canada.
  - .2 Indicate following:
    - .1 Methods of sealing sections.
    - .2 Methods of expansion.
    - .3 Details of thimbles.
    - .4 Bases/Foundations.
    - .5 Supports.
    - .6 Guy details.
    - .7 Rain caps.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.3 QUALITY ASSURANCE**

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, applicable Provincial regulations.
- .2 Certifications:
  - .1 Catalogued or published ratings: obtained from tests carried out by independent testing agency or manufacturer 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 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect chimneys and stacks from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 BREECHINGS**

- .1 Shop fabricated 3.5 mm thick mild steel welded, with sweep bends from boiler outlet to thimble or chimney as indicated.
- .2 Breeching constructed of same vent components as chimney.

### **2.2 TYPE B GAS VENT**

- .1 ULC labelled, [288] degrees C rating maximum, atmospheric gas vent only.
- .2 Sectional, prefabricated, double wall with 13 mm air space. Aluminum inner wall. Galvanized steel outer wall. Mated fittings and couplings.

### **2.3 STEEL CHIMNEY REFRACTORY LINED**

- .1 Material:
  - .1 Prefabricated sections with [90] mm thick high temperature impervious insulating refractory lining, centrifugally spun into [3.5] mm thick circular casing.
- .2 Construction:
  - .1 Prefabricated sections, welded at factory. Use high temperature insulating cement at joints in refractory lining.
- .3 Welding:
  - .1 To full thickness; grind welds smooth.
- .4 Supports:
  - .1 Welded gussets, cleats and bolts for installation on concrete base.
  - .2 Concrete base by Section 03 30 00 - Cast-in-Place Concrete.
- .5 Breeching entry:
  - .1 Tee section with [150] mm minimum refractory lined projection.
- .6 Access door: in bottom section.
- .7 Drain connection: at base of stack.
- .8 Dimensions: as indicated.



**2.4 ACCESSORIES**

- .1 Cleanouts: bolted, gasketed type, full size of breeching, as indicated.
- .2 Barometric dampers: single acting, 70% of full size of breeching area.
- .3 Hangers and supports: in accordance with recommendations SMACNA.
- .4 Rain cap.
- .5 Expansion sleeves with heat resistant caulking, held in place as indicated.

**Part 3 Execution****3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for chimney and stack 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 Follow manufacturer's and SMACNA installation recommendations for shop fabricated components.
- .2 Suspend breeching at [1.5] m centres and at each joint.
- .3 Support chimneys at bottom, roof and intermediate levels as indicated.
- .4 Install thimbles where penetrating roof, floor, ceiling and where breeching enters masonry chimney. Pack annular space with heat resistant caulking.
- .5 Install flashings on chimneys penetrating roofs, as indicated.
- .6 Install rain caps and cleanouts, as indicated.

**3.3 INSTALLATION - REFRACTORY LINED STEEL CHIMNEY**

- .1 Grind welds smooth to form appearance of single tube.
- .2 Seal insulating refractory at top of stack.
- .3 Pack annular space around breeching at entry tee with heat resistant caulking.
- .4 Run drain line from drain connection to neutralizer.
- .5 On completion, paint one coat of rust inhibitive primer and two coats of heat resisting paint of colour, make and quality approved by Departmental Representative.

**3.4 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1 NECB 2011.
- .2 American Boiler Manufacturers Association (ABMA)
- .3 ASME
  - .1 ASME Boiler and Pressure Vessel Code (BPVC), Section VII.
- .4 CSA Group
  - .1 CAN1-3.1-, Industrial and Commercial Gas-Fired Package Boilers.
  - .2 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
  - .3 CSA B139, Installation Code for Oil Burning Equipment.
  - .4 CSA B149.1, Natural Gas and Propane Installation Code.
- .5 Electrical and Electronic Manufacturers Association of Canada (EEMAC)

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for heating boilers 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 Alberta, Canada.
  - .2 Indicate on drawings:
    - .1 General arrangement showing terminal points, instrumentation test connections.
    - .2 Clearances for operation, maintenance, servicing, tube cleaning, tube replacement.
    - .3 Foundations with loadings, anchor bolt arrangements.
    - .4 Piping hook-ups.
    - .5 Equipment electrical drawings.
    - .6 Burners and controls.
    - .7 All miscellaneous equipment.
    - .8 Flame safety control system.
    - .9 Breeching and stack configuration.
    - .10 Stack emission continuous monitoring system to measure CO, O, NOx, SO, stack temperature and smoke density of flue gases.
  - .3 Engineering data to include:

- .1 Boiler efficiency at 25%, 50%, 75%, 100%, of design capacity.
- .2 Radiant heat loss at 100% design capacity.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

### 1.3 CLOSEOUT SUBMITTALS

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

### 1.4 QUALITY ASSURANCE

- .1 Regulatory Requirements: work to be performed in compliance with CEPA, CEAA, applicable Provincial regulations.

### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- .1 Extra materials:
  - .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.
    - .1 Special tools for burners, access opening, handholes and Operation and Maintenance.
    - .2 Spare parts for [1] year of operation.
    - .3 Spare gaskets.
    - .4 Spare gauge glass inserts.
    - .5 Probes and sealants for electronic indication.
    - .6 Spare burner tips.
    - .7 Spare burner gun.
    - .8 Safety valve test gauge.

### 1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect boiler and equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

**Part 2 Products****2.1 GENERAL**

- .1 Packaged boiler:
  - .1 Complete with burner and necessary accessories and controls.
  - .2 Factory tested at rated capacity to, and bearing seal or nameplate certifying compliance with, CSA B140.7.
  - .3 Ready for attachment to piping, electrical power, controls, flue gases exhaust.
  - .4 Designed and constructed to ASME Boiler and Pressure vessel Code.
  - .5 CRN (Canadian Registration Number), to CSA B51.
  - .6 Boiler/burner package to bear ULC CGA label.
- .2 Performance:
  - .1 In accordance with American Boiler Manufacturers Association (ABMA), [or ANSI Z21.13/CSA 4.9 (gas burning)] testing procedures.
  - .2 Performance: refer to schedule.
  - .3 Flue gas temperature leaving boiler:
    - .1 Not to exceed 260 degrees C.
    - .2 Above dewpoint conditions at minimum firing rate.
- .3 Controls: factory wired. Enclosed in EEMAC [1] steel cabinet.
- .4 Thermal insulation:
  - .1 [50] mm thick mineral fibre. Seal insulation at handholes, access opening, mudholes, piping connections with insulating cement or asphaltic paint. Finish with heat resisting paint.
- .5 Jackets: heavy gauge metal, finished with heat resisting paint.
- .6 Mounting:
  - .1 Housekeeping pad.
- .7 Start-up, instruction, on-site performance tests: [3] days per boiler.
- .8 Temporary use by contractor:
  - .1 Contractor may use boilers only after written approval from Departmental Representative.
  - .2 Monitor and record performance continuously. Keep log of maintenance activities carried out.
  - .3 Refurbish to as-new condition before final inspection and acceptance.

**2.2 MODULAR HOT WATER BOILER, NATURAL GAS PULSE FIRED, CONDENSING TYPE**

- .1 Heating boiler seasonal efficiency rating: 90%. Flue gas exhaust temperature: 45 to 55 degrees C, when operating in condensing mode.
- .2 Flue gas: individually direct vented. Combustion air: individually drawn from outdoors through plastic pipes as indicated and as recommended by manufacturer.

- .3 Factory-assemble each module to include:
  - .1 Combustion air inlet chamber.
  - .2 Pre-purge blower assembly.
  - .3 Air-gas fuel control valve.
  - .4 Cast pulse combustion chamber.
  - .5 Welded absorption chamber with spiralled fire tubes and exhaust chamber.
  - .6 House assembly in insulated jacket which includes boiler mounted electrical control panel enclosure with operation sequence indicator lights.
  - .7 Provide coupling on combustion air inlet and exhaust chambers for connections of plastic piping, [PVC] for outside air intake and [CPVC] for outside exhaust.
  - .8 Provide condensate drain fitting on exhaust chamber.
  - .9 Boiler materials will enable operation with flue gas temperature below dewpoint without corrosion.
- .4 Absorption unit: constructed in accordance with ASME Boiler and Pressure Vessel Code for Low Pressure Heating Boilers for [207] kPa working pressure.
- .5 Controls for each module to include:
  - .1 Solid state controller with auxiliary relay.
  - .2 Fan prove pressure switch and pressure sensing flame safeguard system.
  - .3 Provide combination gas control with:
    - .1 Manual shut off valve.
    - .2 System pressure controlled regulator.
    - .3 Automatic redundant shut off valves.
    - .4 High limit water temperature control with adjustable differential.
    - .5 ASME approved pressure relief valve and temperature/pressure indicator.
- .6 Factory wire each module and operationally test.
  - .1 Each module suitable for individual firing.
  - .2 Step firing accomplished by firing individual modules without reducing their thermal efficiency.
  - .3 Control system: designed and provided for heating plant by manufacturer.

## 2.3 AUXILIARIES

- .1 Provide auxiliaries for each boiler and to meet ASME requirements.
- .2 Hot water boilers:
  - .1 Relief valve[s]: ASME rated, set at 206 kPa, to release entire boiler capacity.
  - .2 Pressure gauge: 90 mm diameter complete with shut-off cock.
  - .3 Thermometer: 115 mm diameter range 10 to [150] degrees C.
  - .4 Low water cut-off: with visual and audible alarms.
  - .5 Auxiliary low water cut-off: with separate cold water connection to boiler.
  - .6 Isolating gate valves: on supply and return connections.
  - .7 Drain valve: NPS [2].

- .8 Stack thermometer: range 65 to [400] degrees C.
- .9 Outdoor controller: to reset operating temperature controller.
- .10 [1] set of cleaning tools.

## 2.4 GAS BURNERS

- .1 General:
  - .1 Forced draft with:
    - .1 Built-in blower to supply combustion air, complete with motor, silencer and damper.
    - .2 High voltage ignition transformer.
    - .3 Flame observation port.
    - .4 Easy access to nozzles and electrodes.
  - .2 Gas pilot:
    - .1 To building code and provincial regulations including solenoid gas valve, pressure regulator, pressure gauge, manual shut-off valve.
  - .3 Main gas train:
    - .1 To building code and provincial regulations including main shut-off valve, pressure regulator, motorized electric shut-off valve, downstream block-test valve with test connection and pressure gauge.
  - .4 Controls:
    - .1 Electronic combustion control relay with [flame rod] [ultra-violet] [infra-red] flame detector for combustion control and flame supervision.
    - .2 Control to shut off fuel within [5] seconds upon pilot flame or main flame failure or upon signal of safety interlock and to ensure, when restarted, in sequence:
      - .1 Pre-purge.
      - .2 Pilot ignition and supervision.
      - .3 Main gas valve opening.
      - .4 Pilot cut-off. Pilot-proving period not to exceed 10 seconds.
      - .5 Burner operation.
      - .6 Post-purge burner shut-down.
    - .3 Static pressure interlock. To shut off burner upon loss of combustion air pressure.
    - .4 Fuel-air mixture: control through:
      - .1 2-position motor with end switch to provide for low-fire start and high fire run.
      - .2 2-position motor with linkage to control fuel and air and with end switches to prove low-fire start and energize high fire solenoid valve for high-low fire operation.
      - .3 Modulating motor with end switch to provide for low-fire start and fully modulating operation down to 20% of design capacity.
    - .5 Immersion controllers:

- .1 Operating: to start and stop burner, and operating between adjustable setpoints.
- .2 High-low: to shift burner operation to high or low fire.
- .3 Modulating: to modulate burner output.
- .4 High limit: manual reset.
- .6 Visual and audible alarms: to indicate burner shutdown due to flame failure, low water level, high pressure, high temperature, low air pressure, low gas pressure.
- .7 Pilot lights: to indicate:
  - .1 All stages of burner operation.
- .8 Burner to start up in low fire position.

## 2.5 EMISSION CONTROL

- .1 Rate of discharge of air contaminants from boiler not to exceed:
  - .1 For nitrogen oxides expressed as nitrogen dioxide:
    - .1 [150] ng/J of heat input when fired with solid fossil fuel.
    - .2 [110] ng/J of heat input when fired with oil specified as type 4, 5, or 6, according to CGSB classification.
    - .3 [43] ng/J of heat input when fired with oil specified as type 1 or 2, according to CGSB classification.
    - .4 [22] ng/J of heat input when fired with gaseous fuel.
  - .2 For sulphur dioxide:
    - .1 [500] ng/J of heat input when fired with solid fossil fuel.
    - .2 [500] ng/J of heat input when fired with oil specified as type 4, 5, or 6, according to CGSB classification.
    - .3 [25] ng/J of heat input when fired with oil specified as type 1 or 2, according to CGSB classification.
  - .3 For particulate matter measured undiluted, [160] mg/m<sup>3</sup>, when fired with solid fossil fuel.
  - .4 For carbon monoxide, [125] ng/J of heat input.

## 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 heating boiler 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 in accordance with ASME Boiler and Pressure Vessels Code, regulations of Province having jurisdiction, except where specified otherwise, and manufacturers recommendations.
- .2 Make required piping connections to inlets and outlets recommended by boiler manufacturer.
- .3 Maintain clearances as indicated or if not indicated, as recommended by manufacturer for operation, servicing and maintenance without disruption of operation of any other equipment/system.
- .4 Mount unit level using specified vibration isolation in Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment
- .5 Pipe hot water relief valves full size to nearest drain.
- .6 Pipe blowdown/drain to blowdown tank/floor drain.
- .7 Natural gas fired installations: in accordance with CSA B149.1.

**3.4 MOUNTINGS AND ACCESSORIES**

- .1 Safety valves and relief valves:
  - .1 Run separate discharge from each valve.
  - .2 Terminate discharge pipe as indicated.
  - .3 Run drain pipe from each valve outlet and drip pan elbow to above nearest drain.
- .2 Blowdown valves:
  - .1 Run discharge to terminate as indicated.

**3.5 FIELD QUALITY CONTROL**

- .1 Commissioning:
  - .1 Manufacturer to:
    - .1 Certify installation.
    - .2 Start up and commission installation.
    - .3 Carry out on-site performance verification tests.
    - .4 Demonstrate operation and maintenance.
  - .2 Provide Departmental Representative at least [24] hours' notice prior to inspections, tests, and demonstrations. Submit written report of inspections and test results.

**3.6 CLEANING**

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

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

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.2 REFERENCES**

- .1 CSA C22.2 No.46, Electric Air-Heaters.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for duct heaters and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit product data and include:
    - .1 Element support details.
    - .2 Heater: total kW rating, voltage, phase.
    - .3 Number of stages.
    - .4 Rating of stage: rating, voltage, phase.
    - .5 Heater element watt/density and maximum sheath temperature.
    - .6 Maximum discharge temperature.
    - .7 Unit support.
    - .8 Clearance from combustible materials.
    - .9 Internal components wiring diagrams.
    - .10 Minimum operating airflow.
    - .11 Pressure drop operating airflow.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect duct heaters from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 DUCT HEATERS**

- .1 Duct heaters: flange type.
- .2 Elements:
  - .1 Helical coils of nickel chrome alloy resistance wire.
  - .2 Finned tubular.
  - .3 Incoloy sheathed.
- .3 Staging:
  - .1 Staged heaters: balanced line current at each stage.
  - .2 Each stage: uniform face distribution.
- .4 Maximum temperature at discharge: 35 degrees Celsius.
- .5 Controls:
  - .1 Factory mounted and wired in control box. Use terminal blocks for power and control wiring to thermostat and sail switch.
  - .2 Remote mounted as indicated with terminal strips in heater terminal box for power and control wiring.
  - .3 Controls mounted in a CSA Type 2 enclosure and to include:
    - .1 Magnetic contactors.
    - .2 Pneumatic electric relays.
    - .3 Control transformers.
    - .4 SCR controller.
  - .4 Where controls are mounted in heater, exercise care in mounting contactors to minimize switching noise transmission through ductwork.
  - .5 High temperature cutout and air proving switch.
- .6 Performance: refer to schedule.
- .7 Main isolation disconnect switch.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for 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 INSTALLATION**

- .1 Make power and control connections to CSA C22.2 No.46.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements and Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests in presence of Departmental Representative.
  - .1 Provide test report and include copy with Operations and Maintenance Manuals.

**3.4 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 RELATED REQUIREMENTS**

- .1 23 33 00 - Air Duct Accessories.

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE)
  - .1 ASHRAE 84, Method of Testing Air-to-Air Heat/Energy Exchangers (ANSI approved).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for energy recovery equipment and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
  - .2 Indicate following:
    - .1 Supply air flowrate
    - .2 Exhaust air flowrate
    - .3 Supply air temperature both in winter and summer design condition
    - .4 Exhaust air temperature both in winter and summer design condition
    - .5 Electrical power.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test Reports:
  - .1 Catalogued or published ratings: obtained from tests carried out by manufacturer or those ordered from independent testing agency signifying adherence to codes and standards in force.
  - .2 Provide confirmation of testing.
- .6 Manufacturers' Instructions: submit manufacturer's installation instructions.
  - .1 Departmental Representative will make available [1] copy of systems supplier's installation instructions.

**1.4 MAINTENANCE MATERIAL SUBMITTALS**

- .1 Submit maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

- .2 Extra Materials:
  - .1 Furnish list of individual manufacturer's recommended spare parts for equipment include:
    - .1 Bearings and seals.
    - .2 Addresses of suppliers.
  - .2 List of specialized tools necessary for adjusting, repairing or replacing.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect energy recovery equipment from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials] as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Comply with ASHRAE 84.

### **2.2 AIR TO AIR FIXED PLATE EXCHANGER**

- .1 Casing: 24 gauge galvanized steel.
- .2 Heat transfer surfaces: corrugated aluminum, edge sealed and bonded to casing.
- .3 Cross contamination: not permitted.
- .4 Condensate drain: NPS [2].
- .5 Removable access panels.
- .6 Accessories: water wash.
- .7 Performance characteristics: refer to 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 energy recovery equipment installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of Departmental Representative.
  - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

**3.2 INSTALLATION**

- .1 Install in accordance with manufacturers recommendations.
- .2 Support independently of adjacent ductwork with flexible connections.
- .3 Install access doors in accordance with Section 23 33 00 - Air Duct Accessories for access to coils, dampers, and fans.

**3.3 CLEANING**

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

**END OF SECTION**



**Part 1 General****1.1 REFERENCES**

- .1 Institute of Boiler and Radiator Manufacturers (IBR)
- .2 US Department of Commerce
  - .1 CS 140-47, Commercial Standard.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for finned tube radiation heaters and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
  - .2 Indicate on drawings:
    - .1 Equipment, capacity, piping, and connections.
    - .2 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, sizes and location of mounting bolt holes.
    - .3 Special enclosures.
- .4 Samples:
  - .1 Submit [1200] mm length sample enclosure showing method of securing to structure and connecting to adjacent length of enclosure.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Operation and Maintenance Data: submit operation and maintenance data for finned tube radiation heaters for incorporation into manual.

**1.4 DELIVERY, STORAGE AND HANDLING**

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

- .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .2 Store and protect finned tube radiation heaters from nicks, scratches, and blemishes.
- .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse by manufacturer of pallets, crates, padding, packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction Waste Management and Disposal.

## **Part 2 Products**

### **2.1 DAMPERS**

- .1 Factory built, internal damper, at enclosure air outlet grille for each convection type heating unit not thermostatically controlled. Refer to schedules on drawings.

### **2.2 CAPACITY**

- .1 As indicated, based on 76.7 degrees C average water temperature, [11.1.] degrees C temperature drop and 82.2 degrees C at entering air temperature.

### **2.3 BASEBOARD RADIATION**

- .1 Heating elements: NPS [3/4] copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins, one tube end belled.
- .2 Enclosure: minimum [1.0] mm thick steel surface mounted with [1.0] mm thick back and top of one piece construction. Front panel removable. Run wall to wall unless otherwise indicated. Provide panel corners joiner pieces end caps. Assemble with stainless steel [No.10] oval head sheet metal screws. Finish factory applied baked on enamel.
- .3 Element brackets: [1.2] mm thick galvanized steel to support front panel and element cradle. Space brackets [900] mm centres maximum.
- .4 Provide for noiseless expansion of components.

### **2.4 FINNED TUBE RADIATION**

- .1 Heating elements: NPS [3/4] seamless copper tubing, [1.2] mm minimum wall thickness, mechanically expanded into flanged collars of evenly spaced aluminum fins, [100 x 100] mm nominal, [130] fins per metre suitable for sweat fittings.
- .2 Heating elements: NPS [1 1/4] steel tube [3.1] mm minimum wall thickness, mechanically expanded into flanged collars of evenly spaced steel fins [100 x 100] mm nominal fins, [105] fins per metre.
- .3 Element hangers: ball bearings cradle type providing unrestricted longitudinal movement on enclosure brackets. Space brackets [900] mm centres maximum.

- .4 Standard enclosures: 1.2 mm thick steel complete with components for wall-to-wall or complete with die formed end caps having no knock-outs, with inside corners, outside corners, as indicated. Provide full length channel and sealer strip at top of wall edge. Height as indicated. Joints and filler pieces flush with cabinet. Support rigidly top and bottom, on wall mounted brackets. Joints and filler pieces clear of grilles located to provide easy access to valves and vents. Provide access doors for valves vents or traps. Finish cabinet with factory applied baked primer coat.
- .5 Special enclosures: as indicated.
- .6 Dimensions for enclosures: measure site conditions. Do not scale from drawing.
- .7 Provide for noiseless expansion of components.

## 2.5 CABINET CONVECTORS

- .1 Heating element: seamless copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins and cast iron headers, steel side plates and supports.
- .2 Cabinet: type as indicated, [1.6] mm thick steel back and ends, exposed corners rounded, secured removable front panel, braced and reinforced for stiffness. Provide access doors for valves vents and traps. Finish cabinet with factory applied baked primer coat.
- .3 Catalogue rating: certified IBR ratings.

## 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 finned tube radiation convector heater 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 instructions.
- .2 Install in accordance with piping layout and reviewed shop drawings.
- .3 Provide for pipe movement during normal operation.
- .4 Maintain sufficient clearance to permit performance of service maintenance.
- .5 Check final location with Departmental Representative if different from that indicated prior to installation. Should deviations beyond allowable clearances arise, request and follow Departmental Representative's directive.
- .6 Valves:

- .1 Install valves with stems upright or horizontal unless approved otherwise.
- .2 Install isolating gate valves on inlet and lockshield globe balancing valves on outlet of each unit.
- .7 Venting:
  - .1 Install screwdriver vent on cabinet convector, terminating flush with surface of cabinet.
  - .2 Install automatic air vent on continuous finned tube radiation.
- .8 Clean finned tubes and comb straight.
- .9 Install flexible expansion compensators as indicated.

### **3.3 CLEANING**

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

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for start-up, verification and commissioning, for building Energy Monitoring and Control System (EMCS) and includes:
    - .1 Start-up testing and verification of systems.
    - .2 Check out demonstration or proper operation of components.
    - .3 On-site operational tests.

**1.2 DEFINITIONS**

- .1 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.
- .2 AEL: ratio between total test periods less any system downtime accumulated within that period and test period.
- .3 Downtime: results whenever EMCS is unable to fulfill required functions due to malfunction of equipment defined under responsibility of EMCS contractor. Downtime is measured by duration, in time, between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
  - .1 Outage of main power supply in excess of back-up power sources, provided that:
    - .1 Automatic initiation of back-up was accomplished.
    - .2 Automatic shut-down and re-start of components was as specified.
  - .2 Failure of communications link, provided that:
    - .1 Controller automatically and correctly operated in stand-alone mode.
    - .2 Failure was not due to failure of any specified EMCS equipment.
  - .3 Functional failure resulting from individual sensor inputs or output devices, provided that:
    - .1 System recorded said fault.
    - .2 Equipment defaulted to fail-safe mode.
    - .3 AEL of total of all input sensors and output devices is at least 99 % during test period.

**1.3 DESIGN REQUIREMENTS**

- .1 Confirm with Departmental Representative that Design Criteria and Design Intent are still applicable.
- .2 Commissioning personnel to be fully aware of and qualified to interpret Design Criteria and Design Intent.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 0 - Submittal Procedures.
- .2 Final Report: submit report to Departmental Representative.
  - .1 Include measurements, final settings and certified test results.
  - .2 Bear signature of commissioning technician and supervisor
  - .3 Report format to be approved by Departmental Representative before commissioning is started.
  - .4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments and modifications to EMCS as set during commissioning and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals.
  - .5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions or energy consumption.

**1.5 CLOSEOUT SUBMITTALS**

- .1 Provide documentation, O M Manuals, and training of O M personnel for review of Departmental Representative before interim acceptance in accordance with Section 01 78 00 - Closeout Submittals.

**1.6 COMMISSIONING**

- .1 Do commissioning in accordance with Section 01 91 13 - General Commissioning (Cx) Requirements.
- .2 Carry out commissioning under direction of Departmental Representative and in presence of Departmental Representative] and PWGSC Commissioning Manager.
- .3 Inform, and obtain approval from, Departmental Representative in writing at least [14] days prior to commissioning or each test. Indicate:
  - .1 Location and part of system to be tested or commissioned.
  - .2 Testing/commissioning procedures, anticipated results.
  - .3 Names of testing/commissioning personnel.
- .4 Correct deficiencies, re-test in presence of Departmental Representative until satisfactory performance is obtained.
- .5 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .6 Load system with project software.
- .7 Perform tests as required.

**1.7 COMPLETION OF COMMISSIONING**

- .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by Departmental Representative and PWGSC Commissioning Manager.

**1.8 ISSUANCE OF FINAL CERTIFICATE OF COMPLETION**

- .1 Final Certificate of Completion will not be issued until receipt of written approval indicating successful completion of specified commissioning activities including receipt of commissioning documentation.

**Part 2 Products****2.1 EQUIPMENT**

- .1 Provide sufficient instrumentation to verify and commission the installed system. Provide two-way radios.
- .2 Instrumentation accuracy tolerances : higher order of magnitude than equipment or system being tested.
- .3 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than [2]months prior to tests.
- .4 Locations to be approved, readily accessible and readable.
- .5 Application: to conform to normal industry standards.

**Part 3 Execution****3.1 PROCEDURES**

- .1 Test each system independently and then in unison with other related systems.
- .2 Commission each system using procedures prescribed by the Commissioning Manager Departmental Representative.
- .3 Commission integrated systems using procedures prescribed by Commissioning Manager Departmental Representative.
- .4 Debug system software.
- .5 Optimize operation and performance of systems by fine-tuning PID values and modifying CDLs as required.
- .6 Test full scale emergency evacuation and life safety procedures including operation and integrity of smoke management systems under normal and emergency power conditions as applicable.

**3.2 FIELD QUALITY CONTROL**

- .1 Pre-Installation Testing.
  - .1 General: consists of field tests of equipment just prior to installation.
  - .2 Testing may be on site or at Contractor's premises as approved by Departmental Representative.
  - .3 Configure major components to be tested in same architecture as designed system. Include BECC equipment and 2 sets of Building Controller's including MCU's, LCU's, and TCU's.

- .4 Equip each Building Controller with sensor and controlled device of each type (AI, AO, DI, DO).
- .5 Additional instruments to include:
  - .1 DP transmitters.
  - .2 DP switches used for dirty filter indication and fan status.
- .6 In addition to test equipment, provide inclined manometer, digital micro-manometer, milli-amp meter, source of air pressure infinitely adjustable between [0] and [500] Pa, to hold steady at any setting and with direct output to milli-amp meter at source [and to [BECC]].
- .7 After setting, test zero and span in [10] % increments through entire range while both increasing and decreasing pressure.
- .8 Departmental Representative [0.5] to mark instruments tracking within % in both directions as "approved for installation".
- .9 Transmitters above [0.5] % error will be rejected.
- .10 DP switches to open and close within 2% of setpoint.
- .2 Completion Testing.
  - .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.
  - .2 Include following activities:
    - .1 Test and calibrate field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.
    - .4 Test each DI to ensure proper settings and switching contacts.
    - .5 Test each DO to ensure proper operation and lag time.
    - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
    - .7 Test operating software.
    - .8 Test application software and provide samples of logs and commands.
    - .9 Verify each CDL including energy optimization programs.
    - .10 Debug software.
    - .11 Provide point verification list in table format including point identifier, point identifier expansion, point type and address, low and high limits and engineering units. Include space on commissioning technician and Departmental Representative. This document will be used in final startup testing.
  - .3 Final Startup Testing: Upon satisfactory completion of tests, perform point-by-point test of entire system under direction of Departmental Representative and PWGSC Commissioning Manager and provide:
    - .1 [2] technical personnel capable of re-calibrating field hardware and modifying software.



- .2 Detailed daily schedule showing items to be tested and personnel available.
- .3 Departmental Representative's acceptance signature to be on executive and applications programs.
- .4 Commissioning to commence during final startup testing.
- .5 O M personnel to assist in commissioning procedures as part of training.
- .6 Commissioning to be supervised by qualified supervisory personnel and Departmental Representative.
- .7 Commission systems considered as life safety systems before affected parts of the facility are occupied.
- .8 Operate systems as long as necessary to commission entire project.
- .9 Monitor progress and keep detailed records of activities and results.
- .4 Final Operational Testing: to demonstrate that EMCS functions in accordance with contract requirements.
  - .1 Prior to beginning of [30]day test demonstrate that operating parameters (setpoints, alarm limits, operating control software, sequences of operation, trends, graphics and CDL's) have been implemented to ensure proper operation and operator notification in event of off-normal operation.
    - .1 Repetitive alarm conditions to be resolved to minimize reporting of nuisance conditions.
  - .2 Test to last at least [30] consecutive 24 hour days.
  - .3 Tests to include:
    - .1 Demonstration of correct operation of monitored and controlled points.
    - .2 Operation and capabilities of sequences, reports, special control algorithms, diagnostics, software.
  - .4 System will be accepted when:
    - .1 EMCS equipment operates to meet overall performance requirements. Downtime as defined in this Section must not exceed allowable time calculated for this site.
    - .2 Requirements of Contract have been met.
  - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
  - .6 Correct defects when they occur and before resuming tests.
- .5 Commissioning Manager Departmental Representative to verify reported results.

### 3.3 ADJUSTING

- .1 Final adjusting: upon completion of commissioning as reviewed by Departmental Representative, set and lock devices in final position and permanently mark settings.

**3.4 DEMONSTRATION**

- .1 Demonstrate to Commissioning Manager Departmental Representative operation of systems including sequence of operations in regular and emergency modes, under normal and emergency conditions, start-up, shut-down interlocks and lock-outs in accordance with Section 01 79 00 - Demonstration and Training.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for training program, instructors and training materials, for building Energy Monitoring and Control System (EMCS) Work.

**1.2 DEFINITIONS**

- .1 CDL - Control Description Logic.
- .2 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures, supplemented and modified by requirements of this Section.
- .2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to Departmental Representative 30 days prior to anticipated date of beginning of training.
  - .1 List name of trainer, and type of visual and audio aids to be used.
  - .2 Show co-ordinated interface with other EMCS mechanical and electrical training programs.
- .3 Submit reports within one week after completion of Phase 1 Phase 2 training program that training has been satisfactorily completed.

**1.4 QUALITY ASSURANCE**

- .1 Provide competent instructors thoroughly familiar with aspects of EMCS installed in facility.
- .2 Departmental Representative reserves right to approve instructors.

**1.5 INSTRUCTIONS**

- .1 Provide instruction to designated personnel in adjustment, operation, maintenance and pertinent safety requirements of EMCS installed.
- .2 Training to be project-specific.

**1.6 TIME FOR TRAINING**

- .1 Number of days of instruction to be as specified in this section (1 day = 8 hours including two 15 minute breaks and excluding lunch time).

**1.7 TRAINING MATERIALS**

- .1 Provide equipment, visual and audio aids, and materials for classroom training.

- .2 Supply manual for each trainee, describing in detail data included in each training program.
  - .1 Review contents of manual in detail to explain aspects of operation and maintenance (O M).

## 1.8 TRAINING PROGRAM

- .1 To be in 2 phases over [6] month period.
- .2 Phase 1: [2] day program to begin before 30 day test period at time mutually agreeable to Contractor, Departmental Representative and PWGSC Commissioning Manager.
  - .1 Train O M personnel in functional operations and procedures to be employed for system operation.
  - .2 Supplement with on-the-job training during 30 day test period.
  - .3 Include overview of system architecture, communications, operation of computer and peripherals, report generation.
  - .4 Include detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
- .3 Phase 2: [5] day program to begin [8] weeks after acceptance for operators, equipment maintenance personnel and programmers.
  - .1 Provide multiple instructors on pre-arranged schedule. Include at least following:
    - .1 Operator training: provide operating personnel, maintenance personnel and programmers with condensed version of Phase 1 training.
    - .2 Equipment maintenance training: provide personnel with [2] days training within [5] day period in maintenance of EMCS equipment, including general equipment layout, trouble shooting and preventive maintenance of EMCS components, maintenance and calibration of sensors and controls.
    - .3 Programmers: provide personnel with [2] days training within [5] day period in following subjects in approximate percentages of total course shown:

Software and architecture: [10]%
Application programs: [15]%
Controller programming: [50]%
Trouble shooting and debugging:[10]%
Colour graphic generation: [15]%

## 1.9 ADDITIONAL TRAINING

- .1 List courses offered by name, duration and approximate cost per person per week. Note courses recommended for training supervisory personnel.

## 1.10 MONITORING OF TRAINING

- .1 Departmental Representative to monitor training program and may modify schedule and content.

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 General requirements for building Energy Monitoring and Control System (EMCS) that are common to NMS EMCS Sections.

**1.2 REFERENCES**

- .1 American National Standards Institute (ANSI)/The Instrumentation, Systems and Automation Society (ISA).
  - .1 ANSI/ISA 5.5, Graphic Symbols for Process Displays.
- .2 American National Standards Institute (ANSI)/ Institute of Electrical and Electronics Engineers (IEEE).
  - .1 ANSI/IEEE 260.1, American National Standard Letter Symbols Units of Measurement (SI Units, Customary Inch-Pound Units, and Certain Other Units).
- .3 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE STD 135, BACNET - Data Communication Protocol for Building Automation and Control Network.
- .4 Canadian Standards Association (CSA International).
  - .1 CAN/CSA-Z234.1, Canadian Metric Practice Guide.
- .5 Consumer Electronics Association (CEA).
  - .1 CEA-709.1, Control Network Protocol Specification.
- .6 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Assessment Act (CEAA), 1995, c. 37.
  - .2 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
- .7 National Electrical Manufacturers Association (NEMAC)
- .8 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).
- .9 Transport Canada (TC).
  - .1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

**1.3 ACRONYMS AND ABBREVIATIONS**

- .1 Acronyms used in EMCS:
  - .1 AEL - Average Effectiveness Level.
  - .2 AI - Analog Input.
  - .3 AIT - Agreement on International Trade.

- .4 AO - Analog Output.
- .5 BACnet - Building Automation and Control Network.
- .6 BC(s) - Building Controller(s).
- .7 BECC - Building Environmental Control Center.
- .8 CAD - Computer Aided Design.
- .9 CDL - Control Description Logic.
- .10 CDS - Control Design Schematic.
- .11 COSV - Change of State or Value.
- .12 CPU - Central Processing Unit.
- .13 DI - Digital Input.
- .14 DO - Digital Output.
- .15 DP - Differential Pressure.
- .16 ECU - Equipment Control Unit.
- .17 EMCS - Energy Monitoring and Control System.
- .18 HVAC - Heating, Ventilation, Air Conditioning.
- .19 IDE - Interface Device Equipment.
- .20 I/O - Input/Output.
- .21 ISA - Industry Standard Architecture.
- .22 LAN - Local Area Network.
- .23 LCU - Local Control Unit.
- .24 MCU - Master Control Unit.
- .25 NAFTA - North American Free Trade Agreement.
- .26 NC - Normally Closed.
- .27 NO - Normally Open.
- .28 OS - Operating System.
- .29 O M - Operation and Maintenance.
- .30 OWS - Operator Work Station.
- .31 PC - Personal Computer.
- .32 PCI - Peripheral Control Interface.
- .33 PCMCIA - Personal Computer Micro-Card Interface Adapter.
- .34 PID - Proportional, Integral and Derivative.
- .35 RAM - Random Access Memory.
- .36 SP - Static Pressure.
- .37 ROM - Read Only Memory.
- .38 TCU - Terminal Control Unit.
- .39 USB - Universal Serial Bus.
- .40 UPS - Uninterruptible Power Supply.

#### 1.4 DEFINITIONS

- .1 Point: may be logical or physical.

- .1 Logical points: values calculated by system such as setpoints, totals, counts, derived corrections and may include, but not limited to result of and statements in CDL's.
- .2 Physical points: inputs or outputs which have hardware wired to controllers which are measuring physical properties, or providing status conditions of contacts or relays which provide interaction with related equipment (stop, start) and valve or damper actuators.
- .2 Point Name: composed of two parts, point identifier and point expansion.
  - .1 Point identifier: comprised of three descriptors, "area" descriptor, "system" descriptor and "point" descriptor, for which database to provide [25] character field for each point identifier. "System" is system that point is located on.
    - .1 Area descriptor: building or part of building where point is located.
    - .2 System descriptor: system that point is located on.
    - .3 Point descriptor: physical or logical point description. For point identifier "area", "system" and "point" will be shortforms or acronyms. Database must provide [25] character field for each point identifier.
  - .2 Point expansion: comprised of three fields, one for each descriptor. Expanded form of shortform or acronym used in "area", "system" and "point" descriptors is placed into appropriate point expansion field. Database must provide [32] character field for each point expansion.
  - .3 Bilingual systems to include additional point identifier expansion fields of equal capacity for each point name for second language.
    - .1 System to support use of numbers and readable characters including blanks, periods or underscores to enhance user readability for each of the above strings.
- .3 Point Object Type: points fall into following object types:
  - .1 AI (analog input).
  - .2 AO (analog output).
  - .3 DI (digital input).
  - .4 DO (digital output).
  - .5 Pulse inputs.
- .4 Symbols and engineering unit abbreviations utilized in displays: to ANSI/ISA S5.5.
  - .1 Printouts: to ANSI/IEEE 260.1.
  - .2 Refer also to Section 25 05 54- EMCS: Identification.

## 1.5 SYSTEM DESCRIPTION

- .1 Work covered by sections referred to above consists of fully operational EMCS, including, but not limited to, following:
  - .1 Building Controllers.
  - .2 Control devices as listed in I/O point summary tables.
  - .3 OWS(s).



- .4 Data communications equipment necessary to effect EMCS data transmission system.
- .5 Field control devices.
- .6 Software/Hardware complete with full documentation.
- .7 Complete operating and maintenance manuals.
- .8 Training of personnel.
- .9 Acceptance tests, technical support during commissioning, full documentation.
- .10 Wiring interface co-ordination of equipment supplied by others.
- .11 Miscellaneous work as specified in these sections and as indicated.
- .2 Design Requirements:
  - .1 Design and provide conduit and wiring linking elements of system.
  - .2 Supply sufficient programmable controllers of types to meet project requirements. Quantity and points contents as reviewed by Departmental Representative prior to installation.
  - .3 Location of controllers as reviewed by Departmental Representative prior to installation.
  - .4 Provide utility power to EMCS as indicated.
  - .5 Metric references: in accordance with CAN/CSA Z234.1.
- .3 Language Operating Requirements:
  - .1 Provide English operator selectable access codes.
  - .2 Use non-linguistic symbols for displays on graphic terminals wherever possible. Other information to be in English.
  - .3 Operating system executive: provide primary hardware-to-software interface with associated documentation to be in English.
  - .4 System manager software: include in English system definition point database, additions, deletions or modifications, control loop statements, use of high level programming languages, report generator utility and other OS utilities used for maintaining optimal operating efficiency.
  - .5 Include, in English:
    - .1 Input and output commands and messages from operator-initiated functions field related changes alarms as defined in CDL's or assigned limits (i.e. commands relating to day-to-day operating functions and not related to system modifications, additions, or logic re-defilements).
    - .2 Graphic "display" functions, point commands to turn systems on or off, manually override automatic control of specified hardware points. To be in English at specified OWS and to be able to operate one terminal in English and second in French. Point name expansions in both languages.
    - .3 Reporting function such as trend log, trend graphics, alarm report logs, energy report logs, maintenance generated logs.

## 1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

- .2 Co-ordinate submittal requirements and provide submittals required by Section 01 47 15 - Sustainable Requirements: Construction.
- .3 Submit for review:
  - .1 Equipment list systems manufacturers at time of bid within [10] days after award of contract.
- .4 Quality Control:
  - .1 Provide equipment and material from manufacturer's regular production, CSA certified, manufactured to standard quoted plus additional specified requirements.
  - .2 Where CSA certified equipment is not available submit such equipment to inspection authorities for special inspection and approval before delivery to site.
  - .3 Submit proof of compliance to specified standards with shop drawings and product data in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process. Label or listing of specified organization is acceptable evidence.
  - .4 In lieu of such evidence, submit certificate from testing organization, approved by Departmental Representative, certifying that item was tested in accordance with their test methods and that item conforms to their standard/code.
  - .5 For materials whose compliance with organizational standards/codes/specifications is not regulated by organization using its own listing or label as proof of compliance, furnish certificate stating that material complies with applicable referenced standard or specification.
  - .6 Permits and fees: in accordance with general conditions of contract.
  - .7 Submit certificate of acceptance from authority having jurisdiction to Departmental Representative.

## 1.7 QUALITY ASSURANCE

- .1 Have local office within 150 km of project staffed by trained personnel capable of providing instruction, routine maintenance and emergency service on systems,
- .2 Provide record of successful previous installations submitting tender showing experience with similar installations utilizing computer-based systems.
- .3 Have access to local supplies of essential parts and provide [7] year guarantee of availability of spare parts after obsolescence.
- .4 Ensure qualified supervisory personnel continuously direct and monitor Work and attend site meetings.
- .5 Health and Safety:
  - .1 Do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

## 1.8 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within [2] weeks after award of Contract.
- .2 Waste Management and Disposal:

- .1 Separate waste materials for recycling in accordance with Section 01 74 19 - Construction Waste Management and Disposal.
- .2 Remove from site and dispose of packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper plastic polystyrene corrugated cardboard packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Separate for reuse recycling] and place in designated containers Steel Metal Plastic waste in accordance with Waste Management Plan.
- .5 Place materials defined as hazardous or toxic in designated containers.
- .6 Handle and dispose of hazardous materials in accordance with CEPA, Regional and Municipal regulations.
- .7 Label location of salvaged material's storage areas and provide barriers and security devices.
- .8 Ensure emptied containers are sealed and stored safely.
- .9 Divert unused metal materials from landfill to metal recycling facility as approved by Departmental Representative.
- .10 Fold up metal plastic banding, flatten and place in designated area for recycling.

**Part 2 Products****2.1 EQUIPMENT**

- .1 Control Network Protocol Data Communication Protocol: to ASHRAE STD 135.
- .2 Complete list of equipment and materials to be used on project and forming part of bid documents by adding manufacturer's name, model number and details of materials, and submit for approval.

**2.2 ADAPTORS**

- .1 Provide adaptors between metric and imperial components.

**Part 3 Execution****3.1 MANUFACTURER'S RECOMMENDATIONS**

- .1 Installation: to manufacturer's recommendations.

**3.2 PAINTING**

- .1 Painting: in accordance with Section 09 91 23 - Interior Painting, supplemented as follows:
  - .1 Clean and touch up marred or scratched surfaces of factory finished equipment to match original finish.
  - .2 Restore to new condition, finished surfaces too extensively damaged to be primed and touched up to make good.

- .3 Clean and prime exposed hangers, racks, fastenings, and other support components.
- .4 Paint unfinished equipment installed indoors to NEMA 2Y-1.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes.
  - .1 Methods and procedures for shop drawings submittals, preliminary and detailed review process including review meetings, for building Energy Monitoring and Control System (EMCS).

**1.2 DEFINITIONS**

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

**1.3 DESIGN REQUIREMENTS**

- .1 Preliminary Design Review: to contain following contractor and systems information.
  - .1 Location of local office.
  - .2 Description and location of installing and servicing technical staff.
  - .3 Location and qualifications of programming design and programming support staff.
  - .4 List of spare parts.
  - .5 Location of spare parts stock.
  - .6 Names of sub-contractors and site-specific key personnel.
  - .7 Sketch of site-specific system architecture.
  - .8 Specification sheets for each item including memory provided, programming language, speed, type of data transmission.
  - .9 Descriptive brochures.
  - .10 Sample CDL and graphics (systems schematics).
  - .11 Response time for each type of command and report.
  - .12 Item-by-item statement of compliance.
  - .13 Proof of demonstrated ability of system to communicate utilizing BACnet.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures and coordinate with requirements in this Section.
- .2 Submit preliminary design document within [5] working days after tender closing and before contract award, for review by Departmental Representative.
- .3 Shop Drawings to consist of [3] hard copies and [1] soft copy of design documents, shop drawings, product data and software.
- .4 Hard copy to be completely indexed and coordinated package to assure compliance with contract requirements and arranged in same sequence as specification and cross-referenced to specification section and paragraph number.

- .5 Soft copy to be in Autocad - latest version and Microsoft Word latest version format, structured using menu format for easy loading and retrieval on OWS.

## 1.5 PRELIMINARY SHOP DRAWING REVIEW

- .1 Submit preliminary shop drawings within [15] working days of award of contract and include following:
  - .1 Specification sheets for each item. To include manufacturer's descriptive literature, manufacturer's installation recommendations, specifications, drawings, diagrams, performance and characteristic curves, catalogue cuts, manufacturer's name, trade name, catalogue or model number, nameplate data, size, layout, dimensions, capacity, other data to establish compliance.
  - .2 Detailed system architecture showing all points associated with each controller, signal levels, pressures where new EMCS ties into existing control equipment.
  - .3 Spare point capacity of each controller by number and type.
  - .4 Controller locations.
  - .5 Auxiliary control cabinet locations.
  - .6 Single line diagrams showing cable routings, conduit sizes, spare conduit capacity between control centre, field controllers and systems being controlled.
  - .7 Valves: complete schedule listing including following information: designation, service, manufacturer, model, point ID, design flow rate, design pressure drop, required Cv, Valve size, actual Cv, spring range, pilot range, required torque, actual torque and close off pressure (required and actual).
  - .8 Dampers: sketches showing module assembly, interconnecting hardware, operator locations, operator spring range, pilot range, required torque, actual torque.
  - .9 Flow measuring stations: complete schedule listing designation, service, point ID, manufacturer, model, size, velocity at design flow rate, manufacturer, model and range of velocity transmitter.
  - .10 Compressor schematic and sizing data.

## 1.6 DETAILED SHOP DRAWING REVIEW

- .1 Submit detailed shop drawings within [30] working days after award of contract and before start of installation and include following:
  - .1 Corrected and updated versions (hard copy only) of submissions made during preliminary review.
  - .2 Wiring diagrams.
  - .3 Piping diagrams and hook-ups.
  - .4 Interface wiring diagrams showing termination connections and signal levels for equipment to be supplied by others.
  - .5 Shop drawings for each input/output point, sensors, transmitters, showing information associated with each particular point including:
    - .1 Sensing element type and location.
    - .2 Transmitter type and range.
    - .3 Associated field wiring schematics, schedules and terminations.

- .4 Complete Point Name Lists.
- .5 Setpoints, curves or graphs and alarm limits (high and low, 3 types critical, cautionary and maintenance), signal range.
- .6 Software and programming details associated with each point.
- .7 Manufacturer's recommended installation instructions and procedures.
- .8 Input and output signal levels or pressures where new system ties into existing control equipment.
- .6 Control schematics, narrative description, CDL's fully showing and describing automatic and manual procedure required to achieve proper operation of project, including under complete failure of EMCS.
- .7 Graphic system schematic displays of [air] [water] systems with point identifiers and textual description of system, [and typical floor plans] as specified.
- .8 Complete system CDL's including companion English language explanations on same sheet but with different font and italics. CDL's to contain specified energy optimization programs.
- .9 Listing and example of specified reports.
- .10 Listing of time of day schedules.
- .11 Mark up to-scale construction drawing to detail control room showing location of equipment and operator work space.
- .12 Type and size of memory with statement of spare memory capacity.
- .13 Full description of software programs provided.
- .14 Sample of "Operating Instructions Manual" to be used for training purposes.
- .15 Outline of proposed start-up and verification procedures. Refer to Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

## 1.7 QUALITY ASSURANCE

- .1 Preliminary Design Review Meeting: Convene meeting within [20] working days of award of contract to:
  - .1 Undertake functional review of preliminary design documents, resolve inconsistencies.
  - .2 Resolve conflicts between contract document requirements and actual items (e.g.: points list inconsistencies).
  - .3 Review interface requirements of materials supplied by others.
  - .4 Review "Sequence of Operations".
- .2 Contractor's programmer to attend meeting.
- .3 Departmental Representative retains right to revise sequence or subsequent CDL prior to software finalization without cost to Departmental Representative.

## Part 2 Products

### 2.1 NOT USED

- .1 Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**



**Part 1 General****1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for final control diagrams and operation and maintenance (O M) manual, for building Energy Monitoring and Control System (EMCS) Work.

**1.2 DEFINITIONS**

- .1 BECC - Building Environmental Control Centre.
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 78 00 - Closeout Procedures, supplemented and modified by requirements of this Section.
- .2 Submit As-built drawings, Operation and Maintenance Manual to Departmental Representative in English.
- .3 Provide soft copies and hard copies in hard-back, 50 mm 3 ring, D-ring binders.
  - .1 Binders to be 2/3 maximum full.
  - .2 Provide index to full volume in each binder.
  - .3 Identify contents of each manual on cover and spine.
  - .4 Provide Table of Contents in each manual.
  - .5 Assemble each manual to conform to Table of Contents with tab sheets placed before instructions covering subject.

**1.4 AS-BUILTS**

- .1 Provide 1 copy of detailed shop drawings generated in Section 25 05 02 - EMCS: Submittals and Review Process and include:
  - .1 Changes to contract documents as well as addenda and contract extras.
  - .2 Changes to interface wiring.
  - .3 Routing of conduit, wiring and control air lines associated with EMCS installation.
  - .4 Locations of obscure devices to be indicated on drawings.
  - .5 Listing of alarm messages.
  - .6 Panel/circuit breaker number for sources of normal/emergency power.
  - .7 Names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.

- .8 Test procedures and reports: provide records of start-up procedures, test procedures, checkout tests and final commissioning reports as specified in Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.
- .9 Basic system design and full documentation on system configuration.
- .2 Submit for final review by Departmental Representative.
- .3 Provide before acceptance [4] Hard and [1] soft copy incorporating changes made during final review.

## 1.5 O & M MANUALS

- .1 Custom design O M Manuals (both hard and soft copy) to contain material pertinent to this project only, and to provide full and complete coverage of subjects referred to in this Section.
- .2 Provide [2] complete sets of hard and soft copies prior to system or equipment tests
- .3 Include complete coverage in concise language, readily understood by operating personnel using common terminology of functional and operational requirements of system. Do not presume knowledge of computers, electronics or in-depth control theory.
- .4 Functional description to include:
  - .1 Functional description of theory of operation.
  - .2 Design philosophy.
  - .3 Specific functions of design philosophy and system.
  - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
  - .5 Explicit description of hardware and software functions, interfaces and requirements for components in functions and operating modes.
  - .6 Description of person-machine interactions required to supplement system description, known or established constraints on system operation, operating procedures currently implemented [or planned] for implementation in automatic mode.
- .5 System operation to include:
  - .1 Complete step-by-step procedures for operation of system including required actions at each OWS.
  - .2 Operation of computer peripherals, input and output formats.
  - .3 Emergency, alarm and failure recovery.
  - .4 Step-by-step instructions for start-up, back-up equipment operation, execution of systems functions and operating modes, including key strokes for each command so that operator need only refer to these pages for keystroke entries required to call up display or to input command.
- .6 Software to include:
  - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
  - .2 Detailed descriptions of program requirements and capabilities.

- .3 Data necessary to permit modification, relocation, reprogramming and to permit new software modules to respond to changing system functional requirements without disrupting normal operation.
- .4 Software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device
- .5 Complete program cross reference plus linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, and program execution.
- .6 Software for each Controller and single section referencing Controller common parameters and functions.
- .7 Maintenance: document maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, controller and interface firmware's, plus diagnostics and repair/replacement of system hardware.
- .8 System configuration document:
  - .1 Provisions and procedures for planning, implementing and recording hardware and software modifications required during operating lifetime of system.
  - .2 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
- .9 Programmer control panel documentation: provide where panels are independently interfaced with BECC, including interfacing schematics, signal identification, timing diagrams, and fully commented source listing of applicable driver/handler.

**Part 2 Products****2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution****3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for identification of devices, sensors, wiring tubing, conduit and equipment, for building Energy Monitoring and Control System (EMCS) Work and nameplates materials, colours and lettering sizes.

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA C22.1, The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations.

**1.3 DEFINITIONS**

- .1 For acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.4 SYSTEM DESCRIPTION**

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

**1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures supplemented and modified by requirements of this Section.
- .2 Submit to Departmental Representative for approval samples of nameplates, identification tags and list of proposed wording.

**Part 2 Products****2.1 NAMEPLATES FOR PANELS**

- .1 Identify by [3] mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core].
- .2 Sizes: [25 x 67] mm minimum.
- .3 Lettering: minimum [7] mm high, black.
- .4 Inscriptions: machine engraved to identify function.

**2.2 NAMEPLATES FOR FIELD DEVICES**

- .1 Identify by plastic encased cards attached by chain.
- .2 Sizes: [50 x 100] mm minimum.
- .3 Lettering: minimum [5] mm high produced from laser printer in black.
- .4 Data to include: point name and point address.

- .5 Companion cabinet: identify interior components using plastic enclosed cards with point name and point address.

### **2.3 NAMEPLATES FOR ROOM SENSORS**

- .1 Identify by stick-on labels using point identifier.
- .2 Location: as directed by Departmental Representative.
- .3 Letter size: to suit, clearly legible.

### **2.4 WARNING SIGNS**

- .1 Equipment including motors, starters under remote automatic control: supply and install [orange] coloured signs warning of automatic starting under control of EMCS.
- .2 Sign to read: "Caution: This equipment is under automatic remote control of EMCS" as reviewed by Departmental Representative's.

### **2.5 WIRING**

- .1 Supply and install numbered tape markings on wiring at panels, junction boxes, splitters, cabinets and outlet boxes.
- .2 Colour coding: to CSA C22.1. Use colour coded wiring in communications cables, matched throughout system.
- .3 Power wiring: identify circuit breaker panel/circuit breaker number inside each EMCS panel.

### **2.6 CONDUIT**

- .1 Colour code EMCS conduit.
- .2 Pre-paint box covers and conduit fittings.
- .3 Coding: use fluorescent orange paint and confirm colour with Departmental Representative during "Preliminary Design Review".

## **Part 3 Execution**

### **3.1 NAMEPLATES AND LABELS**

- .1 Ensure that manufacturer's nameplates, CSA labels and identification nameplates are visible and legible at all times.

### **3.2 EXISTING PANELS**

- .1 Correct existing nameplates and legends to reflect changes made during Work.

**END OF SECTION**

**Part 1 General****1.1 REFERENCES**

- .1
- .2 American National Standards Institute (ANSI)
  - .1 ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressures Fittings.
  - .2 ANSI C2, National Electrical Safety Code.
  - .3 ANSI/NFPA 70, National Electrical Code.
- .3 CSA Group
  - .1 CSA C22.1,
  - .2 CAN/CSA-C22.3 No. 7, Underground Systems.
  - .3 CSA C22.2 No. 45.1, Electrical Rigid Metal Conduit.
  - .4 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .5 CSA C22.2 No. 83, Electrical Metallic Tubing.
  - .6 CAN/CSA-C22.3 No. 1-[10], Overhead Systems.

**1.2 SYSTEM DESCRIPTION**

- .1 Electrical:
  - .1 Provide power wiring to EMCS field panels. Circuits to be for exclusive use of EMCS equipment. Panel breakers to be identified on panel legends tagged and locks applied to breaker switches.
  - .2 Hard wiring between field control devices and EMCS field panels.
  - .3 Communication wiring between EMCS field panels and OWS's including main control centre BECC.
- .2 Pneumatic:
  - .1 Pneumatic tubing, valves and fittings for field control devices.
- .3 Mechanical:
  - .1 Pipe Taps Required for EMCS equipment will be supplied and installed by Division 23.
  - .2 Wells and Control Valves Shall Be Supplied by EMCS Contractor and Installed by Division 23.
  - .3 Installation of dampers, and other devices requiring sheet metal trades to be mounted by Division 23. Costs to be carried by designated trade.

**1.3 PERSONNEL QUALIFICATIONS**

- .1 Qualified supervisory personnel to:

- .1 Continuously direct and monitor all work.
- .2 Attend site meetings.

## **Part 2 Products**

### **2.1 SPECIAL SUPPORTS**

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

### **2.2 WIRING**

- .1 As per requirements of Division 26.
- .2 For 70V and above copper conductor with chemically cross-linked thermosetting polyethylene insulation rated RW90 and 600V. Colour code to CSA 22.1.
- .3 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. All other cases use FT4 wiring.
- .4 Terminations:
  - .1 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.

### **2.3 CONDUIT**

- .1 As per requirements of Division 26.
- .2 Electrical metallic tubing to CSA C22.2 No. 83. Flexible and liquid tight flexible metal conduit to CSA C22.2 No. 56. Rigid steel threaded conduit to CSA C22.2 No. 45.1.
- .3 Junction and pull boxes: welded steel.
  - .1 Surface mounting cast FS: screw-on flat covers.
  - .2 Flush mounting: covers with 25 mm minimum extension all round.
- .4 Cabinets: sheet steel, for surface mounting, with hinged door, latch lock, 2 keys, complete with perforated metal mounting backboard. Panels to be keyed alike for similar functions and or entire contract as approved.
- .5 Outlet boxes: 100 mm minimum, square.
- .6 Conduit boxes, fittings:
  - .1 Bushings and connectors: with nylon insulated throats.
  - .2 With push pennies to prevent entry of foreign materials.
- .7 Fittings for rigid conduit:
  - .1 Couplings and fittings: threaded type steel.
  - .2 Double locknuts and insulated bushings: use on sheet metal boxes.
  - .3 Use factory "ells" where 90 degree bends required for 25 mm and larger conduits.
- .8 Fittings for thin wall conduit:
  - .1 Connectors and couplings: steel, set screw type.

**2.4 WIRING DEVICES, COVER PLATES**

- .1 Conform to CSA.
- .2 Receptacles:
  - .1 Duplex: CSA type 5-15R.
  - .2 Single: CSA type 5-15R.
  - .3 Cover plates and blank plates: finish to match other plates in area.

**2.5 STARTERS, CONTROL DEVICES**

- .1 Across-the-line magnetic starters:
  - .1 Enclosures: CSA Type 1, except where otherwise specified.
  - .2 Size, type and rating: to suit motors.
- .2 Starter diagrams:
  - .1 Provide copy of wiring and schematic diagrams - mount one copy in each starter with additional copies for operation and maintenance manual.
- .3 Auxiliary Control Devices:
  - .1 Control transformers: 60 Hz, primary voltage to suit supply, 120 V single phase secondary, VA rating to suit load plus 20% margin.
  - .2 Auxiliary contacts: one "Normally Open" and one "Normally Closed" spare auxiliary contact in addition to maintained auxiliary contacts as indicated.
  - .3 Hand-Off-Automatic switch: heavy duty type, knob lever operator.
  - .4 Double voltage relays: with barrier to separate relay contacts from operating magnet. Operating coil voltage and contact rating as indicated.
- .4 Finish for starters:
  - .1 Exterior: in accordance with Section 26 05 00 - Common Work Results for Electrical.
  - .2 Interior: white.

**2.6 SUPPORTS FOR CONDUIT, FASTENINGS, EQUIPMENT**

- .1 Solid masonry, tile and plastic surfaces: lead anchors or nylon shields.
  - .1 Hollow masonry walls, suspended drywall ceilings: toggle bolts.
- .2 Exposed conduits or cables:
  - .1 50 mm diameter and smaller: one-hole steel straps.
  - .2 Larger than 50 mm diameter: two-hole steel straps.
- .3 Suspended support systems:
  - .1 Individual cable or conduit runs: support with 6 mm diameter threaded rods and support clips.
  - .2 Two or more suspended cables or conduits: support channels supported by 6 mm diameter threaded rod hangers.



**Part 3 Execution****3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

**3.2 SUPPORTS**

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

**3.3 ELECTRICAL GENERAL**

- .1 Do complete installation in accordance with requirements of:
  - .1 Division 26, this specification.
  - .2 CSA 22.1 Canadian Electrical Code.
  - .3 ANSI/NFPA 70.
  - .4 ANSI C2.
- .2 Fully enclose or properly guard electrical wiring, terminal blocks, high voltage above 70 V contacts and mark to prevent accidental injury.
- .3 Do underground installation to CAN/CSA-C22.3 No.7, except where otherwise specified.
- .4 Conform to manufacturer's recommendations for storage, handling and installation.
- .5 Check factory connections and joints. Tighten where necessary to ensure continuity.
- .6 Install electrical equipment between 1000 and 2000 mm above finished floor wherever possible and adjacent to related equipment.
- .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
- .8 Shield and mark live parts "LIVE 120 VOLTS" or other appropriate voltage.
- .9 Install conduits, and sleeves prior to pouring of concrete.
- .10 Holes through exterior wall and roofs: flash and make weatherproof.
- .11 Make necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
- .12 Install cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.

**3.4 CONDUIT SYSTEM**

- .1 Communication wiring shall be installed in conduit. Provide complete conduit system to link Building Controllers to BECC. Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems. Maximum conduit fill not to exceed 40%. Design drawings do not show conduit layout.
- .2 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.

- .3 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Departmental Representative before starting such work. Provide complete conduit system to link field panels and devices with main control centre. Conduit size to match conductors plus future expansion capabilities as specified.
- .4 Locate conduits at least 150 mm from parallel steam or hot water pipes and at least 50 mm at crossovers.
- .5 Bend conduit so that diameter is reduced by less than 1/10th original diameter.
- .6 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
- .7 Limit conduit length between pull boxes to less than 30 m.
- .8 Use conduit outlet boxes for conduit up to 32 mm diameter and pull boxes for larger sizes.
- .9 Fastenings and supports for conduits, cables, and equipment:
  - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
  - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
  - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Departmental Representative.
- .10 Install polypropylene fish cord in empty conduits for future use.
- .11 Where conduits become blocked, remove and replace blocked sections.
- .12 Pass conduits through structural members only after receipt of Departmental Representative's written approval.
- .13 Conduits may be run in flanged portion of structural steel.
- .14 Group conduits wherever possible on suspended or surface channels.
- .15 Pull boxes:
  - .1 Install in inconspicuous but accessible locations.
  - .2 Support boxes independently of connecting conduits.
  - .3 Fill boxes with paper or foam to prevent entry of construction material.
  - .4 Provide correct size of openings. Reducing washers not permitted.
  - .5 Mark location of pull boxes on record drawings.
  - .6 Identify AC power junction boxes, by panel and circuit breaker.
- .16 Install bonding conductor for 120 volt and above in conduit.

### 3.5 WIRING

- .1 Install multiple wiring in ducts simultaneously.
- .2 Do not pull spliced wiring inside conduits or ducts.
- .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
- .4 Tests: use only qualified personnel. Demonstrate that:

- .1 Circuits are continuous, free from shorts, unspecified grounds.
- .2 Resistance to ground of all circuits is greater than 50 Megohms.
- .5 Provide Departmental Representative with test results showing locations, circuits, results of tests.
- .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
- .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
- .8 Do not allow wiring to come into direct physical contact with compression screw.
- .9 Install ALL strands of conductor in lugs of components. Strip insulation only to extent necessary for installation.

### **3.6 WIRING DEVICES, COVER PLATES**

- .1 Receptacles:
  - .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
- .2 Cover plates:
  - .1 Install suitable common cover plate where wiring devices are grouped.
  - .2 Use flush type cover plates only on flush type outlet boxes.

### **3.7 STARTERS, CONTROL DEVICES**

- .1 Install and make power and control connections as indicated.
- .2 Install correct over-current devices.
- .3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.
- .4 Performance Verification:
  - .1 Operate switches and controls to verify functioning.
  - .2 Perform start and stop sequences of contactors and relays.
  - .3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.

### **3.8 GROUNDING**

- .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
- .2 Install separate grounding conductors in conduit within building.
- .3 Install ground wire in all PVC ducts and in tunnel conduit systems.
- .4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

**3.9 TESTS****.1 General:**

- .1 Perform following tests in addition to tests specified Section 25 08 20 - EMCS: Warranty and Maintenance.
- .2 Give [14] days written notice of intention to test.
- .3 Conduct in presence of Departmental Representative and authority having jurisdiction.
- .4 Conceal work only after tests satisfactorily completed.
- .5 Report results of tests to Departmental Representative in writing.
- .6 Preliminary tests:
  - .1 Conduct as directed to verify compliance with specified requirements.
  - .2 Make needed changes, adjustments, replacements.
  - .3 Insulation resistance tests:
    - .1 Megger all circuits, feeders, equipment for 120 - 600V with 1000V instrument. Resistance to ground to be more than required by Code before energizing.
    - .2 Test insulation between conductors and ground, efficiency of grounding system to satisfaction of Departmental Representative and authority having jurisdiction.

**3.10 IDENTIFICATION**

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

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes.
  - .1 Requirements and procedures for warranty and activities during warranty period and service contracts, for building Energy Monitoring and Control System (EMCS).
- .2 References.
  - .1 Canada Labour Code (R.S. 1985, c. L-2)/Part I - Industrial Relations.
  - .2 Canadian Standards Association (CSA International).
    - .1 CSA Z204, Guidelines for Managing Indoor Air Quality in Office Buildings.

**1.2 DEFINITIONS**

- .1 BC(s) - Building Controller(s).
- .2 OWS - Operator Work Station.
- .3 For additional acronyms and definitions refer to Section 25 05 01 - EMCS: General Requirements.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit detailed preventative maintenance schedule for system components to Departmental Representative.
- .3 Submit detailed inspection reports to Departmental Representative.
- .4 Submit dated, maintenance task lists to Departmental Representative and include the following sensor and output point detail, as proof of system verification:
  - .1 Point name and location.
  - .2 Device type and range.
  - .3 Measured value.
  - .4 System displayed value.
  - .5 Calibration detail
  - .6 Indication if adjustment required,
  - .7 Other action taken or recommended.
- .5 Submit network analysis report showing results with detailed recommendations to correct problems found.
- .6 Records and logs: in accordance with Section 01 78 00 - Closeout Submittals.
  - .1 Maintain records and logs of each maintenance task on site.

- .2 Organize cumulative records for each major component and for entire EMCS chronologically.
- .3 Submit records to Departmental Representative, after inspection indicating that planned and systematic maintenance have been accomplished.
- .7 Revise and submit to Departmental Representative in accordance with Section 01 78 00 - Closeout Submittals "As-built drawings" documentation and commissioning reports to reflect changes, adjustments and modifications to EMCS made during warranty period.

#### **1.4 MAINTENANCE SERVICE DURING WARRANTY PERIOD**

- .1 Provide services, materials, and equipment to maintain EMCS for specified warranty period. Provide detailed preventative maintenance schedule for system components as described in Submittal article.
- .2 Emergency Service Calls:
  - .1 Initiate service calls when EMCS is not functioning correctly.
  - .2 Qualified control personnel to be available during warranty period to provide service to "CRITICAL" components whenever required at no extra cost.
  - .3 Furnish Departmental Representative with telephone number where service personnel may be reached at any time.
  - .4 Service personnel to be on site ready to service EMCS within 2 hours after receiving request for service.
  - .5 Perform Work continuously until EMCS restored to reliable operating condition.
- .3 Operation: foregoing and other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and as recommended by manufacturer.
- .4 Work requests: record each service call request, when received separately on approved form and include:
  - .1 Serial number identifying component involved.
  - .2 Location, date and time call received.
  - .3 Nature of trouble.
  - .4 Names of personnel assigned.
  - .5 Instructions of work to be done.
  - .6 Amount and nature of materials used.
  - .7 Time and date work started.
  - .8 Time and date of completion.
- .5 Provide system modifications in writing.
  - .1 No system modification, including operating parameters and control settings, to be made without prior written approval of Departmental Representative.

#### **1.5 SERVICE CONTRACTS**

- .1 Provide in-depth technical expertise and assistance to Departmental Representative and Commissioning Manager in preparation and implementation of service contracts and in-house preventive maintenance procedures.

- .2 Service Contracts to include:
  - .1 Annual verification of field points for operation and calibration.
  - .2 [2] visits per year.
  - .3 Complete inventory of installed system.

**Part 2 Products****2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution****3.1 FIELD QUALITY CONTROL**

- .1 Perform as minimum (3) three minor inspections and one major inspection (more often if required by manufacturer) per year. Provide detailed written report to Departmental Representative as described in Submittal article.
- .2 Perform inspections during regular working hours, 0800 to 1630 h, Monday through Friday, excluding statutory holidays.
- .3 Following inspections are minimum requirements and should not be interpreted to mean satisfactory performance:
  - .1 Perform calibrations using test equipment having traceable, certifiable accuracy at minimum 50% greater than accuracy of system displaying or logging value.
  - .2 Provide dated, maintenance task lists, as described in Submittal article, as proof of execution of complete system verification.
- .4 Minor inspections to include, but not limited to:
  - .1 Perform visual, operational checks to BC's, peripheral equipment, interface equipment and other panels.
  - .2 Check equipment cooling fans as required.
  - .3 Visually check for mechanical faults, air leaks and proper pressure settings on pneumatic components.
  - .4 Review system performance with Operations Supervisor to discuss suggested or required changes.
- .5 Major inspections to include, but not limited to:
  - .1 Minor inspection.
  - .2 Clean OWS(s) peripheral equipment, BC(s), interface and other panels, micro-processor interior and exterior surfaces.
  - .3 Check signal, voltage and system isolation of BC(s), peripherals, interface and other panels.
  - .4 Verify calibration/accuracy of each input and output device and recalibrate or replace as required.
  - .5 Provide mechanical adjustments, and necessary maintenance on printers.

- .6 Run system software diagnostics as required.
- .7 Install software and firmware enhancements to ensure components are operating at most current revision for maximum capability and reliability.
  - .1 Perform network analysis and provide report as described in Submittal article.
- .6 Rectify deficiencies revealed by maintenance inspections and environmental checks.
- .7 Continue system debugging and optimization.
- .8 Testing/verification of occupancy and seasonal-sensitive systems to take place during four (4) consecutive seasons, after facility has been accepted, taken over and fully occupied.
  - .1 Test weather-sensitive systems twice: first at near winter design conditions and secondly under near summer design conditions.

**END OF SECTION**



**Part 1 General****1.1 SUMMARY****.1 Section Includes:**

- .1 System requirements for Local Area Network (LAN) for Building Energy Monitoring and Control System (EMCS).

**1.2 REFERENCES**

- .1 Canadian Standards Association (CSA International).
  - .1 CSA T529, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/TIA/EIA-568-A with modifications).
  - .2 CSA T530, Commercial Building Standard for Telecommunications Pathways and Spaces (Adopted ANSI/TIA/EIA-569-A with modifications).
- .2 Institute of Electrical and Electronics Engineers (IEEE)/Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements.
  - .1 IEEE Std 802.3<sup>TM</sup>-, Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.
- .3 Treasury Board Information Technology Standard (TBITS).
  - .1 TBITS 6.9, Profile for the Telecommunications Wiring System in Government Owned and Leased Buildings - Technical Specifications.

**1.3 DEFINITIONS**

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

**1.4 SYSTEM DESCRIPTION**

- .1 Data communication network to link Operator Workstations and Master Control Units (MCU) in accordance with TBITS 6.9.
  - .1 Provide reliable and secure connectivity of adequate performance between different sections (segments) of network.
  - .2 Allow for future expansion of network, with selection of networking technology and communication protocols.
- .2 Data communication network to include, but not limited to:
  - .1 EMCS-LAN.
  - .2 Modems.
  - .3 Network interface cards.
  - .4 Network management hardware and software.
  - .5 Network components necessary for complete network.

**1.5 DESIGN REQUIREMENTS**

- .1 EMCS Local Area Network (EMCS-LAN).
  - .1 High speed, high performance, local area network over which MCUs and OWSs communicate with each other directly on peer to peer basis in accordance with [IEEE 802.3/Ethernet Standard].
  - .2 EMCS-LAN to: BACnet.
  - .3 Each EMCS-LAN to be capable of supporting at least 50 devices.
  - .4 Support of combination of MCUs and OWSs directly connected to EMCS-LAN.
  - .5 High speed data transfer rates for alarm reporting, quick report generation from multiple controllers, upload/download information between network devices. Bit rate to be [10] Megabits per second minimum.
  - .6 Detection and accommodation of single or multiple failures of either OWSs, MCUs or network media. Operational equipment to continue to perform designated functions effectively in event of single or multiple failures.
  - .7 Commonly available, multiple sourced, networking components and protocols to allow system to co-exist with other networking applications including office automation.
- .2 Dynamic Data Access.
  - .1 LAN to provide capabilities for OWSs, either network resident or connected remotely, to access point status and application report data or execute control functions for other devices via LAN.
  - .2 Access to data to be based upon logical identification of building equipment.
- .3 Network Medium.
  - .1 Network medium: twisted cable compatible with network protocol to be used within buildings.

**Part 2 Products****2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution****3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY****.1 Section Includes:**

- .1 Hardware and software requirements for an Operator Work Station (OWS) in a Building Energy Monitoring and Control System (EMCS), including primary, secondary, portable and remote OWS's.

**1.2 DEFINITIONS**

- .1 Acronyms and definitions: refer to Section 25 05 01 - EMCS: General Requirements.
- .2 Secondary OWS: serves as backup to primary OWS, is storage and retrieval facility of soft copy of as-built contractor supplied data as described in Section 25 05 03 - EMCS: Project Record Documents.
- .3 Portable OWS: used as remote dial-up OWS with same capabilities as primary OWS including graphic display.
- .4 Remote Auxiliary OWS: performs identical user interface functions as primary OWS.

**1.3 OWS SYSTEM DESCRIPTION**

- .1 Consists of commercially available personal computer in current production, with sufficient memory and processor capacity to perform functions specified.
- .2 Primary OWS to include:
  - .1 Colour graphics printer.
  - .2 Modem.
  - .3 Desks, furniture.
- .3 Portable Laptop.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Make submittals in accordance with Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.

**1.5 ENVIRONMENTAL CONDITIONS**

- .1 OWS to operate in conditions of 10 degrees C to 32 degrees C and 20% to 90% non-condensing RH.

**1.6 MAINTENANCE**

- .1 Provide maintenance in accordance with Section 25 05 03 - EMCS: Project Record Documents.

**Part 2 Products****2.1 OWS HARDWARE**

- .1 PC system to include:
  - .1 Processor: capable of supporting software necessary to perform functions specified in this section. System backplane bus (100 Megahertz) to support PCI and ISA boards.
  - .2 Internal clock.
    - .1 Uninterruptible clock: accuracy of plus or minus [5] seconds/month, capable of deriving year / month / day / hour / minute / second.
    - .2 Rechargeable batteries: to provide minimum [48] h clock operation in event of power failure.
  - .3 Asynchronous interfaces for connection to listed peripheral devices including LAN and remote devices.
- .2 Power supply unit to accept [120] V [ 60] Hz source and include line surge and low voltage protection for processor and its peripherals.
- .3 Include UPS to provide [5] minutes minimum operation of PC, CRT and communication and peripheral devices; applies to fixed (non portable) OWS[s] and peripherals.

**2.2 OWS PC COMPONENTS**

- .1 Primary OWS: PC compatible with following as minimum:
  - .1 IDE Disk drive controller to support [4] drives.
    - .1 [1] [20] GB hard disk drive, [12] ms.
    - .2 [1] 3.5" 144 MB floppy disk drive.
    - .3 [1] [48X/24X/48X] CD-RW drive.
  - .2 [256] MB RAM minimum.
  - .3 Enhanced [101] key keyboard.
  - .4 PS2 mouse.
  - .5 Colour monitor: [17"]. Flat panel display TFT, resolution 1280 X 1040, dot pitch 0.26 mm, colour support 24 bit,
  - .6 Video card with 32 MB video RAM.
  - .7 [2] Parallel Ports to support printer[s].
  - .8 [2] USB ports or [2] serial ports.
  - .9 Include two [2] spare expansion slots in system.
  - .10 Internal Modem - [56] k.
  - .11 PCI Ethernet LAN Adapter to connect to local Ethernet LAN network.
  - .12 [200] W minimum power supply.
- .2 Portable OWS: compatible personal laptop computer, with following as minimum:
  - .1 [Pentium IV] processor [2 GHz].
  - .2 [20 GB] hard disk drive, [9 ms] access time.
  - .3 Internal [52X] CD ROM.

- .4 [3.5"], [144] MB floppy disk drive.
- .5 [256] MB RAM.
- .6 Enhanced 101-key keyboard.
- .7 [PS/2] mouse device.
- .8 29.5 cm Colour LCD (active matrix) display.
- .9 Ethernet LAN adapter to connect to local Ethernet Network.
- .10 PCMCIA or internal [56k] bit/s auto-dial modem with Hayes-compatible command set.
- .11 Protective case with serviceable carrying straps.
- .12 CPU and peripherals: IBM compatible.
- .13 Operating system: same as primary OWS and include licenced OWS software as installed on primary OWS.

### 2.3 PRINTERS

- .1 Colour graphics printer include following features:
  - .1 Ink-jet technology capable of printing high quality colour images at speed of [4] pages per minute.
  - .2 Black cartridge to be separate cartridge from red green blue cartridge.
  - .3 Minimum colour resolution 2400 by 1200 dpi.
  - .4 Minimum black and white resolution 1200 by 1200 dpi.
  - .5 Minimum 8 MB RAM.
- .2 Include one box of 8.5 X 11" and one box of 8.5 X 14" paper.

### 2.4 CONTROL DESK CONSOLE

- .1 Capable of accommodating OWS and peripheral equipment specified with provision for operator desk work space.
- .2 Provide printer rack or separate desk for printer[s] as directed by Departmental Representative.
- .3 Layout: as directed by Departmental Representative.
- .4 Desk: steel office type, standard sizes [1] m x [2] m, factory-made, computer type, for equipment mounting, with drawers on one side.
  - .1 Keyboards to be in separate pull-out drawer.
  - .2 Include above desk shelving to support contractor supplied manuals.
- .5 Chair: upholstered, swivel type, with adjustable arms, back and seat, pneumatic seat height adjustment and 5 castors.

### 2.5 OPERATING SYSTEM (OS) OR EXECUTIVE

- .1 OS to support complement of hardware terminals and software programs specified.
- .2 OS to be true multitasking operating environment.
  - .1 MS DOS or PC DOS based software platforms not permitted.

- .3 OWS software to operate in "Windows" based operating environment: Windows 10, XP or Unix "X" Windows based system.

## 2.6 OWS CONTROL SOFTWARE

- .1 OWS is not to form part of real-time control functions either directly or indirectly or as part of communication link. Real-time control functions to reside in MCUs, LCUs, and TCUs with peer to peer communication occurring at MCU to MCU device level.
- .2 Time Synchronization Module.
  - .1 System to provide Time Synchronization of real-time clocks in controllers.
  - .2 System to perform this feature on regular scheduled basis and on operator request.
- .3 User Display Interface Module.
  - .1 OWS software to support "Point Names" as defined in Section 25 05 01 - EMCS: General Requirements.
  - .2 Upon operator's request in either text, graphic or table mode, system to present condition of single point, system, area, or connected points on system to OWS. Display analog values digitally to [1] place of decimal with negative sign as required. Update displayed analog values and status when new values received. Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm. For systems supporting COSV, refresh rate of screen data not to exceed [5] seconds from time of field change and system is to execute supervisory background scan every [20] seconds to verify point data value. For other systems refresh rate not to exceed [5] seconds for points displayed. Initial display of new system graphic display (with up to 30 active points), including presentation of associated dynamic data not to exceed [8] seconds.
- .4 General Event Log Module: to record system activities occurring at OWS or elsewhere in system including:
  - .1 Operator Log-in from user interface device.
  - .2 Communication messages: errors, failures and recovery.
  - .3 Event notifications and alarms by category.
  - .4 Record of operator initiated commands.
- .5 General Event Log:
  - .1 Hold minimum of [4] months information and be readily accessible to operator.
  - .2 Able to be archived as necessary to prevent loss of information.
- .6 Operator Control Software Module: to support entry of information into system from keyboard and mouse, disk, or from another network device. Display of information to user; dynamic displays, textual displays, and graphic displays to display logging and trending of system information and following tasks:
  - .1 Automatic logging of digital alarms and change of status messages.
  - .2 Automatic logging of analog alarms.
  - .3 System changes: alarm limits, set-points, alarm lockouts.

- .4 Display specific point values, states as selected.
  - .5 Provide reports as requested and on scheduled basis when required.
  - .6 Display graphics as requested, and on alarm receptions (user's option).
  - .7 Display list of points within system.
  - .8 Display list of systems within building.
  - .9 Direct output of information to selected peripheral device.
  - .10 On-line changes:
    - .1 Alarm limits.
    - .2 Setpoints.
    - .3 Deadbands.
    - .4 Control and change of state changes.
    - .5 Time, day, month, year.
    - .6 Control loop configuration changes for controller-based CDLs.
    - .7 Control loop tuning changes.
    - .8 Schedule changes.
    - .9 Changes, additions, or deletions, of points, graphics, for installed and future systems.
  - .11 According to assigned user privileges (password definition) following functions are to be supported:
    - .1 Permit operator to terminate automatic (logic based) control and set value of field point to operator selected value. These values or settings to remain in effect until returned to automatic (logic based) control by operator.
    - .2 Requests for status, analog values, graphic displays, logs and controls to be through user interface screens.
  - .12 Software and tools utilized to generate, modify and configure building controllers to be installed and operational on the OWS.
- .7 Dial-up host Module for off site OWSs.
- .1 Operators at dial-up OWS to be able to perform control functions, report functions, data base generation and modification functions as described for OWS's connected via LAN. Provide routines to automatically answer calls and either file or display information sent from remote panels.
  - .2 Operator to be able to access remote buildings by selection of facility by its logical name. Dial-up module to maintain user-definable cross-reference of buildings and associated telephone numbers without manual dialing.
  - .3 Local OWS may serve as dial-up host for remotely connecting OWSs, remote controllers or networks. Alarms and data file transfers handled via dial-up transactions must not interfere with local LAN activity. LAN activity not to prevent work-station from handling incoming calls.
- .8 Message Handling Module - and Error Messages: to provide message handling for following conditions:
- .1 Message and alarm buffering to prevent loss of information.

- .2 Error detection correction and retransmission to guarantee data integrity.
- .3 Informative messages to operator for data error occurrences, errors in keyboard entry, failure of equipment to respond to requests or commands and failure of communications between EMCS devices.
- .4 Default device definition to be implemented to ensure alarms are reported as quickly as possible in event of faulty designated OWS.
- .9 Access Control Module.
  - .1 Minimum [5] levels of password access protection to limit control, display, or data base manipulation capabilities. Following is preferred format of progression of password levels:
    - .1 Guest: no password data access and display only.
    - .2 Operator Level: full operational commands including automatic override.
    - .3 Technician: data base modifications.
    - .4 Programmer: data base generation.
    - .5 Highest Level : system administration - password assignment addition, modification.
  - .2 User-definable, automatic log-off timers from 1 to 60 min. to prevent operators leaving devices on-line inadvertently. Default setting = [3] minutes.
- .10 Trend Data Module: includes historical data collection utility, trend data utility, control loop plot utility. Each utility to permit operator to add trend point, delete trend point, set scan rate.
  - .1 Historical data collection utility: collect concurrently operator selected real or calculated point values at operator selectable rate [30-480] minutes. Samples to include for each time interval (time-stamped), minimum present value, maximum present value, and average present value for point selected. Rate to be individually selectable for each point. Data collection to be continuous operation, stored in temporary storage until removed from historical data list by operator. Temporary storage to have at least [6] month capacity.
  - .2 Trend data utility: continuously collect point object data variables for variables from building controllers as selected by operator, including at minimum; present value of following point object types - DI, DO, AI, AO set points value, calculated values. Trend data utility to have capacity to trend concurrently points at operator-selectable rate of [05] seconds to [3600] seconds, individually selectable for selected value, or use of COSV detection. Collected trend data to be stored on minimum [96] h basis in temporary storage until removed from trend data list by operator. Option to archive data before overwriting to be available.
  - .3 Control loop plot utility: for AO Points provide for concurrent plotting of measured value input - present value, present value of output, and AO setpoint. Operator selectable sampling interval to be selectable between 1 second to 20 seconds. Plotting utility to scroll to left as plot reaches right side of display window. Systems not supporting control loop plot as separate function must provide predefined groups of values. Each group to include values for one control loop display.



- .4 Trend data Module to include display of historical or trend data to OWS screen in X Y plot presentation. Plot utility to display minimum of [6] historical points or [6] trend points concurrently or 1 Control Loop Plot. For display output of real time trend data, display to automatically index to left when window becomes full. Provide plotting capabilities to display collected data based on range of selected value for (Y) component against time/date stamp of collected data for (X) component.
- .5 Provide separate reports for each trend utility. Provide operator feature to specify report type, by point name and for output device. Reports to include time, day, month, year, report title, and operator's initials. Implement reports using report module. Ensure trend data is exportable to third party spreadsheet or database applications for PCs.
- .11 Report Module: reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at MCU level. Refer also to Section 25 30 01 - EMCS: Building Controllers.
  - .1 Reports to include time, day, month, year, report title, operator's initials.
  - .2 Software to provide capability to:
    - .1 Generate and format reports for graphical and numerical display from real time and stored data.
    - .2 Print and store reports as selected by operator.
    - .3 Select and assign points used in such reports.
    - .4 Sort output by area, system, as minimum.
  - .3 Periodic/automatic report:
    - .1 Generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.
    - .2 Reports to include:
      - .1 Power demand and duty cycle summary: see application program for same.
      - .2 Disabled "Locked-out" point summary: include point name, whether disabled by system or by operator.
      - .3 Run time summary: summary of accumulated running time of selected equipment. Include point name, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.
      - .4 Summary of run time alarms: include point name, run time to date, alarm limit.
      - .5 Summary of start/stop schedules: include start/stop times and days, point name.
      - .6 Motor status summary.
  - .4 Report types:
    - .1 Dynamic reports: system to printout or display of point object data value requested by operator. System to indicate status at time of request, when

- displayed, updated at operator selected time interval. Provide option for operator selection of report type, by point name, and/or output device. Ensure reports are available for following point value combinations:
- .2 Points in accessible from this OWS (total connected for this location), multiple "areas".
  - .3 Area (points and systems in Area).
  - .4 Area, system (points in system).
  - .5 System (points by system type).
  - .6 System point (points by system and point object type).
  - .7 Area point (points by system and point object type).
  - .8 Point (points by point object type).
- .5 Summary report: printout or display of point objet data value selected by operator. Report header to indicate status at time of request. Ensure reports are available on same basis as dynamic reports. Provide option as to report type, point name, output device.
- .6 Include preformatted reports as listed in Event/Alarm Module.
- .12 Graphics Display Module: graphics software utility to permit user to create, modify, delete, file, and recall graphics required by Section 25 90 01 - EMCS: Site Requirements, Applications and Systems Sequences of Operation.
- .1 Provide capacity for 100% expansion of system graphics. Graphic interface to provide user with multiple layered diagrams for site, building in plan view, floor furniture plan view and building systems, overlayed with dynamic data appropriately placed and permitting direct operator interaction. Graphic interface to permit operator to start and stop equipment, change set points, modify alarm limits, override system functions and points from graphic system displays by use of mouse or similar pointing device.
  - .2 Display specific system graphics: provide for manual and/or automatic activation (on occurrence of an alarm). Include capability to call up and cancel display of graphic picture.
  - .3 Library of pre-engineered screens and symbols depicting standard air handling components (fans, coils, filters, dampers, VAV), complete mechanical system components (chillers, boilers, pumps), electrical symbols.
  - .4 Graphic development, creation, modification package to use mouse and drawing utility to permit user to:
    - .1 Modify portion of graphic picture/schematic background.
    - .2 Delete graphic picture.
    - .3 Call up and cancel display of graphic picture.
    - .4 Define symbols.
    - .5 Position and size symbols.
    - .6 Define background screens.
    - .7 Define connecting lines, curves.
    - .8 Locate, orient, size descriptive text.
    - .9 Define, display colours of elements.

- .10 Establish co-relation between symbols or text and associated system points or other graphic displays.
- .5 User to be able to build graphic displays showing on-line point data from multiple MCU panels. Graphic displays to represent logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility operation. Data to be refreshed on screen as "changed data" without redrawing of entire screen or row on screen.
- .6 Dynamic data (temperature, humidity, flow, status) to be shown in actual schematic locations, to be automatically updated to show current values without operator intervention.
- .7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, and display of graphic associated with alarm to be viewed without interrupting work in progress. If interface is unable to display several different types of display at same time, provide at minimum [2] OWS's.
- .8 Utilize graphics package to generate system schematic diagrams as required in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation, and as directed by Departmental Representative. In addition provide graphics for schematic depicted on mechanical plan flow diagrams, point lists and system graphics. Provide graphic for floor depicting room sensors and control devices located in their actual location. For floor graphic include secondary diagram to show TCU-VAV box actuator and, flow sensor. Diagram to be single line schematic of ductwork as well as associated heating coil or radiation valve. Departmental Representative to provide CAD floor layouts. Provide display of TCU -VAV's in table form, include following values as minimum; space temp, setpoint, mode, actual flow, min flow setpoint, max flow setpoint, cooling signal value, and heating signal value. Organize table by rooms and floor groupings.
- .9 Provide complete directory of system graphics, including other pertinent system information. Utilize mouse or pointing device to "point and click" to activate selected graphic.
- .10 Provide unique sequence of operation graphic or pop-up window for each graphic that is depicted on OWS. Provide access to sequence of operation graphic by link button on each system graphic. Provide translation of sequence of operation, a concise explanation of systems operation, from control descriptive logic into plain English language.
- .13 Event/Alarm Module: displays in window alarms as received and stored in General Event Log.
  - .1 Classify alarms as "critical", "cautionary", "maintenance". Alarms and alarm classifications to be designated by personnel requiring password level.
  - .2 Presentation of alarms to include features identified under applicable report definitions of Report Module paragraph.
  - .3 Alarm reports.
    - .1 Summary of points in critical, cautionary or maintenance alarm. Include at least point name, alarm type, current value, limit exceeded.

- .2 Analog alarm limit summary: include point name, alarm limits, deviation limits.
    - .3 Summary of alarm messages: include associated point name, alarm description.
  - .4 Software to notify operator of each occurrence of alarm conditions. Each point to have its own secondary alarm message.
  - .5 EMCS to notify operator of occurrence of alarms originating at field device within following time periods of detection:
    - .1 Critical - [5] seconds.
    - .2 Cautionary - [10] seconds.
    - .3 Maintenance - [10] seconds.
  - .6 Display alarm messages in English.
  - .7 Primary alarm message to include as minimum: point identifier, alarm classification, time of occurrence, type of alarm. Provide for initial message to be automatically presented to operator whenever associated alarm is reported. Assignment of secondary messages to point to be operator-editable function. Provide secondary messages giving further information (telephone lists, maintenance functions) on per point basis.
  - .8 System reaction to alarms: provide alarm annunciation by dedicated window (activated to foreground on receipt of new alarm or event) of OWS with visual and audible hardware indication. Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Acknowledgment of alarm to be time, date and operator stamped and stored in General Event Log. Steady state visual indicator to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of alarm not to impede notification of subsequent alarms or function of Controller's/CDL. Do not allow random occurrence of alarms to cause loss of alarm or over-burden system. Do not allow acknowledgment of one alarm as acknowledgement of other alarms.
  - .9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum:
    - .1 Controller not responding - where possible delineate between controller and communication line failure.
    - .2 Controller responding - return to normal.
    - .3 Controller communications bad - high error rate or loss of communication.
    - .4 Controller communications normal - return to normal.
  - .10 Digital alarm status to be interrogated every [2] seconds as minimum or be direct interrupting non-polling type (COV). Annunciate each non-expected status with alarm message.
- .14 Archiving and Restoration Module.
- .1 Primary OWS to include services to store back-up copies of controller databases. Perform complete backup of OWS software and data files at time of system installation and at time of final acceptance. Provide backup copies before and after Controller's revisions or major modifications.

- .2 Provide continuous integrity supervision of controller data bases. When controller encounters database integrity problems with its data base, system to notify operator of need to download copy data base to restore proper operation.
- .3 Ensure data base back-up and downloading occurs over LAN without specialized operator technical knowledge. Provide operator with ability to manually download entire controller data base, or parts thereof as required.
- .15 CDL Generator and Modifier Module.
  - .1 CDL Generator module to permit generation and modification of CDLs.
  - .2 Provide standard reference modules for text based systems module that will permit modification to suit site specific applications. Module to include cut, paste, search and compare utilities to permit easy CDL modification and verification.
  - .3 Provide full library of symbols used by manufacturer for system product installed accessible to operators for systems using graphical environment for creation of CDLs Module to include graphic tools required to generate and create new object code for downloading to building controllers.
  - .4 Module to permit testing of code before downloading to building controllers.

## 2.7 ADDITIONAL UTILITY SOFTWARE

- .1 Supply and install on primary OWS, following CAD software products by Autodesk Inc. and include:
  - .1 AutoCAD latest version.
  - .2 Include special drivers, fonts, to ensure complete and proper functioning of software packages specified. Deliver system complete with full set of User Manuals.
  - .3 Enter soft copy submissions, including "Record" drawings specified in Section 25 05 03 - EMCS: Project Record Documents in OWS.
  - .4 Enter soft copy of Architectural, Electrical, Mechanical systems plans and "Record" drawings in OWS. Plans and drawings to be provided by Departmental Representative.

## Part 3 Execution

### 3.1 INSTALLATION REQUIREMENTS

- .1 Provide necessary power as required from local [120] V emergency power branch circuit panels for OWS's and peripheral equipment.
  - .1 Install tamper locks on breakers of circuit panels.
  - .2 Refer to UPS requirements stated under OWS Hardware in PART 2.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for building automation controllers including:
    - .1 Master Control Unit (MCU).
    - .2 Local Control Unit (LCU).
    - .3 Equipment Control Unit (ECU).
    - .4 Terminal Control Unit (TCU).

**1.2 REFERENCES**

- .1 American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc. (ASHRAE).
  - .1 ASHRAE , Applications Handbook, SI Edition.
- .2 Canadian Standards Association (CSA International).
  - .1 C22.2 No.205, Signal Equipment.
- .3 Institute of Electrical and Electronics Engineers (IEEE).
  - .1 IEEE C37.90.1, Surge Withstand Capabilities (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
- .4 Public Works and Government Services Canada (PWGSC)/Real Property Branch/Architectural and Engineering Services.
  - .1 MD13800, Energy Management and Control Systems (EMCS) Design Manual.  
English: <ftp://ftp.pwgsc.gc.ca/rps/docentre/mechanical/me214-e.pdf>

**1.3 DEFINITIONS**

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

**1.4 DESCRIPTION**

- .1 General: Network of controllers comprising of MCU('s), LCU('s), ECU('s) or TCU('s) to be provided as indicated in System Architecture Diagram to support building systems and associated sequence(s) of operations as detailed in these specifications.
  - .1 Provide sufficient controllers to meet intents and requirements of this section.
  - .2 Controller quantity, and point contents to be approved by Departmental Representative at time of preliminary design review.
- .2 Controllers: stand-alone intelligent Control Units.
  - .1 Incorporate programmable microprocessor, non-volatile program memory, RAM, power supplies, as required to perform specified functions.
  - .2 Incorporate communication interface ports for communication to LANs to exchange information with other Controllers.

- .3 Capable of interfacing with operator interface device.
- .4 Execute its logic and control using primary inputs and outputs connected directly to its onboard input/output field terminations or slave devices, and without need to interact with other controller. Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
  - .1 Secondary input used for reset such as outdoor air temperature may be located in other Controller(s).
- .3 Interface to include provisions for use of dial-up modem for interconnection with remote modem.
  - .1 Dial-up communications to use 56 Kbit modems and voice grade telephone lines.
  - .2 Each stand-alone panel may have its own modem or group of stand-alone panels may share modem.

## 1.5 DESIGN REQUIREMENTS

- .1 To include:
  - .1 Scanning of AI and DI connected inputs for detection of change of value and processing detection of alarm conditions.
  - .2 Perform On-Off digital control of connected points, including resulting required states generated through programmable logic output.
  - .3 Perform Analog control using programmable logic, (including PID) with adjustable dead bands and deviation alarms.
  - .4 Control of systems as described in sequence of operations.
  - .5 Execution of optimization routines as listed in this section.
- .2 Total spare capacity for MCUs and LCUs: at least [25] % of each point type distributed throughout the MCUs and LCUs.
- .3 Field Termination and Interface Devices:
  - .1 To: CSA C22.2 No.205.
  - .2 Electronically interface sensors and control devices to processor unit.
  - .3 Include, but not be limited to, following:
    - .1 Programmed firmware or logic circuits to meet functional and technical requirements.
    - .2 Power supplies for operation of logics devices and associated field equipment.
    - .3 Lockable wall cabinet.
    - .4 Required communications equipment and wiring (if remote units).
    - .5 Leave controlled system in "fail-safe" mode in event of loss of communication with, or failure of, processor unit.
    - .6 Input Output interface to accept as minimum AI, AO, DI, DO functions as specified.
    - .7 Wiring terminations: use conveniently located screw type or spade lug terminals.
  - .4 AI interface equipment to:

- .1 Convert analog signals to digital format with [10] bit analog-to-digital resolution.
- .2 Provide for following input signal types and ranges:
  - .1 [4 - 20] mA;
  - .2 [0 - 10] V DC;
  - .3 100/1000 ohm RTD input;
- .3 Meet IEEE C37.90.1 surge withstand capability.
- .4 Have common mode signal rejection greater than [60] dB to [60] Hz.
- .5 Where required, dropping resistors to be certified precision devices which complement accuracy of sensor and transmitter range specified.
- .5 AO interface equipment:
  - .1 Convert digital data from controller processor to acceptable analog output signals using [8]bit digital-to-analog resolution.
  - .2 Provide for following output signal types and ranges:
    - .1 [4 - 20] mA.
    - .2 [0 - 10] V DC.
  - .3 Meet IEEE C37.90.1 surge withstand capability.
- .6 DI interface equipment:
  - .1 Able to reliably detect contact change of sensed field contact and transmit condition to controller.
  - .2 Meet IEEE C37.90.1 surge withstand capability.
  - .3 Accept pulsed inputs up to [2] kHz.
- .7 DO interface equipment:
  - .1 Respond to controller processor output, switch respective outputs. Each DO hardware to be capable of switching up to [0.5] amps at [24] V AC.
  - .2 Switch up to [5] amps at [220] V AC using optional interface relay.
- .4 Controllers and associated hardware and software: operate in conditions of 0 degrees C to 44 degrees C and 20 % to 90 % non-condensing RH.
- .5 Controllers (MCU, LCU): mount in wall mounted cabinet with hinged, keyed-alike locked door.
  - .1 Provide for conduit entrance from top, bottom or sides of panel.
  - .2 ECUs and TCUs to be mounted in equipment enclosures or separate enclosures.
  - .3 Mounting details as approved by Departmental Representative for ceiling mounting.
- .6 Cabinets to provide protection from water dripping from above, while allowing sufficient airflow to prevent internal overheating.
- .7 Provide surge and low voltage protection for interconnecting wiring connections.

## 1.6 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.



- .1 Submit product data sheets for each product item proposed for this project.

## 1.7 MAINTENANCE

- .1 Provide manufacturers recommended maintenance procedures for insertion in Section 25 05 03 - EMCS: Project Record Documents.

## Part 2 Products

### 2.1 MASTER CONTROL UNIT (MCU)

- .1 General: primary function of MCU is to provide co-ordination and supervision of subordinate devices in execution of optimization routines such as demand limiting or enthalpy control.
- .2 Include high speed communication LAN Port for Peer to Peer communications with OWS(s) and other MCU level devices.
  - .1 MCU must support BACnet.
- .3 MCU local I/O capacity as follows:
  - .1 MCU I/O points as allocated in I/O Summary Table referenced in MD13800.
  - .2 LCUs may be added to support system functions.
- .4 Central Processing Unit (CPU).
  - .1 Processor to consist of minimum [16] bit microprocessor capable of supporting software to meet specified requirements.
  - .2 CPU idle time to be more than [30] % when system configured to maximum input and output with worst case program use.
  - .3 Minimum addressable memory to be at manufacturer's discretion but to support at least performance and technical specifications to include but not limited to:
    - .1 Non-volatile EEPROM to contain operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
    - .2 Battery backed (72 hour minimum capacity) RAM (to reduce the need to reload operating data in event of power failure) to contain CDLs, application parameters, operating data or software that is required to be modifiable from operational standpoint such as schedules, setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS.
  - .4 Include uninterruptible clock accurate to plus or minus [5] secs/month, capable of deriving year/month/day/hour/minute/second, with rechargeable batteries for minimum [72] hour operation in event of power failure.
- .5 Local Operator Terminal (OT): Provide OT for each MCU unless otherwise specified in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.

- .1 Mount access/display panel in MCU or in suitable enclosure beside MCU as approved by Departmental Representative.
- .2 Support operator's terminal for local command entry, instantaneous and historical data display, programs, additions and modifications.
- .3 Display simultaneously minimum of [16] point identifiers to allow operator to view single screen dynamic displays depicting entire mechanical systems. Point identifiers to be in English.
- .4 Functions to include, but not be limited to, following:
  - .1 Start and stop points.
  - .2 Modify setpoints.
  - .3 Modify PID loop parameters.
  - .4 Override PID control.
  - .5 Change time/date.
  - .6 Add/modify/start/stop weekly scheduling.
  - .7 Add/modify setpoint weekly scheduling.
  - .8 Enter temporary override schedules.
  - .9 Define holiday schedules.
  - .10 View analog limits.
  - .11 Enter/modify analog warning limits.
  - .12 Enter/modify analog alarm limits.
  - .13 Enter/modify analog differentials.
- .5 Provide access to real and calculated points in controller to which it is connected or to other controller in network. This capability not to be restricted to subset of predefined "global points" but to provide totally open exchange of data between OT and other controller in network.
- .6 Operator access to OTs: same as OWS user password and password changes to automatically be downloaded to controllers on network.
- .7 Provide prompting to eliminate need for user to remember command format or point names. Prompting to be consistent with user's password clearance and types of points displayed to eliminate possibility of operator error.
- .8 Identity of real or calculated points to be consistent with network devices. Use same point identifier as at OWS's for access of points at OT to eliminate cross-reference or look-up tables.

## 2.2 LOCAL CONTROL UNIT (LCU)

- .1 Provide multiple control functions for typical built-up and package HVAC systems, hydronic systems and electrical systems.
- .2 Minimum of 16 I/O points of which minimum be 4 AOs, 4 AIs, 4 DIs, 4 DOs.
- .3 Points integral to one Building System to be resident on only one controller.
- .4 Microprocessor capable of supporting necessary software and hardware to meet specified requirements as listed in previous MCU article with following additions:
  - .1 Include minimum [2] interface ports for connection of local computer terminal.

- .2 Design so that shorts, opens or grounds on input or output will not interfere with other input or output signals.
- .3 Physically separate line voltage (70V and over) circuits from DC logic circuits to permit maintenance on either circuit with minimum hazards to technician and equipment.
- .4 Include power supplies for operation of LCU and associated field equipment.
- .5 In event of loss of communications with, or failure of, MCU, LCU to continue to perform control. Controllers that use defaults or fail to open or close positions not acceptable.
- .6 Provide conveniently located screw type or spade lug terminals for field wiring.

### 2.3 TERMINAL/EQUIPMENT CONTROL UNIT (TCU/ECU)

- .1 Microprocessor capable of supporting necessary software and hardware to meet TCU/ECU functional specifications.
  - .1 TCU/ECU definition to be consistent with those defined in ASHRAE HVAC Applications Handbook section 45.
- .2 Controller to communicate directly with EMCS through EMCS LAN and provide access from EMCS OWS for setting occupied and unoccupied space temperature setpoints, flow setpoints, and associated alarm values, permit reading of sensor values, field control values (% open) and transmit alarm conditions to EMCS OWS.
- .3 VAV Terminal Controller.
  - .1 Microprocessor based controller with integral flow transducer, including software routines to execute PID algorithms, calculate airflow for integral flow transducer and measure temperatures as per I/O Summary required inputs. Sequence of operation to ASHRAE HVAC Applications Handbook.
  - .2 Controller to support point definition; in accordance with Section [25 05 01 - EMCS: General Requirements].
  - .3 Controller to operate independent of network in case of communication failure.
  - .4 Controller to include damper actuator and terminations for input and output sensors and devices.

### 2.4 SOFTWARE

- .1 General.
  - .1 Include as minimum: operating system executive, communications, application programs, operator interface, and systems sequence of operation - CDL's.
  - .2 Include "firmware" or instructions which are programmed into ROM, EPROM, EEPROM or other non-volatile memory.
  - .3 Include initial programming of Controllers, for entire system.
- .2 Program and data storage.
  - .1 Store executive programs and site configuration data in ROM, EEPROM or other non-volatile memory.

- .2 Maintain CDL and operating data including setpoints, operating constants, alarm limits in battery-backed RAM or EEPROM for display and modification by operator.
- .3 Programming languages.
  - .1 Program Control Description Logic software (CDL) using English like or graphical, high level, general control language.
  - .2 Structure software in modular fashion to permit simple restructuring of program modules if future software additions or modifications are required. GO TO constructs not allowed unless approved by Departmental Representative.
- .4 Operator Terminal interface.
  - .1 Operating and control functions include:
    - .1 Multi-level password access protection to allow user/manager to limit workstation control.
    - .2 Alarm management: processing and messages.
    - .3 Operator commands.
    - .4 Reports.
    - .5 Displays.
    - .6 Point identification.
- .5 Pseudo or calculated points.
  - .1 Software to provide access to value or status in controller or other networked controller in order to define and calculate pseudo point. When current pseudo point value is derived, normal alarm checks must be performed or value used to totalize.
  - .2 Inputs and outputs for process: include data from controllers to permit development of network-wide control strategies. Processes also to permit operator to use results of one process as input to number of other processes (e.g. cascading).
- .6 Control Description Logic (CDL):
  - .1 Capable of generating on-line project-specific CDLs which are software based, programmed into RAM or EEPROM and backed up to OWS. Owner must have access to these algorithms for modification or to be able to create new ones and to integrate these into CDLs on BC(s) from OWS.
  - .2 Write CDL in high level language that allows algorithms and interlocking programs to be written simply and clearly. Use parameters entered into system (e.g. setpoints) to determine operation of algorithm. Operator to be able to alter operating parameters on-line from OWS and BC(s) to tune control loops.
  - .3 Perform changes to CDL on-line.
  - .4 Control logic to have access to values or status of points available to controller including global or common values, allowing cascading or inter-locking control.
  - .5 Energy optimization routines including enthalpy control, supply temperature reset, to be LCU or MCU resident functions and form part of CDL.
  - .6 MCU to be able to perform following pre-tested control algorithms:

- .1 Two position control.
  - .2 Proportional Integral and Derivative (PID) control.
- .7 Control software to provide ability to define time between successive starts for each piece of equipment to reduce cycling of motors.
- .8 Provide protection against excessive electrical-demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
- .9 Power Fail Restart: upon detection of power failure system to verify availability of Emergency Power as determined by emergency power transfer switches and analyze controlled equipment to determine its appropriate status under Emergency power conditions and start or stop equipment as defined by I/O Summary. Upon resumption of normal power as determined by emergency power transfer switches, MCU to analyze status of controlled equipment, compare with normal occupancy scheduling, turn equipment on or off as necessary to resume normal operation.
- .7 Event and Alarm management: use management by exception concept for Alarm Reporting. This is system wide requirement. This approach will insure that only principal alarms are reported to OWS. Events which occur as direct result of primary event to be suppressed by system and only events which fail to occur to be reported. Such event sequence to be identified in I/O Summary and sequence of operation. Examples of above are, operational temperature alarms limits which are exceeded when main air handler is stopped, or General Fire condition shuts air handlers down, only Fire alarm status shall be reported. Exception is, when air handler which is supposed to stop or start fails to do so under event condition.
- .8 Energy management programs: include specific summarizing reports, with date stamp indicating sensor details which activated and or terminated feature.
  - .1 MCU in coordination with subordinate LCU, TCU, ECU to provide for the following energy management routines:
    - .1 Time of day scheduling.
    - .2 Calendar based scheduling.
    - .3 Temporary schedule overrides.
    - .4 Optimal start stop.
    - .5 Night setback control.
    - .6 Peak demand limiting.
    - .7 Temperature compensated load rolling.
    - .8 Hot water reset.
  - .2 Programs to be executed automatically without need for operator intervention and be flexible enough to allow customization.
  - .3 Apply programs to equipment and systems as specified or requested by the Departmental Representative.

## 2.5 LEVELS OF ADDRESS

- .1 Upon operator's request, EMCS to present status of any single 'point', 'system' or point group, entire 'area', or entire network on printer or OWS as selected by operator.

- .1 Display analog values digitally to [1] place of decimals with negative sign as required.
- .2 Update displayed analog values and status when new values received.
- .3 Flag points in alarm by blinking, reverse video, different colour, bracketed or other means to differentiate from points not in alarm.
- .4 Updates to be change-of-value (COV)-driven or if polled not exceeding 2 second intervals.

**2.6 POINT NAME SUPPORT**

- .1 Controllers (MCU, LCU) to support PWGSC point naming convention as defined in Section 25 05 01 - EMCS: General Requirements.

**Part 3 Execution****3.1 LOCATION**

- .1 Location of Controllers to be approved by Departmental Representative.

**3.2 INSTALLATION**

- .1 Install Controllers in secure locking enclosures as directed by Departmental Representative.
- .2 Provide necessary power from local [120] V branch circuit panel for equipment.
- .3 Install tamper locks on breakers of circuit breaker panel.
- .4 Use uninterruptible Power Supply (UPS) and emergency power when equipment must operate in emergency and co-ordinating mode.

**END OF SECTION**

**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 Control devices integral to the Building Energy Monitoring and Control System (EMCS): transmitters, sensors, controls, switches, transducers, valves, valve actuators, low voltage current transformers.
  - .2 Related Sections:
    - .1 Section 01 73 00 - Execution Requirements.
    - .2 Section 07 84 00 - Firestopping.
    - .3 Section 25 01 11 - EMCS: Start-Up, Verification and Commissioning.
    - .4 Section 25 05 01 - EMCS: General Requirements.
    - .5 Section 25 05 02 - EMCS: Shop Drawings, Product Data and Review Process.
    - .6 Section 25 05 54 - EMCS: Identification.
    - .7 Section 25 90 01 - EMCS: Site Requirements Applications and Systems Sequences of Operation.
    - .8 Section 26 05 00 - Common Work Results for Electrical.
    - .9 Section 26 27 26 - Wiring Devices.

**1.2 REFERENCES**

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

**1.3 DEFINITIONS**

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

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit shop drawings and manufacturer's installation instructions in accordance with Section 25 05 02 - EMCS: Submittals and Review Process.
- .2 Pre-Installation Tests.
  - .1 Submit samples at random from equipment shipped, as requested by Departmental Representative, for testing before installation. Replace devices not meeting specified performance and accuracy.
- .3 Manufacturer's Instructions:
  - .1 Submit manufacturer's installation instructions for specified equipment and devices.

**1.5 EXISTING CONDITIONS**

- .1 Cutting and Patching: in accordance with Section 01 73 00 - Execution Requirements supplemented as specified herein.
- .2 Repair surfaces damaged during execution of Work.
- .3 Turn over to Departmental Representative existing materials removed from Work not identified for re-use.

**Part 2 Products****2.1 GENERAL**

- .1 Control devices of each category to be of same type and manufacturer.
- .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight heat resistant assembly.
- .3 Operating conditions: [0] - [32] degrees C with [10] - [90] % RH (non-condensing) unless otherwise specified.
- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters and sensors to be unaffected by external transmitters including walkie talkies.
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.
- .7 Outdoor installations: use weatherproof construction in NEMA [4] enclosures.
- .8 Devices installed in user occupied space not exceed Noise Criteria (NC) of [35]. Noise generated by any device must not be detectable above space ambient conditions.
- .9 Range: including temperature, humidity, and pressure, as indicated in I/O summary in Section 25 90 01 - EMCS: Site Requirements, Applications and System Sequences of Operation.



**2.2 TEMPERATURE SENSORS**

- .1 General: except for room sensors to be resistance or thermocouple type to following requirements:
  - .1 Thermocouples: limit to temperature range of [200] degrees C and over.
  - .2 RTD's: 100 or 1000 ohm at [0] degrees C (plus or minus [0.2] ohms) platinum element with strain minimizing construction, [3] integral anchored leadwires. Coefficient of resistivity: [0.00385] ohms/ohm degrees C.
  - .3 Sensing element: hermetically sealed.
  - .4 Stem and tip construction: copper or type 304 stainless steel.
  - .5 Time constant response: less than 3 seconds to temperature change of [10] degrees C.
  - .6 Immersion wells: NPS [3/4], stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length 100 mm as indicated.
- .2 Room temperature sensors and display wall modules.
  - .1 Temperature sensing and display wall module.
    - .1 Sensor may be either RTD or thermistor type
    - .2 LCD display to show space temperature reading and temperature setpoint.
    - .3 Buttons for occupant selection of temperature setpoint (limited to +/-2°C. midpoint 22°C) [and occupied/unoccupied mode].
    - .4 Jack connection for plugging in laptop personal computer for access to zone bus.
    - .5 Integral thermistor sensing element [10,000] ohm at [24] degrees.
    - .6 Accuracy 0.2 degrees C over range of 0 to 70 degrees C.
    - .7 Stability 0.02 degrees C drift per year.
    - .8 Separate mounting base for ease of installation.
  - .2 Room temperature sensors.
    - .1 Wall mounting, in slotted type covers having [brushed aluminum] [brushed stainless steel] finish, with guard [as indicated].
    - .2 Element [10-50] mm long RTD with ceramic tube or equivalent protection or thermistor, [10,000] ohm, accuracy of plus or minus [0.2] degrees C.
- .3 Duct temperature sensors:
  - .1 General purpose duct type: suitable for insertion into ducts at various orientations, insertion length [460] mm.
  - .2 Averaging duct type: incorporates numerous sensors inside assembly which are averaged to provide one reading. Minimum insertion length [6000] mm. Bend probe at field installation time to [100] mm radius at point along probe without degradation of performance.
- .4 Outdoor air temperature sensors:

- .1 Outside air type: complete with probe length [100 - 150] mm long, non-corroding shield to minimize solar and wind effects, threaded fitting for mating to [13] mm conduit, weatherproof construction in NEMA 4 enclosure.

## 2.3 TEMPERATURE TRANSMITTERS

- .1 Requirements:
  - .1 Input circuit: to accept 3-lead, 100 or 1000 ohm at [0] degrees C, platinum resistance detector type sensors.
  - .2 Power supply: [24] V DC into load of [575] ohms. Power supply effect less than [0.01] degrees C per volt change.
  - .3 Output signal: [4 - 20] mA into [500] ohm maximum load.
  - .4 Input and output short circuit and open circuit protection.
  - .5 Output variation: less than [0.2] % of full scale for supply voltage variation of plus or minus [10] %.
  - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus [0.5] % of full scale output.
  - .7 Maximum current to 100 or 1000 ohm RTD sensor: not to exceed [25] mA.
  - .8 Integral zero and span adjustments.
  - .9 Temperature effects: not to exceed plus or minus [1.0] % of full scale/ [50] degrees C.
  - .10 Long term output drift: not to exceed [0.25] % of full scale/ [6] months.
  - .11 Transmitter ranges: select narrowest range to suit application from following:
    - .1 Minus [50] degrees C to plus [50] degrees C, plus or minus [0.5] degrees C.
    - .2 [0 to 100] degrees C, plus or minus [0.5] degrees C.
    - .3 [0 to 50] degrees C, plus or minus [0.25] degrees C.
    - .4 [0 to 25] degrees C, plus or minus [0.1] degrees C.
    - .5 [10 to 35] degrees C, plus or minus [0.25] degrees C.

## 2.4 PRESSURE TRANSDUCERS

- .1 Requirements:
  - .1 Combined sensor and transmitter measuring pressure.
    - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
  - .2 Output signal: [4] - [20] mA into [500] ohm maximum load.
  - .3 Output variations: less than [0.2] % full scale for supply voltage variations of plus or minus [10] %.
  - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus [0.5] % of full scale output over entire range.
  - .5 Temperature effects: not to exceed plus or minus [1.5] % full scale/ [50] degrees C.
  - .6 Over-pressure input protection to at least twice rated input pressure.

- .7 Output short circuit and open circuit protection.
- .8 Accuracy: plus or minus [1] % of Full Scale.

## 2.5 DIFFERENTIAL PRESSURE TRANSMITTERS

- .1 Requirements:
  - .1 Internal materials: suitable for continuous contact with industrial standard instrument air, compressed air, water, steam, as applicable.
  - .2 Output signal: [4] - [20] mA into [500] ohm maximum load.
  - .3 Output variations: less than [0.2] % full scale for supply voltage variations of plus or minus [10] %.
  - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus [0.5] % of full scale output over entire range.
  - .5 Integral zero and span adjustment.
  - .6 Temperature effects: not to exceed plus or minus [1.5] % full scale/ [50] degrees C.
  - .7 Over-pressure input protection to at least twice rated input pressure.
  - .8 Output short circuit and open circuit protection.
  - .9 Unit to have 12.5 mm N.P.T. conduit connection. Enclosure to be integral part of unit.

## 2.6 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

- .1 Requirements:
  - .1 Internal materials: suitable for continuous contact with compressed air, water, steam, etc., as applicable.
  - .2 Adjustable setpoint and differential.
  - .3 Switch: snap action type, rated at [120V, 15 amps AC] [24 V DC].
  - .4 Switch assembly: to operate automatically and reset automatically when conditions return to normal. Over-pressure input protection to at least twice rated input pressure.
  - .5 Accuracy: within 2% repetitive switching.
  - .6 Provide switches with isolation valve and snubber, where code allows, between sensor and pressure source.
  - .7 Switches on steam and high temperature hot water service: provide pigtail syphon.

## 2.7 TEMPERATURE SWITCHES

- .1 Requirements:
  - .1 Operate automatically. Reset automatically, except as follows:
    - .1 [Low temperature detection: manual reset].
    - .2 [High temperature detection: manual reset].
  - .2 Adjustable setpoint and differential.
  - .3 Accuracy: plus or minus [1] degrees C.

- .4 Snap action rating: [120V, 15 amps] [24V DC] as required. Switch to be DPST for hardwire and EMCS connections.
- .5 Type as follows:
  - .1 Room: for wall mounting on standard electrical box [with] [without] protective guard as indicated.
  - .2 Duct, general purpose: insertion length = [460] mm.
  - .3 Thermowell: stainless steel, with compression fitting for NPS [3/4] thermowell. Immersion length: [100] mm.
  - .4 Low temperature detection: continuous element with [6000] mm insertion length, duct mounting, to detect coldest temperature in any [30] mm length.
  - .5 Strap-on: with helical screw stainless steel clamp.

## 2.8 ELECTROMECHANICAL RELAYS

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

## 2.9 SOLID STATE RELAYS

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

## 2.10 CURRENT TRANSDUCERS

- .1 Requirements:
- .2 Purpose: combined sensor/transducer, to measure line current and produce proportional signal in one of following ranges:

- .1 4-20 mA DC.
- .2 0-1 volt DC.
- .3 0-10 volts DC.
- .4 0-20 volts DC.
- .3 Frequency insensitive from 10 - 80 hz.
- .4 Accuracy to 0.5% full scale.
- .5 Zero and span adjustments. Field adjustable range to suit motor applications.
- .6 Adjustable mounting bracket to allow for secure/safe mounting inside MCC.

## 2.11 CURRENT SENSING RELAYS

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

## 2.12 CONTROL VALVES

- .1 Body: characterized ball.
  - .1 Flow characteristic as indicated on control valve schedule: equal percentage.
  - .2 Flow factor (KV) as indicated on control valve schedule: CV in imperial units.
  - .3 Normally open, as indicated.
  - .4 Leakage rate ANSI class IV, 0.01% of full open valve capacity.
  - .5 Packing easily replaceable.
  - .6 Stem, stainless steel.
  - .7 Plug and seat, stainless steel.
  - .8 Disc, replaceable, material to suit application.
  - .9 NPS 2 and under:
    - .1 Screwed National Pipe Thread (NPT) tapered female connections.
    - .2 Valves to ANSI Class [250], valves to bear ANSI mark.
    - .3 Rangeability [50:1] minimum.

## 2.13 ELECTRONIC / ELECTRIC VALVE ACTUATORS

- .1 Requirements:
  - .1 Construction: steel, cast iron, aluminum.
  - .2 Control signal: [0-10V DC] [or] [4-20 mA DC].

- .3 Positioning time: to suit application. [90] sec maximum.
- .4 Fail to normal position as indicated.
- .5 Scale or dial indication of actual control valve position.
- .6 Size actuator to meet requirements and performance of control valve specifications.
- .7 For interior and perimeter terminal heating and cooling applications floating control actuators are acceptable.

## **2.14 PANELS**

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

## **2.15 WIRING**

- .1 In accordance with Section [26 27 10 - Modular Wiring System] [26 27 26 - Wiring Devices].
- .2 For wiring under 70 volts use FT6 rated wiring where wiring is not run in conduit. Other cases use FT4 wiring.
- .3 Wiring must be continuous without joints.
- .4 Sizes:
  - .1 Field wiring to digital device: 20AWG stranded twisted pair.
  - .2 Analog input and output: #20 minimum stranded twisted pair.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .2 Install field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .3 Temperature transmitters, humidity transmitters, current-to-pneumatic transducers, solenoid air valves, controllers, relays: install in NEMA I enclosure or as required for specific applications. Provide for electrolytic isolation in cases when dissimilar metals make contact.
- .4 Support field-mounted panels, transmitters and sensors on pipe stands or channel brackets.
- .5 Fire stopping: provide space for fire stopping in accordance with Section 07 84 00 - Firestopping. Maintain fire rating integrity.
- .6 Electrical:

- .1 Complete installation in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Terminate wires with screw terminal type connectors suitable for wire size, and number of terminations.
- .3 Install communication wiring in conduit.
  - .1 Provide complete conduit system to link Building Controllers, field panels and OWS(s).
  - .2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.
  - .3 Maximum conduit fill not to exceed 40%.
  - .4 Design drawings do not show conduit layout.
- .4 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Departmental Representative to review before starting Work. Wiring in mechanical rooms, wiring in service rooms and exposed wiring must be in conduit.

### 3.2 TEMPERATURE SENSORS

- .1 Stabilize to ensure minimum field adjustments or calibrations.
- .2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.
- .3 Outdoor installation:
  - .1 Protect from solar radiation and wind effects by non-corroding shields.
  - .2 Install in NEMA 4 enclosures.
- .4 Duct installations:
  - .1 Do not mount in dead air space.
  - .2 Locate within sensor vibration and velocity limits.
  - .3 Securely mount extended surface sensor used to sense average temperature.
  - .4 Thermally isolate elements from brackets and supports to respond to air temperature only.
  - .5 Support sensor element separately from coils, filter racks.
- .5 Averaging duct type temperature sensors.
  - .1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.
  - .2 Wire multiple sensors in series for low temperature protection applications.
  - .3 Wire multiple sensors separately for temperature measurement.
  - .4 Use software averaging algorithm to derive overall average for control purposes.
- .6 Thermowells: install for piping installations.
  - .1 Locate well in elbow where pipe diameter is less than well insertion length.

- .2 Thermowell to restrict flow by less than 30%.
- .3 Use thermal conducting paste inside wells.

### **3.3 PANELS**

- .1 Arrange for conduit and tubing entry from top, bottom or either side.
- .2 Wiring and tubing within panels: locate in trays or individually clipped to back of panel.
- .3 Identify wiring and conduit clearly.

### **3.4 PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES AND SENSORS**

- .1 Install isolation valve and snubber on sensors between sensor and pressure source where code allows.
  - .1 Protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.

### **3.5 IDENTIFICATION**

- .1 Identify field devices in accordance with Section 25 05 54 - EMCS: Identification.

### **3.6 AIR FLOW MEASURING STATIONS**

- .1 Protect air flow measuring assembly until cleaning of ducts is completed.

### **3.7 TESTING AND COMMISSIONING**

- .1 Calibrate and test field devices for accuracy and performance in accordance with Section 25 01 11 - EMCS: Start-up, Verification and Commissioning.

**END OF SECTION**



**Part 1 General****1.1 SUMMARY**

- .1 Section Includes:
  - .1 At minimum detailed narrative description of Sequence of Operation of each system including ramping periods and reset schedules.
  - .1 Control Description Logic (CDL) for each system.
  - .2 Input/output Point Summary Tables for each system.
  - .3 System Diagrams consisting of the following; EMCS System architectural diagram, Control Design Schematic for each system (as viewed on OWS), System flow diagram for each system with electrical ladder diagram for MCC starter interface.

**1.2 REFERENCES**

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

**1.3 SEQUENCE OF OPERATION**

- .1 Present sequencing of operations for systems, in accordance with MD13800 - Energy Management and Control Systems (EMCS) Design Manual.
  - .1 Building heating system.
  - .2 Domestic hot water system
- .2 Sequencing of operations for systems as follows:
  - .1 Building Heating System.
    - .1 The heating system consists of two (2) wall condensing boiler B-1 & B-2, integral boiler pumps BP-1 & BP-2, and heating pumps P-1 & P-2 with VFD. P-1/P-2 are sized for 100% capacity each, one as standby.
    - .2 The boilers shall be set up on a lead lag basis. The boiler control system (by boiler manufacturer) shall control the firing rate and energy input of each individual boiler throughout its full modulating range to maximize the condensing capability and thermal efficiency output of the entire heating plant.
    - .3 The heating water pumps shall be operated on a lead lag basis, and the speed shall be modulated to maintain a constant system differential pressure. Provide minimum run times to prevent short cycling.
    - .4 The setpoint of boilers shall be provided by the BAS system to the individual boilers, and each boiler shall have feedback to the BAS indicating loading of the boiler. Boiler loop supply temperature setpoint is to be reset based on outside air temperature according to the following schedule:

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O/A Temp.	HWS
-20°C or less	82.2°C
10°C or higher	60°C

- .5 Heating system pressure sensors will monitor the heating supply and water system pressures. Provide alarms if the differential pressure increases above 235 kPa or decreases below 35 kPa. Provide alarms for boiler ignition failure, low heating water temperature and pump failure.
- .6 The EMCS shall modulate the bypass valve to maintain a constant differential pressure of 135kPa (adjustable) when the pump is running at minimum speed.
- .7 Disable heating alarms when outside air temperature is above the heating system shutdown set-point.
- .2 Radiation
  - .1 A space temperature sensor or space thermostat shall provide the signal to modulate the 2-way control valve to maintain the desired temperature.
- .3 Force flow heaters
  - .1 The unit heaters shall be controlled by the BAS system. A space temperature sensor shall provide the signal to cycle the fan to maintain the desired temperature.
- .4 Domestic hot water system
  - .1 Integral controls for domestic water heater maintain the water supply temperature setpoint. A BAS sensor monitors the domestic supply water temperature, an alarm is generated if the temperature is above or below alarm limits.
  - .2 The BAS controls the re-circulation pump, the pump is shutdown during un-occupied schedules. An alarm is on pump failure.
- .5 HRV unit with electric reheat coil (typical)
  - .1 All HRVs and electric reheat coils consist of integral controls.
  - .2 Provide supply air temperature, operation status and alarm to EMCS system.
- .6 Weeping tile sump pump
  - .1 The sump pump package shall be complete with all operating controls with an associate control panel.
  - .2 A dry contact in the control panel shall provide a high level alarm condition to the EMCS.

**1.4 POINT LIST**

- .1 A point is a specific software address which is resident in the SCU and which is identified with a particular field sensor, instrument or sensor.
- .2 The point schedule contains a general list and description of the points to be connected. The Contractor shall examine the point schedule and ensure that all points required to

make the described control sequences work are provided whether included in the point schedule or not.

- .3 The relationships between the points, systems and building are described in the control sequences.
- .4 Consult with the Engineer during the shop drawing stage to finalize the physical terminal address of each point within the SCU.
- .5 Heating System

Point Description	Point Type*	Point Tag (Drawings)	Digital			Analog			Remarks
			Output	Input	Alarm	Output	Input	Alarm Limits	
Boiler B-1 Enable	Ry	JZ	X	--	--	--	--	--	
Boiler B-1 Status	St	XS	--	X	--	--	--	--	
B-1 Flame Failure	St	BA	--	X	X				
B-1 Supply Wtr Temp.	Tw	TT	--	--	--	--	X	X	
B-1 Setpt Reset	Ao	BC	--	--	--	X	--	--	
B-1 Load	Kw	JT	--	--	--	--	X	X	
Pump BP-1 Enable	Ry	JZ	X	--	--	--	--	--	
BP-1 Alarm	Rv	XS	--	X	--	--	--	--	
Boiler B-2 Enable	Ry	JZ	X	--	--	--	--	--	
Boiler B-2 Status	St	XS	--	X	--	--	--	--	
B-2 Flame Failure	St	BA	--	X	X	--	--	--	
B-2 Supply Wtr Temp.	Tw	TT	--	--	--	--	X	X	
B-2 Setpt Reset	Ao	BC	--	--	--	X	--	--	
B-2 Load	Kw	JT	--	--	--	--	X	X	
Pump BP-2 Enable	Ry	JZ	X	--	--	--	--	--	
BP-2 Alarm	Rv	XS	--	X	--	--	--	--	
P-1 VFD Enable	Ry	JZ	X	--	--	--	--	--	
P-1 VFD Alarm	Rv	XS	--	X	--	--	--	--	
P-1 Speed Control	VFD	SC	--	--	--	X	--	--	

Point Description	Point Type*	Point Tag (Drawings)	Digital			Analog			Remarks
			Output	Input	Alarm	Output	Input	Alarm Limits	
Pump P-2 VFD Enable	Ry	JZ	X	--	--	--	--	--	
P-2 VFD Alarm	Rv	XS	--	X	--	--	--	--	
P-2 Speed Control	VFD	SC	--	--	--	X	--	--	
System Pressure	Ps	PT	--	--	--	--	X	X	
System Diff Pressure	Ps	PT	--	--	--	--	X	X	
System Supply Temp	Tw	TT	--	--	--	--	X	X	
System Return Temp	Tw	TT	--	--	--	--	X	X	

## .6 HRV &amp; ERH (Typical)

Point Description	Point Type*	Point Tag (Drawings)	Digital			Analog			Remarks
			Output	Input	Alarm	Output	Input	Alarm Limits	
HRV Start/Stop	Ry	JZ	X	--	--	--	--	--	
Supply Air Temp	Tp	TT	--	--	--	--	X	X	
Exhaust Air Temp	Tp	TT	--	--	--	--	X	X	
Reheat Coil Start/Stop	Ry	JZ	X	--	--	--	--	--	
Supply Air Temp	Tp	TT	--	--	--	--	X	X	
Low Temp Alarm	Td	TD	--	X	X	--	--	--	

## .7 Domestic hot water

Point Description	Point Type*	Point Tag (Drawings)	Digital			Analog			Remarks
			Output	Input	Alarm	Output	Input	Alarm Limits	
P-3 Status	Ri	XS	--	X	--	--	--	--	
P-3 Start/Stop	Ry	JZ	X	--	--	--	--	X	
DHW Supply Temp.	Tw	TT	--	--	--	--	X	X	

## .8 Radiation (Typical)

Point Description	Point Type	Point Tag (Drawings)	Digital			Analog			Remarks
			Output	Input	Alarm	Output	Input	Alarm Limits	
<b>Radiation</b>									
Space Temp Setpoint	Tr	Tr	--	--	--	--	X	--	
Space Temperature	Tr	Tr	--	--	--	--	X	X	
Radiation Valve	Ve	FV	--	--	--	X	--	--	

## .9 Force flow (Typical)

Point Description	Point Type*	Point Tag (Drawings)	Digital			Analog			Remarks
			Output	Input	Alarm	Output	Input	Alarm Limits	
<b>Force Flows</b>									
Fan Start/Stop	Ry	JZ	X	--	--	--	--	--	
Space Temp Setpoint	Tr	Tr	--	--	--	--	X	--	
Space Temperature	Tr	Tr	--	--	--	--	X	X	

## .10 Weeping tile sump pump

Point Description	Digital			Analog			Remarks
	Output	Input	Alarm	Output	Input	Alarm	
<b>Sump Pumps</b>							
High Level	--	--	--	--	X	X	

## .11 Miscellaneous

Point Description	Point Type	Point Tag (Drawings)	Digital			Analog			Remarks
			Output	Input	Alarm	Output	Input	Alarm Limits	
<b>O/A Temperature Sensor</b>									
OAT - 1	To	TT	--	--	--	--	X	--	

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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**

- 1 General
- 1.1 **SUMMARY**
  - .1 Section includes:
    - .1 Labour, products, equipment and services necessary to complete the work of this Section.
  - .2 Related Sections
    - .1 Section 05 50 00: Miscellaneous metal fabrications.
    - .2 Section 09 91 00: Painting.
- 1.2 **CASH ALLOWANCES**
  - .1 N/A
- 1.3 **CODES, PERMITS AND INSPECTIONS**
  - .1 Applicable Codes and Standards
    - .1 Canadian Electrical Code, CSA C22.1 Part-I, 2015 edition
    - .2 CSA C22.2, Part II
    - .3 CSA C22.3, Part III, Overhead system
    - .4 CAN3-C235-[83(R2010)], Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
    - .5 Electrical Safety Authority (ESA)
    - .6 Electrical and Electronic Manufacturers Association of Canada (EEMAC)
    - .7 National Electrical Manufacturers Association (NEMA)
    - .8 Alberta Building Code 2006
    - .9 Canadian Standards Association (CSA)
    - .10 Underwriters' Laboratories of Canada (ULC)
    - .11 National Building Code of Canada (NBC) 2005
    - .12 Illuminating Engineering Society (IES)
    - .13 American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., (ASHRAE)
    - .14 CSA C282-09, Emergency Electrical Power Supply for Buildings
    - .15 CSA Z32-09, Electrical safety and Essential Electrical Systems in Health Care Facilities
    - .16 National Fire Protection Association (NFPA)
    - .17 American Standards Association (ASA or ANSI)
    - .18 Institute of Electrical and Electronic Engineers (IEEE)
    - .19 Electronic Industries Association (EIA)
    - .20 Telecommunications Industry Association (TIA)
    - .21 Building Industry Consulting Services, International (BICSI)

- .22 Material Safety Data Sheets by product manufacturers
- .23 Hydro inspection permits
- .24 Codes, standards, and regulations of local governing authorities having jurisdiction
- .25 Additional codes and standards listed in Trade Sections
- .26 Departmental Representative's standards
- .27 Local Hydro Standards
- .2 Comply with Canadian Electrical Code, all local, provincial and federal laws, where applicable and with authorities having jurisdiction. Make any changes or alterations required by authorized inspector of authority having jurisdiction.
- .3 Equipment and material must be acceptable to Electrical Safety Authority.
- .4 Where materials are specified which require special inspection and approval, obtain such approval for the particular installation with the co-operation of the material supplier.
- .5 Obtain and pay for permits and inspections required for work performed.
- .6 Supply and install warning signs, nameplates and glass covered Single Line Diagrams as required by Electrical Safety Authority.
- .7 Submit required Documents and shop drawings to authorities having jurisdiction in order to obtain approval for the Work. Copies of Contract Drawings and Specifications may be used for this purpose.

1.4 **REFERENCE STANDARDS**

- .1 These Specifications supplement the referenced standards.
- .2 Where standards differ between authorities, the most rigid apply.
- .3 Where requirements of the specifications exceed referenced standards, the specifications apply.
- .4 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.5 **DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE STD 100.

1.6 **DRAWING AND SPECIFICATIONS COORDINATION**

- .1 In the case of discrepancies or conflicts between the Drawings and Specifications and local governing authority standards, contact Departmental Representative and obtain direction. If direction is not available prior to close of Bids, include for the most costly arrangement, but ensure that direction is obtained prior to start of the Work.

1.7 **COORDINATION**

- .1 Carefully examine Work and Drawings of all related trades and thoroughly plan the Work so as to avoid interferences. Report defects which would adversely affect the Work. Do not commence installation until such defects have been corrected.



- .2 Coordinate Work of this Division such that items will properly interface with Work of other Divisions.
- .3 All embedded openings shall be considered by structural and architectural disciplines.
- .4 Architectural Drawings, all equipment arrangement and cable or cable tray route shall be rechecked with Architectural drawing before starting installation.
- .5 Mechanical Drawings, all mechanical related loads (location and required power / voltage) shall be rechecked by Mechanical final drawing.
- .6 Coordinate work of this Division to ensure that damage does not occur to the fireproofing work of any other Division.

1.8 **SUBSTITUTIONS**

- .1 When only one manufacturer's catalogued trade name is specified, provide only that catalogued trade name, material or product.
- .2 When more than one manufacturer's trade name is specified for a material or product, the choice is the bidders.
- .3 No substitution is allowed upon award of contract.

1.9 **DIMENSIONS AND QUANTITIES**

- .1 Dimensions shown on Drawings are approximate. Verify dimensions by reference to shop drawings and field measurement.
- .2 Quantities or lengths indicated in Contract Documents are approximate only and shall not be held to gauge or limit the Work.
- .3 Make necessary changes or additions to routing of conduit, cables, cable trays, and the like to accommodate structural, mechanical and architectural conditions. Where raceways are shown diagrammatically run them parallel to building column lines.

1.10 **EQUIPMENT LOCATIONS**

- .1 Devices, fixtures and outlets may be relocated, prior to installation, from the location shown on the Contract Drawings, to a maximum distance of 3 m, without adjustment to Contract price.
- .2 Switch, control device and outlet locations are shown diagrammatically.

1.11 **WORKING DRAWINGS AND DOCUMENTS**

- .1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract. Execute such Work only after verification of dimensions and materials and obtaining Departmental representative's written permission to proceed.

1.12 **INSTALLATION DRAWINGS**

- .1 Prepare installation drawings for equipment, based upon approved Vendor drawings, to check required Code clearances, raceway, busway and cable entries, sizing of housekeeping pads and structure openings. Submit installation drawings to Departmental Representative for review.

1.13 **"AS BUILT" RECORD DRAWINGS**

- .1 Maintain a set of Contract Drawings on site and record all deviations from the Contract Documents. As a mandatory requirement, recording must be done on the same day deviation is made. Be responsible for full compliance with this requirement.
- .2 Mark locations of feeder conduits, junction and terminal boxes and ducts or conduits run underground either below the building or outside the building.
- .3 Where conduit and wiring are underground or underfloor, furnish field dimension with respect to building column lines and inverts with respect to finished floor levels or grades.
- .4 Record deviations from branch circuit numbers shown on Drawings.
- .5 Prepare diagrams of interconnecting wiring between items of equipment including equipment supplied by Departmental Representative and under other Specification Sections.

**1.14 SINGLE LINE DIAGRAM**

- .1 Reproduce this diagram in drawing form under glazed frame and mount in Main Electrical Room. Provide a copy of this diagram to the Departmental Representative and include in the Maintenance Manuals.

**1.15 TEST REPORTS**

- .1 For each check and test performed prepare and submit a Test Report, signed by the Test engineer, and where witnessed, by the Departmental representative.
- .2 Include record of all tests performed, methods of calculation, date and time of test, ambient conditions, names of testing company, test engineer, witnesses, also calibration record of all test instruments used together with manufacturers name, serial number and model number.
- .3 Include calibration record, percentage error and applicable correction factors.
- .4 Submit a Certified Test Report from each manufacturer, signed by the certifying inspector, confirming correct installation and operation of each product and part of Work. Include name of certifying inspector, date and times of inspection, ambient conditions.

**1.16 SUBMITTALS**

- .1 Submittals to be in accordance with Division 01 Submittal Procedures, the articles below and/or as indicated in each electrical specification section.
- .2 Submit manufacturer's printed product literature, specifications and datasheet. Include product characteristics, performance criteria, and limitations.
- .3 Submit two copies of Workplace Hazardous Materials Information System (WHMIS) Material Safety Data Sheets (MSDS) in accordance with Division 01 Submittal Procedures.
- .4 Submit shop drawings in accordance with Division 01 Submittal Procedures.
  - .1 Shop drawings: submit drawings stamped and signed by professional engineer registered or licensed in Province of Alberta, Canada.
  - .2 Provide separate shop drawings for each isolated system complete with performance and product data.

- .5 Submit to the Departmental Representative, the necessary number of electrical drawings and specifications for examination, special inspection and/or approval, prior to the commencement of the work, and pay for all costs and associated fees. If required prepare any additional drawings/documents required by either Authority.
- .6 Obtain and pay for permits and inspections required for the work performed.
- .7 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.
- .8 Quality Control:
  - .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 for special approval before delivery to site.
  - .3 Submit test results of installed electrical systems and instrumentation.
  - .4 Permits and fees: in accordance with contract.
  - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
  - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
- .9 Manufacturer's Field Reports: submit to Departmental Representative the 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.
- .10 Where materials are specified which require special inspection and approval, obtain such approval for the particular installation with the co-operation of the material supplier.

1.17 **QUALITY ASSURANCE**

- .1 Quality Control and Assurance: in accordance with Division 01 Quality Control.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Health and Safety Requirements: do construction and occupational health and safety in accordance with Division 01 Health and Safety Requirements.

1.18 **FACTORY WITNESS TESTS**

- .1 Prior to Departmental Representative attendance at factory for witness testing, perform the following:
  - .1 Successfully conduct test to be witnessed.
  - .2 Following successful testing, inform the Departmental representative, in writing, that tests to be witnessed have been successfully performed.

1.19 **SYSTEM STARTUP**

- .1 Instruct operating personnel in the operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of Factory Service Engineer for major systems, 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.

1.20 **OPERATING AND MAINTENANCE MANUALS**

- .1 Refer to and comply with Division 01 and related Sections.
- .2 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .3 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.
- .4 Provide a video recording of the training sessions for all major electrical equipment and electrical systems.
- .5 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .6 Post instructions where directed.
- .7 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .8 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

1.21 **COMMISSIONING**

- .1 A Commissioning Agent will be appointed by the Departmental Representative to oversee the commissioning activities of the project. This contractor is to:
  - .1 Interface, cooperate and coordinate with the Commissioning Agent and attend commissioning meetings.
  - .2 Perform commissioning activities for aspects of work provided in Electrical Divisions and perform corrective work identified by the Commissioning Agent.
  - .3 Refer to Section 26 08 06 Field Testing and Commissioning Low Voltage for additional requirements.
- .2 Refer to Division 01 for additional commissioning requirements.
- .3 The Commissioning Agent may also be present for any testing/commissioning activities and are to be notified by the Contractor in advance of these activities.
- .4 Submit a copy of test reports of systems and equipment to the Commissioning Agent, prior to start of commissioning activity or as directed by Commissioning Agent.
- .5 Where commissioning specifications are included as part of Division 01, the requirements of the Section entitled Electrical Commissioning are to supplement commissioning requirements of Division 01. Where variances or contradictions exist, the more stringent requirement will apply unless otherwise directed by Departmental representative.

1.22 **LOCAL ELECTRICAL UTILITY REQUIREMENTS**

- .1 Comply with the latest conditions of supply requirements of the local electrical Utility having jurisdiction. Execute infrastructure work related to the local Utility in accordance with requirements and coordinated Utility requirements with the respective Divisions of the Work providing such work. Include for the following in relation to Utility:
  - .1 Two preconstruction meeting;
  - .2 Access for electrical Utility's Inspector to be on duty for duration of work or as required by the Utility;
  - .3 Underground inspection: submission of approval drawings and application for inspection prior to any inspection of work;
  - .4 Approval of work and materials by electrical Utility's Inspector prior to any backfilling work.

1.23 **SERIES RATED COMBINATIONS**

- .1 Series rated combinations of over-current protective devices are not permitted. Provide full rating distribution as shown on plans.

2 **Products**

2.1 **APPROVALS AND QUALITY**

- .1 Provide new materials bearing certification marks or labels acceptable under Canadian Electrical Code.
- .2 Equipment must bear, on manufacturer's label, certification mark or label acceptable under Electrical Safety Authority.
- .3 Provide units of same manufacture where two or more units of same class or type of equipment are required.

- .4 Manufacturer's names are stated in this Specification to establish a definite basis for tender submission and to clearly describe the quality of product that is desired for the work.

## **2.2 STANDARD SPECIFICATIONS**

- .1 Ensure that the chemical and physical properties, design, performance characteristics and methods of construction of all products provided comply with latest issue of applicable Standard Specifications issued by authorities having jurisdiction, but such Standard Specifications shall not be applied to decrease the quality of workmanship, products and services required by the Contract Documents.

## **2.3 MATERIALS AND EQUIPMENT**

- .1 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .2 Factory assemble control panels and component assemblies.
- .3 Ensure no counterfeit breakers are used in the project. Do random sample checks in non-factory supplied breakers.
- .4 Enclosure CSA types referred to in this specification to be in accordance to CAN/CSA 22.2 No.94-M91(R2011)-Special Enclosures and/or their EEMAC/NEMA equivalent, whichever is more stringent.
- .5 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .6 Storage and Handling Requirements:
- .7 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
- .8 Replace defective or damaged materials with new.

## **2.4 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS**

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls as indicated.
- .2 Control Wiring and Conduit: in accordance with section 26 05 05 – Electrical Requirements for Mechanical Equipment, except for conduit wiring and connections below 50V which are related to control systems specified in mechanical sections and as shown on mechanical drawings.

## **2.5 WARNING SIGNS**

- .1 Warning Signs: in accordance with requirements of departmental Representative having jurisdiction.
- .2 Decal signs, minimum size 175 x 250 mm.

## **2.6 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for copper conductors.

**2.7 SPRINKLER PROOF EQUIPMENT**

- .1 Ensure that electrical equipment installed in electrical rooms and other areas containing sprinklers is constructed such that exposure to water from the sprinkler heads does not impair the effectiveness of the enclosed equipment.
- .2 Provide a separate cover or roof on all 2285 mm high equipment. Provide an overhang at the front, rear and sides to effectively prevent the entrance of water either at the top or through projecting faceplates, meters, etc.
- .3 Where penetrations are made in drip shields, flash and seal using manufacturer's approved caulking to maintain drip shield integrity.
- .4 Ensure that enclosure louvres are of outdoor design such that falling water or water running down the sides will not enter the enclosure.
- .5 Where enclosure openings in the top or sides are required for outgoing conduits, provide waterproof conduit fittings.
- .6 Provide panels and transformers with hoods.
- .7 Provide sprinkler proof busways.
- .8 In electrical rooms containing sprinklers provide wall mounted equipment such as pull boxes, junction boxes, splitter troughs, wireways, auxiliary gutters, cable troughs and disconnect switches located below the level of the sprinkler heads with the following accessories:
  - .1 Gaskets on doors and drip shields on equipment, panelboards, panels and enclosures.
  - .2 Louvres facing outward and downward where openings are required for heat dissipation. Expanded metal screening is not acceptable.

**2.8 HOUSEKEEPING PADS**

- .1 Provide 100 mm high concrete pads under floor mounted electrical equipment. Extend pads 50 mm outside the equipment perimeter.

**2.9 FIRE STOPPING AND SMOKE SEALS**

- .1 Where electrical material or devices pass through fire rated separations, make penetrations and provide fire barrier seals with a fire resistance rating equivalent to the rating of the separation.
- .2 Prior to installation, submit for review, proposed fire barrier seal materials, method of installation and ULC system number.
- .3 Provide fire stopping and smoke seals in accordance with Section 07 84 00.

**2.10 MISCELLANEOUS METAL FABRICATIONS**

- .1 Provide miscellaneous structural supports, platforms, braces, brackets and preformed channel struts necessary for suspension, attachment or support of electrical equipment in accordance with Section 05 50 00.

**2.11 SILICONE**

- .1 Products and materials containing silicone are not permitted.

2.12 **EQUIPMENT COLOUR CODING**

- .1 Exterior finish paint colour for control panels, panelboards and devices on emergency and UPS systems:
  - .1 Emergency systems: red
  - .2 UPS systems: blue

2.13 **EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates and labels as follows:
  - .1 Nameplates: lamicaid 3 mm, black face, white core, lettering accurately aligned and engraved into core mechanically attached with self tapping screws.
  - .2 Sizes as follows:

**NAMEPLATE SIZES**

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

- .2 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.
- .3 Wording on nameplates and labels to be approved by Departmental Representative prior to manufacturing.
- .4 Allow for minimum of twenty-five (25) letters per nameplate and label.
- .5 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .6 Disconnects, starters and contactors: indicate equipment being controlled, voltage and power source.
- .7 Terminal cabinets and pull boxes: indicate system and voltage.
- .8 Transformers: indicate capacity, primary and secondary voltages and power source.
- .9 Panelboards: indicate system, rated ampacity, voltage, phase, wire configuration and power source.
- .10 Switchboard: indicate rated ampacity, voltage, phase, wire configuration.
- .11 Receptacles: indicate circuit numbers using P-Touch type labels.

2.14 **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 as follows:
  - .1 Phase A – Red
  - .2 Phase B – Black
  - .3 Phase C – Blue
  - .4 Neutral – White
  - .5 Ground – Green
  - .6 Isolated Ground – Green and Yellow

## 2.15 **CONDUIT AND CABLE IDENTIFICATION**

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at conduit system couplings.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

<b>System</b>	<b>Normal</b>	<b>Emergency</b>	<b>UPS</b>
up to 15 kV	Yellow	-	-
347/600 V	Orange	Orange/Red	Orange/Blue
120/208 V	Black	Black / Red	Black / Blue
Fire Alarm	Red	-	-
Emergency Voice	Red / Blue	-	-
LAN	Green	-	-
Security	Red/Yellow	-	-
Low Voltage Control	White	-	-

## 2.16 **FINISHES**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish to EEMAC standard.
  - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1 (ANSI 61).

## 2.17 **PRODUCTS FURNISHED BY DEPARTMENTAL REPRESENTATIVE**

- .1 Carefully examine the Vendor or Manufacturers' drawings and provide any incidental and miscellaneous materials, mounting hardware and supports required for complete systems.

## 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 the Canadian Electrical Code except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.
- .3 Complete installation in accordance with Alberta Building Code and Canadian Electrical Code.
- .4 Elevator Systems: Provide for "Related Work" listed and identified under Section 14 20 00, Elevators, to be executed by Electrical Contractor.
- .5 Mechanical Systems: Provide for 'Related Work' listed and identified for Divisions 26, 27 and 28, under Mechanical Divisions 21, 22, 23 and 25, to be executed by Electrical Contractor.
- .6 Feature Water Fountain Systems: This contractor is to provide all electrical branch wiring tight-ins at panelboard 'RP-RBA' in Fountain Pump Room (B135) Room for electrical wiring brought to panelboard by Water Fountain Contractor electrical subcontractor.

**3.3 MANUFACTURER'S ATTENDANCE**

- .1 Provide manufacturer's representatives to initially start-up each part of the Work, as specified, to check, adjust, calibrate and balance as applicable all components including controls and field wiring. Provide these services for such period and for as many visits as necessary to achieve complete working order in the subject Work.

**3.4 FIELD INSPECTION**

- .1 Provide Field Engineer for inspection and certification of equipment during installation, testing and commissioning as required.

**3.5 HOUSEKEEPING PADS**

- .1 Provide concrete pads to the requirements of Division 03.

**3.6 FIRE BARRIERS**

- .1 Provide fire stopping to the requirements of Division 07

**3.7 PAINTING**

- .1 Touch up finishes on electrical equipment found to be marred on completion of the Work using same colour and type of finish as originally used.
- .2 Prime paint field fabricated metalwork.

3.8

**CORE DRILLING**

.1 Core Drilling Procedure

- .1 Examine locations to be core drilled where:
  - .1 Diameter is greater than 25 mm
  - .2 Multiple drillings required and where the distance between centres is less than 10 times the diameter of the hole
- .2 Examine by most suitable method including:
  - .1 X-ray
  - .2 Ferro scan
  - .3 Cable detection
- .3 Examine from both sides of the structure to be drilled.
- .4 Examine proposed core drilling locations to determine:
  - .1 Possible interference with
    - .1 Services
    - .2 Structural components
- .5 Select locations as suitable for core drilling and label them:
  - .1 Uniquely number each drilling location and core so that markings will be legible after drilling
  - .2 Mark each core with a north pointing arrow where drilling a slab or upward pointing arrow where drilling a wall
- .6 Without interfering with or damaging any services or structural elements, drill pilot holes sufficient to verify location of potential obstructions or for alignment purposes.
- .7 Use impact drill when drilling holes of 25 mm diameter or less. For holes of greater diameter use core drill.
- .8 Prepare report showing intended core drill locations including printouts, X-ray images. Submit the report for approval prior to drilling to Departmental representative.
- .9 Proceed with core drilling only after approval has been received from Departmental representative.
- .10 Confine drilling operation to time-of-day as stipulated by Departmental representative.
- .11 Position suitable warning notices of a type acceptable to Departmental Representative and exercise caution to ensure safety and protection of personnel and property during drilling especially from effects of water, dust damage, or falling objects below the slab or behind the wall being drilled.
- .12 Stop drilling immediately, and report to Departmental representative, if contact is made with foreign objects such as reinforcing steel (rebar), electrical conduit, water pipes, drainage pipes.
- .13 Cover open holes with secured covers to guard against fall through of objects.

- .14 Provide necessary firestopping, temporary or otherwise, sufficient to firestop holes that would be otherwise open during hours that the location is unattended. Coordinate placement of firestopping with Departmental representative.
- .15 Store all cores or core fragments on site and make them available for inspection by Departmental representative. Dispose of the cores or core fragments after permission is received from Departmental representative.

**3.9 SLEEVES, CONDUIT AND CABLE INSTALLATION**

- .1 Install conduit and sleeves prior to pouring of concrete.
  - .1 Sleeves through concrete: sized for free passage of conduit, and protruding 50mm.
  - .2 Sleeves through concrete floors: sized for free passage of conduit, protruding 50 mm and water-tight.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

**3.10 LOCATION OF OUTLETS**

- .1 Do not install outlets back-to-back in wall; install boxes in adjacent stud wall partitions to preserve STC ratings of compartments.
- .2 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .3 Locate light switches on latch side of doors.
  - .1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

**3.11 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 Light switches and Dimmer Controls: 1400 mm.
  - .2 Wall receptacles:
    - .1 Mount vertically, unless directed otherwise on drawings.
    - .2 General: 300 mm.
    - .3 Above top of continuous baseboard heater: 200 mm.
    - .4 Above top of counters or counter splash backs: 175 mm.
    - .5 Mechanical Rooms: 1400 mm
    - .6 Hazardous Areas: 1400 mm
  - .3 LAN Outlets: 400 mm.
  - .4 Fire alarm pull stations: 1500 mm

- .5 Fire alarm bells: 2100] m.
- .6 Wall mounted speakers or strobes: 2300 mm or 150 mm below ceiling
- .7 Card readers: 900 mm
- .8 Door operators: 900 mm
- .9 Television outlets: [300] mm.
- .10 Panelboards: as required by Canadian Electrical Code or as indicated on plans
- .11 Wall mounted speakers: 2100 mm.
- .12 Clocks: 2100 mm.
- .13 Door bell pushbuttons: 1500 mm.
- .14 Wall mounted exit signs: 150 mm above door frame
- .15 Suspended mounted exit signs:

**3.12 COORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed to required values and settings as determined in accordance with Section 26 05 73.
- .2 Ensure all distribution equipment is labelled in accordance with the Arc Flash Study.
- .3 Provide a signed letter from a Professional Engineer licensed in the Province of Alberta confirming the following:
  - .1 Settings of the protective devices have been adjusted as per the short circuit coordination study.
  - .2 Arc flash classification labels to all items of electrical distribution equipment have been installed as per the Arc-flash study.

**3.13 FIELD QUALITY CONTROL AND COMMISSIONING**

- .1 Carry out testing and commissioning for electrical systems and equipment in in presence of Departmental Representative and in accordance with relevant standards such as CSA, ULC, ANSI. Comply with the Acceptance Testing Specifications for the International Electrical Testing Association Inc (NETA).
- .2 Refer to division 1 of additional commissioning requirements.
- .3 Conduct and pay for all testing and commissioning.
- .4 Refer to each Section of Division 26, 27 and 28 for additional testing requirements for specific equipment components.
- .5 Provide the instruments, meters, equipment and personnel required to conduct the tests during and at the conclusion of the project.
- .6 In addition to the requirements of Division 1, all the electrical generic commissioning forms in connection with the equipment or systems have been structured in 3 parts: product identification, installation/operational check list and performance verification. All available commissioning forms are included in Division 1. Make those forms project specific and develop new ones where not available. Structure any new forms in 3 parts as described and provide all details to capture all requirements. The contractor shall utilize and follow

procedures for testing as outlined in the NETA 2001 standard for acceptance testing and in addition as described in various electrical sections.

- .7 Load Balance:
  - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.
  - .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
  - .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .8 Conduct:
  - .1 Power distribution system including phasing, voltage, grounding and load balancing.
  - .2 Circuits originating from branch distribution panels.
  - .3 Lighting and its control.
  - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
  - .5 Systems: fire alarm and communications.
  - .6 Insulation resistance testing:
    - .1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
- .9 Advise Departmental representative, when testing to be performed.
- .10 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, testing and commissioning in accordance with manufacturer's instructions.
- .11 Ten months after the building has been completed and occupied, and all load balancing and adjustments have been completed, carry out or engage and pay for a specialist to carry out an Infra Red Scan using AEGMA or equivalent instrument, on all major equipment and submit report complete with pictures and recommendations. Scanning time to be fully coordinated with the Departmental representative, at least two (2) weeks in advance, and shall meet all site operational requirements. Submit scanning plan to Departmental Representative and Engineer for review and approval.
  - .1 Major equipment shall include at least the following:
    - .1 All Low Voltage Switchboards

- .2 All Distribution Panels, branch circuit Panels and disconnect switches.
- .3 All motor starters (including VFDs) and all motor connections.
- .4 Busway
- .5 Transformers

.2 Submit to the Departmental Representative scan results within 48 hours of scanning. Adjust and modify the equipment as instructed by the Engineer. For equipment requiring adjustment or modification, rescan under load, until Engineer accepts results. Resubmit results for Engineer's review.

.3 All work to be performed on weekends and after hours.

3.14

**CLEANING**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

End of Section

## **1 General**

### **1.1 SUMMARY**

.1 Section includes:

- .1 Labour, products, equipment and services necessary to complete the work of this Section.

### **1.2 RELATED SECTIONS**

- .1 Section 26 05 01: Basic electrical requirements.
- .2 Section 26 05 54: Electrical identification.

### **1.3 REFERENCES**

- .1 Conform to latest issues, amendments and supplements of following standards:
  - .1 Canadian General Standards Board (CGSB):
    - .1 CAN/CGSB-1.40-M - Primer, Structural Steel, Oil Alkyd Type
  - .2 Canadian Institute of Steel Construction (CISC/CPMA)
    - .1 CISC/CPMA 2.75 - Canadian Institute of Steel Construction/ Canadian Paint Manufacturers Association, A Quick Drying Primer For Use on Structural Steel
  - .3 Canadian Standards Association (CSA):
    - .1 CAN3-C21.1-M - Control Cable - 600V
    - .2 CAN3-C21.2-M - Control Cable for Low Energy Circuits 150V and 300V
    - .3 CAN/CSA C22.2 No. 18 - Outlet Boxes, Conduit Boxes, and Fittings
    - .4 CAN/C22.2 No. 26 - Wireways, Auxiliary Gutters and Associated Fittings
    - .5 CSA C22.2 No. 30-M - Explosion-Proof Enclosures for Use in Class I Hazardous Locations
    - .6 CSA C22.2 No. 38-M - Thermoset Insulated Wires and Cables
    - .7 CSA C22.2 No. 40-M - Cutout, Junction and Pull Boxes
    - .8 CSA C22.2 No. 42-M - General Use Receptacles, Attachment Plugs and Similar Wiring Devices
    - .9 CSA C22.2 No. 45-M - Rigid Metal Conduit
    - .10 CSA C22.2 No. 49 - Flexible Cords and Cables
    - .11 CAN/CSA C22.2 No. 51-M - Armoured Cables
    - .12 CSA C22.2 No. 52-M - Service-Entrance Cables
    - .13 CSA C22.2 No. 56 - Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit
    - .14 CSA C22.2 No. 62 - Surface Raceway Systems
    - .15 CSA C22.2 No. 65 - Wire Connectors
    - .16 CSA C22.2 No. 75-M - Thermoplastic Insulated Wires and Cables
    - .17 CSA C22.2 No. 76-M - Splitters



- .18 CSA C22.2 No. 79 - Cellular Metal and Cellular Concrete Floor Raceways and Fittings
- .19 CSA C22.2 No. 80 - Underfloor Raceways and Fittings
- .20 CSA C22.2 No. 83-M - Electrical Metallic Tubing
- .21 CAN/CSA-C22.2 No. 85-M - Rigid PVC Boxes and Fittings
- .22 CAN/CSA C22.2 No. 94-M -Special Purpose Enclosures
- .23 CSA C22.2 No. 123-M - Aluminum Sheathed Cables
- .24 CSA C22.2 No. 124-M - Mineral-Insulated Cables
- .25 CSA C22.2 No. 126-M - Cable Tray Systems
- .26 CSA C22.2 No. 127 - Equipment Wires
- .27 CAN/CSA-C22.2 No. 131-M - Type Teck 90 Cable
- .28 CSA C22.2 No. 138-M - Heat Tracing Cable and Cable Sets for Use in Hazardous Locations
- .29 CSA C22.2 No. 159-M - Attachment Plugs, Receptacles and Similar Wiring Devices for Use in Hazardous Locations: Class I, Groups A, B, C, and D; Class II, Group G, in Coal or Coke Dust, and in Gaseous Mines
- .30 CSA C22.2 No. 174-M - Cable and Cable Glands for Use in Hazardous Locations
- .31 CSA C22.2 No. 182.1 - Industrial Type, Special Use Attachment Plugs, Receptacles, and Connectors
- .32 CSA C22.2 No. 182.2-M - Industrial Locking Type, Special Use Attachment Plugs, Receptacles, and Connectors
- .33 CSA C22.2 No. 182.3-M - Special Use Attachment Plugs, Receptacles, and Connectors
- .34 CSA C22.2 No. 208-M - Fire Alarm and Signal Cable
- .35 CSA C22.2 No. 211.2-M - Rigid PVC (Unplasticized) Conduit
- .36 CSA C22.2 No. 211.3 - Rigid Fiberglass Reinforced Epoxy (RE) Conduit and Associated Fittings
- .37 CSA C22.2 No. 214-M - Communications Cables
- .38 CSA C22.2 No. 222-M - Type FCC Under-Carpet Wiring System
- .39 CSA C22.2 No. 227.1 - Electrical Nonmetallic Tubing
- .40 CSA C22.2 No. 227.2 - Flexible Liquid-Tight Nonmetallic Conduit
- .41 CSA C22.2 No. 227.3-M - Flexible Nonmetallic Tubing
- .42 CSA C22.2 No. 230-M - Tray Cables
- .43 CSA C22.2 No. 232-M - Optical Fiber Cables
- .4 SSPC: Steel Structures Painting Council
  - .1 SSPC - Steel Structures Painting Council" Steel Structures Painting Manual, Vol. 2"

#### **1.4 SUBMITTALS**

- .1 Departmental Representative reserves the right to require Contractor to submit samples of any materials to be used in this project.
- .2 Dimensioned location drawings indicating required sleeves and/or openings in structural concrete or roofing or other locations affecting other trades work.
- .3 Proposed equipment nameplates and warning signs.
- .4 Detailed cable tray or J-Hook layouts.
- .5 Equipment/product factory testing reports.
- .6 Prior to application for Substantial Performance of the Work, submit the following to Departmental Representative for review:
  - .1 ESA inspection certificates.
  - .2 Fire alarm system pre-testing.
  - .3 Distribution system testing and coordination study performed.
  - .4 Structured network cabling system tested and verified.

## **2 Products**

### **2.1 WIRE - LOW VOLTAGE UP TO 1000V SERVICE**

- .1 Conductors
  - .1 ASTM Class B, soft drawn, electrolytic copper
  - .2 Stranded for # 10 AWG and larger.
- .2 Insulation
  - .1 CSA type RW90 XLPE (-40°C)
    - .1 Heat and moisture resistant
    - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
    - .3 600V or 1000V rated
    - .4 For maximum 90°C conductor temperature
    - .5 For installation at minimum -40°C temperature
    - .6 To CSA C22.2 No. 38
  - .2 CSA type RWU90 XLPE (-40°C):
    - .1 Heat and moisture resistant
    - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
    - .3 1000V rated
    - .4 For maximum 90°C conductor temperature
    - .5 For installation at minimum -40°C
    - .6 To CSA C22.2 No. 38
  - .3 CSA type T90 NYLON (-10°C):

- .1 Heat resistant
- .2 Flame retardant
- .3 Thermoplastic PVC material with extruded nylon cover
- .4 600V rated
- .5 For maximum 90°C conductor temperature dry and 75°C in wet locations
- .6 For installation at minimum -10°C
- .7 To CSA C22.2 No. 75-M
- .4 CSA type TEW:
  - .1 Heat resistant
  - .2 600V rated
  - .3 For maximum 105°C conductor temperature
  - .4 To CSA C22.2 No. 127
- .5 CSA type SEW-2
  - .1 Heat resistant
  - .2 600V rated
  - .3 For maximum 200°C conductor temperature
  - .4 To CSA C22.2 No. 127

## **2.2 CABLE - LOW VOLTAGE UP TO 1000V SERVICE**

- .1 CSA Type AC90 XLPE (-40°C)
  - .1 Conductors
    - .1 ASTM Class B, soft drawn, electrolytic copper
    - .2 Solid for sizes #10 AWG and smaller
    - .3 Stranded for sizes #8 AWG and larger
  - .2 Insulation
    - .1 Heat and moisture resistant
    - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
    - .3 600V rated for sizes #10 AWG and smaller
    - .4 1000V rated for sizes #8 AWG and larger
    - .5 For maximum 90°C conductor temperature
    - .6 For installation at minimum -40°C temperature
    - .7 To CSA C22.2 No. 38
  - .3 Construction
    - .1 2, 3 or 4 insulated conductors
    - .2 Bare ground conductor
    - .3 Overall interlocking aluminium armour

- .4 To CSA C22.2 No. 51
- .2 CSA Type TECK90 (-40°C)
  - .1 Conductors
    - .1 ASTM Class B, soft drawn, electrolytic copper
    - .2 Stranded
  - .2 Insulation
    - .1 Heat and moisture resistant
    - .2 Low temperature, chemically cross-linked thermosetting polyethylene material
    - .3 600V or 1000V rated
    - .4 For maximum 90°C conductor temperature
    - .5 For installation at minimum -40°C temperature
    - .6 CSA type RW90 XLPE
    - .7 To CSA C22.2 No. 38
  - .3 Construction
    - .1 1 or more insulated conductors
    - .2 Bare, stranded, copper ground conductor for multi-conductor cables
    - .3 Bare, solid, served copper ground conductors for single conductor cables
    - .4 Fillers with binder tape to produce a circular cross-section for multi-conductor cables
    - .5 Power cables
      - .1 1, 2, 3 or 4 conductors
      - .2 Conductors 1000V rated
    - .6 Composite cables
      - .1 3 power conductors
      - .2 3 #14 AWG control conductors
      - .3 Conductors 600V rated
    - .7 Extruded PVC inner jacket over conductor assembly
    - .8 Interlocking aluminium armour over inner jacket
    - .9 Extruded PVC overall jacket over armour
      - .1 FT4 flame test rated
      - .2 Colour black unless otherwise indicated
    - .10 Cable assembly for installation at minimum -40°C temperature
    - .11 To CSA C22.2 No. 131 and CSA C22.2 No. 174
- .3 CSA Type NMD90 (Romex):
  - .1 Non-metallic Sheathed Cable

- .2 300V rated
- .4 CSA Type MI
  - .1 Conductors
    - .1 ASTM Class B, soft drawn, electrolytic copper
    - .2 Solid
  - .2 Insulation
    - .1 Powdered magnesium oxide
    - .2 600V rated for feeders on 208/120V system or control wiring
    - .3 1000V rated for feeders on 600/347V systems
  - .3 Construction
    - .1 Solid conductor
    - .2 Insulation around the conductor compressed to form a solid, homogeneous mass between the conductor and the metal sheath throughout the entire length of cable
    - .3 Soft annealed seamless copper sheath over insulation
    - .4 Extruded PVC overall jacket over sheath
      - .1 FT4 flame test rated
      - .2 Colour black unless otherwise indicated
    - .5 Two (2) hour fire rated where indicated on drawings.
    - .6 Connectors: watertight, field installed approved for MI cable.
    - .7 Termination kits: field installed approved for MI cable
    - .8 To CSA C22.1 No. 124-M
  - .4 Acceptable Manufacturer
    - .1 As a minimum performance standard the cabling shall meet the performance specifications as indicated above and as manufactured by Pyrotenax or equivalent.

## **2.3 CONTROL CABLES**

- .1 Type: LVT: 2 soft annealed copper conductors, sized as indicated:
  - .1 Insulation: thermoplastic.
  - .2 Sheath: thermoplastic jacket.
- .2 Type: low energy 300 V control cable: solid annealed copper conductors sized as indicated:
  - .1 Insulation: TW 40 degrees C.
  - .2 Shielding: tape coated with diamagnetic material over each conductor.
  - .3 Overall covering: PVC jackets.
- .3 Type: 600 V stranded annealed copper conductors, sizes as indicated:
  - .1 Insulation: RW90 (x-link).
  - .2 Shielding: non-magnetic tape over each pair of conductors.

- .3 Overall covering: PVC.

## 2.4 CABLE CONNECTORS

- .1 Connectors for Type AC90 Cable
  - .1 Steel or malleable iron
  - .2 Insulated throat
  - .3 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 Efcor 1000B series
    - .2 Elliott 65200 series
    - .3 Thomas & Betts 3110 series
- .2 Connectors for Type TECK90 Cable
  - .1 Copper free aluminium body
  - .2 Steel or copper free aluminium fittings and locknut
  - .3 Certified for use in hazardous locations Classes I, II, and III
  - .4 Class I hazardous location sealing fitting
  - .5 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 Thomas & Betts "STE" series
    - .2 Crouse-Hinds type TMC
    - .3 Commander/Iberville type TEK

## 2.5 WIRE AND CABLE CONNECTORS

- .1 Copper compression type wire and cable terminations for #8 AWG and larger conductors, colour keyed, sized to suit. Long barrel NEMA 2 hole lugs for sizes #1/0 AWG and larger.
  - .1 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 Thomas & Betts series 54000
    - .2 Ideal Powr-Connect
    - .3 Burndy Hylug
- .2 Twist type splicing connectors, copper, sized to suit, with nylon or plastic shroud for tee connections in #10 AWG and smaller conductors.
  - .1 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 Thomas & Betts spring type
    - .2 Ideal Twister
    - .3 Marr Marrette
- .3 Conductor compression splice for #10 AWG or smaller.

- .1 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers

- .1 Thomas & Betts STA-Kon series
- .2 Ideal Splices
- .3 Burndy

## **2.6 WIRE PULLING LUBRICANT**

- .1 Wire pulling lubricant to be "Ideal Industries", Yellow 77 Plus Wire pulling Lubricant or approved equivalent.

## **2.7 HEAT SHRINKABLE TUBING INSULATION, HEAVY WALL**

- .1 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
- .2 Thomas & Betts, Shrink-Kon series
- .3 Ideal Thermo-Shrink, TS-46
- .4 Raychem tubing WCSM
- .5 3M cable sleeve ITCSN

## **2.8 MOTOR LEAD CONNECTION KITS, 600 VOLT**

- .1 Connection kits for low voltage motors.
  - .1 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
  - .2 3M, motor lead splice kit, pigtail, 5300 series
  - .3 Raychem, motor connection kit, MCK, type V

## **2.9 CONDUIT AND FITTINGS**

- .1 Rigid Steel Conduit
  - .1 To CSA C22.2 No. 45-M
  - .2 Rigid thick wall galvanized steel threaded conduit
- .2 Coated Steel Conduit
  - .1 Corrosive resistant coated rigid thickwall steel threaded conduit, CSA approved.
  - .2 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 Rob Roy Plastibond PVC coated
    - .2 Columbex Green Guard II epoxy polyester coated
- .3 Rigid PVC Conduit
  - .1 To CSA C22.2 No. 211.2-M
  - .2 Rigid PVC conduit
- .4 Flexible Steel Conduit
  - .1 To CSA 22.2 No. 56

- .2 Liquid-tight flexible steel conduit with PVC cover
- .5 Non-Metallic Flexible Conduit
  - .1 Non-metallic extra flexible PVC conduit
  - .2 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 Carlon, Carflex X-Flex
    - .2 Hubbell, Polytuff Black
- .6 Rigid Steel Conduit Fittings
  - .1 To CAN/CSA C22.2 No. 18
  - .2 Galvanized or polymer coated cast steel fittings
  - .3 Expansion fittings, watertight with integral bonding jumper suitable for linear expansion and 19 mm deflection in all directions
  - .4 Sealing condulets for hazardous areas
  - .5 Corrosive resistant coated cast steel fittings for corrosive resistant conduit
- .7 Rigid PVC Conduit Fittings
  - .1 To CSA C22.2 No. 85-M
  - .2 Rigid PVC fittings of same manufacture as rigid PVC conduit
- .8 Liquid Tight Flexible Steel Conduit Fittings
  - .1 Watertight connectors with nylon insulated throat
  - .2 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 T & B Series 5331 with Sealing O-ring Series 5262
    - .2 Commander/Iberville Series 6300-IT with nitrile O-ring

## **2.10 EMT AND FITTINGS**

- .1 EMT
  - .1 To CSA C22.2 No. 83-M
  - .2 EMT galvanized cold rolled steel tubing
- .2 EMT Fittings
  - .1 Compression type, steel
    - .1 Gland compression connectors with insulated throats
    - .2 Compression couplings
  - .2 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
    - .1 :
      - .1 T & B Series 5123 & 5120
      - .2 O-Z/Gedney type ZTC series



- .3 Commander/Iberville Series 5600-IT and 5700
- .3 Set screw type, steel, concrete-tight
  - .1 Connectors with insulated throats
  - .2 Couplings
- .4 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
  - .1 Commander/Iberville Series 5400 and 5500

## **2.11 CABLE TRAY**

- .1 Cable Trays and Fittings
  - .1 To EEMAC F5-1
  - .2 To CAN/CSA C22.2 No. 126-M
- .2 Ladder Type
  - .1 Class C1
  - .2 Steel, hot dip galvanized after fabrication
  - .3 Side height, 100 mm
  - .4 Rung spacing, 300 mm
  - .5 Width as indicated on drawings.
- .3 Basket Type
  - .1 Class C1
  - .2 Powder coated with average paint thickness of 30 microns to 75 microns.
  - .3 50 mm x 50 mm grid
  - .4 Side height: 100 mm minimum.
  - .5 Width as indicated on drawings.
- .4 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
  - .1 Legrand Cablofil
  - .2 Cooper B-Line
  - .3 Canadian Electrical Raceways

## **2.12 WIREWAY**

- .1 To CSA C22.1 No. 94-M.
- .2 Steel with hinged cover to give uninterrupted access.
- .3 Elbows, tees, couplings and hanger fittings manufactured as accessories for wireway supplied.
- .4 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
  - .1 Amalgamated Electric

- .2 Canadian Electrical Raceways
- .3 Schneider Square D
- .4 Pilgrim
- .5 Pursley

### 2.13 SURFACE RACEWAY

- .1 Surface Raceway to be Legrand Wiremold Model No. 'DS4000 Designer Series'.
- .2 Surface metal raceway, single or complete with snap-in divider to form 2 compartments for power and data, with removable cover. Width to suit application while keeping Code and Telecommunication standard filling ratios.
- .3 Elbows, couplings, end caps, device brackets and faceplates for power, data and voice, and fittings manufactured as accessories for wireway supplied. 120V power receptacles and mounting only for voice/data.
- .4 Finish: Designer Grey
- .5 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided by the following manufacturers
  - .1 Legrand/Wiremold or approved equivalent.

### 2.14 FASTENINGS, SUPPORTS AND SLEEVES

- .1 Fastenings
  - .1 Galvanized steel straps, beam clamps and threaded rods for structural steel
  - .2 Concrete inserts, Crane Canada No.4-M for concrete work for single or double conduit cable tray.
  - .3 Unistrut multiple type inserts for runs of three or more conduits.
  - .4 Concrete fastener type "WEJ-IT" anchors
  - .5 Drywall, plaster or ceiling, 2-wing spring toggles
  - .6 40mm width, galvanized steel channels complete with accessories for metal framing channels.
    - .1 Unistrut
    - .2 Thomas & Betts
  - .7 Metal "J" hooks cable supports systems for communication systems cabling in accessible ceiling spaces where conduit or cable tray is not being provided.
  - .8 Velcro tie wraps for bundling and securing telecommunication cabling
- .2 Sleeves
  - .1 Schedule 40 steel pipe, minimum I.D. 13 mm larger than O.D. of conduit or cable passing through.
- .3 Strut
  - .1 Continuous slotted channel
  - .2 12 gauge pre-galvanized steel
  - .3 41.2 mm x 41.2 mm minimum

- .4 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided by the following manufacturers

- .1 B-Line
- .2 Pilgrim
- .3 Pursley
- .4 Unistrut

## **2.15 ACCESS DOORS**

- .1 Access doors to Section 10 00 00, manufactured Specialties.

## **2.16 SPLITTER BOXES**

- .1 Code gauge galvanized sheet steel enclosure EEMAC Type 4 or 12, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Cast steel enclosure EEMAC 7 or 9 with gasketed bolt on cover for and to suit the designated hazardous locations.
- .3 Copper main and branch lugs to match required size and number of incoming and outgoing conductors.
- .4 At least 3 spare terminals on each set of lugs in splitters less than 400 A.

## **2.17 JUNCTION BOXES**

- .1 Galvanized steel EEMAC Type 1, 4, 12, size as required by code for number and size of conduits, conductors and devices, complete with covers, corrosion resistant screws, terminal blocks and mounting rails.
- .2 Screw-on sheet steel covers to match enclosure for surface mounting boxes.
- .3 Covers with 25 mm minimum extension around for flush-mounted junction boxes.
- .4 Galvanized steel barriers as required.

## **2.18 TERMINAL BLOCKS - SURGE PROTECTION**

- .1 Terminal blocks, rail mounted, with surge voltage protection, rated for circuit voltage.
- .2 Acceptable Manufacturers
  - .1 Phoenix Contact Termitrab SLKK5 (Termitrab SLKK5-F) (TT-SLKK5-S).

## **2.19 PULL BOXES**

- .1 Galvanized sheet steel welded construction, EEMAC Type 4 or 12.
- .2 Screw-on galvanized sheet steel covers for surface mounting boxes.
- .3 Covers with 25 mm minimum extension around, for flush mounted pull boxes.
- .4 Galvanized steel barriers as required.

## **2.20 METER CABINET**

- .1 Sheet steel CSA Type 2 sprinkler-proof enclosure with meter backplate, to accommodate meters, test terminal block and associated equipment, factory installed and wired.

- .2 Utility metering cabinet to conform with Utilities specifications.

## **2.21 CONDUIT BOXES - GENERAL**

- .1 Boxes for EMT
  - .1 Galvanized pressed steel
- .2 Boxes for Rigid Steel Conduit
  - .1 Galvanized cast iron alloy FS boxes with mounting feet for surface mounted switches and receptacles
  - .2 Gasketed cover plate for exterior location
  - .3 For corrosive resistant coated conduit: cast boxes with same finish as conduit
- .3 Boxes for Rigid PVC Conduit
  - .1 PVC boxes

## **2.22 OUTLET BOXES - SHEET STEEL**

- .1 Pressed steel single and multi-gang flush device boxes, minimum size 100 mm x 50 mm x 38 mm. 100 mm square outlet boxes where more than 1 conduit enters 1 side, with extension rings as required.
- .2 100 mm square or octagonal outlet boxes.
- .3 119 mm square outlet boxes with extension and plaster rings as necessary for flush mounting devices in gypsum board, plaster or panelled walls.

## **2.23 MASONRY BOXES**

- .1 Pressed steel masonry single and multi-gang boxes for devices flush mounted in exposed masonry walls with extension and plaster rings as required.

## **2.24 CONCRETE BOXES**

- .1 Pressed steel concrete type boxes for flush mount in concrete with extension and plaster rings as required.

## **2.25 OUTLET BOXES - FITTINGS**

- .1 Bushings and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of foreign materials.
- .3 Double locknuts and insulated bushings for sheet steel metal boxes.

## **2.26 WIRING DEVICES - SWITCHES**

- .1 Specification grade, general purpose AC switches, manual toggle operated, white and brown colour, 15A, 20A, 120-277V, 347V, single pole, double pole, three-way, four-way switches as required.
- .2 Acceptable manufacturers:
  - .1 Hubbell - HBL1201 Series: HBL1221 Series: HBL18201 Series: HBL 18221 Series
  - .2 P & S - 15AC Series: 20AC Series: 370000 Series
  - .3 Arrow Hart - 1891 Series: 1991 Series: 18201 Series: 18221 Series

- .3 Specification grade, general purpose AC switches, manual rocker operated, white colour, 15A, 20A, 120-277V, 347V, single pole, double pole, 3 way, 4 way switches as required.
- .4 Acceptable Manufacturers
  - .1 Bryant, 120-277V, Fashion Series 9000
  - .2 Hubbell, 120-277V, Style Line 2100 Series
  - .3 Leviton, 120-277V and 347V, Decora Plus 5600 Series
  - .4 Pass & Seymour, 120-277V and 347V, Sierraplex Decorator, 2600 and 2600000 Series

## **2.27 WIRING DEVICES – OCCUPANCY SENSORS**

- .1 Occupancy Sensor, WattStopper, Model No. EW-205 or equivalent:
  - .1 The passive infrared sensor shall be capable of detecting presence in the control area by detecting changes in infrared energy.
  - .2 Sensor shall be sealed and gasketed and shall be moisture and dust proof.
  - .3 Sensor shall function in a temperature range of -40°F (-40°C) to +95°F (+35°C).
  - .4 Sensor shall utilize a temperature compensated, dual element sensor and a multi-element Fresnel lens.
  - .5 Fresnel lens shall be a Poly IR 4 based material (for standard and Long Range lens) to offer superior performance in the infrared wavelengths and filter short wavelength infrared, such as those emitted by the sun and other visible light sources. The lens shall have grooves facing in to avoid dust and residue build up which affects IR reception. Aisleway lenses shall be a poly IR 2 based material.
  - .6 Sensor shall provide 270° coverage with the Standard Lens, up to 50 linear feet with the Long Range Lens.
  - .7 Sensor shall have a DIP switch controlled digital time delay setting, adjustable from 15 seconds to 10 minutes approximately.
  - .8 Sensor shall have DIP switch sensitivity setting adjustable from minimum to maximum.
  - .9 Adjustments and mounting hardware shall be concealed under a removable cover to prevent tampering of adjustments and hardware.
  - .10 Sensors shall be capable of being wired in parallel to allow coverage of large areas.
  - .11 To ensure quality and reliability, sensor shall be manufactured by and ISO9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1%.
  - .12 Sensor shall have a standard 5 year warranty.
  - .13 Sensor shall be UL and CUL listed.
- .2 Light Switch Type 'B' - Dual Technology Dual Relay Wall Switch Sensor, WattStopper, Model No. DW-200 or equivalent:
  - .1 Sensor shall be capable of detecting presence in the control area by detecting shifts in transmitted ultrasound and passive infrared heat changes.
  - .2 Sensor shall utilize ultrasonic and PIR technologies to reduce likelihood of false operations

- .3 Sensor shall feature a trigger mode where the end-user can choose which technology will activate the sensor from Off mode (initial), the type of detection that will reset the time delay (maintain), and the type of detection that will cause the sensor to be turned back On immediately after lights turned Off due to lack of motion (re-trigger). Selection of technologies for initial, maintain, and re-trigger shall be done with DIP switches.
- .4 Sensor shall have its trigger mode factory preset to allow for quick installation in most applications. In this default setting, both technologies must occur in order to initially activate lighting systems. Detection by either technology shall maintain lighting on, and detection by either technology shall turn lights back on after lights were turned off for 5 seconds or less in automatic mode and 30 seconds or less in manual mode.
- .5 Sensor shall have 4 occupancy logic options for customized control to meet application needs.
- .6 Robotic test method as referred in the NEMA WD 7 guide shall be utilized for minor motion coverage verification.
- .7 Automatically adjusts the detection threshold dynamically to compensate for constantly changing levels of activity and air flow throughout controlled space.
- .8 Sensor shall utilize two relays capable of simultaneously controlling independent lighting loads or circuits. The secondary relay is isolated, allowing for two-circuit control.
- .9 Sensor shall have no minimum load requirement and shall be capable of switching from 0 to 800 Watt incandescent; 0 to 800 Watt fluorescent or 1/6 hp @ 120 VAC, 60Hz; and 0 to 1200 Watt fluorescent @ 277 VAC, 60Hz.
- .10 Sensor shall feature a walk-through mode, where lights turn off 3 minutes after the area is initially occupied if no motion is detected after the first 30 seconds, set by a DIP switch.
- .11 To avoid false ON activations, the sensor shall examine the frequency, duration, and amplitude of a signal, to respond only to those signals caused by human motion.
- .12 Sensor shall cover up to 1,000 sq. ft. for walking motion, with a field view of 180 degree
- .13 Sensor shall have automatic-ON or manual-ON operation on both relays adjustable with DIP switch.
- .14 Sensor shall have a time delay that is adjusted automatically or shall have a fixed time delay of 5 to 30 minutes, set by DIP switches.
- .15 In automatic mode, sensor shall be capable to automatically return to Automatic-ON after lights are turned off manually.
- .16 Each sensing technology shall have a LED indicator that remains active at all times in order to verify detection within the area to be controlled.
- .17 Sensor shall have a service switch to allow end-users to operate the sensor in the unlikely event of a failure; set by a trim pot.
- .18 Sensor shall be able to control electronic low voltage, and fluorescent loads.
- .19 Sensor shall have a built-in light level featuring simple, one-step daylighting setup that works from 8 to 180 foot candles.

- .20 Switching mechanism shall be a relay(s). Triac and other harmonic generating devices shall not be allowed. Sensor shall have ground wire and grounded strap for safety.
- .21 The Dual Technology wall switch sensor shall be a completely self contained control system that replaces a standard toggle switch
- .22 Sensor shall have standard 5 year warranty and shall be UL and CUL listed
- .3 Light Switch Type 'OS' – as type 'B' except single relay switch.

## **2.28 WIRING DEVICES - RECEPTACLES FOR GENERAL SERVICE**

- .1 Receptacles: specification grade suitable for back and side wiring, complete with grounding terminal, white colour for straight blade devices and black colour for twistlock devices.
- .2 All receptacles shall be from one manufacturer.
- .3 Acceptable Manufacturers:
  - .1 15A, 125V, (5-15R) Single Straight Blade
    - .1 Arrow Hart 5261
    - .2 Leviton 5261
    - .3 Hubbell 5261
    - .4 Pass & Seymour 5261
  - .2 15A, 125V, (5-15R) Duplex Straight Blade
    - .1 Arrow Hart 5262
    - .2 Leviton 5262
    - .3 Hubbell 5262
    - .4 Pass & Seymour 5262
  - .3 20A, 125V, (5-20R) Single Straight Blade
    - .1 Arrow Hart 5361
    - .2 Leviton 5361
    - .3 Hubbell 6331
    - .4 Pass & Seymour 5361
  - .4 20A, 125V, (5-20R) Duplex Straight Blade
    - .1 Arrow Hart 5392
    - .2 Leviton 5362
    - .3 Hubbell 5392
    - .4 Pass & Seymour 5362
  - .5 15A, 125V, (5-15R) Duplex GFCI, Straight Blade
    - .1 Arrow Hart GF5242AH
    - .2 Leviton 6599-W
    - .3 Hubbell GF-5252
    - .4 Pass & Seymour 1591

- .6 15A, 125V, (5-15R) Duplex Isolated Ground Straight Blade
  - .1 Arrow Hart IG5262AH
  - .2 Leviton 5262-IG
  - .3 Hubbell IG-5262
  - .4 Pass & Seymour IG6200
- .7 20A, 125V, (L5-20R) Single locking, 2 pole, 3 wire grounding
  - .1 Arrow Hart 6200
  - .2 Leviton 2310
  - .3 Hubbell 2310ACN
  - .4 Pass & Seymour L520-RCN
- .8 20A, 250V, (L6-20R) Single locking, 2 pole, 3 wire, grounding
  - .1 Arrow Hart 6210
  - .2 Leviton 2320
  - .3 Hubbell 2320ACN
  - .4 Pass & Seymour L620-RCN
- .9 30A, 250V, (L6-30R) Single locking, 2 pole, 3 wire, grounding
  - .1 Arrow Hart 6340
  - .2 Leviton 70630-FR
  - .3 Hubbell 2620CAN
  - .4 Pass & Seymour L630RCN
- .10 30A, 250V, (L15-30R) Single locking, 3 pole, 4 wire, phase, grounding
  - .1 Arrow Hart 6520
  - .2 Leviton 2720
  - .3 Hubbell 2720ACN
  - .4 Pass & Seymour L1530-RCN
- .11 20A, 347V (L24-20R) Single locking, 2 pole, 3 wire grounding
  - .1 Leviton 3721
  - .2 Pass & Seymour L3720-RCN
- .12 15A, 125V (5-15R) Quad straight blade, 2 pole, 3 wire grounding
  - .1 Bryant 1254
  - .2 Hubbell 415 series
  - .3 Pass & Seymour 1254
- .13 15A, 347V, (24-15R) Quad straight blade, 2 pole, 3 wire grounding
  - .1 Bryant 3474W
  - .2 Hubbell 415347WC
  - .3 Pass & Seymour 3474W



- .14 15A, 125V, (5-15R) Duplex straight blade
  - .1 Arrow Hart 26262
  - .2 Leviton Decora Plus
  - .3 Hubbell 2152 series
  - .4 Pass & Seymour 885
- .15 15A, 125V (5-15R) Duplex straight blade, 2 pole, 3 wire grounding, surge suppression indicator light, blue (ivory) colour
  - .1 Arrow Hart 5250
  - .2 Hubbell 5260
- .16 15A, 125V (5-15R) Duplex straight blade, 2 pole, 3 wire grounding, isolated ground surge suppression indicator light, blue (ivory) colour
  - .1 Arrow Hart IG5250
  - .2 Hubbell IG5262,

## **2.29 WIRING DEVICES - RECEPTACLES FOR PATIENT CARE AREAS**

- .1 Receptacles: CSA Approved, ULC Listed, specification Hospital grade with green dot symbol, suitable for back and side wiring, flush, complete with grounding terminal, thermoplastic polyester face/body construction, 2-pole, 3-wire grounding receptacles complete with one piece nickel-plated brass mounting strip with integral grounding clips, ground retention clips, nickel-plated brass wiring clamps with nickel-plated brass screws, front circuit identification area and reinforced thermoplastic brass colour as required for type of area for straight blade devices.
- .2 Receptacles of one manufacturer.
- .3 Acceptable Manufacturers:
  - .1 15A, 125V, (5-15R) duplex Straight Blade
    - .1 Leviton: 16262-HG
    - .2 Hubbell: HBL 8200
    - .3 Pass & Seymour: 26262HG
  - .2 20A, 125V, (5-20R) duplex Straight Blade
    - .1 Leviton: 16362-HG
    - .2 Hubbell: HBL 8300
    - .3 Pass & Seymour: 26362HG
  - .3 15A, 125V, (5-15R) duplex Straight Blade, ULC Class A, GFCI
    - .1 Leviton: 7599-HG
    - .2 Hubbell: GF8200H
    - .3 Pass & Seymour: 1595HG
  - .4 20A, 125V, (5-20R) duplex Straight Blade, ULC Class A, GFCI
    - .1 Leviton: 7899-HG
    - .2 Hubbell: GF8300H

.3 Pass & Seymour: 2095HG

## 2.30 WIRING DEVICES - COVER PLATES

- .1 Stainless steel Type 302 alloy, vertically brushed, 0.8 mm thick cover plates.
- .2 Nylon, smooth, high impact strength.
- .3 Pressed steel, galvanized.
- .4 Cast covers for cast boxes with gaskets.
- .5 Outdoors:
  - .1 Marine grade outlet box hood
  - .2 Weather proof die cast alloy 360 copper free aluminum
  - .3 Nema 3R rating for in-use protection
  - .4 Gaskets are closed-cell foam
  - .5 Latching covers hold securely
  - .6 Large cord openings
  - .7 Holes for padlocks are 6.4 mm diameter
  - .8 Acceptable manufacturers:
    - .1 Hubbell No. WP7D Series or equivalent.
- .6 Cover plates of same manufacture as devices.

## 2.31 WELDING RECEPTACLES

- .1 Circuit Breaking Receptacle
  - .1 Receptacle and back box assembly, 600 volt, 60 amp, 3 wire, 4 pole, weatherproof, aluminum housing.
  - .2 Acceptable Manufacturers
    - .1 Appleton Powertite, AJA mounting box and spring door
    - .2 Crouse-Hinds, Arktite AREA 6000 series, AJ back box, angle adaptor and spring door
    - .3 Russellstoll, type JRFA, 20 degree angle adaptor and spring door
- .2 Interlocked Receptacle and Switch
  - .1 Receptacle interlocked with unfused disconnect switch, 600 volt, 60 amp, 3 wire, 4 pole. Receptacle with aluminum housing and spring door. Disconnect switch with NEMA 12 sheet steel enclosure.
  - .2 Acceptable Manufacturers
    - .1 Appleton WSRD interlocked receptacle
    - .2 Crouse-Hinds Arktite receptacle with WSRD disconnect switch
    - .3 Schneider Square D with Crouse-Hinds Arktite receptacle and class 3110 disconnect switch
- .3 Compact Interlocked Receptacle and Switch

- .1 Compact unit, receptacle interlocked with unfused disconnect switch, 600 volt, 60 amp, 3 wire, 4 pole, watertight, NEMA 4X non-metallic enclosure.
- .2 Acceptable Manufacturers
  - .1 Bryant, 460SM series
  - .2 Crouse-Hinds, Arktite CSR Series
  - .3 Hubbell, Circuit-Lock

## **2.32 FUSES**

- .1 Form I, Class "J" HRC for continuous loads
- .2 Form II, Class "C" HRC for cycling loads
- .3 Acceptable manufacturers:
  - .1 Ferraz-Shawmut
  - .2 Cooper Bussmann

## **2.33 PUSHBUTTONS OPERATORS**

- .1 Rockwell Automation, 800T Series
- .2 Exact type and rating to suit application
- .3 Acceptable manufacturers:
  - .1 Rockwell Automation
  - .2 Eaton Cutler-Hammer
  - .3 SquareD
  - .4 GE
  - .5 Schneider Electric

## **2.34 ROOFTOP CONDUIT SUPPORT SYSTEM**

- .1 Cooper B-Line "Dura – Blok" series rooftop support systems

## **2.35 PLYWOOD BACKBOARDS**

- .1 Plywood backboards, good one side, 4' x 8' x 3/4" (1220mm x 2440mm x 19mm) unless indicated otherwise. Treat with primer and two coats of fire retardant paint.
- .2 Mount plywood on vertical strapping, on 40 mm centres to provide 10 mm clearance between wall and rear of plywood. Treat strapping similar to plywood.

## **2.36 ELCU EMERGENCY LIGHTING CONTROL UNIT**

- .1 Provides all required functionality to allow any standard lighting control device to control emergency lighting in conjunction with normal lighting in any area within a building.
- .2 Self-contained and provide integral one half inch pip nipple mount with snap in locking feature for mounting into a standard junction box KO.
- .3 Normally closed dry contacts capable of switching 20 amp emergency ballast loads @ 120-277 VAC, 60 Hz, or 10 amp tungsten loads @ 120 VAC, 60 Hz.

- .4 Universal rated voltage inputs provided for normal power sense and normal switched power at 120-277 VAC, 60 Hz.
- .5 Integral momentary test switch. Pressing and holding this switch shall instantly force the unit into emergency mode and turn on emergency lighting. Releasing the test switch shall immediately return the unit to normal operation.
- .6 Dedicated leads and 24 VDC source for connection to remote test switch, fire alarm system, or other external system capable of providing a normally closed dry contact closure. Breaking contact between the terminals shall force and hold the emergency lighting on until the terminals are again closed. An integral LED indicator shall indicate the unit's current remote activation status.
- .7 Separate LEDs to indicate the presence of normal and emergency power sources. The LEDs shall indicate the unit's current operational mode (normal or emergency).
- .8 Automatically switches emergency lighting on and off as normal lighting is switched. When normal power is not available, the unit shall force and hold emergency lighting on regardless of the state of any external control device until normal power is restored.
- .9 Zero crossing circuitry to protect relay contacts from the damaging effects of inrush current generated by switching electronic ballast loads.
- .10 UL94 V-O plenum rated and equipped with compression flying leads.
- .11 UL and cUL listed and labeled for connection to both normal and emergency lighting power sources.
- .12 Acceptable manufacturer: WattStopper Model No. ELCU-200

## **2.37 FINISH**

- .1 Equipment enclosure finish: baked grey enamel, ANSI 49 or ANSI 61.

## **3 Execution**

### **3.1 WIRE AND CABLE**

- .1 Install wiring in raceways unless noted otherwise.
- .2 Install separate and dedicated neutral wires for each circuit fed from:
  - .1 Harmonic mitigation transformers/panelboards (e.g. RP-Hxx)
  - .2 UPS panelboards (e.g. RP-Uxx)
  - .3 Lighting panelboards (e.g. LP-Lxx)
- .3 Provide 300V rated cable for 120/240V single phase applications, 600 V rated cable for up to 208 V application; 1000V rated cable for up to 600 V application.
- .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.
- .5 Utilize NMD90 in wood frame residential applications when cable size is available.
- .6 Minimum wire sizes:
  - .1 Power and lighting No. 14 AWG

- .2 Control No. 14 AWG
- .3 Fire alarm No.: to Section 28 31 00 Fire Detection and Alarm Systems

.7 Wire and cable application and type:

Application	Type
Lighting branch circuits	T90 nylon for conditioned spaces RW90 for unconditioned spaces/areas
Receptacle branch circuits	T90 nylon for conditioned spaces RW90 for unconditioned spaces/areas
Ceiling boxes to luminaires in suspended ACT	T90 nylon or AC90 cable (max. length as noted below)
Ceiling boxes to luminaires in non-accessible ceilings.	T90 nylon or AC90 cable (max. length as noted below)
Ceiling boxes to receptacles	T90 nylon for conditioned spaces RW90 for unconditioned spaces/areas
Wiring inside high temperature equipment (including final connection)	TEW or SEW-2
Underground and under slab raceways, duct banks, direct burial	RWU90
All distribution feeders and equipment feeders	RW90 or Mineral Insulated
Life safety feeders and equipment feeders	Mineral insulated – 2 hr rated.
Hazardous locations	RW90 or mineral insulated (as per OESC Class 1 zone 2.

.8 Type AC90 cable length limitations:

- .1 Ceiling box to luminaire:
  - .1 2 m maximum in non-accessible ceilings;
  - .2 3 m in accessible ceilings
- .2 Junction box to outlet:
  - .1 4 m maximum

.9 Load current limitations:

- .1 Conductors rated for more than 90°C:
  - .1 75°C code ampacity rating
  - .2 90°C code ampacity rating if terminating device and/or equipment maximum conductor termination temperature is 90°C rated.
- .2 Motor connection:
  - .1 75°C code ampacity rating

- .10 Use wire lubricant when pulling wires into conduit. Wires shall be kept straight and not twisted.

### **3.2 CONNECTORS**

- .1 Install compression terminations and splices in accordance with manufacturer's written instructions.
- .2 Make splices in junction boxes.
- .3 Make connections in lighting circuits with twist type splicing connectors.
- .4 Terminate and splice conductors No. 8 and larger at terminal blocks in junction boxes.
- .5 Seal terminations and splices exposed to moisture, corrosive conditions or mechanical abrasions with heavy wall heat shrinkable insulation.
- .6 Install fixture type connectors and tighten. Replace insulating cap.

### **3.3 MOTOR LEAD CONNECTION KITS, 600 VOLT**

- .1 Install motor lead connection kits for low voltage motors.

### **3.4 CONDUIT AND EMT - GENERAL**

- .1 Run parallel or perpendicular to building lines.
- .2 Group raceways wherever possible. Support on channels.
- .3 Install expansion joints as required.
- .4 Run raceways in web portion of structural steel columns and beams.
- .5 Do not drill structural members to pass through.
- .6 Locate raceways behind infrared or unit heaters with 1500 mm clearance.
- .7 Locate raceways not less than 125 mm clear where parallel to steam or hot water lines with a minimum of 75 mm at crossovers.
- .8 Do not install horizontal runs in masonry walls.
- .9 Use metallic raceway where temperatures exceed 75°C or where enclosed in thermal insulation.
- .10 EMT and non-metallic conduits to contain insulated green ground wire.
- .11 Install 6 mm diameter nylon pull cord in empty raceways.
- .12 Conduits may be surface mounted (exposed) in mechanical and electrical rooms and spaces; and concealed elsewhere.

### **3.5 CONDUIT AND FITTINGS**

- .1 Minimum conduit sizes:
  - .1 Surface installation: 21 mm trade size conduit
  - .2 Embedded in concrete: 27 mm trade size conduit
  - .3 Directly buried: 53 mm trade size conduit

.2 Conduit application and type:

Application	Type
Corrosive areas	rigid steel corrosion resistant coated
Hazardous areas	rigid steel
Outdoor areas	rigid steel hot dip-galvanized
Embedded in concrete	rigid PVC
In or below grade slab	Rigid PVC
Exposed in unfinished areas up to 3 m above finished floor. Use EMT above 3m	rigid steel
Connection to motors and equipment subject to vibration	liquid tight flexible steel conduit
Final connection to dry type transformer	flexible steel conduit
Whip connection to modular furniture - power	Furniture whip provided by furniture system manufacturer or flexible EMT
Whip connection to modular furniture - others	non-metallic extra flexible PVC
Unheated parking garage area	Rigid steel

- .3 Use field threads on rigid conduit of sufficient length to draw conduits up tight.
- .4 Do not bend coated steel conduit. Use elbows for deflections.
- .5 Do not install conduit under slab on grade.
- .6 Do not install conduit in slab, unless indicated otherwise on drawings.
- .7 Use factory "ells" where 90° bends are required for 27 trade size and larger conduits.
- .8 Bend conduit offsets cold. Do not install crushed or deformed conduits and avoid trapped runs in damp or wet locations. Prevent the entrance of water and lodging of concrete, plaster, dirt, or trash in conduit, boxes, fittings, and equipment during course of construction.
- .9 Where conduit joints occur in damp or wet locations, make joints watertight by applying an approved compound on the entire thread area before assembling. Draw up all conduit joints as tightly as possible.
- .10 Cap exposed empty conduits which do not terminate in outlets, panels, cabinets, etc., with standard galvanized plumber's pipe caps.
- .11 Plug empty conduits which terminate flush with floors or walls with flush coupling and brass plug.
- .12 Install conduit sleeves for all exposed conduits and cables passing through walls, ceilings, or floors, and fill void between sleeve and conduit with caulking. If fire-rated caulking is required by code, use same class as walls, ceilings or floors.
- .13 Terminate conduit stubbed up through concrete floor for connection to free standing equipment with a coupling flush with finish floor, and extend rigid conduit to equipment, except where required, use flexible conduit from a point 150 mm above floor.

- .14 Install double locknuts and bushings on all rigid conduit terminations into threadless openings. Increase length of conduit threads at terminations sufficiently to permit bushing to be fully seated against end of conduit.
- .15 Mechanically bend steel conduit.
- .16 Install sealing condulets in conduits at hazardous area boundaries.
- .17 Conduits in Poured Concrete
  - .1 Locate to suit reinforcing steel. Secure firmly to prevent movement during pour.
  - .2 Clear each conduit with mandrel and brush before concrete sets.
  - .3 Protect conduits from damage where they stub out of concrete.
  - .4 Install sleeves where conduits pass through slab or wall.
  - .5 Provide oversized sleeve before membrane is installed where conduits pass through waterproof membrane. Use cold mastic between sleeve and conduit.
  - .6 Encase conduits completely in concrete; provide 50 mm minimum concrete cover.
  - .7 Replace with exposed conduit, any conduit run found to be obstructed after concrete sets.

### **3.6 EMT AND FITTINGS**

- .1 Minimum EMT size: 21 mm trade size conduit.
- .2 EMT Application
  - .1 Exposed in unfinished areas, above truss level and for drops in column web to 3 m above finished floor. Use rigid steel conduit below 3 m.
  - .2 In block walls and stud partitions.

### **3.7 CABLE TRAY**

- .1 Install cable tray systems.
- .2 Provide barriers where required by Code.
- .3 Support cable trays from structural members. Support cable tray on both sides or on cantilever brackets to provide continuous open access to one side of the tray as required. Coordinate support locations and weight per support with building structure. Provide any additional support fastenings required.
- .4 Provide the following minimum clearances:
  - .1 300 mm vertical between top of tray and equipment or structure above.
  - .2 300 mm vertical between trays (between bottom of the upper tray to top of lower tray).
  - .3 600 mm horizontal on access side of tray.
- .5 Ensure that sharp burrs or projections are removed to prevent damage to cables and injury to personnel.
- .6 Install cables individually.
- .7 Lay cables into cable tray. Use rollers where necessary, to pull cables.



- .8 For maintained spacing, secure cables in cable tray at 3 m centers for horizontal runs with black coloured tie wraps and at 1500 mm centres for vertical runs with aluminum clamps supplied by tray manufacturer.
- .9 Maintain power cables greater than one diameter minimum spacing unless shown otherwise.
- .10 Firestop Fire Barriers (refer to Section 26 05 01).
  - .1 Penetration of fire rated walls with cable trays is not allowed. Provide instead metallic sleeves to match cable tray capacity to allow for transitioning of cabling. Pack, seal and firestop around and inside in accordance with Section 07 84 00 Fire Stopping and Smoke Seals.

### **3.8 WIREWAYS**

- .1 Install per manufacturer's recommendations.
- .2 Keep number of elbows, offsets and connections to a minimum.
- .3 Install barriers where required by Code.
- .4 Install gutters to full length of equipment.

### **3.9 SURFACE RACEWAYS**

- .1 Install per manufacturer's recommendations.

### **3.10 FASTENINGS AND SUPPORTS**

- .1 Provide supports and fastenings for the Work of this Division. Do not use supports or equipment provided by other Trades.
- .2 Equipment fastenings and supports shall conform to manufacturers recommendations.
- .3 Do not attach to, or suspend any electrical product or service from the roof deck, mechanical ductwork or piping.
- .4 Do not use wire lashing or perforated strap to support or secure raceways or cable.
- .5 Support rods for any suspended item must not be attached to or extended through steel pan type roofs or through concrete slab roofs.
- .6 For surface mounting of two or more raceways or cables use channels.
- .7 Where there is no wall support for raceways and cables dropped vertically to equipment, provide channel properly secured to floor and structure.
- .8 Hang supports from structural members. Where location does not permit direct support from structure provide necessary brackets, frames, channels secured to structural members.
- .9 Fasten exposed conduit and cables to building construction or support systems using straps. Use beam clamps on exposed steelwork.
- .10 Masonry, tile and plaster surfaces: use lead anchors.
- .11 Poured concrete: use expandable inserts. Low velocity powder activated fastenings may be used only in poured concrete.

- .12 Steel structures: use clips, spring loaded bolts, cable clamps, designed as accessories to basic channel members.
- .13 Do not use powder activated fasteners in, tile, precast concrete or steel structure.
- .14 Do not install conduits or cables on the bottom chord of joists or trusses.
- .15 Use beam clamps of the 2-bolt design and of such type that the rod load is transmitted only concentrically to the beam web centreline. The use of "C" and "I" beam side clamps will not be allowed.
- .16 Where the roof or floor framing consists of open web or long span steel joists and/or trusses, ensure that hangers are located at or within 150 mm of the joist or truss top or bottom chord panel points, otherwise provide additional structural steel as required where hanger spacing does not coincide with joist or truss spacing. Design suspension assembly such that the hanger load is transmitted only concentrically to the supporting joist or truss. The use of "C" and "I" beam clamps, brackets, etc., will not be allowed.
- .17 Locate secondary structural steel members between joists or trusses at or within 150 mm of top or bottom chord panel points. Where the secondary structural steel member cannot be located at or near a joist or truss panel point, provide additional diagonal structural steel web member/members designed for the applicable load to the nearest panel point in the opposite chord member. Diagonal hangers which will induce lateral stresses in the chord members of the joist will not be permitted. Submit shop drawings of the suspension assembly indicating the location of suspension or support points, the maximum load at each suspension point, location and size of hangers, brackets and intermediate framing members when required, and also details of connection to building structure.

### **3.11 ACCESS DOORS**

- .1 Provide an access door and arrange for its installation by the Division in whose work it occurs, whenever any electrical item equipment requiring accessibility, maintenance or adjustment is concealed.

### **3.12 SPLITTER BOXES**

- .1 Install splitters as indicated and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement.

### **3.13 JUNCTION BOXES**

- .1 Install junction boxes in inconspicuous but accessible locations. Secure to structure.
- .2 Install terminal blocks on mounting rails, for termination of each wire and cable regardless of size.
- .3 Only one voltage source is permitted in a junction box.
- .4 Install barriers to separate different auxiliary systems.
- .5 In areas with hard ceilings (e.g. gypsum board), install junction boxes in an accessible area. Extend conduit to junction or pull boxes.
- .6 If an accessible area is not within reasonable reach, group all junction boxes for all systems in one area of the room and advise the Design Architect/Departmental Representative of the need of an access door. Do not proceed with work until approval for access panel is received from the Design Architect.

### **3.14 TERMINAL BLOCKS - SURGE SUPPRESSION**

- .1 Install surge suppression terminal blocks.

### **3.15 PULL BOXES**

- .1 Install pull boxes in inconspicuous but accessible locations. Secure to structure.
- .2 Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.
- .3 Only one voltage source is permitted in a pull box.
- .4 Install barriers to separate different auxiliary systems.
- .5 In areas with hard ceilings (e.g. gypsum board), install pull boxes in an accessible area. Extend conduit to junction or pull boxes.
- .6 If an accessible area is not within reasonable reach, group all pull boxes for all systems in one area of the room and advise the Design Architect/Departmental Representative of the need of an access door. Do not proceed with work until approval for access panel is received from the Design Architect.

### **3.16 OUTLET AND CONDUIT BOXES**

- .1 Install conduit outlet boxes for conduit up to 32 mm and pull boxes for larger conduits.
- .2 Support boxes independently of connecting conduits.
- .3 Seal boxes during construction to prevent entry of debris, dust and dirt.
- .4 For flush installations mount plaster rings to box, flush with wall surface to permit wall finish to come within 6 mm of opening.
- .5 Provide correct size of openings in boxes for conduit, armoured cable connections. Reducing washers will not be acceptable.
- .6 Install switches and other controls close to door lock or latch jambs and other openings, maintaining a minimum of 100 mm from trims of doors (except where installed in door frames of metal partitions) check door swings.
- .7 Install 100 mm square or octagonal outlet boxes for lighting fixture outlets.

### **3.17 METER CABINET**

- .1 Install meter cabinet as close as feasible to service entrance switchboard.
- .2 For utility meters install cabinets with all local utility requirements.

### **3.18 MASONRY BOXES**

- .1 In block walls use deep boxes to provide clear space around knockout for AC90 cable entry.

### **3.19 WIRING DEVICES - SWITCHES**

- .1 In all front of house areas and public areas, all switches are to be Decora/Decorator style.
- .2 Install single throw switches with handle in UP position when switch is closed.
- .3 Install switches in gang type outlet box when more than one switch is required in a location.

- .4 Mount toggle switches at height indicated.
- .5 Install switch colours as follows:

Area	Colour
Gypsum board, plaster or paneled	White
Office	White
Service	Brown
Patient Care Areas	White
Feature wood panels	Black

### 3.20 WIRING DEVICES - OCCUPANCY SENSORS

- .1 Install each occupancy sensor at locations indicated.
- .2 Mount occupancy sensor/switches at height indicated.

### 3.21 WIRING DEVICES - RECEPTACLES

- .1 Generally, install receptacles vertically with ground pins up.
- .2 In patient care areas, 15A/20A straight blade receptacles to be hospital grade.
- .3 In all front of house areas and public areas, all receptacles are to be Decora/Decorator style.
- .4 Comply with requirements of CSA Standard Z32, with regards to identifying the circuit number and supplying panelboard, permanently identified at the outlets. Identify this information in the areas on the front of each receptacle.
- .5 Install receptacles vertically, use gang type outlet box where more than one receptacle is required in a location.
- .6 Where split receptacle has a portion switched, mount vertically and switch upper portion.
- .7 Coordinate with architectural and interior design drawings for final positioning and mounting heights of power and voice/data receptacles. Where there is disagreement between electrical and architectural drawings, take the architectural drawings as correct.
- .8 Maintain clearances between receptacle outlet boxes and millwork as stipulated on the drawings.
- .9 Align and evenly space outlet boxes that are mounted as a group.
- .10 Install receptacle colours as follows:

Area	Colour
Gypsum board, plaster or panelled	White
Office	White
Service, exterior	gray
Patient Care Areas	White

Feature wood panels	Black
---------------------	-------

### **3.22 WIRING DEVICES - COVER PLATES**

- .1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.
- .2 Install suitable common cover plates where wiring devices are grouped.
- .3 Do not use cover plates designed for flush outlet boxes on surface-mounted boxes.
- .4 Provide plaster ring where necessary.
- .5 Install cover plates as follows:

Area	Cover Plate Type
Gypsum board, plaster or panelled	stainless steel (nylon)
Offices	Nylon
Service	galvanized steel
Exterior	Lockable weather proof
Patient Care Areas	Stainless Steel
Feature wood panels	Black

### **3.23 WELDING RECEPTACLES**

- .1 Install welding receptacles.
- .2 Ensure that phase rotation is similar for all receptacles.

### **3.24 CONTROL DEVICES**

- .1 Install as indicated.

### **3.25 PLYWOOD BACKBOARDS**

- .1 Install G1S plywood backboards where indicated on drawings.
- .2 Backboards shall be installed to 8' high from floor.
- .3 Backboards shall be painted with intumescent grey paint.

### **3.26 FIELD FABRICATED METAL WORK**

- .1 Clean and prime paint field fabricated metal work.
- .2 After fabrication deburr, scrape, grind smooth, wire brush with power brush and degrease metal work.
- .3 Prime paint steel with 1 coat of CISC/CPMA 2.75 oil alkyd primer.
- .4 Prime paint aluminum as follows: wash with detergent solution and wipe down with SSPC-SP1 solvent. Apply Glidden #Y-5229 primer to 1.5 mils DFT.
- .5 For brass and bronze alloy materials, prepare as for aluminum but apply 1 coat of CAN/CGSB-1.40-M zinc chromate primer.

END OF SECTION

**General**

**1.1 SUMMARY**

- .1 Section includes:  
Labour, products, equipment and services necessary to complete the work of this Section.
- .2 Refer to grounding riser diagram on drawings for additional information.

**Products**

**2.1 GROUND CONDUCTORS**

- .1 Copper conductors, soft drawn, ASTM Class B stranded.
- .2 Insulated or bare conductors. Insulation colour green.
- .3 Acceptable Manufacturers:  
Erico  
Approved equal manufacturer

**2.2 BURIED CONNECTIONS - EXOTHERMIC TYPE CONNECTION**

- .1 Cable to rod / cable to pipe / cable to cable.
- .2 Moulds, weld metal and accessories.
- .3 Acceptable Manufacturers:  
Erico  
Burndy  
Approved equal manufacturer

**2.3 CONNECTIONS TO STEEL STRUCTURES**

- .1 Exothermic connection (for underground connections) or compression ground connector (for above ground connections).
- .2 Bi-metalic washers shall be used in the case of steel-copper compression connection.
- .3 Acceptable Manufacturers:  
Erico  
Burndy  
Approved equal manufacturer

**2.4 MISCELLANEOUS HARDWARE**

- .1 Galvanized steel ground studs, bolts, washers, nuts and accessories necessary for grounding system, including but not limited to:  
Grounding and bonding bushings  
Bolt type conductor connectors  
Bonding jumpers, straps  
Pressure type wire connectors

- .2 Acceptable Manufacturers:
  - Erico
  - Burndy
  - T & B Blackburn

## **2.5 GROUND RODS**

- .1 Copper-clad steel, minimum 19 mm diameter, 3 m long, two 1.5m sections which are connected via grounding coupling.
- .2 At manholes provide screw down lugs on ground rods.
- .3 Acceptable Manufacturers:
  - Erico
  - Hydel
  - T & B Blackburn
  - Approved equal manufacturer

## **2.6 GROUND ELECTRODE INSPECTION BOX**

- .1 Inspection box, hot dip galvanized steel or hard PVC, with flush cover and ground lug, minimum 245mm dia., 300 mm deep, lockable door.
- .2 Acceptable Manufacturers:
  - Erico
  - Burndy
  - Lacal
  - Hydel
  - Approved equal manufacturer

## **2.7 GROUND BUS**

- .1 Ground bus: copper, 50 mm x 6 mm thick complete with insulated supports, fastenings, connectors, length as indicated.
- .2 Telecommunication Main Grounding Busbar (TMGB): copper, 100mm x 6 mm thick complete with insulated supports, fastenings, connector, and length as indicated.
  - The TMGB shall be predrilled with holes for use with standard sized lugs.
  - The TMGB shall be UL listed and meet the requirements of ANSI-J-STD-607-A
  - The TMGB shall be sized as above or lengthen to meet the requirements of the immediate application with consideration for future growth.
- .3 Telecommunication Grounding Busbar (TGB): copper, 50mm x 6 mm thick complete with insulated supports, fastenings, connector, and length as indicated.
  - The TGB shall be predrilled with holes for use with standard sized lugs.
  - The TGB shall be UL listed and meet the requirements of ANSI-J-STD-607-A
  - The TGB shall be sized as above or lengthen to meet the requirements of the immediate application with consideration for future growth.



- .4 Acceptable manufacturers:

Erico

Burndy

Harger

Approved equal manufacturer

## **2.8 ALUMINUM STRUCTURES AND EQUIPMENT**

- .1 Use tin or silver plated connectors for grounding connections to aluminum structures and equipment.

- .2 Acceptable Manufacturers:

Erico

Burndy

Thomas & Betts

Approved equal manufacturer

## **Execution**

### **3.1 GENERAL**

- .1 Clean all paint, rust and dirt from all surfaces to which ground lugs are bolted.
- .2 Protect exposed grounding conductors from mechanical damage.
- .3 Ensure that moulds, for exothermic type connections, are not used for more than 50 connections.
- .4 All panels, junction and terminal boxes, shall be bonded to grounding conductors.
- .5 Primary grounding:
- Install continuous grounding system including, electrodes, conductors, connectors and accessories as indicated and to requirements of ESA (Electrical Safety Authority) and Horizon Utilities.
- Install connectors and cadweld in accordance with manufacturer's instructions.
- Protect exposed grounding conductors during and after construction.
- Make buried connections, and connections to electrodes, structural steel work, using copper welding by thermite process.
- Use mechanical connectors for grounding connections to equipment provided with lugs.
- Use tinned copper conductors for aluminium structures, in all connection of two different metals, bimetallic washers shall be used.
- Do not use bare copper conductors near unjacketed lead sheath cables.
- .6 Secondary grounding:
- Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories.
- Where EMT or rigid steel is used, run separate and dedicated ground wire for each circuit within.
- Install connectors in accordance with manufacturer's instructions.

Protect exposed grounding conductors from mechanical injury.

Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermite process.

Use mechanical connectors for grounding connections to equipment provided with lugs.

Soldered joints are not permitted.

Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of flexible conduit.

Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.

Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

Bond single conductor, metallic armoured cables to cabinet at supply end, and provide non-metallic entry plate at both ends.

Make ground connections to continuously conductive underground water pipe on street side of water meter.

Install water meter shunt.

### **3.2 EQUIPMENT GROUNDING**

- .1 Install grounding connections as indicated to typical station equipment including: metallic water main, line sky wire, neutral, gradient control mats. Non current carrying parts of: transformers, generators, motors, circuit breakers, reclosers, current transformers, frames of gang-operated switches and fuse cutout bases. Cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers. Meter and relay cases. Any exposed building metal, within or forming part of station enclosure. Sub-station fences, pothead bodies. Outdoor lighting.
- .2 Ground hinged doors to main frame of electrical equipment enclosure with flexible jumper.
- .3 Connect metallic piping (water, oil, air, etc.) inside station to main ground bus at several locations, including each service location within station.[Make connections to metallic water pipes outside station to assist in reduction of station ground resistance value].

### **3.3 BURIED GROUNDING LOOP**

- .1 For buried grounding connected only exothermic connection types are permitted.
- .2 Install ground rods 300 mm below finished grade.
- .3 Install ground loop around transformer foundation 300 mm below finished grade. Refer and comply with Horizon Utilities ground requirements for pad mounted transformers.

### **3.4 DUCT BANKS**

- .1 Bond metal raceway within duct banks to system ground each 10 m distance (at least from two points).
- .2 Connect grounding conductor in duct banks to ground bus or ground rods in electrical rooms, substations, manholes, etc.

**3.5 MANHOLES**

- .1 Provide ground rod(s) in each manhole and connect to metalwork such as, ladder, cable racks, manhole metal frame.
- .2 Install ground rod with top projecting through floor slab and install a screw down lug for connection of portable appliances etc.
- .3 Where more than one compartment is provided, install ground rod in each compartment.

**3.6 STRUCTURAL STEEL AND BUILDING GROUNDING**

- .1 Ground building structural steel columns to buried perimeter grounding conductor. Ensure perimeter cable is slack to avoid stressing the connections.
- .2 Install grounding jumpers across building expansion joints.
- .3 Install ground rods close to column foundations and drive top of rod 300 mm below grade or finished floor level of slab on grade.
- .4 Install inspection boxes.

**3.7 ELECTRICAL ROOMS**

- .1 Install ground buses as indicated on plans.
- .2 Connect electrical panels and equipment ground buses and lugs to electrical room perimeter or bar ground bus. Make connections to bus with cable lugs, bolted through the copper bus with shakeproof lockwashers and nuts. Use minimum No. 2/0 AWG or as shown on drawings, bared copper conductor to bond ground bus to grounding system.

**3.8 LIGHTING POLES**

- .1 Lighting poles shall be connected to the grounding system via the grounding conductor inside the lighting cable (fifth core in 5-core cables or third-core in 3-core cables)

**3.9 PAD MOUNTED TRANSFORMERS**

- .1 Main transformer (utility transformer) body shall be connected to the ground grid around it from at least two points.
- .2 Main transformer neutral point shall be connected directly to the ground grid with minimum 4/0 AWG size grounding conductor.
- .3 Also, transformer neutral points shall be interconnected via interconnection cables (Neutral core of the connecting cable).

**3.10 POLE MOUNTED TRANSFORMER GROUNDING**

- .1 Drive ground rods at base of each pole on which transformers are mounted and interconnect transformer, system neutral, lightning arresters and ground rods.

**3.11 NEUTRAL GROUNDING**

- .1 Connect transformer neutral and distribution neutral together using 1000 V insulated conductor to one side of ground test link, the other side of the test link being connected directly to main station ground. Ensure distribution neutral and neutrals of potential transformers and service banks are bonded directly to transformer neutral and not to main station ground.
- .2 Interconnect electrodes and neutrals at each grounding installation.

- .3 Connect neutral of station service transformer to main neutral bus with tap of same size as secondary neutral.
- .4 Ground transformer tank with continuous conductor from tank ground lug through connector on ground bus to primary neutral. Connect neutral bushing at transformer to primary neutral in same manner.

### **3.12 LOW VOLTAGE PANELS**

- .1 All electrical panels' body shall be connected to the panel ground bus from two points. Panel ground busbar shall be connected to the grounding busbar in electrical room from two different points.

### **3.13 CONDUCTORS**

- .1 Conductors: bare, stranded, soft annealed copper wire, size No. 4/0 AWG and 2/0 AWG for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections.
- .2 Conductors: bare or PVC insulated coloured green, stranded [un] [tinned] soft annealed copper wire, size No. 4 AWG for grounding cable sheaths, raceways, pipe work, screen guards, switchboards, potential transformers.
- .3 Conductors: pvc insulated coloured green, stranded soft annealed copper wire No. 10 AWG for grounding meter and relay cases.
- .4 Conductors: No. 3/0 AWG extra flexible (425 strands) copper conductor for connection of switch mechanism operating rod to gradient control mat, fence gates, vault doors.

### **3.14 RACEWAYS**

- .1 On raceways, lock-up tight all couplers and connections to boxes and enclosures. Install bonding jumpers at expansion joints, and where necessary. Maintain ground continuity throughout run of raceway.
- .2 Install bonding jumpers on both ends of flexible conduit. Use grounding bushing, solderless lug, clamp or cup washer and screw connection. Install grounding conductor inside flexible conduit.
- .3 EMT and non-metallic raceways: install insulated grounding conductor in raceway.
- .4 Branch and feeder circuits in rigid conduit: use raceway as bonding conductor.
- .5 Cable trays: provide a bare No. 2/0 AWG ground conductor along inside of tray run bonded to tray at 15 m intervals. Where multiple cable trays are supported on a common structure bond all trays to one common grounding conductor at 15 m intervals. Keep grounding continuity when cable trays transition to conduit. Provide conduit bonding lugs as required.

### **3.15 TELECOMMUNICATIONS ROOMS**

- .1 Bond metallic raceways to building ground
- .2 Provide telecommunications ground bus TMGB or TGB as designated on drawings, on one wall of telecommunications room (as indicated). Mounted TMGB and TGB on stand-off brackets to clear adjacent obstructions.
- .3 Provide No. 6 AWG insulated grounding conductor from TGB to ground bus to telecommunications room power distribution panel.

- .4 Maintain isolation between building ground and all components within the telecommunications room connected to the TMGB or TGB.
- .5 Provide isolated ground receptacles in telecommunications rooms. Provide a separate ground conductor from each receptacle to the ground bus in the power distribution panel.
- .6 Connection to the TMGB and TGB shall be made by exothermic welding or by listed two-hole compression lugs.
- .7 Provide No. 6 AWG insulated grounding conductor to bond TMGB to ground bus in main electrical room
- .8 All metal conduits or raceways for telecommunications cabling located within the same room or space as the TMGB or TGB shall be bonded to TMGB or TGB.

Metal conduits 27mm diameter and larger shall be bonded using electro thin plated pipe clamps.

Metal conduits 21mm diameter and smaller shall be bonded using electro thin plated conduit bonding clamps.

Metal cable trays shall be bonded using electro-tinplated cable tray bonding clamps.

Bonding surface areas shall be cleaned to bare metal removing all paint, etc. The contact area shall be protected from corrosion using antioxidant joint compound.
- .9 Where an electrical panelboard for telecommunication equipment is located in the same room or space as the TGB or TMGB, the panelboard ground bus or panelboard enclosure shall be bonded to the TMGB or TGB.
- .10 The TMGB or TGB shall be located in an area that is accessible to telecommunications personnel.
- .11 Provide individual No. 6 AWG insulated grounding conductors from each telecommunications cabinet or frame to the TGB
- .12 Provide #12AWG insulated green conductor from static dissipative tile (SDT) to TGB.

### **3.16 TESTING**

- .1 Test the primary grounding loop resistance to ground, before bonding to others loops or devices (e.g. lightning protection loops) the connection is made to link them together.
- .2 For resistance to ground measurements use a ground resistance test set with an accuracy of 10 milliohms.
- .3 For measuring resistance to ground use the fall of potential method as outlined in IEEE Standard No. 81. After selecting the distance for the current probe take resistance measurements at a minimum of six voltage probe locations. Ensure that three of the voltage probe locations have resistance values such that the difference between any two is 0.5 ohm or less. If this is not the case repeat and retest with a larger distance for the current probe until this condition is satisfied.
- .4 Perform testing under average weather conditions; allow three days after the last rain before conducting test. Do not test resistance to ground under frozen soil conditions unless specifically approved by Consultant.
- .5 Test the integrity of the connections between the various components of the total grounding system. Test separately the continuity of the building perimeter loop (if used) and the connections between the primary grounding grid and the building grounding system.

- .6 For continuity measurements use a bridge or similar type test meter designed for the purpose with an accuracy of 1 milliohm.
- .7 Where readings are not acceptable to Electrical Inspection and Consultant provide additional ground conductors, ground rods, connections, as necessary to satisfy the requirements of both.
- .8 Prepare and submit a Test Report, signed by the Test Engineer, and where witnessed, by Consultant. Include record of tests performed, methods of calculation, date and time of test, ambient conditions, and names of testing company, test engineer, witnesses, also calibration record of all test instruments used together with manufacturers name, serial number and model number. Calibration record shall include percentage error, correction factors, if any. Submit 3 copies.

**END OF SECTION**

- 1 General
- 1.1 **SUMMARY**
  - .1 Section includes:
    - .1 Labour, products, equipment and services necessary to complete the work of this Section.
- 1.2 **APPROVALS**
  - .1 Identification subject to prior approval of Departmental Representative.
- 2 Products
- 2.1 **WIRE AND CABLE MARKERS**
  - .1 Wire and Cable Diameter Less Than 13 mm
    - .1 Acceptable manufacturer
      - .1 Wieland Z type
  - .2 Cable Diameter 13 mm and Larger
    - .1 Acceptable manufacturer
      - .1 Wieland K type
  - .3 Non-Circular Wire
    - .1 Acceptable manufacturer
      - .1 Raychem Shrinkmark sleeves
- 2.2 **CONDUIT AND ELECTRICAL METALLIC TUBING MARKERS**
  - .1 Stick-On Marker
    - .1 Raceway Size    Minimum Character Height
      - .1 ¾" - 1¼"    15 mm
      - .2 1½" - 2"    19 mm
      - .3 Over 2"    32 mm
  - .2 Acceptable Manufacturers
    - .1 Brady, vinyl cloth, black on orange, type B-500
    - .2 Panduit, vinyl cloth, black on yellow, type PCL
    - .3 Wieland, mylar, black on yellow, type NL
- 2.3 **CABLE TRAY MARKERS**
  - .1 Stick-On Marker each 15m
    - .1 Acceptable Manufacturers
      - .1 Brady, vinyl cloth, black on orange, 48 mm character height, type B-500
      - .2 Safety Supply Canada, conduit and voltage markers, style A, 48 mm character height

- .3 Panduit, vinyl indoor/outdoor, black on yellow, 50 mm character height, type PVL
- .4 Wieland, black on yellow, 50 mm character height, Electrocode NL

## 2.4 BUSWAY MARKERS

- .1 Stick-On Marker
  - .1 Acceptable Manufacturers
    - .1 Brady, vinyl cloth, black on orange, 48 mm character height, type B-500
    - .2 Safety Supply Canada, conduit and voltage markers, style A, 48 mm character height
    - .3 Panduit, vinyl indoor/outdoor, black on yellow, 50 mm character height, type PVL
    - .4 Wieland, black on yellow, 50 mm character height, Electrocode NL
  - .2 Laminated plastic, black letters on white background, 75 mm character height.
  - .3 Suspended sign, rigid vinyl, black on yellow, 75 mm character height.
    - .1 Acceptable Manufacturers
      - .1 Panduit
      - .2 Safety Supply Canada
  - .4 Typical Identification: "347/600 V, 800A, 3-ph, 4W" "FED from MSB".

## 2.5 PANELBOARD IDENTIFICATION

- .1 Engraved laminated plastic, black lettering on white background, 6 mm character height.
- .2 Typical 2-line identification for lighting panel:
  - "LP-L2A, 120/208V, 3ph, 4W" "FED from TX2C"
- .3 Directories: Typewritten identification of breaker number, ampere rating and connected equipment.

## 2.6 SWITCHBOARD IDENTIFICATION

- .1 Engraved laminated plastic, black lettering on white background, 15 mm minimum character height.
- .2 Typical Identification: "Switchboard AAA, 347/600V, 3 ph, 4 w".

## 2.7 MOTOR STARTER, CONTACTOR AND DISCONNECT SWITCH IDENTIFICATION

- .1 Engraved laminated plastic, black lettering on white background, 6 mm character height.
- .2 Typical Identification: "Pump S4, 600V, 3 ph". "FED from DP-MBA"

## 2.8 MAGLOCK/FIRE ALARM PULL STATIONS IDENTIFICATION

- .1 Engraved laminated plastic, red lettering on white background, 25 mm character height.
- .2 Identification: "EMERGENCY EXIT UNLOCKED BY FIRE ALARM OR BY SECURITY SYSTEM".



**2.9 WARNING SIGNS**

- .1 Outdoor - metal, porcelain enamel finish. Indoor - rigid vinyl.
- .2 Typical Identification: "Danger - High Voltage".
- .3 Acceptable Manufacturers
  - .1 Outdoor: Safety Supply Canada
  - .2 Indoor: Safety Supply Canada, Panduit

**2.10 MARKER TAPE, SERVICE AND PHASE IDENTIFICATION**

- .1 As a minimal standard of performance the electrical device shall meet the or exceed the construction standards as provided be the following manufacturers
  - .1 3M, Scotch Code Tape, type STD with SDR colour refills or 3M Scotch 35 colour tape.

**3 Execution**

**3.1 SYSTEMS IDENTIFICATION**

- .1 Identify outlet boxes for various systems with distinctive paint colour. Apply a small area of paint to inside of outlet, junction and pull boxes and panels. In suspended ceiling areas, apply paint to inside and outside of junction boxes. System colours:

System	Normal	Emergency	UPS
120/208 volt	black	black/red	black/blue
347/600 volt	orange	orange/red	orange/blue
Fire alarm	red		
Intercom	brown		
Low voltage control	black		
Security	light green		

**3.2 POWER COMPANY SERVICE IDENTIFICATION**

- .1 Identify service conductors with coloured marker tape as follows:
  - .1 Phase A red
  - .2 Phase B black
  - .3 Phase C blue
  - .4 Neutral white
  - .5 Ground green

**3.3 WIRE AND CABLE IDENTIFICATION**

- .1 Identify power, control, lighting and receptacle wires with continuous coloring as follows:
  - .1 Phase A red
  - .2 Phase B black
  - .3 Phase C blue
  - .4 Neutral white
  - .5 Ground green

- .6 Isolating ground green and yellow
- .7 Control red
- .8 Interlock yellow
- .9 D.C. blue
- .2 For larger wire sizes available only in black, install colored wire marker tape in accordance with above coding.
- .3 Cables Bearing Identification Numbers on the Drawings
  - .1 Install identification markers at each end of cable run.
- .4 Control/Indication Conductors
  - .1 Install conductor identification markers at switchgear, motor control centres and motor starter terminal blocks and at remote devices.
  - .2 Identification in accordance with the Drawings and reviewed shop drawings.
- .5 Lighting and Receptacle Branch Circuits
  - .1 Install conductor identification markers at panel, outlet box connections to lighting fixtures and device outlet boxes.
  - .2 Typical identification if fixture or device is connected to panel RP-H2B, circuit 5: H2B-5.
- .6 Low Voltage Lighting Control
  - .1 Install conductor identification marker at relay phase conductors. Typical identification if connected to panel LP-L2A, circuit 5: L2A-5.
  - .2 Install conductor identification marker on conductors between control locations and relay panels. Identify in accordance with reviewed shop drawings.
- .7 Data, Voice and Fibre Optic Cables
  - .1 Label horizontally distributed cabling at the following locations:
    - .1 Both ends of cable run
    - .2 Entrance and exit of cable pathway (i.e. cable trays, zone conduits, etc.)
  - .2 Label riser/backbone distribution cables at the following locations:
    - .1 Both ends of cable run
    - .2 Entrance and exit of cable pathway (ie. cable trays, zone conduits, etc.)
    - .3 1.5 m above finished floor in communication closets and equipment rooms
    - .4 At entrance and exit of a sleeve or slot in communication closets and equipment rooms
  - .3 Use the following color codes for labels:

Function	Color
Auxiliary and miscellaneous circuits	Yellow
Common equipment	Purple
Customer side of network interface	Green
First level backbone	White

Horizontal cabling to workstations	Blue
Inter-building backbone	Brown
Key telephone systems	Red
Network side of network interface	Orange
Second level backbone	Gray

Note: Common equipment refers to PBX equipment, host computer, LANs and multiplexer. Miscellaneous refers to maintenance alarms, security, paging systems, and other system and circuits not an integral part of common equipment. Color codes to ANSI/TIA/EIA-606.

.8 Fire Alarm and Miscellaneous Systems

- .1 Install identification on conductors at panels, remote devices and system connections. Identify in accordance with reviewed shop drawings.
- .2 Install maglock/fire alarm pull station identification adjacent to each door equipped with a maglock.

3.4 **CONDUIT AND ELECTRICAL METALLIC TUBING (EMT) IDENTIFICATION**

- .1 Where Drawings indicate conduit and EMT identification numbers/letters, install identification markers at each end of run and at pull box locations.

3.5 **CABLE TRAY IDENTIFICATION**

- .1 Install markers indicating system, voltage, or voltages for trays with barriers, and identification number at intervals of 20 m maximum, at branches and termination locations.

3.6 **BUSWAY IDENTIFICATION**

- .1 Install stick-on markers indicating busway identification number and rating at cable tap boxes and thereafter at intervals of 30 m maximum.
- .2 Install suspended identification signs at start of run and at intervals of 30 m maximum.

3.7 **PANELBOARD IDENTIFICATION**

- .1 Install identification plates, using adhesive, on outside of panel.
- .2 Install directory.
- .3 Identify main bus as follows:
  - .1 Phase A red
  - .2 Phase B black
  - .3 Phase C blue
  - .4 Neutral white
  - .5 Ground green

3.8 **SWITCHBOARD IDENTIFICATION**

- .1 Install identification plates for panel and branch feeders.

3.9 **MOTOR STARTER, CONTACTOR AND DISCONNECT SWITCH IDENTIFICATION**

- .1 Install identification plates using self-tapping screws.

**3.10 IDENTIFICATION AFTER FINISH PAINTING**

- .1 Behind access doors at shaft plenums: identify busways, feeder cables and feeder conduits.

**3.11 EQUIPMENT WARNING SIGNS**

- .1 Install "Danger - High Voltage" signs.
- .2 When equipment is supplied from more than one source install red warning signs to this effect.

**3.12 PATCH PANEL AND FACEPLATE IDENTIFICATION**

- .1 Identify each jack at each wall or furniture outlet with a label supplied by the faceplate manufacturer. Each jack identification designation to match the respective cable identification designation.
- .2 Identify each jack at each patch panel jack with labels, front and back, supplied by the patch panel manufacturer. Each jack identification designation to match the respective cable identification designation.
- .3 In addition to an alphanumeric label use manufacturer's matching colour coded icons, which conform to ANSI/TIA/EIA-606, to identify individual jacks on faceplate and patch panels.

End of Section

## **1 General**

### **1.1 SUMMARY**

- .1 Section includes:
  - .1 Labour, products, equipment and services necessary to complete the work of this Section.

### **1.2 RELATED SECTIONS**

- .1 Section 26 05 01: Basic electrical requirements.
- .2 Section 26 05 54: Electrical identification.

### **1.3 REFERENCES**

- .1 Conform to latest issues, amendments and supplements of following standards:
  - .1 CSA C22.2 No.29-11, Panelboards and enclosed Panelboards.
  - .2 CSA-C22.2 No. 5-02, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

### **1.4 SYSTEM DESCRIPTION**

- .1 Panelboards – Power Switching Circuit Breaker Type

## **2 Products**

### **2.1 PANELBOARDS - CIRCUIT BREAKER TYPE**

- .1 All of Panelboards to be product of one manufacturer.
- .2 Enclosures: Steel, NEMA 2, sprinklerproof.
- .3 Bus: Copper, ground bar, isolated ground bar and full capacity neutral bar, braced for interrupting capacity as indicated on drawings or schedules.
- .4 A minimum of 10% spares.
- .5 Breakers
  - .1 Moulded-case circuit breakers, circuit breakers and ground-fault circuit-interrupters to CSA C22.2 No. 5.
  - .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
  - .3 Common-trip breakers: with single handle for multi-pole applications.
  - .4 Circuit breakers to have minimum symmetrical rms interrupting capacity rating as required in the single line diagrams.
  - .5 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
  - .6 Ground Fault Interrupter Breakers – Class A:
    - .1 Single or two pole ground fault circuit interrupter c/w test and reset

- facilities.
- .2 30mA trip sensitivity.
- .7 Ground Fault Equipment Protector Breakers – Class B:
  - .1 Single or two pole ground fault circuit interrupter c/w test and reset facilities.
  - .2 30 mA trip sensitivity.
- .8 Main breaker:
  - .1 Separately mounted in vertical position on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .9 Provide RED colour breakers with lock-on devices for breakers serving fire alarm devices.
- .10 Lock-on devices for all security, life safety and asset integrity circuits as identified.
- .11 Breaker Arrangement: Locate breakers at specific circuit number locations shown on panelboard schedule sheet.
- .12 Lock-on Devices: For circuits supplying continuously operating equipment. Minimum quantity 10% of 15A, 20A and 30A rated breakers.
- .6 Door: Hinged lockable door.
- .7 Keys: 2 keys per panelboard; key panelboards alike.
- .8 In addition to CSA requirements, manufacturer's nameplate to indicate panel withstand fault current.
- .9 Spaces: Fully bussed for future breakers with removable filler plates.
- .10 Acceptable Manufacturers
  - .1 Cutler-Hammer
  - .2 Schneider Electric / Square D
  - .3 GE Canada
  - .4 Siemens Canada

## **2.2 PANELBOARDS – POWER SWITCHING CIRCUIT BREAKER TYPE**

- .1 The Power Switching Panelboard is an Eaton Cutler Hammer, "Pow-R-Command 750" or approved equivalent.
- .2 Acceptable Manufacturers:
  - .1 Eaton Cutler Hammer
  - .2 Schneider Electric / Square D
  - .3 Siemens Canada
- .3 Enclosures:
  - .1 Steel, NEMA 2, sprinklerproof.
  - .2 Interiors shall be capable of housing a control module and sized to allow easy access and replacement of the control modules.

- .3 Interiors shall provide a Class 2 separation for the control module with an internal Class 2, 120/277 VAC power supply with secondary thermal magnetic ON/OFF protection to provide power to the panelboard control module. Power supply shall be fed from panelboard bus.
- .4 Provide dead front cover for access to control module
- .5 Control module shall be provided with local ON/OFF switch and programming/diagnostic port.
- .4 Bus: Copper, ground bar and full capacity neutral bar, braced for interrupting capacity as indicated on drawings or schedules.
- .5 A minimum of 10% spares.
- .6 Integral programmable plug and play lighting control module that provides ON/OFF control for low voltage switchable circuit breakers.
- .7 Pre-wired and factory assembled.
- .8 Switching 'Smart' Breakers
  - .1 Low voltage controlled thermal magnetic circuit breaker in a standard panelboard enclosure.
  - .2 Branch circuit breakers shall have bolt-on type bus connectors. Plug-in type circuit breakers are not acceptable.
  - .3 Circuit breakers shall have an overcenter toggle mechanism, which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- pole circuit breakers shall have common tripping of all poles.
  - .4 Circuit breaker trip target shall be provided. In addition, the circuit breaker handle shall move to center of travel on breaker trip.
  - .5 Circuit breakers marked "Remotely Controlled" on drawings shall respond to a remote low voltage Class 2 signal for Open or Closed contact positioning. Circuit breaker power contacts shall remain Open when the breaker handle is in the OFF or tripped position, regardless of the remote close command. Remote control shall only be possible when the breaker handle is in the ON position. Circuit breakers may be manually controlled by operating the breaker handle in the event of a control module failure. Control power for circuit breakers shall be derived from the control module.
- .9 Standard Breakers
  - .1 Moulded-case circuit breakers, circuit breakers and ground-fault circuit-interrupters to CSA C22.2 No. 5.
  - .2 Bolt-on moulded case circuit breaker: quick- make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees C ambient.
  - .3 Common-trip breakers: with single handle for multi-pole applications.
  - .4 Circuit breakers to have symmetrical rms interrupting capacity rating as specified in the single line diagram.
  - .5 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

- .6 Ground Fault Interrupter Breakers – Class A:
  - .1 Single or two pole ground fault circuit interrupter c/w test and reset facilities.
  - .2 30mA trip sensitivity.
- .7 Ground Fault Equipment Protector Breakers – Class B:
  - .1 Single or two pole ground fault circuit interrupter c/w test and reset facilities.
  - .2 30 mA trip sensitivity.
- .8 Main breaker:
  - .1 Separately mounted in vertical position on top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .9 Provide RED colour breakers with lock-on devices for breakers serving fire alarm devices.
- .10 Lock-on devices for all security, life safety and asset integrity circuits as identified.
- .11 Breaker Arrangement: Locate breakers at specific circuit number locations shown on panelboard schedule sheet.
- .12 Lock-on Devices: For circuits supplying continuously operating equipment. Minimum quantity 10% of 15A, 20A and 30A rated breakers.
- .10 Door: Hinged lockable door.
- .11 Keys: 2 keys per panelboard; key panelboards alike.
- .12 In addition to CSA requirements, manufacturer's nameplate to indicate panel withstand fault current.
- .13 Spaces: Fully bussed for future breakers with removable filler plates.

### **3 Execution**

#### **3.1 GENERAL**

- .1 Protect equipment from dust, debris, moisture, and physical damage, with sealed envelope of plastic or other impervious material until building is enclosed and cleaned and equipment is energized.
- .2 Protect from condensation by maintaining at suitable temperature above 0°C.
- .3 Finish equipment enclosures to ANSI 49 or ANSI 61, baked grey enamel.

#### **3.2 PANELBOARDS**

- .1 Locate panelboards, secure, plumb true and square to structure.
- .2 Mounting Methods
  - .1 Exterior walls and interior combustible walls: mount on continuous slotted channel strut with 75 mm clear between back of panel and wall. Where practical, group panelboards on common frame.
  - .2 Interior non-combustible walls: mount against wall.



- .3 Provide plywood backboards behind all wall mounted panelboards. Plywood to G1S and painted with Intumescent grey paint.
- .3 Where panelboards are flush mounted, provide 3 – 25 mm spare empty conduits from each panelboard into ceiling space above.
- .4 Identify load circuits on panel directory complete with name and location.
- .5 Where panelboards are equipped with fused switches, install fuses immediately prior to energize. Record fuse rating on breaker or switch cover.
- .6 Training
  - .1 Provide a training session for the Departmental Representatives for normal workdays at a jobsite location determined by the Departmental representative.
  - .2 The training session shall be conducted by a manufacturer's qualified representative. Training program shall include review of all system components and their function and operation instructions.
  - .3 Factory Testing
    - .1 The factory service shall provide adequate testing of the supplied equipment to ensure that the system performs as intended by the specification. Building engineering personnel shall be trained on all aspects of operating and maintaining the system. Care shall be taken to ensure that the system load connections are to the electrical drawing and that the control scenarios are operating properly.
  - .4 Field Quality Control
    - .1 Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in starting-up the system for a period of working days. The manufacturer's representative shall be factory-trained and shall have a thorough knowledge of the system and functions:
      - .1 Check installation of all smart panelboards, expansion cabinets and the central operator's station
      - .2 Test operation of all remote-controlled loads
      - .3 Repair or replace any defective component
      - .4 Test operation of complete lighting control system
      - .5 Conduct system point-by-point walk through
  - .5 The Contractor shall provide three (3) copies of the manufacturer's field startup.

### **3.3 DELIVERY, STORAGE AND HANDLING**

- .1 Do not ship equipment to site prior to completion of factory testing and acceptance of test results by Departmental representative.

### **3.4 WARRANTY**

- .1 Warranty requirements shall be as indicated in Division 01 except for this equipment the duration of warranty period shall be 12 months from the date the equipment is placed in service or 18 months from the date the equipment is accepted at site, whichever shall occur first.

**END OF SECTION**

## **1 General**

### **1.1 SUMMARY**

- .1 Section includes:
  - .1 Labour, products, equipment and services necessary to complete the work of this Section including, but not limited to, the following:
    - .1 Lighting equipment as per the luminaire schedule and as specified herein.
- .2 Refer to Electrical lighting plan for exact location of luminaires.
- .3 Check latest ceiling finish schedule in areas where recessed luminaires are specified to ensure that luminaires have suitable ceiling trim for particular ceiling finish.
- .4 Refer to Luminaire Schedule located on drawings for specific light fixture information.

### **1.2 SUBMITTALS**

- .1 Submit shop drawings in accordance with Division 01.
- .2 Submit certified copies of photometric test data, for each luminaire type, prepared by independent testing laboratory. Photometric data to include total input watts, candlepower summary, candlepower distribution, zonal lumen summary, luminaire efficiency, coefficient of utilization table, lamp type, ballast type and manufacturer, and lumen rating in accordance with IESNA testing procedures.
- .3 Submit samples as directed by Departmental Representative for the following luminaire types:

### **1.3 REFERENCES**

- .1 CSA C22.2 No. 9-M1988 Luminaires
- .2 CSA C22.2 No. 34-M1987 Electrode Receptacles, Fittings, and Connectors for Gas Tubes
- .3 CSA C22.2 No. 43-M1984 Lampholders
- .4 CSA C22.2 No. 66-1988 Specialty Transformers
- .5 CSA C22.2 No. 74-92 Equipment for Use with Electric Discharge Lamps
- .6 CSA C22.2 No. 141-M1985 Unit Equipment for Emergency Lighting
- .7 ANSI/IEEE C62.41 Guide for Surge Voltages in Low Voltage AC Power Circuits

### **1.4 CODES AND STANDARDS**

- .1 All wiring to be in accordance with the Alberta Electrical Safety Code.
- .2 Provide only equipment bearing a label acceptable to the Electrical Safety Authority (ESA) to indicate that the equipment has been tested to applicable CSA standards.

## **2 Products**

### **2.1 LUMINAIRES**

- .1 General

- .1 Furnish luminaires in accordance with CSA C22.2 No. 9.
- .2 Luminaire finishes shall resist chipping, crazing, and discolouration.
- .3 Luminaires to contain no asbestos.
- .4 Furnish luminaires with flanges and gaskets to eliminate light leaks.
- .2 Fluorescent Luminaires
  - .1 Fabricate steel luminaires from minimum 22 gauge mild sheet steel with joints securely fastened.
  - .2 Do not use pre-painted steel.
  - .3 Remove sharp edges.
  - .4 Phosphate dip, prime and paint luminaire body, hardware and accessories with 2 coats of baked enamel, or other finish where indicated, after fabrication.
  - .5 Interior baked enamel finish to have a minimum 88% reflectance and a minimum thickness of 1.2 mils.
  - .6 Where 2 level switching is indicated, furnish 2 ballasts, separately switched, with one ballast connected to the outer lamps and the other ballast connected to the inner lamp(s).
  - .7 Acrylic lens, 100% virgin acrylic, 0.125" nominal thickness, extruded aluminum hinged frame.
- .3 Exit Light Luminaires
  - .1 150 mm high red letters.
  - .2 Universal ceiling, end-to-wall, surface back-to-wall mounting or recessed mounting if indicated.
  - .3 Connection for emergency 12V source where indicated.
  - .4 Refer to luminaire schedule.

## **2.2 BALLASTS – NON-DIMMABLE**

- .1 Fluorescent
  - .1 To CSA C22.2 No. 74.
  - .2 Electronic, to operate 1 or 2 lamps, integrally mounted in luminaire unless otherwise indicated.
  - .3 Rapid start type for normal output lamps unless otherwise indicated.
  - .4 Instant start type for high output lamps.
  - .5 Programmed start type for applications with occupancy/vacancy sensors.
  - .6 Type as indicated in luminaire type appendix.
  - .7 Totally enclosed containing no polychlorinated biphenyls.
  - .8 Rated 60 Hz, voltage as indicated.
  - .9 Rated for operation over an ambient temperature range of 10°C to 40°C.
  - .10 Maximum case temperature not greater than 25°C above ambient temperature.
  - .11 Operate at in a frequency range of 25 kHz to 40 kHz.

- .12 Produce no visible flicker.
- .13 Minimum sound rating of Class A.
- .14 Minimum ballast factor of 0.9.
- .15 Minimum power factor of 0.95.
- .16 Maximum crest factor of 1.5.
- .17 Maximum input current total harmonic distortion of 10% measured at rated output.
- .18 To withstand line transients as defined by ANSI/IEEE C62.41, Category A.
- .19 Acceptable manufacturers:
  - .1 Lutron
  - .2 Philips Advance
  - .3 Osram Sylvania
  - .4 GE Motorola
- .2 LED Drivers
  - .1 Dims continuously from 100% to 1% lighting level (if applicable)
  - .2 Rated for a 50,000 hour lifetime
  - .3 Constant current reduction (CCR) or pulse width modulation (PWM) dimming for constant current drivers selection
  - .4 Works with [Forward Phase controls \(neutral wire required\)](#), [3-wire fluorescent controls](#) and network lighting management controls
  - .5 Constant Current model: 200 mA to 2.1 A (in 10 mA steps), 5 W to 40 W
  - .6 Constant Voltage model: 10 Volts to 40 Volts (in 0.5 V steps), 5 W to 40 W
  - .7 Universal input voltage
  - .8 Full range of UL Class 2 products operating at low DC voltage
  - .9 Operational down to -30° C for use in outdoor and cold areas
  - .10 Integrated short circuit protection
  - .11 Acceptable manufacturers:
    - .1 Lutron
    - .2 Philips Advance
    - .3 Osram Sylvania
    - .4 GE Motorola
- .3 Compact Fluorescent
  - .1 Ballasts shall be CSA and/or UL listed, Class P thermally protected and meet ANSI C62.41 (IEEE 587, Category A) for surge protection.
  - .2 Light level output shall be continuous, smooth and flicker free over the entire dimming range.
  - .3 Ballast shall have:
    - .1 Power factor greater than .95 and it should be self-compensated

- .2 Total harmonic distortion less than 10%
- .4 Ballast shall have an ambient noise level of 27dB or less throughout the dimming range.
- .5 Ballasts must comply with FCC part 18 regulations and shall not interfere with other electrical or electronic equipment
- .6 Ballasts shall have a minimum starting temperature of 10 deg C.
- .7 Ballasts shall have protected control wire input which is not damaged by miswire.
- .8 Ballasts current inrush shall not exceed three amps at 120 volts to avoid nuisance circuit breaker trips and control contact malfunctions.
- .9 Lead length from ballast to lamp socket shall not exceed 1M (3ft.)
- .10 Acceptable manufacturers:
  - .1 Lutron
  - .2 Philips Advance
  - .3 Osram Sylvania
  - .4 GE Motorola
- .4 Metal halide ballast:
  - .1 Rating: [voltage as indicated] 120 V, 60 Hz, for use with 1-400W metal halide lamp. Provide circuitry for quartz re-strike standby light where indicated.
  - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
  - .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
  - .4 Input voltage range: plus or minus 10% of nominal.
  - .5 Minimum starting temperature: minus 30 degrees Celsius at 90% line voltage.
  - .6 Mounting: as per drawings.
  - .7 Current crest factor: 1.7 maximum current.
- .5 High pressure sodium ballast: to ANSI C82.4 design.
  - .1 Rating: 120 V, 60Hz, for use with 1-400W high pressure sodium lamp.
  - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
  - .3 Power factor: minimum 95 % with 95% of rated lamp lumens.
  - .4 Type: as recommended by manufacturer.
  - .5 Input voltage range: plus 10% to minus 10% of nominal.
  - .6 Minimum starting temperature: minus 40 degrees Celsius at 90% line voltage.
  - .7 Mounting: As per drawings..
  - .8 Current crest factor: 1.7 maximum current.
- .6 Low pressure sodium ballast:
  - .1 Rating: 120 V, 60 Hz, for use with 1-35W low pressure sodium lamp.
  - .2 Totally encased and designed for 40 degrees Celsius ambient temperature.
  - .3 Power factor: minimum 95% with 95% of rated lamp lumens.
  - .4 Input voltage range: plus or minus 20% of nominal.
  - .5 Minimum starting temperature: minus 34 degrees Celsius at 90% line voltage.

- .6 Mounting: as per drawings.

## 2.3 BALLASTS – DIMMABLE

### .1 Fluorescent

- .1 Ten-year operational life while operating with a case temperature range of 10 degrees C (50 degrees F) to 75 degrees C (167 degrees F) and 90 percent non-condensing relative humidity.
- .2 Designed and tested to withstand electrostatic discharges up to 15,000 V without impairment IEC 801-2.
- .3 Electrolytic capacitors to operate at least 20 degrees C below the capacitor's maximum temperature rating when the ballast is under fully-loaded conditions and case temperature is 75 degrees C (167 degrees F).
- .4 Programmed Rapid Start Type.
- .5 Current crest factor (CCF) less than 1.7.
- .6 Meet ANSI C82.11 High frequency ballast standard.
- .7 Will not interfere with infrared devices operating at frequencies between 38 kHz and 42 kHz.
- .8 Withstand up to a 4,000 volt surge without impairment of performance as defined by ANSI C62.41 Category A.
- .9 Manufactured in a facility that employ ESD reduction practices in compliance with ANSI/ESD S20.20.
- .10 Inaudible in a 27 dBA ambient.
- .11 No visible change in light output with a variation of +/- 10 percent line voltage input.
- .12 Total Harmonic Distortion less than 10 percent and meet ANSI C82.11 maximum allowable THD requirements
- .13 Actively prevent overheating in T5-HO linear fluorescent lamp applications.
- .14 Ballasts to track evenly across:
  - .1 Multiple lamp lengths.
  - .2 All light levels.
- .15 Dimming range of ballast shall be from 1% to 100% illuminance level.
- .16 Acceptable manufacturers:
  - .1 Lutron
  - .2 Philips Advance
  - .3 Osram Sylvania
  - .4 GE Motorola

### .2 Compact Fluorescent

- .1 Continuous dimming from 100 percent to 5 percent relative light output for T4 compact and T5 twin tube lamps.
- .2 Generate digital communication commands to distribute ballast data on the digital bus.

- .3 Monitor and report lamp and ballast status.
  - .4 Lights automatically return to the setting prior to power interruption.
  - .5 Each ballast responds independently to:
    - .1 Up to 32 occupant sensors.
    - .2 Up to 64 personal control inputs.
    - .3 Up to 2 daylight sensors.
  - .6 Unique internal reference number visibly displayed on ballast cover.
  - .7 Averages 2 independent daylight harvesting inputs internally.
  - .8 Responds to digital load shed command.
    - .1 Sets high end trim.
    - .2 Automatically scales light output proportional to load shed command.
      - .1 Example: If light output is at 30 percent and a load shed command of 10 percent is received, the ballast automatically sets the maximum light output at 90 percent and lowers current light output by 3 percent to 27 percent.
  - .9 Maximum inrush current of 7 amperes for 120V ballasts and 3 amperes for 277V ballasts.
  - .10 Acceptable manufacturers:
    - .1 Lutron
    - .2 Philips Advance
    - .3 Osram Sylvania
    - .4 GE Motorola
- .3 Light Emitting Diodes (LEDs)
- .1 Continuous dimming from 100 percent to 1 percent relative light output.
  - .2 Ability to operate with installed or specified building control system.
  - .3 Lights automatically return to the setting prior to power interruption.
  - .4 Each driver responds independently to:
    - .1 Up to 32 occupant sensors.
    - .2 Up to 16 daylight sensors.
  - .5 Responds to digital load shed command.
  - .6 Sets high end trim.
  - .7 Automatically scales light output proportional to load shed command.
    - .1 Example: If light output is at 30 percent and a load shed command of 10 percent is received, the driver automatically sets the maximum light output at 90 percent (of the 30 percent light level) and lowers current light output by 3 percent to 27 percent.
  - .8 Acceptable manufacturers:
    - .1 Lutron



- .2 Philips Advance
- .3 Osram Sylvania
- .4 GE Motorola

## **2.4 LAMPS**

- .1 Fluorescent Lamps are as per project luminaire schedule and lighting plan drawings.
- .2 Incandescent lamps to be - clear, A19, 100 Watt with 1000 hour lamp life, rough-service rated; or as indicated..
- .3 Tungsten halogen lamps to be - clear, T-3, 300 Watt, RSC base, 2000 hour lamp life, 5000 lumens; or as indicated.
- .4 Fluorescent lamps to be - T8, 32 Watt, medium bi-pin, rapid-start, 4100 K, 30,000 hour lamp life, 2950 initial lumens, CRI [80]; or as indicated.
- .5 Metal halide lamps to be - clear, BT37, 400 Watt, mogul base, horizontal burn, 4100 K, 15,000 hour lamp life, 36,000 initial lumens, CRI[65], open or enclosed type to suit the luminaire; or as indicated.
- .6 Low pressure sodium lamps to be - clear, T21, 135 Watt, BY22d base, horizontal burn, 16,000 hour lamp life, 22,000 initial lumens; or as indicated.
- .7 High pressure sodium lamps to be - clear, ED18, 400 Watt, mogul base, 30,000 hour lamp life, 54,000 initial lumens; or as indicated.
- .8 Compact fluorescent lamps to be - 18 Watt, G24q-2 base, 12,000 hour lamp life, 12,000 initial lumens, 4100 K, CRI [80]; or as indicated.
- .9 Light emitting diodes (LEDs):
  - .1 Provide the most technically proven, advanced and successfully tested LED technology at time of installation.
  - .2 Colour temperature range to be from 2800 K to 4000 K as shown on luminaire schedule
  - .3 Minimum CRI of: 80
  - .4 Rated life: at least 50,000 hours based on 70% lumen depreciation level
  - .5 Heat sinks to adequately remove heat from bottom of semiconductor

## **2.5 LIGHTING POLES**

- .1 Design poles and arms to withstand wind loading of 160 km/h and gusts of 1.3, without deformation, with designated luminaires installed.
- .2 Furnish poles round, aluminum, finish and colour as shown, designed for mounting on concrete base, height as indicated, complete with base bolt covers, grounding lug, handhole and flush weatherproof cover at base housing fuses and terminal strip.
- .3 Fuseholder, in-line, waterproof, breakaway type with 10A fuse.
  - .1 Acceptable manufacturers:
    - .1 Bussman, Tron fuseholder, HEB series with insulation boot

- .2 Buchanan/Elastimold, Style 65
- .3 Gould Shawmut, GEB series with insulating boots

## 2.6 EMERGENCY BATTERY UNITS

- .1 Supply voltage 120 V AC, 1PH, 60Hz.
- .2 Output voltage 12 V DC.
- .3 Batteries: sealed lead acid calcium alloy grid type sized to operate the lamp load to 91% of initial voltage for 30 minutes.
- .4 Battery charger: solid state, multi-rate, voltage/current regulated, sized to restore battery to full charge in 12 hours.
- .5 Low voltage disconnect: solid state, modular, operates at 80% battery voltage.
- .6 EEMAC 2 code gauge steel housing.
- .7 Auxiliary equipment:
  - .1 "AC Power ON"
  - .2 "Fast charge" pilot light
  - .3 Voltmeter
  - .4 Test switch
  - .5 5 minute time delay relay
  - .6 Cord and plug
- .8 Lamp heads: mounted as indicated, 360° horizontal and 180° vertical adjustment, (12W) (20W) (55W) (micro quartz) (quartz halogen composite) lamps.
- .9 Acceptable Manufacturers:
  - .1 –Refer to Luminaire Schedule.

## 3 Execution

### 3.1 INSTALLATION - GENERAL

- .1 Provide supports for luminaires. For continuous row fluorescent type, provide support for each end plus at least one for each channel section, or additional as required. Swivel mount stems. Provide concrete inserts at points of luminaire support in unfinished areas where a concrete slab serves as ceiling. Provide support from concrete floor and roof steel above ceiling as applicable.
- .2 Align luminaires in rows, maintain required heights, and install luminaires clear of other work.
- .3 Keep luminaires covered and protected from construction dust and debris until building is broom clean and free of suspended dust clouds.
- .4 Do not lamp luminaires until ready for testing and use. Obtain Departmental Representative's approval before lamping. Install lamps in lampholders.
- .5 When installation is complete, demonstrate operation to satisfaction of Departmental Representative.

- .6 Standard octagonal boxes may be supplied where conduits feeding luminaires in finished areas are exposed on ceiling if hanger canopies entirely cover outlet boxes and are neatly notched for conduit. Otherwise, provide cast conduit outlet boxes with a diameter larger than canopies.
- .7 Attach boxes or hickeyes directly to poured concrete with 6 mm minimum diameter bolts and lead expansion anchors where luminaires are suspended directly from concrete slabs. Use 8 mm minimum bolts through precast slabs, welded to 100 mm x 100 mm minimum, 3.5 mm plate above slabs.
- .8 Do not mount luminaires above pipes, ducts or equipment. In event of unavoidable tight locations, provide hangers to clear obstructions. Check layouts of other trades on job and plan cooperatively. Luminaires in any room shall hang at one height. Obtain approval before any changes are made to layouts shown.
- .9 Provide continuous 12 mm x 38 mm channel above ceiling, where luminaires are suspended or mounted on furred ceilings. Fasten luminaires to channel with two 6 mm minimum diameter studs with minimum 1220 mm on centre.
- .10 Where two 4'-0" surface or suspended fluorescent luminaires occur in tandem, an 8'-0" body may be used. Where two single lamp luminaires occur in tandem, a common lamp ballast may be used.
- .11 Verify catalogue number of luminaires with description prior to ordering, and check for final ceiling finish in areas where recessed luminaires are called for in order to provide ceiling trim, flanges and mounting brackets to suit particular construction used where luminaires are installed.
- .12 Support luminaires in an approved manner to comply with the Ontario Electrical Safety Code and the Ontario Building Code.
- .13 Provide steel luminaire studs, brackets and hangers. Where luminaires are hung on chain hangers, provide chain of closed link type capable of supporting ten times luminaire weight. Use U-bolts for chain ends; S-hooks are not acceptable.

### **3.2 INSTALLATION - EMERGENCY AND EXIT LIGHTS**

- .1 Exit sign installation shall meet all requirements of the authorities having jurisdiction.
- .2 Install emergency battery units where shown. Support on brackets supplied by manufacturer.
- .3 Aim heads to properly illuminate exit path.

### **3.3 INSTALLATION - CEILINGS**

- .1 Suspend luminaires mounted from or in a suspended T-bar ceiling directly from building structure, independent of the T-bar system, to ULC, Local Fire Marshal's Office, Alberta Building Code, Electrical Safety Authority (ESA) and Departmental Representative's approval.
- .2 In non-accessible ceilings wire with not more than 1200 mm of AC90 or RW90 XLPE wire in flexible conduit to adjacent outlet boxes placed above finished ceiling within reach of the luminaire openings.
- .3 In accessible ceilings wire with not more than 1800 mm of AC90 or RW90 XLPE wire in flexible conduit to adjacent outlet boxes, locations as shown on the Drawings.

- .4 Provide suitable trim for all luminaires installed in drywall ceilings or within lay-in or snap-in tiles.

### **3.4 INSTALLATION - POLES**

- .1 Wire down inside of lighting poles with No. 10 AWG RW90 plus No. 10 AWG insulated ground wire and secure to clips. Provide strain relief at the top of the pole so that the weight of the wiring down to the bottom of the pole does not place a strain on the wiring terminations. Install fuse holders and fuses.
- .2 Assemble arms and luminaires securely to pole. Provide lamps in lampholders.
- .3 Erect pole plumb and true on base. Along roadways, orient pole handhole on the side opposite the roadway unless otherwise indicated.
- .4 Connect underground ground wire and pole ground wire at ground lug in pole.
- .5 Leave slack in wires to allow connector and ground wire to be pulled out of handhole 150 mm clear of pole without disconnecting.

**END OF SECTION**

**1 General**

**1.1 SUMMARY**

- .1 Section includes:
  - .1 Labour, products, equipment and services necessary to complete the work of this Section.

**1.2 DIMENSIONS AND QUANTITIES**

- .1 Dimensions shown on Drawings are approximate. Verify dimensions by reference to shop drawings and field measurement.
- .2 Quantities or lengths indicated in any of the Contract Documents are approximate only and are not to gauge or limit the Work.
- .3 Make necessary changes to routing of cables and the like to accommodate structural, mechanical, electrical and architectural conditions. Coordinate with other trades and make allowance for conditions that will arise from work in progress under separate contract.

**1.3 WORKING DRAWINGS AND DOCUMENTS**

- .1 Where the word "HOLD" appears on Drawings and other Contract Documents, the Work is included in the Contract. Execute such Work only after verification of dimensions and materials and obtaining Departmental Representative's written permission to proceed.

**1.4 OPERATING AND MAINTENANCE MANUALS**

- .1 Submit Operating and Maintenance Manuals.

**1.5 "AS BUILT" RECORD DRAWINGS**

- .1 Where wiring is underground or underfloor, furnish field dimension with respect to building column lines and inverts with respect to finished floor levels or grades.
- .2 Record deviations from cable numbers shown on the Contract Drawings.
- .3 Prepare records of interconnecting and cross-connecting wiring between items of equipment including equipment supplied by Departmental Representative and under other Specification Sections. Provide the records loaded into a data base. Select the data base by mutual agreement with the Departmental Representative.
- .4 Approved data base products:
  - .1 Microsoft Access
  - .2 Microsoft Excel
- .5 Prepare drawings clearly identifying routes taken by cable where the cable is not supported along its length by either conduit or raceway.
- .6 Include all test reports as part of the "As-built" submittals.
- .7 Provide all test data and numeric as-built information in a format approved by the Departmental Representative selected from the following alternatives:
  - .1 CD-ROM (write once, read many)
  - .2 DVD-ROM (write once, read many)

## 1.6 MANUFACTURER'S ATTENDANCE

- .1 Provide manufacturer's representatives to verify installation practices for each part of the Work as may be relevant to all components including wiring and terminations.

## 1.7 FIELD INSPECTION

- .1 Provide field engineer for inspection and certification of equipment during installation, testing and commissioning as required.

## 1.8 QUALITY ASSURANCE

- .1 These Specifications supplement the Electrical and Electronic Manufacturers Association of Canada, Canadian Standards Association Standards, Electronic Industries Association, Telecommunications Industries Association standards and recommendations. Conditions of the EEMAC, CSA, EIA, TIA and ISO/IEC standards and recommendations apply unless superseded or modified by this Specification.
- .2 Where requirements of the specifications exceed referenced standards, the specifications apply. Where standards differ between authorities, the most rigid applies.
- .3 Requirements of the specifications that are substandard to referenced standards should be brought to the attention of Departmental Representative during bidding period in sufficient time to allow suitable action to be taken and addenda issued as necessary.
- .4 Equipment must be acceptable to electrical inspection authorities.
- .5 Where any part of the Work fails tests, repair the fault in a manner to prevent recurrence and re-test.
- .6 Where any part of the Work fails tests and that Work is to be built without physical discontinuity, remove the offending material and install new without increase in cost to the Contract.

## 1.9 AREA CLASSIFICATION

- .1 No area in the Work is classified as Hazardous.

## 2 Products

### 2.1 MANUFACTURERS

- .1 Cable Support Hardware
  - .1 Cable supports of open hook construction with curved cable bearing surface. Do not exceed minimum bending radius restriction.
  - .2 Flexible corrugated non-metallic conduit to be available in colours:
    - .1 Orange
  - .3 Flexible corrugated non-metallic conduit to be available in the following nominal sizes:
    - .1 25 mm inside diameter
    - .2 32 mm inside diameter
  - .4 Flexible corrugated non-metallic conduit to be available in the following fire ratings:
    - .1 FT4

.2 FT6 - plenum rated

## 2.2 WLAN INFRASTRUCTURE

- .1 The entire building is to have 100% wireless LAN (WLAN) coverage. Category 5E horizontal network cabling drops are shown on drawings as provisions to enable the deployment the WLAN access points (AP) throughout the facility.
- .2 This contractor is to:
  - .1 Site Signal Survey:
    - .1 Perform a coverage site signal survey/audit and confirm if additional Cat. 5E cabling drops are required or locations of the ones on drawings need to be adjusted.
    - .2 Site survey is to be performed immediately after all interior partitions are in place.
    - .3 Submit a copy of survey/audit to the Engineer for review.
  - .2 Coordinate and install active AP equipment supplied by the Departmental Representative.
    - .1 Make recommendation to the Departmental Representative of type of AP to be provided (e.g. Directional, omnidirectional) for each particular location.
- .3 Location criteria:
  - .1 Minimum threshold coverage: -65 dBm
  - .2 User density:
    - .1 Second floor: high density user area (teaching rooms, multipurpose room)
    - .2 Remaining floors: standard density user areas.
  - .3 Above accessible ceilings or on underside of slab in no-ceiling areas
  - .4 In service areas/rooms adjacent to public areas
  - .5 In accessible light coves hiding antennas from view
  - .6 Near an access panel if in hard ceilings.

## 3 Execution

### 3.1 GENERAL

- .1 All cables and cable pathways to run parallel or perpendicular to building lines.
- .2 Proposed installation drawings to be submitted to the Engineer or Departmental Representative prior to installation.

### 3.2 DUCT DISTRIBUTION

- .1 Clean out each section of duct by pulling a steel wire brush and mandrel of the correct size through the duct before pulling cables.
- .2 When cleaning ducts, if obstructions are encountered which cannot be removed, advise the Departmental Representative of the problems encountered.

- .3 Cable entry and exit from ducts to be protected by flexible corrugated non-metallic conduit or plastic bushings attached to the end of the conduit.
- .4 Pull cables in underground duct-bank in continuous length. Splicing of any kind will not be permitted.
- .5 Pull cable in bottom ducts first, leaving top ducts for future.
- .6 Apply manufacturer recommended lubricant to cables to reduce friction between the cable and the duct.
- .7 Cable grip to be attached to the sheath and its strength members so that no direct force is applied to the conductors/fibres. The cable grip shall have a ball bearing swivel to prevent the cable from twisting during pulling.
- .8 Station personnel at each access point (i.e. manhole/handhole) to observe and lubricate the cables during pull.
- .9 Cable passing through manholes to have sufficient slack for expansion and contraction and to be mounted with clips to prevent sagging.
- .10 Submit tension pulling calculation for installation of cables to Engineer.
- .11 The fibre optic cables maximum tensile rating shall not be exceeded during installation. Tension of cable to be monitored during installation.
- .12 Minimum bend radius to be as per manufacturer's recommendations or 10 times the cable outside diameter which ever is the greater.
- .13 Where cable must be pulled through a distance of greater than 30 m or through a pathway containing more than one 90° bend, use a dynamometer to record installation tension and a tension limiting device to be used to prevent exceeding the maximum pulling tension specification during installation. The tension limit shall be set at or below the manufacturer's maximum limit. The cable to be taken up at intermediate pulling points with an intermediate cable take-up device as approved by the Departmental Representative, to prevent over tension on the cable.
- .14 Make cable pulls continuous and steady between pull points and not to interrupt the pull unless necessitated by excessive tension on the cable.
- .15 Following the installation of the cables, all duct entrance into buildings to be sealed with duct sealing compound to prevent the ingress of moisture, foreign materials and rodents.
- .16 Exposed cable ends shall be protected from moisture ingress.
- .17 For underground non-metallic conduit run-empty/spare or with fiber optic cables, provide a metal tracing cable through their entire length within the conduit conveying such cable. The tracing cable will be a minimum size # 12 AWG wire to be terminated at each end so that tracer can be attached. All underground buried conduits will also be marked with plastic caution tape, within a layer of backfill just above the conduit as a warning for future excavation.

### **3.3 GROUNDING**

- .1 All grounding bonding to comply with CSA C22.1 standard or after applicable codes.
- .2 Install grounding cables between all equipment frames and enclosures and connect to grounding bus.



- .3 Support grounding cables in the non-metallic conduits or cable trays provided.

**3.4 WARRANTY**

- .1 Test complete structural cabling system to meet manufacturer's best warranty.
- .2 Submit all necessary test results, drawings, and any other documents required to receive manufacturer's warranty certificate to manufacturer's representative.

**END OF SECTION**

- 1 General
  - 1.1 **SUMMARY**
    - .1 Section includes:
      - .1 Labour, products, equipment and services necessary to complete the work of this Section.
  - 1.2 **SHOP (VENDOR) DRAWINGS AND PARTS LISTS**
    - .1 Submit for review, manufacturer's or vendor's drawings and specifications for all products being furnished. Include rating, performance, specification sheets, descriptive literature, schematic and wiring diagrams, dimensional layouts and weights of components as well as complete assemblies.
  - 1.3 **AREA CLASSIFICATION**
    - .1 No area in the Work is classified as Hazardous.
- 2 Products
  - 2.1 **MANUFACTURERS**
    - .1 Copper Cable Labels
      - .1 All cables to be labelled using self-adhesive, self-laminating material.
        - .1 Label to be installed 100 mm from each end of cable termination.
        - .2 All grounding conductors to be labelled with materials in compliance with CSA-T528 or ANSI/TIA/EIA-606 specification.
    - .2 Identification Labels
      - .1 All faceplate and icons labels to suit selected faceplate.
      - .2 All patch panels and termination strips to be labelled with materials to suit selected patch panel or termination strip.
      - .3 All pullboxes, cabinet, racks to have 75 mm high (minimum) lamacoid labels at the top of unit.
      - .4 Colour code labels in accordance with EIA/TIA-606A or as Instructed by the Engineer.
    - .3 Fibre Labels
      - .1 Provide fibre labels along the length of the fibre cable or fibre conduit in interval of 3 meters.
      - .2 Provide labels at junction and pull boxes.
      - .3 Provide labels at each end of the fibre cables within 150 mm of the termination.
      - .4 Provide labels at fibre optic patch panels.
    - .4 Provide 15% additional labels in each room for future use.
- 3 Execution

**3.1 INSTALLATION GENERAL**

- .1 Submit shop drawings and sample of all proposed labels and obtain approval before printing of any labels.
- .2 Clearly identify all cables according to the administration system shown on the Contract Drawings.
- .3 Use only approved cable marking materials.
- .4 Clearly identify all outlets, patch-panels, patch-cords, cables, racks, enclosures, spaces, closets, conduit, and raceways according to the administration system shown on the contract drawings.
- .5 Use only machine printed labelling for outlets.
- .6 Use only engraved plastic plates for the labelling of enclosures and racks.
- .7 For each termination panel port affix and secure two (2) corresponding unique Identification labels on the termination panel front and back surfaces.

**3.2 LABELLING**

- .1 Provide horizontal cabling labelling in accordance with McMaster Standards. Labelling shall have the following format at both ends of the cable:
  - .1 Label each drop with the room number and jack number. The jack number is determined by the patch panel. Using a 48 port patch panel:
    - .1 Patch Panel #1
      - .1 room#-1 Room#-24
      - .2 room#-25 Room#-48
    - .2 Patch Panel #2
      - .1 room#-49 Room#-72
      - .2 room#-73 Room#-96
  - .3 Example: Room 110, the label will read: "110-53"

End of Section

1 General

1.1 **SUMMARY**

.1 Section includes:

.1 Labour, products, equipment and services necessary to complete the work of this Section.

.2 Include all test reports as part of the "As-built" submittals.

.3 Provide all test data and numeric as-built information in a format approved by the Departmental Representative selected from the following alternatives:

.1 CD-ROM (write once, read many)

.2 DVD-ROM (write once, read many)

1.2 **TEST REPORTS**

.1 For each check and test performed prepare and submit a Test Report, signed by the Test engineer, and where witnessed, by the Departmental Representative.

.2 Test Reports to include a record of all tests performed, methods of calculation, date and time of test, ambient conditions, names of testing company, test engineer, witnesses, also calibration record of all test instruments used together with manufacturers name, serial number and model number.

.3 Calibration record to include percentage error and applicable correction factors.

.4 Tests performed with instruments that have not been calibrated or certified as Fit for Purpose within 12 months preceding the date of use will not be accepted.

.5 Submit a Certified Test Report from each manufacturer, signed by the certifying inspector, confirming correct installation and operation of each product and part of Work. Include name of certifying inspector, date and times of inspection, ambient conditions.

.6 Submit evidence from each third party warranting performance guarantees of any part of the cabling system of their agreement that testing and site inspection procedures are fit for the purpose of upholding the warranty.

.7 Undertake either full or sample testing daily and have reports available for inspection by the Departmental Representative as an assurance that standards of working practices are being maintained.

.8 Complete test records and certification of such records prior to project cutover.

1.3 **MANUFACTURER'S ATTENDANCE**

.1 Provide manufacturer's representatives to verify installation practices for each part of the Work as may be relevant to all components including wiring and terminations.

1.4 **FIELD INSPECTION**

.1 Provide field engineer for inspection and certification of equipment during installation, testing and commissioning as required.

**1.5 QUALITY ASSURANCE**

- .1 These Specifications supplement the Electrical and Electronic Manufacturers Association of Canada, Canadian Standards Association Standards, Electronic Industries Association, Telecommunications Industries Association standards and recommendations. Conditions of the EEMAC, CSA, EIA, TIA and ISO/IEC standards and recommendations apply unless superseded or modified by this Specification.
- .2 Where requirements of the specifications exceed referenced standards, the specifications apply. Where standards differ between authorities, the most rigid applies.
- .3 Requirements of the specifications that are substandard to referenced standards should be brought to the attention of Departmental Representative during bidding period in sufficient time to allow suitable action to be taken and addenda issued as necessary.
- .4 Equipment must be acceptable to electrical inspection authorities.
- .5 Where any part of the Work fails tests, repair the fault in a manner to prevent recurrence and re-test.
- .6 Where any part of the Work fails tests and that Work is to be built without physical discontinuity, remove the offending material and install new without increase in cost to the Contract.

**2 Products**

**3 Execution**

**3.1 TESTING AND ACCEPTANCE**

- .1 Horizontal cabling testing to be completed according to the following test criteria.
  - .1 All terminated cabling runs shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements found in the TIA/EIA-568-C series of standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, patch panels, and cordage shall be repaired or replaced in order to ensure 100% usability of all installed runs.
  - .2 All balanced twisted-pair cable links shall be tested for basic for:
    - .1 Wire map, including shield connection if present
    - .2 Insertion loss
    - .3 Cable length;
    - .4 Attenuation;
    - .5 NEXT loss, pair-to-pair, measured from local end
    - .6 NEXT loss, pair-to-pair, measured from far-end
    - .7 NEXT loss, power sum, measured from local end
    - .8 NEXT loss, power sum, measured from far-end
    - .9 ELFEXT, pair-to-pair

- .10 ELFEXT, power sum
- .11 Return loss, measured from local end
- .12 Return loss, measured from far-end
- .13 Propagation delay
- .14 Delay skew
- .15 ACR;
- .16 Power sum ACR;
- .17 End to end continuity;
- .18 Opens or shorts;
- .19 Pair polarity.
- .3 Provide full bandwidth graphical results for all cables.
- .4 Category 6 performance testing shall be done according to the published standards.
- .2 Fibre optic cabling testing to be completed according to the following test criteria.
  - .1 The backbone optical fibre cabling link segment shall be tested in at least one direction at both operating wavelengths to account for attenuation deltas associated with wavelength.
    - .1 Singlemode backbone links should be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper.
    - .2 Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A, Method B, One Reference Jumper.
    - .3 Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation should be used to determine acceptance values based upon this Standard's component requirement at each of the applicable wavelengths.
  - .2 Test every fibre of each cable with an Optical Time Domain Reflectometer for length and attenuation. Include a hard copy chart recording with the test documentation.
  - .3 Tabulate and include test results with the test documentation.
- .3 Correct all cable faults. Splicing of any cable will not be permitted, for any reason, unless prior authorization is received in writing by the Departmental Representative.
- .4 All installed cables and terminations must meet and exceed the minimum performance specifications as outline by the cable manufacturer. Marginal passes are NOT acceptable and must be corrected prior to test results submission.
- .5 All defects and deficiencies which become evident during the warranty period are to be repaired or replaced within a time frame that is acceptable to the Departmental Representative and at no extra cost.
- .6 Submit complete test results in hard and soft format.

- .7 Submit letter of system certification within 3 weeks of substantial completion. Include:
  - .1 Notification of systems installed (Category 6)
  - .2 Verification of performance of the system
  - .3 Manufacturer certificate number
  - .4 Copy warranties

End of Section

- 1 General
- 1.1 **SUMMARY**
  - .1 Section includes:
    - .1 Labour, products, equipment and services necessary to complete the work of this Section.
- 1.2 **SHOP (VENDOR) DRAWINGS AND PARTS LISTS**
  - .1 Submit for review, manufacturer's or vendor's drawings and specifications for all products being furnished. Include rating, performance, specification sheets, descriptive literature, schematic and wiring diagrams, dimensional layouts and weights of components as well as complete assemblies.
- 2 Products
- 2.1 **MANUFACTURERS**
  - .1 Horizontal (Distribution) UTP Cables
    - .1 The copper backbone cables shall be Belden "IBDN DataTwist 2400 UTP, Category 5E".
    - .2 Horizontal UTP cables to be of characteristic impedance 100Ω and comply with ANSI/EIA/TIA 568A specification for Category 5E UTP cables except where indicated otherwise on the Contract Drawings.
    - .3 Bandwidth: 250 MHz
    - .4 Horizontal UTP cable to be 4 pair 23 AWG solid conductor.
    - .5 Exposed cable in air space between underside of ceiling and underside of overhead slab to be FT6 Plenum rating (CMP).
    - .6 Cable routed through the air space between underside of ceiling and underside of overhead slab and fully contained in metallic conduit or electrical metallic tubing to be FT4 rated (CMG).
- 3 Execution
- 3.1 **GENERAL**
  - .1 All cables and cable pathways to run parallel or perpendicular to building lines.
  - .2 The following minimum clearances from electrical and heat sources are to be maintained when routing cables.

.1	Unit substations	10 m
.2	Power transformers (greater than 30KVA)	10 m
.3	Transformers	1.2 m
.4	Motors	1.2 m
.5	Switch gear (greater than 600V)	10 m
.6	Feeder cables (600V and above)	1 m
.7	Distribution cables (less than 600V)	750 mm



- |     |   |        |
|-----|---|--------|
| .8  | Conduit (Enclosing 30A branch circuits) | 300 mm |
| .9  | Conduit (Enclosing 20A branch circuits) | 75 mm  |
| .10 | Conduit (Enclosing 15A branch circuits) | 65 mm  |
| .11 | Fluorescent luminaires                  | 120 mm |
| .12 | Pipes (gas, oil, water, etc.)           | 300 mm |
| .13 | HVAC (equipment, ducts, etc.)           | 150 mm |
- .3 Any deviation from cable routing shown on drawings to be approved by Engineer and documented on as-built drawings.
- .4 Avoid scraping, denting, crushing, twisting, kinking or otherwise damaging cables, before, during or after installation. Damaged cables to be replaced by the Contractor without additional compensation.
- .5 Patch-panels and cable management panels to be mounted with clearance between equipment enclosure doors and patch cables.
- .6 Proposed installation drawings to be submitted to the Engineer or Departmental Representative prior to installation.

3.2 **CABLING - GENERAL**

- .1 Pull all UTP cables in a continuous run. Cable splices will not be permitted.
- .2 Install all cables in accordance with manufacturer's specifications ensuring that proper installation techniques are observed and that the cable maximum pull-force and minimum bend radius specifications are adhered to.
- .3 Utilize all indicated and available cable pathways such as slots, sleeves, conduits, cable trays, ducts, raceways and furniture system channels except where otherwise noted to route cable vertically and horizontally through the building. Exercise caution when pulling cables in such pathways to avoid damage to any existing cables and follow manufacturer's maximum pull-force and minimum bend radii.
- .4 Where cables are exposed to risk of being damaged by sharp edges of furniture, cable tray, raceway etc. protect cables by feeding them through a length of flexible plastic conduit.
- .5 Where cables exit the cable tray and are exposed to sharp bends, reduce the bending stress by covering the cable tray with protective flexible plastic conduit.
- .6 Neatly bundle, secure and tie-wrap all cables. Ensure cable ties do not deform the cable jacket.
- .7 Where cables are terminated on a patch panel, bundle and dress cables in groups of 12 or 24, each group consisting of cables from a single 12 or 24 port patch panel.
- .8 Where cables are terminated on a cross-connect field, bundle and dress cables in groups of 12 or 24, each group consisting of cables from a single cross-connect panel.
- .9 Where voice and data cables are separately identified on the Contract Drawings, separate voice and data cable into distinct bundles.
- .10 Do not maintain bundles for distances greater than 1m in cable trays.

- .11 For cables being terminated on a backboard mounted cross-connect field, pass all cables behind backboard in bundles and pass them through holes positioned in the center of the termination mount.
- .12 When bundling Category 5E cable bundles, comply with manufacturer's recommended bundling practices for Category 5E installations. Ensure that no cable bundling puts excess pressure on the cable at any point which may result in compression or deformation of the cable jacket and internal pair/conductor geometry.
- .13 Follow proper installation and termination practices for Category 5E UTP cabling. Do not kink or exceed manufacturer's restrictions on the UTP cable minimum bend radius.
- .14 For UTP cables, maintain a minimum bending radius of 4 times cable diameter or 25 mm whichever is the greater.
- .15 When terminating UTP cables to IDC blocks or outlet connections, observe the manufacturer's recommendations on stripping back insulation and the extent that pairs may be untwisted. Do not untwisted pairs for more than 13 mm.
- .16 When terminating UTP cables follow manufacturer's installation instructions. Unless directed by the manufacturer's instructions otherwise, remove cable jacket only enough to perform termination and untwist pairs no more than 13 mm for Category 5E cable.
- .17 Secure UTP distribution cables at rear of patch panels. Ensure cable approach to the patch panel is normal to the panel and stress is not transmitted to the termination.
- .18 Ground all metallic strength members integral to cables and components to manufacturer's specifications and standard practices
- .19 Do not strap cables to, or lay cables on, any length of conduit, pipe, ventilation duct or other building element not expressly installed for the purpose of cable support.
- .20 When determining a cable routing pathway, give priority to air handling ducts, fire sprinkler pipes and electrical conduits.
- .21 Except for spare cables, terminate all pairs of UTP cable at both ends.
- .22 Terminate all pairs of spare UTP cable in telecommunication closet and store workstation end in ceiling space by coiling neatly and suspending. Do not rest cables on ceilings or air handling ducts.
- .23 Spare cables to be of sufficient length to permit reaching any point in the room to which they apply.

### **3.3 HORIZONTAL DISTRIBUTION**

- .1 Where practicable and where the maximum allowable cable length is not exceeded, provide 3 m of slack UTP cable at the workstation end of each distribution cable to permit outlet relocation after installation. Neatly coil slack in ceiling space and store suspended.
- .2 Secure and support cables every 1.2 m when running in free space. Bundle and tie-wrap all suspended cables so that droop between supports is minimized.
- .3 Attach cable supports only to the building structure or to support wires installed expressly for cable suspension. Do not attach cable supports to ceiling support wires.

- .4 Where the telecommunications outlet is mounted on a wall box or floor box or system furniture, provide working slack allowance for UTP cable of 300 mm. Coil neatly and secure.
- .5 Where the telecommunications outlet is mounted on furniture, do not crimp or trap the cable between the outlet receptacle and furniture structure.
- .6 Select least obstructed pathway through modular or system furniture. Where available, use eye-level pathways in preference to base-level pathways.
- .7 Install blank filler plates for all unused modular jack positions on faceplates.
- .8 Install blank cover plates for all unused or abandoned outlet boxes.
- .9 Inform Departmental Representative immediately of any horizontal cable runs exceeding 90 m in length.

End of Section

- 1 General
- 1.1 **SUMMARY**
  - .1 Section includes:
    - .1 Labour, products, equipment and services necessary to complete the work of this Section.
- 1.2 **RELATED SECTIONS**
  - .1 Section 26 05 01 – Common Work Results for Electrical
  - .2 Section 26 05 02 - Electrical Basic Materials and Methods
- 1.3 **REFERENCES**
  - .1 Design, manufacture, install and test fire alarm system in accordance with good industry practice and in accordance with the following Codes and Standards:
    - .1 CAN/ULC-S524-06 - Standard for the Installation of Fire Alarm Systems
    - .2 CAN/ULC-S536-04 - Standard for the Inspection and Testing of Fire Alarm Systems
    - .3 CAN/ULC-S537-04 - Standard for the Verification of Fire Alarm Systems
    - .4 Alberta Building Code
    - .5 National Fire Code
    - .6 Canadian Electrical Code
    - .7 CAN/ULC-S525 - Audible Signal Appliance for Fire Alarm Signal
    - .8 CAN/ULC-S526 - Visual Signalling Appliances
    - .9 CAN/ULC-S527 - Control Units for Fire Alarm Systems
    - .10 CAN/ULC-S528 - Manually Actuated Signalling Boxes for Fire Alarm System
    - .11 CAN/ULC-S529 - Smoke Detectors for Fire Alarm Systems
    - .12 CAN/ULC-S530 - Heat Detectors for Fire Protective Signalling Systems
    - .13 CAN/ULC-S531 - Smoke Alarm
    - .14 CAN/ULC-S548 - Water Flow Indicators for Fire Protective Signalling System
    - .15 CSA 282 - Emergency Electrical Power Supply for Buildings
    - .16 CAN4-S101 - Methods of Fire Endurance Tests of Building Construction and Material
  - .2 If any of the requirements of the above Codes and Standards is in conflict with the Drawings or Specifications, the Code or Standard requirements shall govern, but, in no instance shall the standards established by these Drawings and Specifications be reduced by any of the Codes and Standards listed above.
- 1.4 **SUMMARY**
  - .1 This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

- .2 Work covered by this section includes the furnishing of labour, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- .3 The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
  - .1 Fire alarm and detection operations
  - .2 Control and monitoring of elevators, door hold-open devices, fire suppression systems, emergency power systems, and other equipment as indicated in the drawings and specifications.

**1.5 MANUFACTURER'S ATTENDANCE**

- .1 Provide services of manufacturer's representative in accordance with section 26 05 01.

**1.6 SUBMITTALS**

- .1 Submit shop drawings in accordance with Division 01 and items noted below.
  - .1 Documentation to be project specific.
  - .2 Generic documentation and/or alternate or as-equal products are unacceptable.
  - .3 Product data for each type of system component including list of materials and Underwriters' Laboratories of Canada (ULC) listing. Product data to include technical documentation features, and/or functions, and parts list.
  - .4 Plan drawings illustrating location of all devices, system components, conduit runs with types and quantities of conductors.
  - .5 Dimensioned drawings illustrating minimum clearances and any required access space.
  - .6 Drawings illustrating all features and devices including circuiting and details of graphic annunciator.
  - .7 Dimensional elevation of fire alarm control panel and mounting instructions.
  - .8 Point to point wiring diagrams of the entire installed system differentiating clearly between factory and field installed wiring. Identify all terminals and interconnections including conductor numbering.
  - .9 System operation description to include method of operation and supervision of each type of circuit and sequence of operation for all manually and automatically initiated systems input and output.
  - .10 Operation and Maintenance Manuals: Data on each product type including all features and operating sequences for both automatic and manual operations including trouble shooting and maintenance instructions, schematic and wiring diagrams, final reviewed shop drawings, manufacturer's warranty and verification test report.
  - .11 Signed certified product documentation of system components confirming products comply with specified requirements.
  - .12 Final device address list and application program listing for the system as installed at the time of acceptance.
  - .13 A list of all input and output points in the system with a label indicating location or use of initiating device circuit, notification appliance circuit, relay, sensor, and auxiliary control circuits.

- .14 System power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per ULC standards
- .15 Operating instructions for control panel.
- .16 Installation and programming manuals covering the installed system.
- .17 All final and certified documentation.
- .18 Drawings in PDF format.

**1.7 QUALITY ASSURANCE**

- .1 Testing Personnel Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control", provide persons currently certified by the Canadian Fire Alarm Association (CFAA) for fire alarm system testing and verification, to supervise on-site testing and verification as specified in Part 3.
- .2 Installer Qualifications: Engage an experienced factory-authorized installer to supervise work of this Section.
- .3 Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.
- .4 Compliance with Local Requirements: Comply with the applicable building code, local ordinances, and regulations, and the requirements of the authorities having jurisdiction.
- .5 Listing and Labelling: Provide fire alarm systems and components specified in this Section that are listed and labelled by ULC.

**1.8 TESTING AND COMMISSIONING**

- .1 Perform testing and commissioning services described herein, after fire alarm system has been installed and pretested.

**1.9 DEMONSTRATION/TRAINING**

- .1 Startup Services: Engage a factory-authorized service representative to provide startup service and to demonstrate and train Owner's maintenance personnel as specified below.
  - .1 Train Owner's maintenance personnel on procedures and schedules related to system operation, startup and shutdown, troubleshooting, servicing, adjusting, and preventive maintenance.
  - .2 Instruct and demonstrate programming procedures.
  - .3 Training Aid: Use the approved final version of the operation and maintenance manual as a training aid. Provide sufficient documentation to train 4 people.
  - .4 Provide course outline and list of documentation to be provided.
  - .5 Schedule training with Owner with at least 7 days' advance notice.

**1.10 WARRANTY**

- .1 Provide a warranty for materials and workmanship, including microprocessor components and software, to be free of defects for period from date of acceptance of system by Owner in accordance with the General Conditions.

- .2 Repair response times for problems defined as routine to be addressed and corrected within twenty-four (24) hours, excepting statutory holidays and weekends.
- .3 Repair response times for problems defined as major to be addressed and corrected within four (4) hours, excepting statutory holidays and weekends.
- .4 Contractor to provide a recommended list of spare components and devices.
- .5 Manufacturers of the major components to provide written confirmation of full warranty, extended warranty and service back-up in case of the failure to perform or insolvency of the successful supplier.
- .6 Maintain maintenance records for each system supplied, and must submit a monthly report containing a time and date record of all reported or detected problems, detail of corrective action taken and the cause of the problem.
- .7 At end of warranty period, perform tests described above, and in accordance to CAN/ULC-S536 annual inspection and produce a final inspection report.

**1.11 MAINTENANCE MANUALS**

- .1 Cable or Wiring Layout Manuals and Drawings: Prepare and submit in accordance with Division 01, showing external interconnecting cable and wiring diagram showing exact point to point connections and identifications, including junction and pull boxes.
- .2 Operations and Maintenance Manuals: Submit such manuals in accordance with Division 01, and prior to completion of project, in triplicate, containing following:
  - .1 Actual system functional description, and sequence of operation of completed installation.
  - .2 Detailed maintenance instructions for control equipment and each device type, maintenance schedule in accordance with CAN/ULC-S536. Trouble shooting guide for control panels and devices.
  - .3 Pictorial drawing of control equipment layout, showing location of components, modules and parts, indicating catalogue numbers.
  - .4 Schematic diagrams of control equipment, except modules which can be exchanged as unit and internal interconnecting cables and wires.
  - .5 Copy of verification certificate, verification report and warranty certificates such as for fire alarm system, batteries, ancillary devices, including battery suppliers date coding for batteries.
  - .6 Name, address and telephone number of service representative of manufacturer to be contacted during warranty period.
  - .7 Name, address and telephone number of representative responsible for future software programming changes.

**1.12 SYSTEM DESCRIPTION**

- .1 General: The Fire Alarm System is to be a single-stage, addressable, zoned, non-coded, indicating, fully integrated and field programmable system. The entire system is designed as a distributed data communication and processing system.
- .2 Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software

operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download. To accommodate this capability, the download of a new Panel program will be transferred to a "secondary" configuration memory bank, while the Panel continues to function on the "primary" configuration memory bank.

- .3 History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- .4 Wiring/Signal Transmission:
  - .1 Transmission shall be hard-wired, using separate addressable signal transmission, dedicated to fire alarm service only.
  - .2 System connections for initiating circuits and notification appliance circuits shall be Class A and Class B respectively.
  - .3 Class B notification circuits shall be wired in an 'A' and 'B' circuit configuration to provide even 50% coverage in any one area should a circuit fail.
  - .4 Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the Fire Alarm Control Panel (FACP). Provide a distinctive indicating audible tone and alphanumeric annunciation.
- .5 Required Functions: The following are required system functions and operating features:
  - .1 Priority of Signals: Alert and alarm events have highest priority. Subsequent alert and alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
  - .2 Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent activations.
  - .3 Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided under another contract.
  - .4 Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the location and type of device.
  - .5 A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
- .6 Audible Alarm Notification: By tone signals.
- .7 Fire Suppression Monitoring:
  - .1 Water flow: Activation of a water flow switch shall initiate the fire alarm sequence of operations.



- .2 Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
- .3 WSO: Water flow switch and sprinkler valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.
- .8 Power Requirements
  - .1 The control unit shall receive AC power via a dedicated fused disconnect circuit.
  - .2 The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 30 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
  - .3 All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
  - .4 The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.
  - .5 The system batteries shall be supervised so that a low battery or depleted battery condition or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
  - .6 The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control
  - .7 The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
  - .8 Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

#### 1.13 **SEQUENCE OF OPERATION**

- .1 Implement the following sequence of operation for a single stage fire alarm system in a low rise building as defined by the Alberta Building Code Latest Edition.
- .2 Actuation of any alarm initiating device on to:
  - .1 Cause electronic latch to lock-in alarm state at central control unit and data gathering panel/transponder as per local fire authority.
  - .2 Indicate zone of alarm at central control unit and remote annunciator display.
  - .3 Cause audible devices throughout building to sound.
  - .4 Cause visual devices to activate throughout building.
  - .5 Transmit signal to fire department and facilities via master fire alarm box.
  - .6 Cause air conditioning and ventilation fans to shut down.
  - .7 Cause fire doors and smoke control doors, if normally held open, to close automatically.
  - .8 Cause elevators to return to floor of egress, or to alternate floor, as required.

- .9 Cause to release doors equipped with electromagnetic door locks.
- .10 Cause to relay signal to security systems.
- .11 Cause to relay signal to network lighting control system.
- .12 Cause to relay signal to audio/visual systems.
- .13 Cause to relay signal to electrical system (e.g. diesel generator load bank shunt breaker).
- .14 Cause to relay signal to Building Management Systems (BMS) Where BMS system is installed.
- .3 Acknowledging alarm: indicated at central control unit.
- .4 Possible to silence signals by "alarm silence" switch at control unit, after silencing inhibit timer has timed out. If the "Alarm Silence" button is pressed, all audible and visible alarm signals shall cease operation.
- .5 Subsequent alarm, received after previous alarm has been silenced, to re-activate signals.
- .6 Upon activation of a supervisory device including but not limited to fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows:
  - .1 Cause electronic latch to lock-in supervisory state at central control unit and data gathering panel/transponder.
  - .2 Indicate respective supervisory zone at local and remote annunciator display.
  - .3 Cause audible signal at central control unit to sound.
  - .4 Activate common supervisory sequence.
  - .5 Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
  - .6 Record the event in the FACP historical log.
  - .7 Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
- .7 System Reset
  - .1 The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
  - .2 Should an alarm condition continue, the system will remain in an alarmed state.
- .8 Trouble on system to:
  - .1 Indicate circuit in trouble on central control unit.
  - .2 Activate "system trouble" indication, buzzer and common trouble sequence.
  - .3 Acknowledging trouble condition to silence audible indication; visual indication to remain until trouble is cleared and system is back to normal.
- .9 Troubles on system: suppressed during course of alarm.

- .10 Trouble condition on any circuit in system not to initiate alarm conditions.

#### 1.14 **SYSTEM SUPERVISION**

- .1 The complete fire detection and alarm system comprising fire alarm, shall be electrically supervised for open circuits, ground faults, short circuit condition and loss of power supply, for all circuitry.
- .2 Audible and visible trouble signals shall be individually indicated at the control panel, commonly indicated at the annunciator and the CFAP.
- .3 Provide at the annunciator location, the following:
  - .1 Trouble and signal silence switch, with ring-back and subsequent alarm features. Access to these features only by direct key locked door.
  - .2 Loss of normal power indication.
- .4 The Data Gathering Panels (DGPs) shall have standalone capabilities in the event that communication is lost between the central fire alarm panel and the DGPs. The DGPs shall be capable of receiving and processing alarms and all other functions for their respective areas in the event of a communication loss with the fire alarm control panel.

#### 1.15 **SOFTWARE REPROGRAMMING**

- .1 Carry and include allowance for additional costs for the system manufacturer to make necessary on site final changes to applicable system/equipment software. Reprogramming changes are to be completed after successful testing and verification of the systems, but prior to turn over to Owner. After successful final verification of the work, confirm and obtain approval of final nomenclature in writing from Owner and Consultant. The software revisions to incorporate final room names/area names/building names and equipment identification.

#### 2 **Products**

##### 2.1 **MATERIALS**

- .1 All new material shall comply with the related IEEE, ANSI and ASTM standards.
- .2 Control Panel
  - .1 Control panel shall be housed in a surface wall mounted cabinet of code gauge construction with baked enamel finish, full viewing window and hinged front door cover complete with lock and two keys. Opening cabinet door shall provide access to all operating controls, but will not expose live electrical connections.
  - .2 Control panel, with number of zones as identified on fire alarm schedule plus 20% spare capacity, shall contain the following:
    - .1 Reset button, LED test button, alarm signal silencing push button, ground fault indicator light, system trouble indicating light, trouble signal silencing button and annunciator trouble indicating light.
    - .2 Relays and control modules as required for door releases, fan shut-down, extinguishing system release and audible alarms.
    - .3 Alarm receiving modules for number of zones as indicated on drawings plus provision for 20% spares. Zone modules shall be capable of handling any type of device including pull stations, smoke detectors, and heat

- detectors to allow for future changing of devices without changing modules. Each module to contain a trouble alarm indicator.
  - .4 Power supply modules as required.
  - .5 Gate valve supervision module as required.
  - .6 Signal control modules as required.
  - .7 Fire department connection plug-in module complete with disconnect switch and LED "Disconnect" indicator.
  - .8 All modules shall have visual supervision against removal.
- .3 Power Supplies
- .1 120 V, 60 Hz as primary source of power for system.
  - .2 Voltage regulated, current limited distributed system power.
  - .3 Primary power failure or power loss less than 102 V will activate common trouble sequence.
  - .4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.
  - .5 During normal operating conditions fault in battery charging circuit, short or open in battery leads to activate common trouble sequence and standby power trouble indicator.
  - .6 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.
  - .7 Standby batteries: sealed, maintenance free, lead calcium sealed batteries.
    - .1 The batteries shall be sealed maintenance free type with expected life of ten years.
    - .2 Batteries shall be enclosed in a steel housing.
    - .3 A fully automatic battery charger shall be provided which shall be capable of restoring 90% of a dead batteries capacity within 24 hours.
    - .4 The battery shall be protected against excessive discharge by automatically disconnecting battery from system when voltage of battery drops to 60%.
- .4 Initiating/ Input Circuits
- .1 Receiving circuits for alarm initiating devices including but not limited to manual pull stations, smoke detectors, heat detectors and water flow switches, wired in DCLA configuration to central control unit.
  - .2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.
  - .3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation".
  - .4 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLA configuration to central control unit.
  - .5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation".

- .5 Alarm Output Circuits
  - .1 Alarm output circuit: connected to strobes, wired in Class B configuration to central control unit and GDP.
    - .1 Signal circuits' operation to follow system programming. Each signal circuit: rated at 3 A, 24 V DC; fuse-protected from overloading/overcurrent.
    - .2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.
- .6 Auxiliary Circuits
  - .1 Auxiliary contacts for control functions.
  - .2 Actual status indication (positive feedback) from controlled device.
  - .3 Alarm and or supervisory trouble on system to cause operation of programmed auxiliary output circuits.
  - .4 Four sets of separate contacts for elevator capture (to main floor of egress and to alternate floor of egress).
  - .5 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.
  - .6 Auxiliary circuits: rated at 2 A, 24 V dc or 120 V ac, fuse-protected.
- .7 Wiring
  - .1 Copper conductors: Type FAS 105
  - .2 To initiating circuits: 18 AWG minimum, and in accordance with manufacturer's requirements.
  - .3 To signal circuits: 16 AWG minimum, and in accordance with manufacturer's requirements.
  - .4 To speaker circuits: twisted, shielded pairs, and in accordance with manufacturer's requirements.
  - .5 To telephone circuits: twisted, shielded pairs, and in accordance with manufacturer's requirements.
  - .6 To control circuits: 14 AWG minimum, and in accordance with manufacturer's requirements.
  - .7 Risers for DGPs: twisted, shielded pairs, 2 h fire-rated mineral insulated configured to eliminate interference and cross-talk.
  - .8 Fire alarm systems wiring to meet minimum sizes noted above and in accordance with the OESC, whichever is most stringent.
- .8 Alarm Initiating Devices
  - .1 Heat detectors, fixed temperature, non- restorable, rated 57 degrees C.
    - .1 Moisture proof type, where indicated on drawings.
  - .2 Thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 88 degrees C, rate of rise 8.3 degrees C per minute.

- .3 Addressable thermal fire detectors, combination fixed temperature and rate of rise, non-restorable fixed temperature element, self-restoring rate of rise, fixed temperature 88 degrees C, rate of rise 8.3 degrees C per minute.
  - .1 Electronics to communicate detector's status to addressable module/transponder.
  - .2 Detector address to be set on detector base head in field.
- .4 Smoke detector: photo-electric air duct type.
  - .1 Provide integral control and power modules required for operation with main control panel.
  - .2 Ensure detectors and associated modules are compatible with main control panel and suitable for use in supervised circuit.
  - .3 Detector circuits: 4-wire type where detector operating power is transmitted over conductors separate from initiating circuit. Malfunction of electrical circuits to detector or its control or power modules to cause operation of system trouble signals. Provide a separate, fused power circuit for each smoke detection initiating circuit.
  - .4 Failure of power circuit: indicated as a trouble condition on corresponding initiating circuit.
  - .5 Provide duct detectors in accordance with NFPA 90A.
  - .6 Provide duct detectors with approved duct housing, mounted exterior to duct, with perforated sampling tubes extending across width of duct. Provide access door on duct for maintenance purposes.
  - .7 Activation of duct detectors to cause shutdown of associated air handling unit annunciation at control panel and tripping of master box transmitter and sounding of building evacuation alarms.
  - .8 Provide detectors with visible indicator lamp that flashes when detector is in normal standby mode and glows continuously when detector is activated.
  - .9 Provide remote indicator lamp for each detector.
  - .10 Permanently label remote indicator with description number of associated air handling unit(s).
  - .11 Provide each detector with remote test switch. Mount switch not more than 1.8 m above finished floor.
  - .12 Permanently label test switch with description number of associated air handling unit(s).
- .5 Addressable smoke detector:
  - .1 Photo-electric type. Electronics to communicate detector's status to addressable module/transponder.
  - .2 Detector address to be set on detector base in field.
- .6 Addressable Manual Alarm Stations
  - .1 Pull lever, push, semi-flush wall mounted type, single action, single stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to supply power to station. Station address to be set on station in field. Bilingual English French signage.

- .2 Auxiliary contact for exit door release that is electrically held closed by security system.
- .3 Auxiliary contact for door held open device that is electrically controlled by security system.
- .4 Key operated reset lock in order that they may be tested, and so designed that after actual Emergency Operation, they cannot be restored to normal except by use of a key.
- .5 Provide protective cover to mitigate false alarms where indicated on plans. Cover to be ULC listed and labelled, hinged door Lexan cover. Where required by Code or by AHJ, include integral audible alarm to sound when cover is opened.
- .6 For non-climate control applications, such the basement garage, provide weather-proof ULC listed and labelled, hinged door Lexan cover. Where required by Code or by AHJ, include integral audible alarm to sound when cover is opened.
- .9 Addressable Circuit Interface Modules
  - .1 Addressable Circuit Interface Modules: Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of AHU systems.
    - .1 Addressable Dry Contact Monitor Module
    - .2 Addressable Control Module
    - .3 Addressable Relay Module
  - .2 Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.
  - .3 All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the CPU. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.
- .10 Isolators
  - .1 Provide isolators in accordance with code requirements and installed as per system manufacturer's requirements to isolate/monitor zones, loops, group of devices within the building and between buildings.
- .11 Visual Alarm Signal Devices
  - .1 Strobe type: flashing, 24 V DC, synchronized, "FIRE" marking on polycarbonate lens; illumination of at least 75 cd @ 50' (15m) with other settings of 15/30/110 cd; suitable for mounting on surface/flush back boxes; red/white plastic housing
  - .2 Designed for recessed mounting in finished areas and surface mounted in service areas.
  - .3 Designed as weatherproof where required.



- .4 Combined with speaker where shown on plans.
- .12 End-of-line Resistors
  - .1 End-of-line devices to control supervisory current in signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.
  - .2 End-of-line resistors shall be mounted on a stainless steel plate and bear a ULC label.
- .13 Door Holders
  - .1 Door holders shall be magnetic type, wall floor mounted, with approximately 35 lbs holding power, for operation on 12V DC 24C DC 24V AC 120C AC.
- .14 Remote Alarm Indicators
  - .1 Remote alarm indicators shall be wall ceiling mounted and shall provide remote indication of a specific detector using an electrical connection. Unit shall consist of a red LED lamp on a mounting plate.
- .15 Remote Test Station
  - .1 Remote test station shall provide testing of a detector and indication of an alarm condition at a remote location. Unit shall consist of a key test switch and a red LED lamp mounted on a single gang plate.
  - .2 Password Control:
    - .1 Multiple Access Levels. Operator access level is determined during log-in. Select functional access to match the training and responsibility of the operator. Operators with additional Incident Commander and fire alarm network training may be qualified for access to sensitive areas. For operators who are primarily concerned with immediate facility security, a lower level access will provide the information necessary for proper response but will not allow access to key parameters that determine overall system/network operation.
  - .3 Network Diagnostics
    - .1 Graphical Network Status Views. Automatic, built-in diagnostics are available to provide graphical views of Network topology and Network status.
    - .2 Missing communications links due to wiring breaks or shorts as well as inactive network nodes are indicated clearly to guide in returning the system to normal.
    - .3 Information screens are available to provide detail about each specific network node.
    - .4 Network level functions such as timekeeper node and monitor node are indicated as well as identification of the node being used for the diagnostic.
  - .4 All-in-one touchscreen computer/monitor, powered from the fire alarm system power supply, including battery backup.
    - .1 Pan-and-zoom features allow precise navigation.
    - .2 Configurable coverage zones allow user defined zones within a graphics



screen to highlight to indicate the area of activity without zooming into the point of interest.

- .3 Auto-jump allows the screen view to jump to a graphic or alarm list menu.
- .5 High resolution (1280 x 1024), 19" (483 mm) touchscreen computer/monitor with UL I/O Card, compact keyboard and mouse.
- .6 Windows 7 Professional 32-bit operating system.
- .7 Enable to be mounted at main front security desk console
- .8 Connects to the fire alarm Network as a node allowing access to remote panel activity status, or a fire alarm event, can take control of remote panel activity over the fire alarm network.
- .9 TCP/IP and LAN/WAN connections with dedicated and listed Fire Alarm LAN equipment, listed remote clients can have control access.
- .10 Supports standard fire service annunciation icons to provide security personnel and first responders with critical fire response information.
- .11 Color graphical annunciation and control capacity for up to 50,000 points or point groups.
- .12 Floatable and dockable windows allows windows to either be fixed (docked) or floatable.
- .13 Extensive historical logging; up to 500,000 events with operator notations.
- .14 Optional interface to Digital Alarm Communicating Receiver (DACR) integrates multiple systems onto a single Incident Commander
- .15 Available optional connections for printers or other compatible systems

### 3 Execution

#### 3.1 CONNECTIONS TO OTHER SYSTEMS

- .1 Sprinkler and Fire Standpipe Systems
  - .1 Provide wiring and connections from the fire alarm system to all alarm check valves, supervised valves and pressure switches supplied and installed under Mechanical Division.
  - .2 Provide wiring and connections from the fire alarm system to sprinkler and fire standpipe system pumps supervisory contacts supplied and installed under Mechanical Division, for "Loss of Power" and "Pump(s) Running" annunciation.
  - .3 Wire all excess pressure pumps.
- .2 Motor Starter Connections
  - .1 The fire alarm panel shall be complete with shutdown relays to stop all motors of supply air fans, return air fans upon fire alarm activation.
  - .2 Provide all wiring and connections from the fire alarm system to designated new starters. All other starter controls wiring shall be under Mechanical Division.
- .3 Elevator System Connection
  - .1 Provide all wiring and connections from the fire alarm system to the elevator controller required for fire mode operation.

- .4 Security System Connection
  - .1 Provide all wiring and connection from the fire alarm system to the security system controller for specified operation.
  - .2 Provide all wiring and connection from the fire alarm system to the electromagnetic lock for specified operation.
- .5 Audio/Visual System Connection
  - .1 Provide all wiring and connection from the fire alarm system to the audio/visual system controller for specified operation.
- .6 Electrical System Connection
  - .1 Provide all wiring and connection from the fire alarm system to the generator set load bank (shunt) breaker for specified operation.

3.2 **INSTALLATION**

- .1 Install to CAN/ULC S524.
- .2 Install wiring for standard type initiating circuits in separate raceway system from alarm signal circuits, unless wiring is individually shielded and single point ground connected and acceptable to equipment manufacturer.
- .3 Wire alarm signals in accordance with requirements by manufacturer and operation. Install end-of-line device for signal circuit in suitable box adjacent to last signal of signal circuit or mounted on suitable terminal strips in control panel.
- .4 Install lightning protection units at each interior building local alarm initiating or signal circuit wire, connected to ground bus in control panel with #12 gauge copper conductor.
- .5 Install surge protector at each external to building initiating or signal circuit as required by manufacturer.
- .6 Equip raceways with separate green ground-wire and bond to ground lug at each outlet box of device and bond ground wires directly to ground bus in control panel.
- .7 Take power for control panel from bus on load side of main disconnecting device as described in Section 32 of Canadian Electrical Code. Make connection using approved lugs. Bond ground cable to ground bus at control panel.
- .8 Install external power regulator in electrical room close to electrical distribution supply and connect to 120 Volt AC, 60 Hz supply for fire alarm system in accordance with manufacturer's instructions.
- .9 Clear wiring of shorts, opens and grounds on completion of work.
- .10 Mount detectors on ceiling as per CAN/ULC-S524 Standard unless otherwise specified herein with minimum and maximum distances as required for respective type of detector, at highest point where variations in ceiling height exist. Do not mount detectors on sides, undersides, or less than 600 mm from walls, beams, joints, ducts, open web steel joists or any structure projecting below actual ceiling height and especially from lighting fixtures and air exhaust handling or heating outlets, but 900 mm from air supply handling or heating outlet.
- .11 Should interference from obstruction, lamp positions, air outlets or heat radiating surfaces be encountered in locating any detector where indicated, locate detector as near as

- possible to indicated position, clear of obstacles, to satisfaction of Owner's Designee, but maintain clear space of 600 mm on ceiling, below and around.
- .12 Identify signal circuit, alarm initiating circuit, auxiliary circuit and other wiring at fire alarm control panel, annunciator, terminal boxes or elsewhere on completion of work with appropriate marking labels. Mark single conductors with suitable self adhesive type, indelible numbered markers, identify cables with clear polyester tag, attached with self-locking TY-RAP.
  - .13 Provide, install and connect wiring and interconnecting wires and cables as specified herein, as required by control panel manufacturer and as indicated on Drawings.
  - .14 Wire magnetic fire door holder and closing units, electro-magnetic locking devices, air conditioning fans and any other ancillary device in accordance with manufacturer instruction and their operational requirements.
  - .15 Provide electro-magnetic locking devices, fire door releases and/or magnetic fire door holder and closing units to Division 08. Supervise installation and ensure unit functions as per manufacturer's specifications.
  - .16 Supply and install 1- 15 A, 120 Volt AC duplex receptacle beside new control panel, connect into nearest receptacle circuit of adequate capacity.
  - .17 Where moisture-proof, corrosion resistant or waterproof detectors are used, use raintight connectors with waterproof gasketed back box and tape wiring connectors.
  - .18 Maintain following heights from finished floor to centre of box for
    - .1 Manual Station: 1200 mm
    - .2 Alarm signal: not less than 1800 mm.
    - .3 End of Line device: not more than 1800 mm.
    - .4 Annunciator: 1600 mm from finished floor to top of unit.
    - .5 Control Panel: as per Site instruction by Owner's Designee.
  - .19 Wiring:
    - .1 In no case shall the voltage drop exceed 5%.
  - .20 Class A wiring shall be used for all alarm initiating devices.
  - .21 Power to be provided by 120V AC emergency circuit.
  - .22 Provide EMT rigid conduits with steel set screw fittings with nylon insulated thread rigid coupling as manufactured by T & B or approved equal. Size conduits to Code requirements or larger sizes where indicated.
  - .23 Terminal cabinets shall be 460 x 610 mm type "T" with wood back, door within the trim complete with latch and lock.
  - .24 Outlet box for alarm signals shall be a single gang, masonry box unless indicated otherwise and shall be flush mounted in all areas with finished ceilings. In all other areas, outlet boxes shall be 101 mm square surface.
  - .25 Outlet boxes for manual stations shall be a single gang masonry box unless indicated otherwise and shall be flush mounted, in all areas with finished ceilings. In all other areas, outlet boxes shall be flush mounted if possible.

- .26 Should interference from obstructions, lamp positions or heat radiating surfaces be encountered in locating any fire alarm device where shown, the device shall be located as near as possible to indicated position, clear of obstacles, to the satisfaction of Consultant.
- .27 Install Fire Alarm System components as follows:
  - .1 Install fire alarm control panel and DGP, where shown on drawings
  - .2 Install fire alarm annunciator near the main entrance, where shown on plans
  - .3 Install Incident Commander in front security desk console.
    - .1 Coordinate with millwork trades for mounting hardware and proper supports.
  - .4 Install non-emergency paging handset at front security desk console.
    - .1 Coordinate with millwork trades for mounting hardware and proper supports.

### 3.3 FIELD QUALITY CONTROL

- .1 Inspection and Verification
  - .1 Only directly prior to verification, remove smoke detector protectors and clean smoke detectors thoroughly.
  - .2 Inspect and verify each individual device in entire system for proper connection, supervision and function in accordance with CAN/ULC-S537. Identify detectors, manual pull stations and signal appliances not installed within requirements of CAN/ULC-S524 in remarks column of verification report and bring to Owner's Designee's attention prior to acceptance test.
  - .3 Hire the services of a professional engineer licensed in the province of Alberta to witness the fire alarm verification in accordance with the local AHJ. The electrical contractor is not obligated to hire NORR Architects Engineers Planners to witness the fire alarm verification. Another party may be utilized provided they are licensed to do so by the Authority Having Jurisdiction.
  - .4 If an alternate professional engineer is utilized to witness the fire alarm verification a copy of the fire alarm verification reports and certificates must be sent to NORR once completed. The building code C schedules will not be released until these documents have been received.
  - .5 Obtain verification certificate and report from professional engineer showing each device checked, and that this work has been carried out.
  - .6 Obtain verification certificate and verification report from manufacturer showing each device checked, and that this work has been carried out. Utilize standard verification forms similar to Canadian Fire Alarm Association (C.F.A.A.) forms.
  - .7 Inspection and checking shall include smoke testing of each ionization or photoelectric smoke detector when installed with similar material found in area protected or as directed otherwise by Owner's Designee. Submit smoke detectors sensitivity calibration reading, as read on place of installation as part of verification report.
  - .8 Fire alarm manufacturer shall supply to electrical contractor reasonable amounts of technical assistance with respect to any changes necessary to execute work during period of inspection by manufacturer, electrical contractor shall make available, to manufacturer, electricians as designated by manufacturer.

- .9 Verify only when entire system is fully operational and no subsequent work will be performed, unless project is designated for phased occupancy.
- .10 For phased occupancy construction provide interim testing and verification service and retest entire system at the end of the project.
- .11 Issue certificate of verification only after completion of deficiencies noted during verification have been corrected and re-verified.

3.4 **FINAL COMMISSIONING**

- .1 After completion of above inspection and verification, make arrangement with Owner's Designee, manufacturer of control equipment and other installers of related and connected equipment (extinguishing systems, fans, doors, elevators and other equipment) to perform functional acceptance tests, giving ample notice to parties concerned to be present.
- .2 Tests to include:
  - .1 Spot check of devices to ensure proper connections and supervision.
  - .2 Operation of at least 1 alarm initiating device on each detection circuit to verify required operation of alarm devices, annunciator and other installations.
  - .3 Testing of signal devices for correct operation and function.
  - .4 Testing of smoke detectors with similar material found in area to be protected.
  - .5 Record sound pressure levels in each room during an alarm condition and at ambient levels.

3.5 **DEMONSTRATION**

- .1 Provide 20 hrs familiarization and instruction period, to familiarize user and Owner's maintenance staff with working and function of system and equipment and to instruct maintenance personnel about proper maintenance.

End of Section

## **1 General**

### **1.1 SUMMARY**

- .1 This Section includes the following:
  - .1 Excavating and backfilling for site demolition and preparation
  - .2 Excavating and backfilling for utility trenches
  - .3 Excavation and backfilling for structures
  - .4 Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures

### **1.2 REFERENCES**

- .1 American Society for Testing and Materials ([ASTM](#)):
  - .1 ASTM D69800ae1 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ftlb/ft<sup>3</sup> (600 kNm/m<sup>3</sup>))
  - .2 ASTM C11704 Test Method for Material Finer Than: 0.075 mm Sieve in Mineral Aggregates by Washing.
  - .3 ASTM C13604 Method for Sieve Analysis of Fine and Coarse Aggregates
  - .4 ASTM D155702e1 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ftlb/ft<sup>3</sup> (2,700 kNm/m<sup>3</sup>))
- .2 Canadian General Standards Board ([CGSB](#)):
  - .1 CAN/CGSB 8.188 Sieves Testing, Woven Wire, Inch Series
  - .2 CAN/CGSB 8.2M88 Sieves, Testing, Woven Wire, Metric
- .3 Canadian Standards Association ([CSA](#)):
  - .1 CSAA23.1/A23.200 Concrete Materials and Methods of Concrete Construction/Methods of Tests for Concrete

### **1.3 DEFINITIONS**

- .1 Backfill: Soil material or controlled low strength material used to fill an excavation
  - .1 Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe
  - .2 Final Backfill: Backfill placed over initial backfill to fill a trench
- .2 Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe
- .3 Borrow Soil: Satisfactory soil imported from off site for use as fill or backfill
- .4 Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated
- .5 Authorized Additional Excavation:
  - .1 Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by geotechnical consultant
  - .2 Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work
- .6 Unauthorized Excavation:
  - .1 Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by geotechnical consultant

- .2 Unauthorized excavation, as well as remedial work directed by geotechnical consultant, shall be without additional compensation
- .7 Common Excavation: Excavation of materials of whatever nature, which can be ripped and excavated with heavy construction equipment
- .8 Rock Excavation: Excavation of material from solid masses of igneous, sedimentary or metamorphic rock which, prior to its removal, was integral with its parent mass, and boulders or rock fragments having individual volume in excess of 1 m<sup>3</sup>
- .9 Fill: Soil materials used to raise existing grades
- .10 Geotechnical Consultant: A professional who is not the Consultant for the project. The geotechnical consultant will be hired directly by the Owner to undertake ongoing soils investigations, testing and recommendations on behalf of the Owner. Reports and recommendations will be forwarded to the Owner, Consultant and Trade Contractor responsible for this portion of the Work.
- .11 Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man made stationary features constructed above or below the ground surface
- .12 Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill
- .13 Topsoil: Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding
- .14 Utilities: On site underground pipes, conduits, ducts, and cables, as well as underground services within buildings

#### **1.4 SUBMITTALS**

- .1 Comply with requirements of Section 01 33 00.
- .2 Submit drawings indicating all required shoring and related work. Drawings must bear the seal of the Professional Engineer responsible for the shoring design.
- .3 Submit a drawing indicating required underpinning, construction methods and sequences. The drawing must bear the seal of a Professional Engineer responsible for the underpinning design.
- .4 Submit soil density test results and soil engineer reports before placing footings or slab on grade.
- .5 Samples: At least 2 weeks prior to commencing work, inform Consultant of proposed source of fill materials and provide access for sampling; provide testing agency with 70 kg samples of type of fill specified.

#### **1.5 QUALITY ASSURANCE**

- .1 An independent testing agency qualified to conduct geotechnical testing and observation will be retained by the Owner to conduct and document conditions of soil materials, and to provide geotechnical recommendations.
- .2 Soil testing and inspection will be paid for directly by the Owner, and done by a firm selected by the Owner.
- .3 Testing to be done under the supervision of a registered professional engineer.
- .4 Arrange in advance for services of an approved soil engineer to make such services available when needed. Inspect footing excavations before placing footings, and provide soil density testing as required.
- .5 Prior to the placement of backfill, the testing laboratory shall as a minimum confirm that the subbase has been prepared properly to accept backfill.
- .6 It is the Contractor's responsibility to coordinate with the Testing Agency and to ensure that the specified number of tests are provided at the appropriate time. All costs associated with retesting for areas that did not meet the specified results are to be borne by the Contractor.

- .7 Frequency of compaction tests shall be as follows:
  - .1 Exterior side of perimeter walls: One test / 40 lineal m (130 lineal feet) / compacted lift of backfill
  - .2 Within building area under basement and subbasement floating slabs on grade: One test / 1,000 m<sup>2</sup> (10,764 ft<sup>2</sup>) / compacted lift of backfill
  - .3 Within building area under main floor structural slabs on grade: One test / 40 m<sup>2</sup> (430 ft<sup>2</sup>) / compacted lift of backfill
  - .4 Under exterior floating concrete slabs: One test / 1,000 m<sup>2</sup> (10,764 ft<sup>2</sup>) / compacted lift of backfill
  - .5 Under exterior structural slabs: One test / 40 m<sup>2</sup> (430 ft<sup>2</sup>) / compacted lift of backfill
  - .6 Retaining walls: One test / 100 lineal m (328 lineal feet) / compacted lift of backfill
  - .7 Asphalt pavement subbase: One test / 1000 m<sup>2</sup> (10,764 ft<sup>2</sup>) / compacted lift of backfill or recompacted lift of native material
  - .8 Asphalt pavement granular base: One test / 1000 m<sup>2</sup> (10,764 ft<sup>2</sup>) / compacted lift of backfill
  - .9 Trenches more than 15 m (49 feet) in length 2 density tests per 600 mm (24") of trench depth per 100 m (328 feet) of trench length
  - .10 Trenches 15 m (49 feet) or less in length: Minimum of 3 density test evenly spaced through the depth and length of trench
  - .11 Landscaped areas: One test / 40 m<sup>2</sup> (430 ft<sup>2</sup>) / compacted lift of backfill

## **1.6 PROJECT CONDITIONS**

- .1 A geotechnical report will be prepared for this Project and made available for viewing under the following conditions:
  - .1 The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer.
  - .2 Owner will not be responsible for interpretations or conclusions drawn from the report.
  - .3 Consultant has used the information for their own design purposes, and will not be responsible for further interpretations or conclusions drawn from the report.
  - .4 Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
- .2 Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Consultant and then only after arranging to provide temporary utility services according to requirements indicated.
- .3 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
- .4 Prior to commencing any excavation work, notify Consultant, establish location and state of use of buried utilities including existing communication and security lines and structures. Clearly mark such locations to prevent disturbance during work. Immediate restoration and replacement of any damaged equipment or lines will be imposed at the Contractor's expense.
- .5 Confirm locations to buried utilities by careful test excavations.
- .6 When directed, reroute existing lines in area of excavation. Pay costs for such work.
- .7 Record location of maintained, rerouted and abandoned underground lines.
- .8 Conduct, with Consultant, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracts and paving, survey benchmarks and monuments which may be affected by work.



- .9 Protect existing buildings and surface features which may be affected by work from damage while work is in progress and repair damage resulting from work.
- .10 Where the excavation necessitates root or branch cutting, do so only as approved by Consultant.

## **1.7 WARRANTY**

- .1 The Contractor will be responsible for all reinstatement of surface paving, slabs, etc. due to settlement for 2 years from date of Substantial Performance.

## **2 Products**

### **2.1 SOIL MATERIALS**

- .1 General:
  - .1 Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
  - .2 Coordinate with geotechnical consultant for types of fill materials required for the Project.
- .2 SiteExcavated Material:
  - .1 Site excavated soil, where approved as backfill and fill material, is to be free of debris, organic matter, snow and ice. Do not use frozen soil for fill.
  - .2 Site excavated soil is to include only site material removed by required excavation and grading.
- .3 Granular Backfill and Fill Material:
  - .1 Where backfill or fill material is required to be pitrun gravel, crushed gravel, or sand, it is to be a clean natural stone. Do not exceed 2% organic content; gradation is to be within the specified limits.
- .4 PitRun Gravel A:

<u>Sieve Size (mm)</u>	<u>Percent Passing</u> <u>By Weight</u>	
100	100	
75	60 100	Total Sample
25	60 80	
2.36	25 45	Material Passing
1.18	16 25	75 mm Sieve
0.60	8 18	
0.150	4 10	
0.075	2 6	

.5 PitRun Gravel B:

<u>Sieve Size (mm)</u>	Percent Passing
	<u>By Weight</u>
80	100
50	55 100
25	38 100
16	32 85
5	20 65
0.35	6 30
0.080	2 15

.6 Crushed Gravel A:

<u>Sieve Size (mm)</u>	Percent Passing
	<u>By Weight</u>
25	100
20	95 100
10	60 80
4.75	40 60
2.36	28 48
0.60	13 29
0.15	6 15
0.075	4 10

.7 Crushed Gravel B:

<u>Sieve Size (mm)</u>	<u>Percent Passing</u> <u>By Weight</u>
25	100
20	100
12.5	60 92
5	37 62
2	26 44
0.40	12 27
0.16	7 18
0.08	2 8

.8 Coarse Gravel:

<u>Sieve Size (mm)</u>	<u>Percent Passing</u> <u>By Weight</u>
50	100
40	90 100
20	35 70
10	10 30
4.75	0 5

.9 Sand A:

<u>Sieve Size (mm)</u>	<u>Percent Passing</u> <u>By Weight</u>
10	100
4.75	95 100
1.18	50 85
0.60	25 60
0.30	10 30
0.15	2 10

.10 Sand B:

<u>Sieve Size (mm)</u>	<u>Percent Passing</u> <u>By Weight</u>
10	65 100
5.0	50 90
2.0	35 75
0.4	10 45
0.15	0 20
0.080	0 10

### **3 Execution**

#### **3.1 PREPARATION**

- .1 Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- .2 Preparation of sub-grade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface.
- .3 Protect and maintain erosion and sedimentation controls during earthwork operations.
- .4 Protect sub-grade from softening, undermining, washout, and damage by rain or water accumulation as follows:
  - .1 Reroute surface water runoff away from excavated areas
  - .2 Do not allow water to accumulate in excavations
  - .3 Do not use excavated trenches as temporary drainage ditches
  - .4 Maintain until dewatering until it is no longer required

#### **3.2 GENERAL EXCAVATION**

- .1 It is not expected that any unclassified excavated materials will be encountered during excavation operations:
  - .1 Unclassified excavated materials may include rock, soil materials not reported in geotechnical investigation, and sub-grade obstructions not indicated on drawings or in specifications.
- .2 Excavate to sub-grade elevations indicated on drawings including foundation elements and building obstructions resulting from demolition of existing building and site features to a tolerance of  $\pm 25$  mm (1").
- .3 Extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
- .4 Support excavations having an angle of repose greater than that allowable for the soil types in accordance with requirements.

### **3.3 EXCAVATION FOR UTILITY TRENCHES**

- .1 Excavate trenches to indicated gradients, lines, depths, and elevations.
- .2 Excavate trenches to allow installation of top of pipe below frost line, where they occur beyond building perimeter.
- .3 Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit:
  - .1 Excavate trench walls vertically from trench bottom to 305 mm (12") higher than top of pipe or conduit
  - .2 Clearance: 305 mm (12") each side of pipe or conduit.
- .4 Trench Bottoms:
  - .1 Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit.
  - .2 Shape sub-grade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
  - .3 Remove projecting stones and sharp objects along trench sub-grade.
  - .4 Hand excavate trench bottoms for pipes and conduit, and flat bottomed and multiple duct conduit units < 150 mm (6") Ø nominal, and support pipe and conduit on an undisturbed sub-grade.
  - .5 Shape bottom of trench to support bottom 90 degrees of pipe circumference for pipes and conduit < 150 mm (6") Ø nominal and fill depressions with tamped sand backfill.

### **3.4 STRUCTURE EXCAVATION**

- .1 Excavate to elevations and dimensions indicated on Drawings within a tolerance of ±50 mm, and extending a sufficient distance from footings and foundation walls to permit placing and removal of concrete formwork, installation of services, other required construction, and for inspection.
- .2 In excavating for footings and foundations, take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- .3 Protect bottom of excavations and soil around and beneath footings from frost and ingress of water.

### **3.5 SUB-GRADE INSPECTION**

- .1 Notify geotechnical consultant and Consultant when excavations have reached required sub-grade.
- .2 Continue excavation and replace with compacted backfill or fill material as directed where geotechnical consultant determines that unsatisfactory soil is present.
- .3 Proof roll sub-grade below the building slabs and pavements with heavy pneumatic tired equipment to identify soft pockets and areas of excess yielding using equipment acceptable to the geotechnical consultant; do not proof roll wet or saturated sub-grade, and as follows:
  - .1 Proof roll in direction and speed as directed by geotechnical consultant.
  - .2 Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by geotechnical consultant, and replace with compacted backfill or fill as directed.
- .4 Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- .5 Reconstruct sub-grade damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by geotechnical consultant, without additional compensation.

### **3.6 UNAUTHORIZED EXCAVATION**

- .1 Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation or other method as directed by the geotechnical consultant.

- .2 Fill unauthorized excavations under other construction or utility pipe as directed by geotechnical consultant.

### **3.7 STORAGE OF SOIL MATERIALS**

- .1 Stockpile topsoil and other acceptable fill materials in locations as directed by Consultant.

### **3.8 UTILITY TRENCH BACKFILL**

- .1 Place backfill on sub-grade free of mud, frost, snow, or ice.
- .2 Place and compact bedding course on trench bottoms and where indicated.
- .3 Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- .4 Backfill trenches excavated under footings and within 450 mm (18") of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.
- .5 Provide 100 mm (4") thick, concrete base slab support for piping or conduit less than 762 mm (30") below surface of roadways, followed by complete enclosure of piping or conduit in a minimum of 100 mm (4") of concrete after installation and testing and before backfilling or placing roadway sub-base.
- .6 Place and compact initial backfill of satisfactory soil, free of particles larger than 25 mm (1") in any dimension, to a height of 305 mm (12") over the utility pipe or conduit, and as follows:
  - .1 Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit.
  - .2 Coordinate backfilling with utilities testing.
- .7 Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- .8 Place and compact final backfill of satisfactory soil to final sub-grade elevation.

### **3.9 SOIL MOISTURE CONTROL**

- .1 Uniformly moisten or aerate sub-grade and each subsequent fill or backfill soil layer before compaction to within 2% of optimum moisture content, and as follows:
  - .1 Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - .2 Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2% and is too wet to compact to specified dry unit weight.

### **3.10 COMPACTION OF SOIL BACKFILLS AND FILLS**

- .1 Place backfill and fill soil materials in layers not more than 203 mm (8") in loose depth for material compacted by heavy compaction equipment, and not more than 100 mm (4") in loose depth for material compacted by hand operated tampers.
- .2 Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- .3 Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:
  - .1 Under structures, building slabs, steps, and pavements, scarify and recompact top 305 mm (12") of existing subgrade and each layer of backfill or fill soil material at 100%.
  - .2 Under walkways, scarify and recompact top 150 mm (6") below subgrade and compact each layer of backfill or fill soil material at 100%.
  - .3 Under lawn or unpaved areas, scarify and recompact top 150 mm (6") below subgrade and compact each layer of backfill or fill soil material at 95%.
  - .4 For utility trenches, compact each layer of initial and final backfill soil material at 98%.

### **3.11 GRADING**

- .1 Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated, and as follows:
  - .1 Provide a smooth transition between adjacent existing grades and new grades.
  - .2 Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- .2 Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrade to required elevations within the following tolerances:
  - .1 Lawn or Unpaved Areas:  $\pm 25$  mm (1")
  - .2 Walks:  $\pm 25$  mm (1")
  - .3 Pavements:  $\pm 13$  mm ( $\frac{1}{2}$ ")
- .3 Grading inside Building Lines: Finish subgrade to a tolerance of 13 mm ( $\frac{1}{2}$ ") when measured against a 3050 mm (10'0") straightedge.

### **3.12 FIELD QUALITY CONTROL**

- .1 Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality control testing.
- .2 Allow testing agency to inspect and test sub-grade and each fill or backfill layer.
- .3 Proceed with subsequent earthwork only after test results for previously completed work complies with requirements.
- .4 When testing agency reports that sub-grade, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.
- .5 Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- .6 Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions as follows:
  - .1 Scarify or remove and replace soil material to depth as directed by geotechnical consultant; reshape and re-compact.
- .7 Remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing where settling occurs before Project correction period elapses as follows:
  - .1 Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### **3.13 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

- .1 Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

### **3.14 RESTORATION AND CLEAN UP**

- .1 Upon completion of work, remove surplus materials and debris, trim slopes, and correct defects noted by Consultant.
- .2 Replace topsoil as indicated.
- .3 Reinstall pavement, sidewalks, and landscaping to condition and elevation that existed before excavation.
- .4 Clean and reinstall areas affected by work as directed by Consultant.



**END OF SECTION**

**Part 1            General**

**1.1        References**

- .1        American Society for Testing and Materials (ASTM)
  - .1        ASTM C117-95, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
  - .2        ASTM C131-96, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - .3        ASTM C136-96a, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .4        ASTM D422-63 (1998), Standard Test Method for Particle-Size Analysis of Soils.
  - .5        ASTM D698-00a, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft<sup>3</sup>) (600kN-m/m<sup>3</sup>).
  - .6        ASTM D1557-00, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft<sup>3</sup>) (2,700kN-m/m<sup>3</sup>).
  - .7        ASTM D1883-99, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
  - .8        ASTM D4318-00, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2        Canadian General Standards Board (CGSB)
  - .1        CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

**1.2        Waste Management And Disposal**

- .1        Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2        Divert unused granular material from landfill to local facility as approved by the Departmental Representative.

**Part 2            Products**

**2.1        General**

- .1        Granular sub-base material for the road shall be Pit Run Gravel.
- .2        Granular base material for the road shall be 25 mm Crushed Gravel:

**2.2        Materials**

- .1        Pit Run Gravel: River sand and gravel free from silt, clay, loam, friable or soluble materials, vegetative matter and conforming to the following grading:
  - .1        Gradation to be within the following limits when tested to ASTM C136-06 and ASTM C117-04 and giving a smooth curve without sharp breaks when plotted on a semi-log chart.

Sieve Sizes (Square Openings)	Percent Passing by Weight
200 mm	100 of Total Sample
150 mm	96 - 100 of Total Sample
75 mm	60 - 80 of Total Sample
25 mm	70 - 100 of Material Passing 75 mm Sieve
4.75 mm	25 - 63 of Material Passing 75 mm Sieve
1.18 mm	14 - 41 of Material Passing 75 mm Sieve
0.6 mm	7 - 30 of Material Passing 75 mm Sieve
0.15 mm	3 - 18 of Material Passing 75 mm Sieve
0.075 mm	2 - 9 of Material Passing 75 mm Sieve

- .2 Any grading variation from the above is at the discretion of the Departmental Representative, however, the percent of material passing 0.075 mm sieve shall not exceed 2/3 of the material passing the 0.6 mm sieve.
- .3 The pit run gravel shall be free of any form of coating.
- .4 Pit run gravel containing clay, loam or other deleterious materials will be rejected.
- .5 No oversize material is tolerated.
- .2 25 mm Crushed Gravel conforming to the following grading:
  - .1 Gradation to be within following limits when tested to ASTM C136-06 and ASTM C117-04, and giving a smooth curve without sharp breaks when plotted on a semi-log grading chart.

Sieve Sizes (Square Openings)	Percent Passing by Weight
25.0 mm	100
20.0 mm	95 - 100
10.0 mm	60 - 80
4.75 mm	40 - 60
2.36 mm	28 - 48
600 micron	13 - 29
300 micron	9 - 21
150 micron	6 - 15
75 micron	4 - 10

- .2 At least 50% of the material retained on the 4.75 mm sieve shall have two or more fractured faces.
- .3 Any gravel containing clay, loam or other deleterious materials will be rejected.

### Part 3 Execution

#### 3.1 Placing

- .1 Place granular sub-base after subgrade is inspected and approved by the Departmental Representative.
- .2 Construct granular sub-base to depth and grade in areas indicated.
- .3 Ensure no frozen material is placed.
- .4 Place material only on clean unfrozen surface, free from snow or ice.
- .5 Begin spreading sub-base material on crown line or high side of one-way slope.
- .6 Place granular sub-base materials using methods which do not lead to segregation or degradation.

- .7 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
- .8 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. The Departmental Representative may authorize thicker lifts if specified compaction can be achieved.
- .9 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .10 Remove and replace portion of layer in which material has become segregated during spreading.

### **3.2 Compaction**

- .1 Compact to density of not less than 100% corrected Standard Proctor Density.
- .2 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.
- .3 Apply water as necessary during compaction to obtain specified density.
- .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by the Departmental Representative.
- .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

### **3.3 Proof Rolling**

- .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm maximum.
- .2 Obtain approval from the Departmental Representative to use non standard proof rolling equipment.
- .3 Proof roll at level in sub-base as indicated. If non standard proof rolling equipment is approved, the Departmental Representative to determine level of proof rolling.
- .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- .5 Where proof rolling reveals areas of defective subgrade:
  - .1 Remove sub-base and subgrade material to depth and extent as directed by the Departmental Representative.
  - .2 Backfill excavated subgrade sub-base material and compact in accordance with this section.
  - .3 Replace sub-base material and compact.
- .6 Where proof rolling reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.

### **3.4 Site Tolerances**

- .1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

**3.5 Protection**

- .1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by the Departmental Representative.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials (ASTM)
  - .1 ASTM C117-[95], Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
  - .2 ASTM C131-[96], Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - .3 ASTM C136-[96a], Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .4 ASTM D422-[63(1998)], Standard Test Method for Particle-Size Analysis of Soils.
  - .5 ASTM D698-[00a], Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft<sup>3</sup>) (600kN-m/m<sup>3</sup>).
  - .6 ASTM D1557-[00], Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft<sup>3</sup>) (2,700kN-m/m<sup>3</sup>).
  - .7 ASTM D1883-[99], Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
  - .8 ASTM D4318-[00], Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

**1.2 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert unused granular material from landfill to local facility as approved by the Departmental Representative.

**Part 2 Products**

**2.1 MATERIAL**

- .1 .1 25 mm Crushed Gravel conforming to the following gradation:
  - .1 Gradation to be within the following limits when tested to ASTM C136-01 and ASTM C117-95, and giving a smooth curve without sharp breaks when plotted on a semi-log grading chart.

<u>Sieve Sizes</u> <u>(Square Openings)</u>	<u>Percent Passing by Weight</u>
25.0 mm	100
20.0 mm	95 - 100
10.0 mm	60 - 80
4.75 mm	40 - 60
2.36 mm	28 - 48
600 micron	13 - 29
300 micron	9 - 21
150 micron	6 - 15
75 micron	4 - 10

- .2 At least 50% of the material retained on the 4.75-mm sieve shall have two or more fractured faces.
- .3 Any gravel containing clay, loam or other deleterious materials will be rejected.

### Part 3 Execution

#### 3.1 SEQUENCE OF OPERATION

- .1 Place granular base after sub-base surface is inspected and approved by the Departmental Representative.
- .2 Placing
  - .1 Construct granular base to depth and grade in areas indicated.
  - .2 Ensure no frozen material is placed.
  - .3 Place material only on clean unfrozen surface, free from snow and ice.
  - .4 Begin spreading base material on crown line or on high side of one-way slope.
  - .5 Place material using methods which do not lead to segregation or degradation of aggregate.
  - .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
  - .7 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. Departmental Representative may authorize thicker lifts (layers) if specified compaction can be achieved.
  - .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
  - .9 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 Compacting
  - .1 Compact to density of not less than 100% corrected Standard Proctor Density
  - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
  - .3 Apply water as necessary during compacting to obtain specified density.
  - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Departmental Representative.

- .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
- .4 Proof rolling
  - .1 For proof rolling use standard roller of [45400] kg gross mass with four pneumatic tires each carrying [11350] kg and inflated to [620] kPa. Four tires arranged abreast with centre to centre spacing of [730] mm.
  - .2 Obtain approval from Departmental Representative to use non standard proof rolling equipment.
  - .3 Proof roll at level in granular base as indicated. If use of non standard proof rolling equipment is approved, Departmental Representative to determine level of proof rolling.
  - .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
  - .5 Where proof rolling reveals areas of defective subgrade:
    - .1 Remove base, sub-base and subgrade material to depth and extent as directed by Departmental Representative.
    - .2 Backfill excavated subgrade with sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-Base.
    - .3 Replace sub-base material and compact in accordance with Section 32 11 16.01 - Granular Sub-base.
    - .4 Replace base material and compact in accordance with this Section.
  - .6 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Departmental Representative and replace with new materials in accordance with Section 32 11 16.01 - Granular Sub-base and this section at no extra cost.

### **3.2 SITE TOLERANCES**

- .1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

### **3.3 PROTECTION**

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Departmental Representative.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials International, (ASTM)
  - .1 ASTM D140-01, Standard Practice for Sampling Bituminous Materials.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-16.2-M89, Emulsified Asphalts, Anionic Type, for Road Purposes.

**1.2 QUALITY ASSURANCE**

- .1 Upon request by Departmental Representative, submit manufacturer's test data and certification that asphalt tack coat material meets requirements of this section.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with ASTM D140.
- .2 Provide, maintain and restore asphalt storage area.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Divert unused asphalt from landfill to facility capable of recycling materials.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Anionic emulsified asphalt: to CAN/CGSB-16.2, grade: SS-1.
- .2 Water: clean, potable, free from foreign matter.

**Part 3 Execution**

**3.1 APPLICATION**

- .1 Obtain Departmental Representative approval of surface before applying asphalt tack coat.
- .2 Apply asphalt tack coat only on clean and dry surface.
- .3 Dilute asphalt emulsion with water at 1: 1 ratio for application.
  - .1 Mix thoroughly by pumping or other method approved by Departmental Representative.
- .4 Apply asphalt tack coat evenly to pavement surface at rate as directed by Departmental Representative, between 0.20 and 0.40 L/m<sup>2</sup> but not to exceed 0.5 L/m<sup>2</sup>.
- .5 Paint contact surfaces of curbs, gutters, headers, manholes and like structures with thin, uniform coat of asphalt tack coat material.
- .6 Do not apply asphalt tack coat when air temperature is less than 5 degrees C or when rain is forecast within 2 hours of application.

- .7 Apply asphalt tack coat only on unfrozen surface.
- .8 Evenly distribute localized excessive deposits of tack coat by brooming as directed by Departmental Representative.
- .9 Where traffic is to be maintained, treat no more than one half of width of surface in one application.
- .10 Keep traffic off tacked areas until asphalt tack coat has set.
- .11 Re-tack contaminated or disturbed areas as directed by Departmental Representative.
- .12 Permit asphalt tack coat to set before placing asphalt pavement.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Society for Testing and Materials International, (ASTM)
  - .1 ASTM D140-01, Standard Practice for Sampling Bituminous Materials.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-16.2-M89, Emulsified Asphalts, Anionic Type, for Road Purposes.

**1.2 QUALITY ASSURANCE**

- .1 Upon request from Departmental Representative, submit manufacturer's test data and certification that asphalt prime material meets requirements of this Section in accordance with Section 01 33 00 - Submittal Procedures.

**1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials to ASTM D140.
- .2 Provide, maintain and restore asphalt storage area.

**Part 2 Products**

**2.1 MATERIAL**

- .1 Asphalt material: CAN/CGSB-16.2 grade: SS-1.
- .2 Sand blotter: clean granular material passing 4.75 mm sieve and free from organic matter or other deleterious materials.
- .3 Water: clean, potable, free from foreign matter.

**Part 3 Execution**

**3.1 APPLICATION**

- .1 Obtain Departmental Representative's approval of granular base surface before applying asphalt prime.
- .2 Cutback asphalt:
  - .1 Heat asphalt prime to between 121 and 163 degrees C for pumping and spraying.
  - .2 Apply asphalt prime to granular base at rate as directed by Departmental Representative, between 0.20 and 0.50 L/m<sup>2</sup> but not to exceed 2 L/m<sup>2</sup>.
  - .3 Apply on dry surface unless otherwise directed by Departmental Representative.
- .3 Anionic emulsified asphalt:
  - .1 Dilute asphalt emulsion with clean water at 2 parts SS-1 emulsion to 1 part water.
  - .2 Mix thoroughly by pumping or other method approved by Departmental Representative.

- .3 Apply diluted asphalt emulsion at rate directed by Departmental Representative, between 0.27 and 0.45 L/m<sup>2</sup> but do not exceed 2 L/m<sup>2</sup>.
- .4 Apply diluted asphalt emulsion on damp surface unless otherwise directed by Departmental Representative.
- .4 Apply asphalt prime only on unfrozen surface.
- .5 Do not apply prime when air temperature is less than 5 degrees C or when rain is forecast within two (2) hours.
- .6 Paint contact surfaces of curbs, gutters, headers, manholes and like structures with thin, uniform coat of asphalt prime material.
- .7 Where traffic is to be maintained, treat no more than one-half width of surface in one application.
- .8 Prevent overlap at junction of applications.
- .9 Do not prime surfaces that will be visible when paving is complete.
- .10 Apply additional material to areas not sufficiently covered as directed by Departmental Representative.
- .11 Keep traffic off primed areas until asphalt prime has cured/set.
- .12 Permit prime to cure/set before placing asphalt paving.

**3.2 USE OF SAND BLOTTER**

- .1 If asphalt prime fails to penetrate within 24 hours, spread sand blotter material in amounts required to absorb excess material.
- .2 Allow sufficient time for excess prime to be absorbed as directed by the Departmental Representative.
- .3 Apply second application of sand blotter as required.
- .4 Sweep and remove excess blotter material.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 American Association of State Highway and Transportation Officials (AASHTO)
  - .1 AASHTO M320 - Current Edition, Standard Specification for Performance Graded Asphalt Binder.
  - .2 AASHTO R29- Current Edition, Standard Specification for Grading or Verifying the Performance Graded of an Asphalt Binder.
  - .3 AASHTO T245- Current Edition, Resistance to Plastic flow of Bituminous Mixtures Using Marshall Apparatus.
- .2 Asphalt Institute (AI)
  - .1 AI MS2- Current Edition Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
- .3 American Society for Testing and Materials International, (ASTM)
  - .1 ASTM C123- Current Edition, Standard Test Method for Lightweight Particles in Aggregate.
  - .2 ASTM C127- Current Edition, Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
  - .3 ASTM C128- Current Edition, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
  - .4 ASTM C131- Current Edition, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - .5 ASTM C136- Current Edition, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .6 ASTM D3203- Current Edition, Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.
  - .7 ASTM D4791- Current Edition, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
- .4 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-8.2- Current Edition, Sieves Testing, Woven Wire, Metric.
  - .2 CAN/CGSB-16.3- Current Edition, Asphalt Cements for Road Purposes.

**1.2 PRODUCT DATA**

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit viscosity-temperature chart for asphalt cement to be supplied showing either Saybolt Furol viscosity in seconds or Kinematic Viscosity in centistokes, temperature range 105 to 175 degrees C at least 4 weeks prior to beginning Work.
- .3 Submit manufacturer's test data and certification that asphalt cement meets requirements of this Section.
- .4 The Contractor shall submit to the Departmental Representative, at least 7 working days prior to the commencement of field paving, a proposed job mix formula in writing for the asphalt mixture to be supplied.

- .5 The job mix formula so submitted shall list the following information:
  - .1 The sieve analysis of the combined aggregate in the mix.
  - .2 The sieve analysis of aggregate in each bin separation to be used.
  - .3 The weight of the material to be used from each bin for one batch of mix.
  - .4 The weight of asphalt to be used in each batch.
  - .5 The mixing temperature of the asphalt as determined from the temperature-viscosity relationship for the asphalt.
- .6 The formula shall be posted in a conspicuous place within sight of the plant operator. Any subsequent changes must be approved by the Departmental Representative in writing.

### **1.3 DELIVERY, STORAGE AND HANDLING**

- .1 Handle all aggregate in a manner that will prevent segregation and intrusion of foreign materials.
- .2 Submit to Departmental Representative copies of freight and waybills for asphalt cement as shipments are received. Departmental Representative reserves right to check weights as material is received.

### **1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert unused asphalt to facility capable of recycling materials.

### **1.5 REGULATIONS**

- .1 Abide by the bylaws and regulations of the Province of Alberta or Municipality in which the work is located.
- .2 Obtain permission from the Local or Highway Authority for haul routes and abide by the regulations with respect to their maintenance.

### **1.6 QUALITY ASSURANCE**

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

### **1.7 SITE EXAMINATION**

- .1 Examine all existing structures and protect them from damage during paving operations.
- .2 Ascertain that the base course is properly compacted and prepared for placement of the surface course.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Asphalt Cement
  - .1 Asphalt cement: to CAN/CGSB-16.3, Grade 150/200, Group: A.

Property	CGSB Specification	Test Method
Flash Point (C.O.C.), °C	205 Minimum	ASTM D 92
Penetration at 0°C, 200 g/60s, dmm	30 minimum	ASTM D 5
Viscosity at 60°C, Pa.s	60 minimum	ASTM D 2171
Viscosity at 135°C, cSt	200 minimum	ASTM D 2170
Solubility in Trichloroethylene, % by Mass	99.5 minimum	ASTM D 2042
Ductility at 25°C, 5 cm/min, cm (4)	100 minimum	ASTM D 113
Thin Film Oven Test:		ASTM D 1754
% Loss in Mass	1.3 maximum	
% of Original Penetration at 25°C	50 minimum	
Ratio of Absolute Viscosity of residue to Original	4.0 maximum	

- .2 Asphalt shall be prepared by the refining of petroleum.
- .3 Asphalt shall be uniform in character and shall not foam when heated to 177°C.
- .4 Delivery temperature shall be between 135°C and 177°C.
- .2 Aggregates: in accordance with Section 31 05 16 - Aggregate Materials and the following requirements:
  - .1 25mm Road Crush Gravel.
  - .2 Gradations: within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.
  - .3 Table

Sieve Designation	% Passing
25 mm	100
19 mm	95-100
12.5 mm	-
9.5 mm	60-80
4.75 mm	40-60
2.00 mm	25-45
0.425 mm	10-25
0.180 mm	-
0.075 mm	2-10]

- .4 For crushed aggregate not less than 60 percent of the material retained on the 4.75 mm sieve shall be crushed particles. The ratio of the percentage passing the 4.75 mm sieve to the ratio passing the 425 micro-m sieve shall not exceed two-thirds and preferably not less than one half.

## **2.2 MINIMUM QUALITY CONTROL TEST FREQUENCIES**

- .1 The following frequencies of testing are the minimum required. The Contractor shall coordinate with the Departmental Representative's third-party testing agency to perform as many tests as are necessary to ensure that the Work conforms to the requirements of the Contract regardless of the minimum number specified.
  - .1 Crushed Gravel
    - .1 One sieve analysis for every 500 m3 of crushed gravel.
    - .2 One field density for every 2000 m2 of compacted layers.
  - .2 Asphalt
    - .1 Submit a certified laboratory analysis to the Departmental Representative for each shipment of asphalt cement.
    - .2 Provide test data (re: the temperature viscosity relationship).
    - .3 Submit one copy of results of each of the following control tests, for each class of aggregate to be used:
      - .1 Los Angeles Abrasion Test - ASTM-C 131.
      - .2 Crushed Fragments.
      - .3 Specified Gravity and Absorption ASTM-C127 and ASTM-C128.
      - .4 Material passing 75 micro-m sieve - ASTM-C117.
    - .4 Combined aggregate tests shall be taken prior to the aggregate being combined with asphalt.
      - .1 Sieve analysis (ASTM-C136) will be taken daily.
      - .2 Moisture contents of dried aggregates will be taken daily.
    - .5 The testing agency shall sample asphalt mixtures daily and in accordance with ASTM-D1559 method. Subject the samples to a density, air voids and an asphalt content determination.
    - .6 A stability value shall be established at least once in each five days of mixing.
    - .7 Density determination and air void contents will shall be taken by the Departmental Representative's Testing Agency at a rate of one test for each layer at each site; and at least one each day during placing operations.
    - .8 Nuclear density determinations will be in accordance with ASTM-D2950 and one test will be taken at each paving site at a minimum.
    - .9 Cores will be measured and tested to provide the following information.
      - .1 Thickness
      - .2 Asphalt content
      - .3 Density
      - .4 Sieve analysis
      - .5 Percentage air voids: ASTM-D3203

## **2.3 MIX DESIGN**

- .1 The Contractor shall pay for and submit duplicate copies of a design mix as recommended by a testing agency employed by the Departmental Representative. The design mix shall satisfy the following criteria based on the Standard Marshall Test Procedure (ASTM-D1559).
  - .1 Compaction blows on each face of test specimens: 50.
  - .2 Marshall Stability Newtons at 60°C: 4450 min
  - .3 Flow Index (Units of 0.3mm): 8-14
  - .4 % Voids in Mineral Aggregate



- .1 19mm Maximum Aggregate: 14 min
- .2 13mm Maximum Aggregate: 15 min
- .5 % Voids in Total Mix: 3 – 5
- .6 % Asphalt Cement (by weight) of dry aggregate: 6.0 min
- .7 % Moisture Content: 0.5
- .8 Air voids: to ASTM D3203.
- .2 Do not change job-mix without prior approval of Departmental Representative. When change in material source proposed, new job-mix formula will be provided to Departmental Representative for review.

**Part 3 Execution**

**3.1 PREPARATION**

- .1 Apply prime coat and tack coat in accordance with Section 32 12 13.23 - Asphalt Prime Coats and Section 32 12 13.16 - Asphalt Tack Coats prior to paving.
- .2 Prior to laying mix, clean surfaces of loose and foreign material.

**3.2 TRANSPORTATION OF MIX**

- .1 Transport mix to job site in vehicles cleaned of foreign material.
- .2 Paint or spray truck beds with limewater, soap or detergent solution, or non-petroleum based commercial product, at least daily or as required. Elevate truck bed and thoroughly drain. No excess solution to remain in truck bed.
- .3 Schedule delivery of material for placing in daylight, unless Departmental Representative approves artificial light.
- .4 Deposit mix from surge or storage silo to trucks in multiple drops to reduce segregation. Do not dribble mix into trucks.
- .5 Deliver material to paver at uniform rate and in an amount within capacity of paving and compacting equipment.
- .6 Deliver loads continuously in covered vehicles and immediately spread and compact. Deliver and place mixes at temperature within 10°C of the temperature specified by the Departmental Representative.

**3.3 PLACING**

- .1 Obtain Departmental Representative approval prior to placing asphalt.
- .2 Place asphalt concrete to thicknesses, grades and lines as indicated or as directed by Departmental Representative.
- .3 Placing conditions:
  - .1 Place asphalt mixtures only when air temperature is above 5 degrees C.
  - .2 When temperature of surface on which material is to be placed falls below 10 degrees C, provide extra rollers as necessary to obtain required compaction before cooling.

- .3 Do not place hot-mix asphalt when pools of standing water exist on surface to be paved, during rain, or when surface is damp.
- .4 Place asphalt concrete in compacted lifts of thickness as indicated.
- .5 Where possible do tapering and levelling where required in lower lifts.
- .6 Spread and strike off mixture with self-propelled mechanical finisher.
  - .1 Construct longitudinal joints and edges true to line markings. Position and operate paver to follow established line closely.
  - .2 Maintain constant head of mix in auger chamber of paver during placing.
  - .3 If segregation occurs, immediately suspend spreading operation until cause is determined and corrected.
  - .4 Correct irregularities in alignment left by paver by trimming directly behind machine.
  - .5 Correct irregularities in surface of pavement course directly behind paver. Remove by shovel or lute excess material forming high spots. Fill and smooth indented areas with hot mix. Do not broadcast material over such areas.
  - .6 Do not throw surplus material on freshly screeded surfaces.
- .7 When hand spreading is used:
  - .1 In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand, if so directed by the Departmental Representative.
  - .2 Use approved wood or steel forms, rigidly supported to assure correct grade and cross section. Use measuring blocks and intermediate strips to aid in obtaining required cross-section.
  - .3 Distribute material uniformly. Do not broadcast material.
  - .4 During spreading operation, thoroughly loosen and uniformly distribute material by lutes or covered rakes. Reject material that has formed into lumps and does not break down readily.
  - .5 After placing and before rolling, check surface with templates and straightedges and correct irregularities.
  - .6 Provide heating equipment to keep hand tools free from asphalt. Control temperature to avoid burning material. Do not use tools at higher temperature than temperature of mix being placed.

### **3.4 COMPACTING**

- .1 General:
  - .1 Provide at least two rollers and as many additional rollers as necessary to achieve specified pavement density. When more than two rollers are required, one roller must be pneumatic tired type.
  - .2 Start rolling operations as soon as placed mix can bear weight of roller without excess displacement of material or cracking of surface.
  - .3 Operate roller slowly initially to avoid displacement of material. Do not exceed 5 km/h for breakdown and intermediate rolling for static steel-wheeled and pneumatic tired rollers. Do not exceed 9 km/h for finish rolling.
  - .4 Use static compaction for levelling course less than 25 mm thick.
  - .5 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 25 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing not to exceed compacted lift thickness.
  - .6 Overlap successive passes of roller by minimum of 200 mm and vary pass lengths.

- .7 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.
- .8 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.
- .9 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.
- .10 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side. Ensure that all points across width of pavement receive essentially equal numbers of passes of compactors.
- .11 When paving in echelon, leave unrolled 50 to 75 mm of edge which second paver is following and roll when joint between lanes is rolled.
- .12 Where rolling causes displacement of material, loosen affected areas at once with lutes or shovels and restore to original grade of loose material before re-rolling.
- .2 Breakdown rolling:
  - .1 Begin breakdown rolling immediately following rolling of transverse and longitudinal joint and edges.
  - .2 Operate rollers as close to paver as necessary to obtain adequate density without causing undue displacement.
  - .3 Operate breakdown roller with drive roll or wheel nearest finishing machine.
  - .4 Use only experienced roller operators.
- .3 Intermediate rolling:
  - .1 Use pneumatic-tired, steel wheel or vibratory rollers and follow breakdown rolling as closely as possible and while paving mix temperature allows maximum density from this operation.
  - .2 Rolling to be continuous after initial rolling until mix placed has been thoroughly compacted.
- .4 Finish rolling:
  - .1 Accomplish finish rolling with two-axle or three-axle tandem steel wheeled rollers while material is still warm enough for removal of roller marks. Conduct rolling operations in close sequence.
- .5 Density
  - .1 Minimum in place densities after second rolling shall be:
    - .1 Prior to September 1 - 96% of the laboratory design density
    - .2 After September 1 - 98% of the laboratory design density.
  - .2 Mixes that tend to move unduly under a roller and show excessive cracking shall be modified to correct this problem.

### 3.5 JOINTS

- .1 General:
  - .1 Remove surplus material from surface of previously laid strip. Do not deposit on surface of freshly laid strip.
  - .2 Paint contact surfaces of existing structures such as manholes, curbs or gutters with bituminous material prior to placing adjacent pavement.
- .2 Transverse joints:
  - .1 Offset transverse joint in succeeding lifts by at least 600mm.

- .2 Cut back to full depth vertical face and tack face with thin coat of hot asphalt prior to continuing paving.
- .3 Compact transverse joints to provide smooth riding surface. Use methods to prevent rounding of compacted surface at joints.
- .3 Longitudinal joints:
  - .1 Offset longitudinal joints in succeeding lifts by at least 150mm.
  - .2 Cold joint is defined as joint where asphalt mix is placed, compacted and left to cool below 100 degrees C prior to paving of adjacent lane.
    - .1 If cold joint cannot be avoided, cut back by saw cutting previously laid lane, by at least 150 mm, to full depth vertical face, and tack face with thin coat of hot asphalt of adjacent lane.
  - .3 Overlap previously laid strip with spreader by 25 to 50mm.
  - .4 Before rolling, carefully remove and discard coarse aggregate in material overlapping joint with lute or rake.
  - .5 Roll longitudinal joints directly behind paving operation.
  - .6 When rolling with static or vibratory rollers, have most of drum width ride on newly placed lane with remaining 150 mm extending onto previously placed and compacted lane.

### 3.6 FINISH TOLERANCES

- .1 Finish the surface smooth, uniform and true to the lines of the specified grade.
- .2 Finished asphalt surface to be within 5mm of design elevation but not uniformly high or low.
- .3 Finished asphalt surface not to have irregularities exceeding 5mm when checked with 4.5m straight edge placed in any direction.
- .4 Uneven surfaces shall be corrected by loosening the surface and adding new material or removing high areas.

### 3.7 SAMPLING AND TESTING FREQUENCY

- .1 A minimum of one test sample shall be taken at each road crossing requiring rehabilitation or as directed by the Departmental Representative.
- .2 Minimum Marshall Test sampling size is 10 Kg or as directed by the Departmental Representative.

### 3.8 THICKNESS TOLERANCE

- .1 Pavement found to be deficient in thickness by more than 13 mm shall be removed and replaced by pavement of sufficient thickness, at the Contractor's expense.

### 3.9 DEFECTIVE WORK

- .1 Correct irregularities which develop before completion of rolling by loosening surface mix and removing or adding material as required. If irregularities or defects remain after final compaction, remove surface course promptly and lay new material to form true and even surface and compact immediately to specified density.
- .2 Repair areas showing checking, rippling, or segregation.
- .3 Adjust roller operation and screed settings on paver to prevent further defects such as rippling and checking of pavement.

**END OF SECTION**

**Part 1 General**

**1.1 DESCRIPTION**

- .1 This section specifies construction of concrete walks, curbs and gutters.

**1.2 MATERIAL CERTIFICATION**

- .1 Prior to delivery of materials on site and commencing work, submit manufacturer's test data and certification stating that materials meet requirements of this section.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Concrete
- .1 32 MPa Type 10 in accordance with Section 03 30 00 - Cast-in-Place Concrete
- .2 Formwork
- .1 Metal or timber properly seasoned and free from warps or other defects. Metal forms shall be of the approved type and section.
- .2 All formwork to conform to CAN-A23.1.M, CSA Standard S269.1 and CSA Standard 0141.
- .3 Face of curb form shall be removable without disturbing back and gutter forms.
- .4 Forms shall be smooth and clean on the surface(s) next to the concrete and shall be oiled with Parvelube No. 30 or approved equal.
- .3 Reinforcing
- .1 Bars to meet ASTM A184 and ASTM A304 intermediate grade new billet deformed steel.
- .2 Cold drawn steel wire to meet ASTM A82.
- .3 Wire mesh to meet ASTM A185.
- .4 Membrane Curing Compound
- .1 Curing compound shall be impervious resin base, conforming to ASTM stand specification C309 type, ID-type B. The curing compound shall contain white fugitive dye.
- .5 Granular Cushion
- .1 Granular cushion shall be a granular material meeting the following gradation when tested to ASTM C136 and ASTM C117, and give a smooth curve without sharp breaks when plotted on a semi-log grading chart.

<u>Sieve Size</u>	<u>% Passing by Weight</u>
19.0 mm	100
4.75 mm	20 - 60
0.150 mm	10 - 20

- .2 The liquid limit shall not exceed 25 and the plasticity index shall not exceed 6 for the portion of material passing the 400 sieve.

**Part 3 Execution**

**3.1 BASE PREPARATION**

- .1 The bed for the sidewalk, curb and gutter shall be excavated and prepared to the lines, grades and cross-sections on the plans or as designated by the Departmental Representative.
- .2 Unsuitable material shall be removed and replaced with approved granular fill, thoroughly compacted as designated by the Departmental Representative.
- .3 The subgrade shall be uniformly compacted to eliminate all soft and spongy area to provide a firm base for all concrete work.
- .4 A layer of compacted granular cushion (minimum 50mm thick) shall be used as a foundation material under concrete sidewalks, curbs and driveway crossings.
- .5 The base on which the concrete will rest shall be thoroughly wetted immediately prior to placing the concrete and must not be frozen, muddy or have areas of water ponding.
- .6 The subgrade elevation shall be finished to tolerances requiring 50 mm of granular cushion on the subgrade. This material shall be compacted to 100% Standard Proctor Density.

**3.2 FORMS**

- .1 Forms shall be of steel or wood of sufficient strength to resist the pressure of wet concrete, and the supply shall be sufficient to permit their remaining in place not less than 12 hours after the concrete has been placed, or longer if the Departmental Representative considers it necessary.
- .2 The use of bent, twisted, battered or worn-out forms will not be permitted.
- .3 Forms will be checked for line and grade by the Departmental Representative before concrete is poured, and shall be cleaned and oiled before each use.
- .4 Forms shall be held securely by approved methods to prevent movement and bulging when the concrete is placed.
- .5 Forms must be approved by the Departmental Representative before any concrete is poured.

**3.3 REINFORCING**

- .1 Where required, reinforcing shall be secured in the location shown on the drawings.
- .2 Reinforcing shall be clean and free from defects, kinks, loose rust or mill scale at the time the concrete is placed.
- .3 Reinforcing mesh shall be rolled or otherwise straightened to make a perfectly flat surface before placing.
- .4 The mesh or bars reinforcing shall be supported above the compacted base to ensure a 50 mm cover of concrete. The manner of supporting the reinforcing shall be approved by the Departmental Representative.

- .5 Overlapping of mesh reinforcing shall be a minimum of 300 mm and be wired together if directed by the Departmental Representative.
- .6 Overlapping of bar reinforcing shall be 30 bar diameters, and be wired together.

### **3.4 PLACING OF CONCRETE**

- .1 The Contractor shall give the Departmental Representative notice of his intentions to pour in sufficient time to permit testing of the concrete.
- .2 The concrete shall be placed as soon as possible after mixing, but not later than 1.5 hours after mixing has begun. Retempered concrete will not be used.
- .3 The concrete shall be placed by methods, which will prevent segregation and deposited on the subgrade so that as little handling as possible is required. Rehandling of concrete is not permitted.
- .4 Concrete shall be placed continuously until the section, panel, or scheduled pour is complete.
- .5 The concrete shall be thoroughly consolidated against and along the faces of the forms. Special care shall be taken to place the concrete against the forms, particularly in corners, in order to prevent voids, rough areas, and honey combing. Hand spreading shall be done with shovels, not with rakes, in order that the concrete will not be segregated. Precautions should be taken to prevent overworking of the concrete.
- .6 The concrete shall be struck-off and compacted by means of an approved vibrating screed. Vibrators or vibrating screeds shall operate at a minimum of 5000 cycles per minute. The technique and use of vibrators or vibrating screeds is at the discretion of the Departmental Representative. Every precaution shall be taken to make all concrete solid, compact, watertight and smooth.

### **3.5 EXTRUDED SIDEWALK, CURB AND GUTTER**

- .1 The Contractor is given the option of constructing extruded sidewalk, curb and gutter at the unit rate bid. Automatic grade and line control is required.
- .2 Any material excavated to accommodate the extruding machine shall be either stockpiled at a specified location or windrowed to the centre of the street with a minimal disruption to traffic. After the installation of the concrete works, the excavated material shall be replaced to the original street grade or the elevation designated by the Departmental Representative and compacted to not less than 95% of Standard Proctor Density. Granular material, which may have existed, shall be replaced on the street.
- .3 In areas where monolithic sidewalk is constructed in two separate operations, the Contractor shall ensure a proper bond between the curb and gutter and the sidewalk by a method approved by the Departmental Representative. The cost for providing this bond shall be included in the unit rate bid for monolithic sidewalk.

### **3.6 OBSTRUCTIONS**

- .1 Appurtenances shall be located, examined for deficiencies and staked by the Contractor prior to work beginning on a particular section and any deficiencies noted must be reported to the Departmental Representative immediately. Upon completion of the block of work, the Contractor shall relocate these structures and inspect them with the Departmental Representative.
- .2 Any damage, which may have occurred during the concreting operations and deficiencies not previously, reported to the Departmental Representative, shall be repaired at the Contractor's



expense. All costs involved, including replacement of road base destroyed, shall be covered by the unit rate for curb and gutter and monolithic sidewalk.

- .3 The Contractor is required to carefully fit, cut and mark the sidewalk around all openings, iron covers, manholes, vaults, waterworks stop cock boxes, lamp standards, hydrants, poles and other surface installations. The surface joint shall be neatly tooled and marked to the satisfaction of the Departmental Representative.
- .4 Expansion joint material, 15 mm thick and the full depth of the sidewalk, shall be placed around the base of all poles and hydrants which encroach upon or are within the sidewalk.

### **3.7 JOINTS**

- .1 Expansion Joints
  - .1 Lateral expansion joints are required at the beginning and end of every corner. The joints shall consist of an approved mastic preformed material, 15 mm by 90 mm cross-section, laid plumb and straight, 6 mm below the finished sidewalk grade.
  - .2 Expansion joints shall be installed wherever the walk is adjacent to an improvement constructed with rigid materials.
- .2 Contraction Joints
  - .1 Contraction joints shall be cut at every 1.5 m by means of a marking tool or other approved method. Joints shall not be less than 30 mm in depth and 6 mm in width. The edges of the joint shall be rounded off with an edger having a radius of 6 mm.
  - .2 Contraction joints in monolithic sidewalk shall extend through the full width of the sidewalk and curb and gutter.
  - .3 Contraction joints at catch basins shall be cut through the full width of the sidewalk in line with both outside edges of the catch basin side inlet.
- .3 Sawed Joints
  - .1 Saw cuts as specified are made with a concrete saw capable of producing a true straight joint of constant depth as specified.
- .4 Surface Joints
  - .1 Surface joints shall be 15 mm in depth and 6 mm in width. The edge of the joint shall be rounded off with an edger having a radius of 6 mm.

### **3.8 FINISHING**

- .1 After placing, the concrete shall be adequately worked with wood and steel trowels to a smooth finish with the required edges neatly rounded.
- .2 Excessive trowelling shall be avoided. If there is evidence of concrete bleeding, finishing shall cease until the excess water has been evaporated to the satisfaction of the Departmental Representative.
- .3 Concrete shall have a light sandblast finish to the acceptance of the contract administrator

### **3.9 CURING**

- .1 Immediately after the final finishing, the concrete surface shall be protected by applying two applications of membrane curing compound.

- .2 The membrane material shall be applied uniformly by means of an approved pressure distribution at an average of 0.2 litres per square metre.
- .3 The compound, when applied, shall present a uniform appearance and effectively obscure the original colour of the concrete.
- .4 Under no circumstances is any material added to the curing compound as delivered by the manufacturer.

### **3.10 COLD WEATHER REQUIREMENTS**

- .1 After September 30 the following applies:
  - .1 The minimum allowable concrete compressive strength shall be attained in 7 days.
  - .2 The concrete temperature shall be maintained at a minimum of 4°C for the first 24 hours after placing.
- .2 When concrete is placed in cold weather, all equipment needed for adequate protection and curing shall be on hand and ready for use before the concrete placement is started.
- .3 Snow and ice shall be removed using heat where necessary. In no case shall concrete be deposited on or against any surface, which is at a temperature of less than 4°C.
- .4 The Contractor shall adequately cover and protect the freshly placed concrete and maintain it at a minimum temperature of 4°C for the first 24 hours after placing. Covering shall be maintained for 72 hours.
- .5 The official air temperature will be as issued by the Atmospheric Environment Services.
- .6 The Departmental Representative may, at his discretion, require the Contractor to establish at his own expense a record of the temperature in each pour of 150 linear metre or portion thereof.
- .7 If the Contractor uses forced air heating units, the concrete shall be kept continuously moist during the complete heating and curing period. Combustion type heaters may be used but they shall be so constructed and so placed that their combustion gases do not come in contact with the surfaces of the concrete during placing and curing. The period of protection shall be a minimum of 72 hours and the Contractor shall bear the costs of all heating and protection.
- .8 Any concrete failing to comply with the temperature requirements shall:
  - .1 if compliant to all other specifications, be left in place with no payment,
  - .2 if non-compliant in any other aspect, be replaced,
  - .3 if freezing has occurred, be replaced.

Where non-compliance occurs, the test indicating non-compliance is held as representative of the test area.

- .9 At the sole discretion of the Departmental Representative, the placing of concrete may be suspended or terminated at any time after September 30.

### **3.11 HOT WEATHER REQUIREMENTS**

- .1 The requirements of this sub-section govern whenever the ambient air temperature is 23°C or above
- .2 The concrete temperature at time of placing shall not exceed 30°C.

- .3 Retarding admixtures may be used subject to the approval by the Departmental Representative.

### **3.12 MARKINGS**

- .1 Contractor and Year of Construction
  - .1 The Contractor shall mark the sidewalk, curb and gutter with a suitable marking tool approved by the Departmental Representative, showing the name of the Contractor and the year of construction. The letters and numerals of the marking tool shall be 40 mm high.
  - .2 Marks are placed at the end of curve of each corner of the block, i.e. there is a minimum of eight marks per block. If the construction begins or terminates within the middle of the block, the Contractor shall also mark these locations or as directed by the Departmental Representative. In addition, a similar mark shall be embossed on the corner of each apron and driveway.
- .2 Reinforcing
  - .1 All sections containing reinforcing rods shall be marked at their extreme limits with a marking tool showing the letter "R". This letter shall be 40 mm high.

### **3.13 STRIPPING OF FORMS**

- .1 Face of curb forms are removed after the initial set. Adequate care shall be taken in removing forms to avoid spoiling or marring the concrete.
- .2 Such patching as may be necessary shall be started immediately after removal of the forms.
- .3 Immediately after form removal and/or patching, the exposed surfaces shall be sprayed with a membrane curing material.

### **3.14 WHEELCHAIR RAMPS**

- .1 Wheelchair ramps shall be constructed at all intersection locations where sidewalks abut curbs and gutters or as directed by the Departmental Representative.
- .2 Wheelchair ramps are not required where sidewalks are not provided or planned.

### **3.15 ALLOWABLE TOLERANCES**

- .1 After trowelling, the surface grade along the lip of gutter shall be checked by the Contractor with straight edges, to ensure an accuracy of 6 mm in 3 metres. The maximum allowable variation across the gutter is 3 mm.
- .2 The elevation of any given point shall not vary by more than 20 mm from the design grades.
- .3 Deviations in alignment at any given point from that given on the survey stake shall not exceed 15 mm and the fluctuations in the alignment shall not be greater than 25 mm in 100 metres.

### **3.16 INSPECTION AND TESTING**

- .1 Tests will be made of the concrete to ensure that it meets these specifications. Testing shall be done by an independent testing agency and shall conform to the following standard specifications:

<u>Test</u>	<u>Current Issue of ASTM</u>
Sampling of Fresh Concrete	C172
Test for Slump of Concrete	C143
Compression and Flexure Test	C31
Compressive Strength of Moulded Concrete Cylinders	C30
Measurement of Air Content	C173 or C231

- .2 Three concrete cylinders shall constitute one test and shall be made from the same batch or load. The cylinders shall be stored undisturbed on-site for 24 hours, covered with a plastic sheet to prevent loss of moisture. After the transfer to an approved testing laboratory and laboratory cured, one cylinder is tested at seven days and the other two at twenty-eight days. A set of three cylinders will be taken for every 50 m<sup>3</sup> of concrete poured, or for each day of the work.
- .3 The Departmental Representative reserves the right to request additional cylinders to be made in order to establish a concrete strength pattern at the beginning of the construction.

### 3.17 FAILED TESTS

- .1 Contractors have the option at their expense to show evidence of strength by coring and testing according to CAN3-A23.2M-14C performed by a quality control laboratory within 14 days after the failed cylinder test.
  - .1 Three cores shall be drilled from the hardened concrete at the location represented by the failed cylinder strength test.
  - .2 If the average strength of the three cores is equal to at least 85% of specified strength and no one core is less than 75% of specified strength, then the strength specification will be considered met; otherwise, the concrete will be subject to pay factor penalties as per the table above on the basis of the cylinder strength test.

### 3.18 MAINTENANCE STANDARDS

- .1 The following maintenance standards do apply at the time of final acceptance inspection to all sidewalks, curb and gutter and related on grade concrete work.
  - .1 Surface Condition: area based on 1.5 m sidewalk section, 3 m section of curb and 3 m section of gutter.
    - .1 Loss of surface mortar and/or aggregate less than 3 mm deep. Cracking is not included if there is no evidence of loose or lifting mortar.
      - .1 0% to 15% of surface area - acceptable
      - .2 Greater than 15% - replace
    - .2 Loss of surface mortar and/or aggregate between 3 mm and 6 mm deep.
      - .1 0% to 10% of surface area - acceptable
      - .2 Greater than 10% - replace
    - .3 Loss of surface mortar and/or aggregate greater than 6 mm deep.
      - .1 0% to 5% of surface area - liquidated damages
      - .2 5% or more - replace
  - .2 Sidewalk and Curb and Gutter Failure
    - .1 Replacement of affected sections shall be required when one or more of the following exist:

- .1 Any crack greater than 3 mm in width, with no vertical displacement, or chipping or spalling edges.
  - .2 Any crack with vertical displacement, or chipping or spalling edges.
  - .3 Any longitudinal crack greater than or equal to 1.5 mm in width.
  - .4 A displacement, at a joint of greater than or equal to 12 mm.
  - .5 A dished surface of sidewalk.
  - .6 A reverse crossfall, or crossfall greater than 8% or less than 0.7%.
  - .7 A random cracking of any size.
  - .8 Any feature considered detrimental to pedestrian safety or the walk appearance.
  - .9 A corner cut exists.
- .2 All breakout shall end at a contraction, expansion or surface joint. The edge of a surface mark is sawn to a depth of 50 mm minimum, while contraction joints may be neatly hand chiselled to produce a true straight joint. The contraction edge shall be exposed to produce a good bond.
- .3 All replacement work will be done in accordance with this Section.
- .4 No grouting of cracks is allowed.
- .5 Mortar and/or tar on the walk, which is considered detrimental to pedestrian safety or the walk appearance, shall be removed or the sidewalk replaced, at the discretion of the Departmental Representative.

### **3.19 PROTECTION OF WORK**

- .1 The Contractor shall supply and place all necessary material to protect the work from rain, dust, frost or other similar weather action.
- .2 The Contractor shall barricade the work and keep people, animals and vehicles off the work for a period of 5 days after the finishing of the concrete is completed. Any damage occurring to the work during this 5 day period regardless of the origin, shall be replaced or repaired by the Contractor to the satisfaction of the Departmental Representative within 1 month after notice is given to the Contractor.
- .3 Where the Departmental Representative considers damage to any private walk, driveway, steps, fence, gate, post or other private property, is caused by negligence on the part of the Contractor, the Contractor, at his own expense and within 2 weeks of notice being given, shall repair or replace the specific damage to the satisfaction of the Departmental Representative. The Departmental Representative's decision on all matters pertaining is final.

### **3.20 BACKFILLING**

- .1 The Contractor shall backfill along the backs of walks or curbs, to the top of the concrete, within seven (7) days of the placing of the concrete.
- .2 The backfill shall be mechanically tamped in maximum lifts of 150 mm to a minimum density of 95% Standard Proctor Density, to a distance 300 mm from the back of the walk or curb.

### **3.21 CLEAN UP**

- .1 As the work progresses, the Contractor shall clean up the site and all areas in which work has been done shall be left in a neat and presentable condition.
- .2 All gutters and street drainage ditches which have been blocked as a result of Contractor's operations shall be restored or repaired at the Contractor's expense.

- .3 The Contractor shall at his own expense dispose of all surplus excavated material, organic soil, rock, and pieces of concrete and masonry at an approved location.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Agriculture and Agri-Food Canada
  - .1 The Canadian System of Soil Classification, Third Edition, 1998.
- .2 Canadian Council of Ministers of the Environment
  - .1 PN1340-2005, Guidelines for Compost Quality.
- .3 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

**1.2 DEFINITIONS**

- .1 Compost:
  - .1 Mixture of soil and decomposing organic matter used as fertilizer, mulch, or soil conditioner.
  - .2 Compost is processed organic matter containing 40% or more organic matter as determined by Walkley-Black or Loss On Ignition (LOI) test.
  - .3 Product must be sufficiently decomposed (i.e. stable) so that any further decomposition does not adversely affect plant growth (C:N ratio below (25) (50)), and contain no toxic or growth inhibiting contaminants.
  - .4 Composed bio-solids to: CCME Guidelines for Compost Quality, Category (A) (B).

**1.3 SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality control submittals :
  - .1 Soil testing: submit certified test reports showing compliance with specified performance characteristics and physical properties as described in PART 2 - SOURCE QUALITY CONTROL.
  - .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

**1.4 QUALITY ASSURANCE**

- .1 Pre-installation meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements in accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM)

**1.5 WASTE MANAGEMENT AND DISPOSAL**

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



- .2 Divert unused soil amendments from landfill to official hazardous material collections site approved by Departmental Representative.
- .3 Do not dispose of unused soil amendments into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

## **Part 2 Products**

### **2.1 TOPSOIL**

- .1 Topsoil for sodded areas and planting beds : mixture of particulates, micro organisms and organic matter which provides suitable medium for supporting intended plant growth.
  - .1 Soil texture based on The Canadian System of Soil Classification, to consist of a fertile, friable, natural loam, containing not less 4% organic matter for clay loams and not less than 2% organic matter for sandy loams to a maximum of 15%; and capable of sustaining vigorous plant growth, free of rocks of 50mm in diameter and over, subsoil contamination, roots and weeds (as determined by the Departmental Representative) and having a pH ranging from 7.0 to 8.5.
  - .2 Contain no toxic elements or growth inhibiting materials.
  - .3 Finished surface free from:
    - .1 Debris and stones over 50 mm diameter.
    - .2 Course vegetative material, 10 mm diameter and 100 mm length, occupying more than 2% of soil volume.
  - .4 Consistence: friable when moist.

### **2.2 TOPSOIL TESTING AND AMENDMENTS**

- .1 Contractor will arrange and pay for services of accredited testing laboratory, approved by Consultant, to perform complete soil quality analysis on imported topsoil(s). Provide adequate tests from all sources of topsoil and submit original copy of analysis to Consultant.
- .2 Where stockpiled topsoil exists on site, Departmental Representative will perform soil tests.
- .3 Conduct soils test on three separate soil samples, taken as directed by Departmental Representative. Samples shall be taken from a minimum of three random locations and mixed to create a single uniform sample for testing.
- .4 Testing of soil shall be done within three weeks prior to soil placement.
- .5 Testing laboratory shall be approved by Departmental Representative prior to submitting samples.
- .6 Inform approved testing laboratory that soil tests are for growing native grasses and shrubs. Analysis and recommendations from laboratory should be specific for growing native grasses and shrubs.
- .7 Test specifically for the following: Nitrogen, Phosphorous, and Potassium. The analysis should also include measurement of percent sand, fines, (silt and clay), and organic matter to total 100%; soil pH; recommendation on quantity of lime required to achieve

pH 6.5; water soluble salts; total carbon to total nitrogen ratio; total nitrogen and available levels of calcium and magnesium; and herbicide content.

- .8 Submit to the Departmental Representative 1 copy of the soils test analysis report from the testing laboratory. Cost of initial analysis and subsequent tests to ensure compliance with specification shall be borne by the Contractor.
- .9 The analysis report shall include laboratory's recommendations for amendments, fertilizer and other required modifications to make the proposed growing medium meet the requirements of this specification and should clearly state the type, quantity and application procedure that is to be used.
- .10 At the discretion of the Departmental Representative, submit up to two additional soil samples for testing at intervals outlined by the Departmental Representative. Samples shall be taken from a minimum of three random locations and mixed to create a single uniform sample for testing. Results of these tests shall be presented to the Departmental Representative for review.
- .11 Failure to satisfy these contractual requirements could result in the Contractor being required to remove unacceptable growing medium at their expense.

## **2.3 SOURCE QUALITY CONTROL**

- .1 Advise Departmental Representative of sources of topsoil to be utilized with sufficient lead time for testing.
- .2 Contractor is responsible for amendments to supply topsoil as specified.
- .3 Soil testing by recognized testing facility for PH, P and K, and organic matter.
- .4 Testing of topsoil will be carried out by testing laboratory designated by Departmental Representative.
  - .1 Soil sampling, testing and analysis to be in accordance with Provincial standards.

## **Part 3 Execution**

### **3.1 PREPARATION OF EXISTING GRADE**

- .1 Verify that grades are correct.
  - .1 If discrepancies occur, notify Departmental Representative and do not commence work until instructed by Departmental Representative.
- .2 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage.
- .3 Remove debris, roots, branches, stones in excess of 50mm diameter and other deleterious materials.

- .1 Remove soil contaminated with calcium chloride, toxic materials and petroleum products.
- .2 Remove debris which protrudes more than 75mm above surface.
- .3 Dispose of removed material off site.
- .4 Cultivate entire area which is to receive topsoil to minimum depth of 100 mm.
  - .1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

### **3.2 PLACING AND SPREADING OF TOPSOIL/PLANTING SOIL**

- .1 Place topsoil after Departmental Representative has accepted subgrade.
- .2 Spread topsoil in uniform layers not exceeding 150 mm.
- .3 For sodded areas keep topsoil 15mm below finished grade.
- .4 Spread topsoil as indicated to following minimum depths after settlement.
  - .1 150mm for sodded areas.
  - .2 300 mm for mixed sod and perennial beds as shown on drawings.
  - .3 500mm for shrub beds.
- .5 Manually spread topsoil/planting soil around trees, shrubs and obstacles.

### **3.3 FINISH GRADING**

- .1 Grade to eliminate rough spots and low areas and ensure positive drainage.
  - .1 Prepare loose friable bed by means of cultivation and subsequent raking.
- .2 Consolidate topsoil to required bulk density using equipment approved by Departmental Representative.
  - .1 Leave surfaces smooth, uniform and firm against deep footprinting.

### **3.4 ACCEPTANCE**

- .1 Departmental Representative will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

### **3.5 SURPLUS MATERIAL**

- .1 Dispose of materials except topsoil not required where directed by Departmental Representative off site.

### **3.6 CLEANING**

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

**END OF SECTION**

## **1.1 SUBMITTALS**

- .1 Samples.
  - .1 Submit samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Submit:
    - .1 Sod for each type specified.
      - .1 Install approved samples in one square metre mock-ups and maintain in accordance with maintenance requirements during establishment period.
    - .2 Bio-degradable geotextile fabric.
  - .3 Obtain approval of samples by Departmental Representative.

## **1.2 QUALITY ASSURANCE**

- .1 Test Reports: certified test reports showing compliance with specified performance characteristics and physical properties.
- .2 Certificates: product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, installation instructions and warranty requirements. Comply with Section.

## **1.3 SCHEDULING**

- .1 Schedule sod laying to coincide with preparation of soil surface.
- .2 Schedule sod installation when frost is not present in ground.

## **1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 - Construction/Demolition Waste Management And Disposal.
- .2 Divert unused fertilizer from landfill to official hazardous material collections site approved by Departmental Representative.
- .3 Do not dispose of unused fertilizer into sewer systems, into lakes, streams, onto ground or in locations where it will pose health or environmental hazard.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Number One Turf Grass Nursery Sod: sod that has been especially sown and cultivated in nursery fields as turf grass crop.
  - .1 Turf Grass Nursery Sod types:
    - .1 Number One Kentucky Bluegrass Sod: Nursery Sod grown solely from seed of cultivars of Kentucky Bluegrass, containing not less than 50% Kentucky Bluegrass cultivars.

- .2 Fescue Sod: Nursery Sod grown solely from seed mixture of cultivars of Kentucky Bluegrass and Chewing Fescue or Creeping Red Fescue, containing not less than 40% Kentucky Bluegrass cultivars and 30% Chewing Fescue or Creeping Red Fescue cultivar[s].
- .3 Number One Named Cultivars: Nursery Sod grown from certified seed.
- .2 Turf Grass Nursery Sod quality:
  - .1 Not more than 2 broadleaf weeds or 10 other weeds per 40 square metres.
  - .2 Density of sod sufficient so that no soil is visible from height of 1500 mm when mown to height of 50 mm.
  - .3 Mowing height limit: 35 to 65 mm.
  - .4 Soil portion of sod: 6 to 15 mm in thickness.
- .2 Sod establishment support:
  - .1 Erosion control blankets: biodegradable, 25mm square mesh on all slopes exceeding 40%.
  - .2 Wooden pegs: 17 x 8 x 200mm for all slopes exceeding 33% (3 height to 1 vertical).
- .3 Water:
  - .1 Supplied by Departmental Representative at designated source.
- .4 Fertilizer:
- .5 Fertilizer shall be standard commercial grade with guaranteed chemical analysis and subject to approval by Departmental Representative.
- .6 Apply according manufacturer's instructions. Application rates to be approved by Departmental Representative prior to application.
- .7 Apply RX30, Muracid as per manufacturer's recommendations.

## **2.2 SOURCE QUALITY CONTROL**

- .1 Obtain approval from Departmental Representative of sod at source.
- .2 When proposed source of sod is approved, use no other source without written authorization from Departmental Representative.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Verify that grades are correct and prepared in accordance with Section 32 91 19.13 - Topsoil Placement and Grading. If discrepancies occur, notify Departmental Representative and do not commence work until instructed by Departmental Representative.
- .2 Do not perform work under adverse field conditions such as frozen soil, excessively wet soil or soil covered with snow, ice, or standing water.

- .3 Fine grade surface free of humps and hollows to smooth, even grade, to contours and elevations indicated, to tolerance of plus or minus 8 mm, for Turf Grass Nursery Sod and fescue sod.
- .4 Remove and dispose of weeds; debris; stones 50 mm in diameter and larger; soil contaminated by oil, gasoline and other deleterious materials; off site in location as directed by Departmental Representative.

### **3.2 SOD PLACEMENT**

- .1 Lay sod within 24 hours of being lifted if air temperature exceeds 20 degrees C.
- .2 Lay sod sections in rows, joints staggered. Butt sections closely without overlapping or leaving gaps between sections. Cut out irregular or thin sections with sharp implements.
- .3 Roll sod as directed by Departmental Representative. Provide close contact between sod and soil by light rolling. Use of heavy roller to correct irregularities in grade is not permitted.

### **3.3 SOD PLACEMENT ON SLOPES, PEGGING, AND EROSION CONTROL BLANKETS**

- .1 Install and secure erosion control blankets in areas indicated, in accordance with manufacturer's instructions.
- .2 Start laying sod at bottom of slopes.
- .3 Peg sod on slopes steeper than 3 horizontal to 1 vertical, within 1m of catch basins and within 1 m of drainage channels and ditches to following pattern:
  - .1 100 mm below top edge at 200 mm on centre for first sod sections along contours of slopes.
  - .2 Not less than 5 pegs per square metre.
  - .3 Not less than 7 pegs per square metre in drainage structures. Adjust pattern as directed by Departmental Representative.
  - .4 Drive pegs to 20mm above soil surface of sod sections.
- .4 Add Erosion Control Blankets as per manufacturer's installation instructions on all slope that exceed 40% as indicated on drawings.
  - .1 Pegs as per manufacturer's instructions.
  - .2 Pattern and amount of pegs as per manufacturer's instructions.

### **3.4 MAINTENANCE DURING ESTABLISHMENT PERIOD**

- .1 Perform following operations from time of installation until acceptance.
- .2 Water sodded areas in sufficient quantities and at frequency required to maintain optimum soil moisture condition to depth of 75mm.
- .3 Cut manicured sod area to 50 mm when or prior to it reaching height of 75mm. Remove clippings which will smother grassed areas.

- .4 Maintain sodded areas weed free 99%.
- .5 Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.

### **3.5 ACCEPTANCE**

- .1 Turf Grass Nursery Sod areas will be accepted by Departmental Representative provided that:
  - .1 Sodded areas are properly established.
  - .2 Sod is free of bare and dead spots.
  - .3 No surface soil is visible from height of 1500 mm when grass has been cut to height of 50mm.
  - .4 Sodded areas have been cut minimum 2 times prior to acceptance.
- .2 Fescue Sod areas will be accepted by Departmental Representative provided that:
  - .1 Sodded areas are properly established.
  - .2 Sod is free of bare or dead spots and extent of weeds apparent in grass is acceptable.
  - .3 Fertilizing in accordance with fertilizer program has been carried out at least once.
- .3 Areas sodded in fall will be accepted in following spring one month after start of growing season provided acceptance conditions are fulfilled.

### **3.6 MAINTENANCE DURING WARRANTY PERIOD**

- .1 Perform following operations from time of acceptance until end of warranty period:
  - .1 Water sodded Turf Grass Nursery Sod and Fescue Sod areas at weekly intervals to obtain optimum soil moisture conditions to depth of.
- .2 Repair and re-sod dead or bare spots to satisfaction of Departmental Representative.
- .3 Cut grass and remove clippings that will smother grass as directed by Departmental Representative to height as follows:
  - .1 Turf Grass Nursery Sod:
    - .1 50mm during normal growing conditions.
    - .2 Cut grass at 2 week intervals or as directed by Departmental Representative but at intervals so that approximately one third of growth is removed in single cut.
  - .2 Fecue Sod :
    - .1 Does not require cutting and will be in natural areas only.
- .3 Spread half of required amount of fertilizer in one direction and remainder at right angles and water in well.
- .4 Eliminate weeds by mechanical means to extent acceptable to Departmental Representative.



**3.7            CLEANING**

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

**END OF SECTION**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Materials and installation for plant material, accessories, mulch, planting, tree support, mulching and maintenance.

**1.2 REFERENCES**

- .1 Agriculture and Agri-Food Canada (AAFC).
  - .1 Plant Hardiness Zones in Canada-2000.
- .2 Canadian Nursery Landscape Association (CNLA).
  - .1 Canadian Standards for Nursery Stock-2001.
- .3 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Protection Act (CEPA), 1999, c. 33.
  - .2 Transportation of Dangerous Goods Act (TDGA), 1992, c.34.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Material Safety Data Sheets (MSDS).

**1.3 DEFINITIONS**

- .1 Mycorrhiza: association between fungus and roots of plants. This symbiosis, enhances plant establishment in newly landscaped and imported soils.

**1.4 SUBMITTALS**

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit product data for:
  - .1 Fertilizer.
  - .2 Mycorrhiza.
  - .3 Anti-desiccant.
  - .4 Guying assembly including clamps, collar, guying wire, anchors and wire tightener.
  - .5 Mulch.
- .3 Submit samples for:
  - .1 Mulch.
  - .2 Mycorrhiza.

**1.5 QUALITY ASSURANCE**

- .1 Certification: provide Canadian Nursery Landscape Association certification.

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- .1 Nomenclatures shall conform to the International Code of Nomenclature for Cultivated Plants and the latest edition of Standardized Plant Names.
- .2 All plant material must be nursery grown and meet the specifications set out in the latest Guide Specifications for Nursery Stock prepared by Canadian Nursery Trade Association (C.N.T.A.) and the International Society of Arboriculture (I.S.A.) for size, height, spread, grading, quality and method of cultivation.
- .3 Plants to be supplied free of disease, insect infestations, insect eggs, rodent damage, sun scald, frost cracks and other abrasions or scars to bark.
- .4 Substitutions will only be accepted if it is shown that the specified tree is unobtainable.
- .5 Approval of nursery grown plant material at source does not preclude the right of the Departmental Representative to inspect plants upon arrival on site or during planting process and reject damaged plants or those not conforming to specifications.
- .6 All plant material must be purchased from a local nursery and seed source identified.

#### **1.6 STORAGE AND PROTECTION**

- .1 Protect plant material from frost, excessive heat, wind and sun during delivery.
- .2 Immediately store and protect plant material which will not be installed within 1 hour after arrival at site in storage location approved by Departmental Representative.
- .3 Protect plant material from damage during transportation:
  - .1 When delivery distance is less than 30 km and vehicle travels at speeds under 80 km/h, tie tarpaulins around plants or over vehicle box.
  - .2 When delivery distance exceeds 30 km or vehicle travels at speeds over 80 km/h, use enclosed vehicle where practical.
  - .3 Protect foliage and root balls using anti-desiccants and tarpaulins, where use of enclosed vehicle is impractical due to size and weight of plant material.
- .4 Protect stored plant material from frost, wind and sun and as follows:
  - .1 For bare root plant material, preserve moisture around roots by heeling-in or burying roots in sand or topsoil and watering to full depth of root zone.
  - .2 For pots and containers, maintain moisture level in containers.
  - .3 For balled and burlapped and wire basket root balls, place to protect branches from damage. Maintain moisture level in root zones.
- .5 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and] recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
  - .2 .

#### **1.7 SCHEDULING**

- .1 Obtain approval from Departmental Representative of schedule 7 days in advance of shipment of plant material.

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- .2 Schedule to include:
  - .1 Quantity and type of plant material.
  - .2 Shipping dates.
  - .3 Arrival dates on site.
  - .4 Planting Dates.

## **1.8 WARRANTY**

- .1 For plant material as itemized on plant list, the 12 months warranty period prescribed in subsection GC 32.1 of General Conditions "C" is extended to 24 months.
- .2 End-of-warranty inspection will be conducted by Departmental Representative.
- .3 Departmental Representative reserves the right to extend Contractor's warranty responsibilities for an additional one year if, at end of initial warranty period, leaf development and growth is not sufficient to ensure future survival.

## **Part 2 Products**

### **2.1 PLANT MATERIAL**

- .1 Type of root preparation, sizing, grading and quality: comply to Canadian Standards for Nursery Stock.
  - .1 Source of plant material: grown in Zone 3 in accordance with Plant Hardiness Zones in Canada.
  - .2 Plant material must be planted in zone indicated as appropriate for its species.
  - .3 Plant material in location appropriate for its species.
- .2 Plant material: free of disease, insects, defects or injuries and structurally sound with strong fibrous root system.
- .3 Trees: with straight trunks, well and characteristically branched for species except where specified otherwise.
- .4 Trees larger than 200mm in caliper: half root pruned during each of two successive growing seasons, the latter at least one growing season prior to arrival on site.
- .5 Bare root stock: nursery grown, in dormant stage, not balled and burlapped or container grown.
- .6 Collected stock: maximum 40 mm in caliper, with well developed crowns and characteristically branched; no more than 40% of overall height may be free of branches.

### **2.2 WATER**

- .1 Free of impurities that would inhibit plant growth.

### **2.3 STAKES**

- .1 T-bar, steel, 40 x 40 x 5 x 2440.

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**2.4 WIRE TIGHTENER**

- .1 Type 1: galvanized steel rod, triangular shape.
- .2 Type 2: turnbuckle, galvanized steel, 9.5 mm diameter with 270mm open length.

**2.5 GUYING WIRE**

- .1 Type 1: steel, 11 guage

**2.6 CLAMPS**

- .1 U-bolt: galvanized, 13mm diameter, c/w curved retaining bar and hex nuts.
- .2 Crimp type.

**2.7 ANCHORS**

- .1 Drive-in type.
  - .1 Type 1: 18 mm diameter x 120 mm long, aluminum.

**2.8 GUYING COLLAR**

- .1 Tube: plastic, 13 mm diameter, nylon reinforced.

**2.9 TRUNK PROTECTION**

- .1 Plastic: perforated spiralled strip.

**2.10 MULCH**

- .1 Shredded wood: varying in size from 25 to [100mm in length, from coniferous trees.

**2.11 FERTILIZER**

Synthetic commercial type as recommended by soil test report – see section 32 91 19.13  
Topsoil Placement

**2.12 ANTI-DESICCANT**

- .1 Wax-like emulsion.

**2.13 FLAGGING TAPE**

- .1 Fluorescent, orange colour.

**2.14 SOURCE QUALITY CONTROL**

- .1 Obtain approval from Departmental Representative of plant material prior to planting.
- .2 Imported plant material must be accompanied with necessary permits and import licenses. Conform to Federal, Provincial or Territorial regulations.

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**Part 3            Execution**

**3.1                PRE-PLANTING PREPARATION**

- .1        Ensure plant material acceptable to Departmental Representative.
- .2        Remove damaged roots and branches from plant material.
- .3        Apply anti-desiccant to conifers and deciduous trees in leaf in accordance with manufacturer's instructions.

**3.2                EXCAVATION AND PREPARATION OF PLANTING BEDS**

- .1        Establishment of sub-grade for planting beds is specified in Section 31 20 00.
- .2        Preparation of planting beds is specified in Section 32 91 19.13 - Topsoil Placement and Grading.
- .3        For individual planting holes:
  - .1        Stake out location and obtain approval from Departmental Representative.
  - .2        Excavate to depth and width as indicated.
  - .3        Remove subsoil, rocks, roots, debris and toxic material from excavated material that will be used as planting soil for trees and individual shrubs. Dispose of excess material.
  - .4        Scarify sides of planting hole as per landscape details.
  - .5        Remove water which enters excavations prior to planting. Notify Departmental Representative if water source is ground water.

**3.3                PLANTING**

- .1        For bare root stock, place 50mm backfill soil in bottom of hole. Plant trees and shrubs with roots placed straight out in hole.
- .2        For jute burlapped root balls, cut away top one third of wrapping and wire basket without damaging root ball. Do not pull burlap or rope from under root ball.
- .3        For container stock or root balls in non-degradable wrapping, remove entire container or wrapping without damaging root ball.
- .4        Plant vertically in locations as indicated. Orient plant material to give best appearance in relation to structure, roads and walks.
- .5        For trees and shrubs:
  - .1        Backfill soil in 150 mm lifts. Tamp each lift to eliminate air pockets. When two thirds of depth of planting pit has been backfilled, fill remaining space with water. After water has penetrated into soil, backfill to finish grade.
  - .2        Form watering saucer as indicated.
- .6        For ground covers, backfill soil evenly to finish grade and tamp to eliminate air pockets.
- .7        Water plant material thoroughly.

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- .8 After soil settlement has occurred, fill with soil to finish grade.
- .9 Dispose of burlap, wire and container material off site.

### **3.4 TRUNK PROTECTION**

- .1 Install trunk protection on deciduous trees as indicated.
- .2 Install trunk protection prior to installation of tree supports when used.

### **3.5 TREE SUPPORTS**

- .1 Install tree supports as indicated.
- .2 Use single stake tree support for deciduous trees less than 3 m and evergreens less than 2 m.
  - .1 Place stake on prevailing wind side and 150 mm from trunk.
  - .2 Drive stake minimum 150 mm into undisturbed soil beneath roots. Ensure stake is secure, vertical and unsplit.
  - .3 Install 150 mm long guying collar 1500 mm above grade.
  - .4 Thread Type 1 guying wire through guying collar tube. Twist wire to form collar and secure firmly to stake. Cut off excess wire.
- .3 Use 3 guy wires and anchors for deciduous trees greater than 3 m and evergreens greater than 2 m.
  - .1 Attach guy wire to anchors. Tension wire and secure by [multi-wraps] [installing clamps].
  - .2 Install wire tightener ensuring that guys are secure and leave room for slight movement of tree.
  - .3 Saw tops off wooden anchors which extend in excess of 100 mm above grade or as directed by Departmental Representative.
  - .4 Install flagging tape to guys as indicated.
- .4 After tree supports have been installed, remove broken branches with clean, sharp tools.

### **3.6 MULCHING**

- .1 Ensure soil settlement has been corrected prior to mulching.
- .2 Spread mulch as indicated.

### **3.7 CLEAN UP**

- .1 Broom clean pavement and sidewalks at end of each working day.
- .2 Clear soil and rubble from underground utility appurtenances.
- .3 Leave site in neat and acceptable condition after each working day and at the completion of landscape works.

**END OF SECTION**