

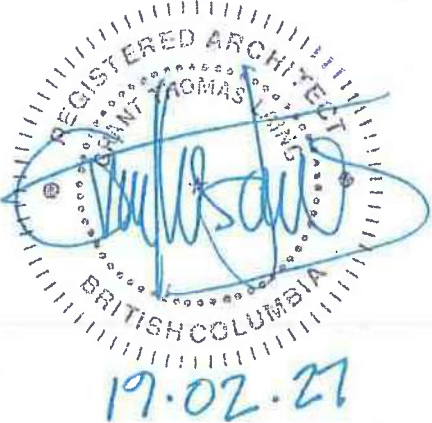


DRAWINGS AND SPECIFICATIONS FOR:
AMPHITRITE POINT EQUIPMENT BUILDING
CANADIAN COAST GUARD (CCG)
UCLUELET, BC

PREPARED BY: CCG Western Region Maritime & Civil Infrastructure
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C-003 DEMO SITE PLAN
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BUILDING ENVELOPE

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BE-001 BUILDING PLAN, SECTION & CODE CHECK
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STRUCTURAL

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FP-01 FIRE SUPPRESSION SYSTEMS

END OF SECTION 00 01 00

Part 1 General

1.1 WORK COVERED BY CONTRACT DOCUMENTS

- .1 Work of this Contract is located at Amphitrite Point, Ucluelet B.C. and comprises the provision of all labour, materials, services and equipment necessary for the construction of the following located as fully described in the Contract Documents:
 - .1 New Amphitrite Point Equipment Building to post-disaster standards.
 - .2 Underground power, communications systems and building utilities.
 - .3 Helipad lighting upgrades.

1.2 TIME OF COMPLETION

- .1 Commence work immediately upon official notification of acceptance of offer and complete the work of this Contract (Amphitrite Pt. Equipment Building) ready for CCG use by **October 8, 2019**.

1.3 CONTRACT METHOD

- .1 Construct work under lump sum contract.

1.4 WORK BY OTHERS

- .1 Co-operate with other Contractors and Canadian Coast Guard (CCG) in carrying out their respective works and carry out instructions from Departmental Representative.
- .2 Co-ordinate work with that of other Contractors and CCG Forces. If any part of work under this Contract depends for its proper execution or result upon work of another Contractor, report promptly to Departmental Representative, in writing, any defects which may interfere with proper execution of Work.
- .3 Work of Project executed during Work of this Contract, and which is specifically excluded from this Contract:
 - .1 Communications Tower:
 - .1 Foundation construction.
 - .2 Tower erection.
 - .3 Waveguide Bridge construction.
 - .2 Supply and installation of Air Cooled Diesel Generator, generator cooling air discharge ducting and exhaust by CCG.
 - .3 Installation of Generator Fuel System by CCG
 - .4 CCTV Cameras by CCG.
- .4 Work of Project which will be executed after completion of Work of this Contract, and which is specifically excluded from this Contract:
 - .1 Server racks by CCG.
 - .2 Owner's Communications Equipment by CCG.
 - .3 Connection of Remote Transmitter Site power and communications conductors and cabling by CCG.

- .5 Work of this Project must include provisions for co-ordinating related work, identified in Contract Documents, for following principal items.
 - .1 Installation of generator and related equipment within the Equipment Building.
 - .2 Installation of fuel system.

1.5 WORK SEQUENCE

- .1 Construct Work in stages to ensure Owner's continued operation and use of facilities during construction.
- .2 Co-ordinate Progress Schedule and co-ordinate with Owner Occupancy during construction.
- .3 Co-ordinate commissioning as described in Section 01 91 13 General Commissioning Requirements.
- .4 Maintain fire access/control.

1.6 CODES

- .1 Perform work to current Codes, Construction Standards, Standards and Bylaws.

1.7 RELATED REQUIREMENTS

- .1 Section 01 14 00 Work Restrictions
- .2 Section 01 33 00 Submittal Procedures
- .3 Section 01 45 00 Quality Control
- .4 Section 01 91 13 General Commissioning Requirements.
- .5 Section 01 78 00 Closeout Submittals

1.8 CONTRACT DOCUMENTS

- .1 The Contract documents, Drawings, and Specifications are intended to complement each other, and to provide for and include all elements necessary for the completion of the work.
- .2 The specifications are sub-divided in accordance with the current 6-digit National Master Specifications System:
 - .1 Each specification forms a part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
 - .1 The specifications are arranged in a manner to illustrate the process of the Work and is not intended to establish limits of responsibility of the sub-contractors or suppliers. It is the General Contractor's obligation to establish the areas or scope of responsibility for each sub-contractor or supplier.

1.9 CONTRACTOR USE OF PREMISES

- .1 Use of areas designated on Contract documents until Substantial Completion.
- .2 Co-ordinate use of premises under direction of Departmental Representative.

- .3 Remove or alter existing work to prevent injury or damage to portions of existing work which remain.
- .4 Repair or replace portions of existing work which have been altered during construction operations to match existing or adjoining work, as directed by Departmental Representative.
- .5 At completion of operations condition of existing work: equal to or better than that which existed before new work started.

1.10 OWNER OCCUPANCY

- .1 Owner will occupy premises during entire construction period for execution of normal operations.
- .2 Execute work with least possible interference or disturbance to normal use of premises and continuous operation of MCTS center, ER Building, Remote Transmitter site and Light Station maintained by CCG.
- .3 Co-operate with Owner in scheduling operations to minimize conflict and to facilitate Owner usage.

1.11 PRE-PURCHASED EQUIPMENT

- .1 Departmental Representative has placed orders with suppliers for specific products to expedite Work and for other purposes in Owner's interests.
- .2 Contractor is responsible for the installation of the following products purchased and supplied by the Owner:
 - .1 One (1) ASCO Automatic Transfer Switch: Cat # J3ATSA20600FGC - 600Amp/240Volt, 2Pole/Solid Neutral, Type 1 Enclosed.
- .3 Owner is responsible for purchase, handling, and installation of the following pre-ordered products:
 - .1 One (1) Simpson Maxwell Standby Emergency Power Air Cooled Diesel Generator Set: Model 118TDS-U3G. 100kW Prime, 120/240V, 1Ph, 60Hz. Air cooled diesel generator.
 - .2 Generator Fuel System.
- .4 Obtain necessary shop drawings from Departmental Representative for inclusion in maintenance manual in accordance with Section 01 33 00- Submittal Procedures.

1.12 ALTERATIONS, ADDITIONS OR REPAIRS TO OWNER FACILITIES

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

1.13 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. CCG partner agencies have active communications networks at the site. Coordination with agencies is the responsibility of the Departmental Representative. Coordination will be made based on Contractor's approved schedule. Adhere to approved schedule and provide notice to affected parties.
- .4 Provide temporary services where required to maintain critical building and CCG operational systems.
- .5 Provide adequate bridging over trenches which cross sidewalks or roads to permit normal traffic.
- .6 Where unknown services are encountered, immediately advise Departmental Representative and confirm findings in writing.
- .7 Protect, relocate or maintain existing active services. When inactive services are encountered, cap off in manner approved by authorities having jurisdiction.
- .8 Record locations of maintained, re-routed and abandoned service lines.

1.14 TESTING AND INSPECTION

- .1 Within (21) calendar days after Award of Contract submit list of proposed testing services or testing laboratories for Departmental Representative review and approval.
- .2 Particular requirements for inspecting and testing to be carried out by testing service or laboratory approved by Departmental Representative are specified in Section 01 45 00 – Quality Control.
- .3 The Contractor to retain and pay for the services of testing agency or testing laboratory as specified, and where required by the following:
 - .1 Inspection and testing required by laws, ordinances, rules, regulations or orders of public authorities.
 - .2 Inspection and testing performed exclusively for Contractor's convenience.
 - .3 Testing, adjustment and balancing of mechanical and electrical equipment and systems.
 - .1 Mill tests and certificates of compliance.
 - .2 Tests specified in the contract documents to be carried out by Contractor which may be under the Departmental Representative's supervision.
 - .4 Two (2) fire alarm acceptance tests, one for building hand over to client for occupancy and one after CCG installs and connects generator to fire alarm system. Test required to confirm annunciation and panel functionality.
- .4 Contractor to retain and pay for services of geotechnical testing company acceptable to the Departmental Representative for testing concrete materials.
- .5 Contractor to retain and pay for services of geotechnical testing company acceptable to the Departmental Representative for testing granular materials.
- .6 Where test or inspections by designated testing laboratory reveal work is not in accordance with the Contract requirements, Contractor shall pay costs for additional test or inspections as the Departmental Representative may require, to verify, acceptability of corrected work.

- .7 Contractor shall furnish labour and facility to carry out specified testing and notify Departmental Representative in advance of planned testing.
- .8 Where materials are specified to be tested, deliver representative samples in required quantity to testing laboratory.
- .9 Pay costs for uncovering and making good work that is covered before required inspection of testing is completed and approved by Departmental Representative.
- .10 Provide Departmental Representative with digital copy of testing laboratory reports as soon as they are available.
- .11 Departmental Representative will coordinate and pay for additional soil characterization sampling where required as determined by Owner's environmental consultant.
- .12 Departmental Representative will coordinate and pay for review of foundation excavation by Owner's geotechnical engineer prior to foundation installation.

1.15 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 Approved Work Schedule.
 - .10 Health and Safety Plan and Other Safety Related Documents.
 - .11 Other documents as specified.

1.16 COST BREAKDOWN

- .1 Within (21) calendar days after Award of Contract, and before submitting the first progress claim, Contractor to submit a breakdown of lump sum prices in detail as requested by the Departmental Representative, aggregating to the Contract price. After approval, the cost breakdown will form the basis of progress payments.
- .2 Within (14) calendar days after Award of Contract, provide a monthly cash flow projection for the whole contract period in detail as directed by Departmental Representative. Contractor should provide a monthly update of cash flow projection according to the actual work schedule and progress payment submitted.

END OF SECTION

Part 1 General

1.1 ACCESS AND EGRESS

- .1 Design, construct and maintain temporary "access to" and "egress from" work areas, including stairs, landing pad, 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 MCTS and ER buildings and provide for personnel and vehicle access.
- .3 Where security is reduced by work provide temporary means to maintain security.
- .4 Closures: protect work temporarily until permanent enclosures are completed.

1.3 SPECIAL REQUIREMENTS

- .1 Rock blasting is not permitted due to proximity to sensitive electronic communications equipment located at site.
- .2 Helipad is a 24/7 facility requiring access at all times. Contractor must limit loose material storage 10m from edge of Helipad due to impact of rotor wash associated with take-off and landing of aircraft.
- .3 Hydro Vactor excavation is only permitted for location of existing active communication and 600V power system..
- .4 Notify Departmental representative of communication corridor installation work between Sta 1+000 and 1+175 minimum (14) calendar days in advance of planned work. Departmental Representative to confirm procedures for working around active communications towers and grounding radials for work in this area.
- .5 Carry out noise generating work from 8:00 to 17:00 hours. Work outside these hours may be permitted on a limited basis and requires prior approval of the Departmental Representative.
- .6 Coordinate delivery of materials and equipment with Departmental Representative.

1.4 ALTERATIONS, ADDITIONS OR REPAIRS TO EXISTING BUILDINGS

- .1 Execute work with least possible interference or disturbance to normal use of premises and continuous operation of MCTS center, ER Building, Remote Transmitter site and Light Station maintained by Canadian Coast Guard. Arrange with Departmental Representative to facilitate execution of work.

1.5 EXISTING SERVICES

- .1 Notify Departmental Representative of intended interruption of services and obtain required permission minimum (5) calendar days in advance of planned work.
- .2 Where Work involves breaking into or connecting to existing services, give Departmental Representative minimum (5) calendar days' notice for necessary interruption of

mechanical or electrical service throughout course of work. Keep duration of interruptions minimum.

1.6 SECURITY

- .1 Provide temporary means to maintain security where security has been reduced by Work.

1.7 BUILDING SMOKING ENVIRONMENT

- .1 Smoking is not permitted on site.

END OF SECTION

Part 1 General

1.1 ADMINISTRATIVE

- .1 Schedule and administer project meetings throughout the progress of the work at the call of Departmental Representative.
- .2 Prepare agenda for meetings.
- .3 Distribute written notice of each meeting 7 days in advance of meeting date to Departmental Representative.
- .4 Meetings to be held at site every two (2) weeks. CCG boardroom is available within MCTS building for CCG project 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 3 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 51 00 – Temporary Facilities.
 - .5 Delivery schedule of materials and equipment.
 - .6 Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.

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

1.3 PROGRESS MEETINGS

- .1 During course of Work and 4 weeks prior to project completion, schedule progress meetings every 2 weeks.
- .2 Contractor, major Subcontractors involved in Work, Departmental Representative and required Consultant(s) 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 3 days after meeting.
- .5 Agenda to include the following:
 - .1 Review, approval of minutes of previous meeting.
 - .2 Review of Work progress since previous meeting.
 - .3 Field observations, problems, conflicts.
 - .4 Problems which impede construction schedule.
 - .5 Review of off-site fabrication delivery schedules.
 - .6 Corrective measures and procedures to regain projected schedule.
 - .7 Revision to construction schedule.
 - .8 Progress schedule, during succeeding work period.
 - .9 Review submittal schedules: expedite as required.
 - .10 Maintenance of quality standards.
 - .11 Review proposed changes for affect on construction schedule and on completion date.
 - .12 Other business.

END OF SECTION

Part 1 General

1.1 MEASUREMENT PROCEDURES

- .1 Cost of providing Construction Progress Schedules will be considered incidental to the work and no additional payment will be made.

1.2 DEFINITIONS

- .1 **Activity:** An element of Work performed during course of Project. An activity normally has an expected duration, and expected cost and expected resource requirements. Activities can be subdivided into tasks.
- .2 **Bar Chart (GANTT chart):** A 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, plus or minus approved scope changes.
- .4 **Construction Work Week:** Monday to Sunday, inclusive, will provide seven 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 an activity or other project element, usually expressed as work days or work weeks.
- .6 **Master Plan:** A summary-level schedule that identifies major activities and key milestones.
- .7 **Milestone:** A significant event in project, usually completion of major deliverable.
- .8 **Project Schedule:** The planned dates for performing activities and the planned dates for meeting milestones. A 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.

1.3 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 twenty (20) working days, to allow for progress reporting.
- .4 Ensure that it is understood that Award of Contract or time of beginning, rate of progress, Interim Certificate and Final Certificate as defined times of completion are of essence of this contract.

1.4 SUBMITTALS

- .1 Submit to Departmental Representative within fourteen (14) calendar days of Award of Contract, Bar Chart (GANTT) as Master Plan for planning, monitoring and reporting of project progress.
- .2 Submit Project Schedule to Departmental Representative within fourteen (14) calendar days of receipt of acceptance of Master Plan.

1.5 PROJECT MILESTONES

- .1 Project milestones form targets for Project Schedule. Completion of Construction:
 - .1 Interim Certificate (Substantial Completion) by **September 24, 2019**.
 - .2 Complete all work by **October 8, 2019** (Contract Completion Date).

1.6 MASTER PLAN

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

1.7 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 Permits.
 - .3 Submission of:

- .1 Project Schedule.
- .2 List of Sub-Contractors, supplies and Departmental Representative.
- .3 Prime Contractor/co-ordination with other Contractors Plan.
- .4 Contractor Chain of Command including Sub-Contractors and Departmental Representatives.
- .5 Work Plan.
- .6 Environmental Protection Plan.
- .7 Traffic Management Plan.
- .8 Site access/Detour Plan.
- .9 Emergency Response Protocol.
- .10 Site Specific Health and Safety Plan, incl. MSDS sheets.
- .11 On site Contingency and Emergency Response Plan.
- .12 Survey Plan.
- .13 Quality Control Plan.
- .14 Shop Drawings.
- .4 Mobilization.
- .5 Material Delivery.
- .6 Work for all Items including:
 - .1 Demolition
 - .2 Earth Movement
 - .3 Quality Control.
 - .4 Interim inspection.
 - .5 Site clean-up and demobilization.

1.8 PROJECT SCHEDULE REPORTING

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

1.9 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.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 This Section specifies general requirements and procedures for the Contractor's submissions of shop drawings, product data, samples and other requested submittals to Departmental Representative for review. Additional specific requirements for submissions are specified in individual technical sections.
- .2 Contractor is to provide submittals to Departmental Representative in advance of, and throughout the duration of the Work.
- .3 All Sections of the Contract documents shall apply to requirements for submittals associated with the Work. The Contractor shall review and be familiar with the structure and contents of all required submittals.
- .4 Detailed requirements for each submittal are stipulated in the related Sections of the Specification.

1.2 SUBMISSION REQUIREMENTS

- .1 Coordinate each submission with the requirements of the work and the Contract documents. Individual submissions will not be reviewed until all related information is available.
- .2 Allow 10 (ten) calendar days for Departmental Representative's review of each submission, unless noted otherwise.
- .3 Present shop drawings, product data and samples in SI Metric units.
- .4 Where items or information is not produced in SI Metric units, converted values are acceptable.
- .5 Contractor's responsibility for errors and omissions in submission is not relieved by Departmental Representative's review of submissions.
- .6 Notify Departmental Representative in writing at time of submission, identifying deviations from requirements of Contract documents and stating reasons for deviations.
- .7 Contractor's responsibility for deviations in submission from requirements of Contract documents is not relieved by Departmental Representative's review of submission unless Departmental Representative gives written acceptance of specific deviations.
- .8 Make any changes in submissions which Departmental Representative may require consistent with Contract documents and resubmit as directed by Departmental Representative.
- .9 Notify Departmental Representative in writing, when resubmitting, of any revisions other than those requested by Departmental Representative.
- .10 Do not proceed with work until relevant submissions are reviewed and approved by the Departmental Representative.
- .11 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.

1.3 SUBMITTALS

- .1 This pre-construction summary list (**Table 1**) is presented for the Contractor's convenience only, and no warranty is given to its accuracy or completeness. In the event of any discrepancies with individual Sections of the Specification, the requirements of the individual Section of the Specification apply.

SUMMARY LIST OF PRE-CONSTRUCTION SUBMITTALS

Table 1 – Pre-Construction Submittals

ITEM #	SPEC ID	Clause	Submittal	Submittal Schedule
1	01 11 00	1.14.1	List of testing services or testing agencies.	Within (21) calendar days of Award of Contract.
2	01 11 00	1.16.1	Cost Breakdown	Within (21) calendar days of Award of Contract.
3	01 11 00	1.16.2	Monthly Cash Flow Breakdown	Within (14) calendar days of Award of Contract.
4	01 32 18	1.4.1	Bar Chart (GANTT) as Master Plan for Project	within (14) calendar days of Award of Contract.
5	01 32 18	1.4.2	Project Schedule	within (14) calendar days of receipt of acceptance of Master Plan.
6	01 33 00	1.19.1	Work Safe BC status	Immediately after Award of Contract
7	01 33 00	1.19.2	Transcription of Insurance	Immediately after Award of Contract
8	01 35 29.06	1.4.1	.1 Company Safety Manual .2 Site specific Health and Safety Plan .3 Copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors. .4 Copies of incident and accident reports. .5 Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Materials Information System (WHMIS) requirements. .6 Emergency procedures.	Within (14) calendar days of Award of Contract.
9	01 35 46	1.2.1	Environmental Protection Plan	within (14) calendar days of Award of Contract
10	01 51 00	1.1.1	Temporary facilities plan	within (14) calendar days of Award of Contract
11	01 51 00	1.1.2	Moisture-Protection Plan	within (21) calendar days of Award of Contract
12	01 51 00	1.1.3	Construction site sign proof	within (14) calendar days of Award of Contract
13	01 91 13	1.7	Commissioning work	Within (28) calendar days of Award of Contract

ITEM #	SPEC ID	Clause	Submittal	Submittal Schedule
14	07 42 13	1.6	Metal Wall Panel Product	Within (28) calendar days of Award of Contract
15	07 61 13	1.4.2	Metal Roofing Product	Within (28) calendar days of Award of Contract
16	26 36 23	1.3.2	Automatic Transfer Switch	Within (28) calendar days of Award of Contract
17	31 23 33.01	1.6.2.1	Contaminated Soil disposal facility location	Within (14) calendar days of Award of Contract
18	31 23 33.01	1.6.2.4	Granular materials CCME compliance certifications	Within (21) calendar days of Award of Contract

1.4 SHOP DRAWINGS

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 Submit drawings stamped and signed by professional engineer registered or licensed in Province of British Columbia where required.
- .3 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
- .4 Allow (7) calendar 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 Without restricting the generality of the foregoing, the Contractor is responsible for:
 - .1 Dimensions to be confirmed and correlated at the job site.
 - .2 Information that pertains solely to fabrication processes or to techniques of construction and installation.
 - .3 Coordination of the work of all sub-trades.
- .8 Submissions shall include:
 - .1 Date and revision dates.
 - .2 Project title and number.
 - .3 Name and address of:
 - .1 Subcontractor.
 - .2 Supplier.
 - .3 Manufacturer.

- .4 Contractor's stamp, signed by Contractor's authorized representative, certifying approval of submissions, verification of field measurements and compliance with Contract documents.
- .5 Details of appropriate portions of work as applicable.
 - .1 Fabrication.
 - .2 Layout, showing dimensions (including identified field dimensions: and clearances.
 - .3 Setting or erection details.
 - .4 Capacities.
 - .5 Performance characteristics.
 - .6 Standards.
 - .7 Operating weight.
 - .8 Wiring diagrams.
 - .9 Single line and schematic diagrams.
 - .10 Relationship to adjacent work.
- .6 After Departmental Representative's review, distribute copies.
- .9 Submit one electronic copy of shop drawings for each requirement requested in the specification sections and as requested by the Departmental Representative.
- .10 Submit one electronic copy of product data sheets or brochures for requirements requested in specification Sections and as requested by Departmental Representative where shop drawings will not be prepared due to standardized manufacture of product.
- .11 Submit one electronic copy of test reports for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.
 - .2 Testing must have been within 3 years of date of contract award for project.
- .12 Submit one electronic copy of certificates for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.
 - .2 Certificates must be dated after award of project contract complete with project name.
- .13 Submit one electronic copy of manufacturer's instructions for requirements requested in specification Sections and as requested by Departmental Representative.
 - .1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.
- .14 Submit one electronic copy of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Departmental Representative.
- .15 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

- .16 Submit one electronic copy of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Departmental Representative.
- .17 Delete information not applicable to project.
- .18 Supplement standard information to provide details applicable to project.
- .19 Cross-reference shop drawing information to applicable portions of the Contract documents.
- .20 Review of shop drawings by Departmental Representative is for the sole purpose of ascertaining conformance with the general concept.
 - .1 This review shall not mean that Departmental Representative approves the detail design inherent in the shop drawings, responsibility for which shall remain with Contractor submitting same.
 - .2 This review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the construction and Contract documents.

1.5 PRODUCT DATA

- .1 Product data: manufacturers' catalogue sheets, MSDS sheets, brochures, literature, performance charts and diagrams, used to illustrate standard manufactured products or any other specified information.
- .2 Delete information not applicable to project.
- .3 Supplement standard information to provide details applicable to project.
- .4 Cross-reference product data information to applicable portions of Contract documents.
- .5 Submit one electronic copy of product data.

1.6 SAMPLES

- .1 Submit for review samples in duplicate as requested in respective specification Sections. Label samples with origin and intended use.
- .2 Samples: examples of materials, equipment, quality, finishes and workmanship.
- .3 Deliver samples prepaid to Departmental Representative's office.
- .4 Notify Departmental Representative in writing, at time of submission of deviations in samples from requirements of Contract Documents.
- .5 Where colour, pattern or texture is a criterion, submit a full range of samples.
- .6 Reviewed and accepted samples will become the standard of workmanship and material against which installed work will be verified.

1.7 MOCK-UPS

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

1.8 PHOTOGRAPHIC DOCUMENTATION

- .1 Submit electronic copies of colour digital photography in jpg format, standard resolution monthly with progress statement to Departmental Representative.
- .2 Project identification: name and number of project and date of exposure indicated.

- .3 Number of viewpoints: 2 locations.
 - .1 Viewpoints and their location as determined by Departmental Representative.
- .4 Frequency of photographic documentation: monthly.
 - .1 Upon completion of: excavation, and other work as directed by Departmental Representative.

1.9 PROGRESS SCHEDULE

- .1 Submit work schedule and cost breakdown as required in Section 01 11 55.

1.10 TEST RESULTS AND INSPECTION REPORTS

- .1 Submit in duplicate test results and inspection reports.

1.11 CERTIFICATES AND TRANSCRIPTS

- .1 Immediately after Award of Contract, submit Work Safe BC status.
- .2 Immediately after Award of Contract, submit transcription of insurance.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Government of Canada:
 - .1 Canada Labour Code – Part II
 - .2 Canada Occupational Health and Safety Regulations.
- .2 National Building Code of Canada (NBC):
 - .1 Part 8, Safety Measures at Construction and Demolition Sites.
- .3 The Canadian Electric Code (as amended)
- .4 Canadian Standards Association (CSA):
 - .1 CSA Z797-2009, Code of Practice for Access Scaffold.
 - .2 CSA S269.1-1975 (R2003), Falsework for Construction Purposes.
 - .3 CSA S350-M1980 (R2003), Code of Practice for safety in Demolition of Structures.
 - .4 CSA Z1006-10 Management of Work in Confined Spaces.
 - .5 CSA Z462- Workplace Electrical Safety Standard
- .5 National Fire Code of Canada 2010 (as amended)
 - .1 Part 5 – Hazardous Processes and Operations and Division B as applicable and required.
- .6 American National Standards Institute (ANSI):
 - .1 ANSI A10.3, Operations – Safety Requirements for Powder-Actuated Fastening Systems.
- .7 Province of British Columbia:
 - .1 Workers Compensation Act Part 3 Occupational Health and Safety.
 - .2 Occupational Health and Safety Regulation.

1.2 WORKERS COMPENSATION BOARD COVERAGE

- .1 Comply fully with the Workers' Compensation Act, regulations and orders made pursuant thereto, and any amendments up to the completion of the work.
- .2 Maintain Workers' Compensation Board coverage during the term of the Contract, until and including the date that the Certificate of Final Completion is issued.

1.3 COMPLIANCE WITH REGULATIONS

- .1 PSPC may terminate the Contract without liability to PSPC where Contractor, in the opinion of PSPC, refuses to comply with a requirement of the Workers' Compensation Act or the Occupational Health and Safety Regulations.
- .2 It is the Contractor's responsibility to ensure that all workers are qualified, competent and certified to perform the work as required by the Workers' Compensation Act or the Occupational Health and Safety Regulations.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with 01 33 00 – Submittal Procedures.
- .2 Submit the following within (14) calendar days of Award of Contract and prior to commencement of Work.
 - .1 Company Safety Manual.
 - .2 Site-specific Health and Safety Plan,
 - .3 Copies of reports or directions issued by Federal, Provincial and Territorial health and safety inspectors.
 - .4 Copies of incident and accident reports.
 - .5 Complete set of Material Safety Data Sheets (MSDS), and all other documentation required by Workplace Hazardous Materials Information System (WHMIS) requirements.
 - .6 Emergency procedures.
- .3 Departmental Representative will review Contractor's site-specific Health and Safety Plan and provide comments to Contractor within (7) calendar days after receipt of plan. Revise plan as appropriate and resubmit plan to Departmental Representative within (5) calendar days after receipt of comments from Departmental Representative.
- .4 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.
- .5 Medical Surveillance: where prescribed by legislation, regulation or safety program, submit certification of medical surveillance for site personnel prior to commencement of Work, and submit additional certifications for any new site personnel to Departmental Representative.
- .6 On-site Contingency and Emergency Response Plan: Contractor shall coordinate and comply with Departmental Representative regarding any specific emergency response procedures required by Canadian Coast Guard (CCG) at Amphitrite Point, and address standard operating procedures to be implemented during emergency situations.

1.5 RESPONSIBILITY

- .1 Assume responsibility as Prime Contractor for the work under this Contract.
- .2 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.
- .3 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.

1.6 HEALTH AND SAFETY CO-ORDINATOR

- .1 Employ and assign to Work, competent and authorized representative as Health and Safety Co-ordinator. Health and Safety Co-ordinator must:

- .1 Be responsible for completing Contractor's Health and Safety Training Sessions and ensuring that personnel not successfully completing required training are not permitted to enter site to perform Work.
- .2 Be responsible for implementing, revising, daily enforcing, and monitoring the Site Specific Health and Safety Plan.
- .3 Be on site during execution of work

1.7 GENERAL CONDITIONS

- .1 Provide safety barricades and lights around the Contractor's Work Site (as necessary) to provide a safe working environment for workers and protection for pedestrian and vehicular traffic.
 - .1 Provide appropriate means by use of barricades, fences, warning signs, traffic control personnel, and temporary lighting as required.
 - .2 Ensure that non-authorized persons are not allowed to circulate in designated construction areas of the Contractor's Work Site.
 - .3 Secure site(s) at night time as deemed necessary to protect site against entry
- .2 Provide and maintain competent signal flag operators, traffic signals, barricades and flares, lights, or lanterns as required to perform Work and protect other site users.

1.8 PROJECT/SITE CONDITIONS

- .1 Work at site will involve contact with:
 - .1 Multi-employer works site.
 - .2 Federal employees and the general public.
 - .3 Other contractors.

1.9 UTILITY CLEARANCES

- .1 The Contractor is solely responsible for all utility detection and clearances prior to starting the Work.
- .2 The Contractor will not rely solely upon Reference Drawings or other information provided for utility locations.

1.10 REGULATORY REQUIREMENTS

- .1 Comply with specified codes, acts, bylaws, standards and regulations to ensure safe operations at site.
- .2 In event of conflict between any provision of the above authorities, the most stringent provision will apply. Should a dispute arise in determining the most stringent requirement, the Departmental Representative will advise on the course of action to be followed.

1.11 WORK PERMITS

- .1 Obtain required specialty permit(s) related to project before start of work.

1.12 FILING OF NOTICE

- .1 Contractor is to complete and submit a Notice of Project with Provincial authorities before work commences.
- .2 Provide copies of all notices to Departmental Representative.

1.13 HEALTH AND SAFETY PLAN

- .1 Conduct a site-specific hazard assessment based on review of Contract documents, required work, and project site. Identify any known and potential health risks and safety hazards.
- .2 Prepare and comply with a site-specific project Health and Safety Plan based on hazard assessment, including, but not limited to, the following:
 - .1 Primary requirements:
 - .1 Contractor's safety policy.
 - .2 Identification of applicable compliance obligations.
 - .3 Definition of responsibilities for project safety/organization chart for project.
 - .4 General safety rules for project.
 - .5 Job-specific safe work procedures.
 - .6 Inspection policy and procedures.
 - .7 Incident reporting and investigation policy and procedures.
 - .8 Occupational Health and Safety
 - .9 Committee/Representative procedures.
 - .10 Occupational Health and Safety meetings.
 - .11 Occupational Health and Safety communications and record keeping procedures.
 - .2 Summary of health risks and safety hazards resulting from analysis of hazard assessment, with respect to site tasks and operations which must be performed as part of the work.
 - .3 List hazardous materials to be brought on site as required by work.
 - .4 Indicate Engineering and administrative control measures to be implemented at the site for managing identified risks and hazards.
 - .5 Identify personal protective equipment (PPE) to be used by workers.
 - .6 Identify personnel and alternates responsible for site safety and health.
 - .7 Identify personnel training requirements and training plan, including site orientation for new workers.
- .3 Develop the plan in collaboration with all subcontractors. Ensure that work/activities of subcontractors are included in the hazard assessment and are reflected in the plan.
- .4 Revise and update Health and Safety Plan as required, and re-submit to the Departmental Representative.
- .5 Departmental Representative's review: the review of Site Specific Health and Safety Plan by Public Service and Procurement Canada (PSPC) shall not relieve the Contractor of

responsibility for errors or omissions in final Site Specific Health and Safety Plan or of responsibility for meeting all requirements of construction and Contract documents.

1.14 EMERGENCY PROCEDURES

- .1 List standard operating procedures and measures to be taken in emergency situations. Include an evacuation plan and emergency contacts (i.e. names/telephone numbers) of:
 - .1 Designated personnel from own company.
 - .2 Regulatory agencies applicable to work and as per legislated regulations.
 - .3 Local emergency resources.
 - .4 Departmental Representative.
- .2 Include the following provisions in the emergency procedures:
 - .1 Notify workers and the first-aid attendant, of the nature and location of the emergency.
 - .2 Evacuate all workers safely.
 - .3 Check and confirm the safe evacuation of all workers.
 - .4 Notify the fire department or other emergency responders.
 - .5 Notify adjacent workplaces or residences which may be affected if the risk extends beyond the workplace.
 - .6 Notify Departmental Representative.
- .3 Provide written rescue/evacuation procedures as required for, but not limited to:
 - .1 Work at high angles.
 - .2 Work in confined spaces or where there is a risk of entrapment.
 - .3 Work with hazardous substances.
 - .4 Underground work.
 - .5 Work on, over, under and adjacent to water.
 - .6 Workplaces where there are persons who require physical assistance to be moved.

Design and mark emergency exit routes to provide quick and unimpeded exit.

1.15 HAZARDOUS PRODUCTS

- .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 the Departmental Representative and in accordance with the Canada Labour Code.
- .2 Where use of hazardous and toxic products cannot be avoided:
 - .1 Advise Departmental Representative beforehand of the product(s) intended for use. Submit applicable MSDS and WHMIS documents as per Section 01 33 00.
 - .2 In conjunction with Departmental Representative, schedule to carry out work during "off hours" when tenants have left the building.
 - .3 Provide adequate means of ventilation in accordance with Section 01 51 00.

- .4 The contractor shall ensure that the product is applied as per manufacturers recommendations.
- .5 The contractor shall ensure that only pre-approved products are brought onto the work site in an adequate quantity to complete the work.

1.16 ASBESTOS HAZARD

- .1 Carry out any activities involving asbestos in accordance with applicable Provincial / Federal Regulations.
- .2 Removal and handling of asbestos will be in accordance with applicable Provincial / Federal Regulations.

1.17 REMOVAL OF LEAD CONTAINING PAINTS

- .1 All paints containing TCLP lead concentrations above 5 ppm are classified as hazardous.
- .2 Carry out demolition and/or remediation activities involving lead-containing paints in accordance with Worksafe BC Regulations.
- .3 Dry Scraping/Sanding of any materials containing lead is strictly prohibited.
- .4 The use of Methylene Chloride based paint removal products is strictly prohibited.

1.18 SILICA

- .1 Carry out work in accordance with Worksafe BC regulations.

1.19 ELECTRICAL LOCKOUT

- .1 Develop, implement and enforce use of established procedures to provide electrical lockout and to ensure the health and safety of workers for every event where work must be done on any electrical circuit or facility.
- .2 Prepare the lockout procedures in writing, listing step-by-step processes to be followed by workers, including how to prepare and issue the request/authorization form. Have procedures available for review upon request by the Departmental Representative.
- .3 Keep the documents and lockout tags at the site and list in a log book for the full duration of the Contract. Upon request, make such data available for viewing by Departmental Representative or by any authorized safety representative.

1.20 OVERLOADING

- .1 Ensure no part of work is subjected to a load which will endanger its safety or will cause permanent deformation.

1.21 FALSEWORK

- .1 Design and construct falsework in accordance with CSA SD269.1 (R2003) (Falsework for Construction Purposes).

1.22 SCAFFOLDING

- .1 Design, construct and maintain scaffolding in a rigid, secure and safe manner, in accordance with CSA Z797-2009 (Code of Practice for Access Scaffold) and B.C. Occupational Health and Safety Regulations.

1.23 CONFINED SPACE

- .1 Carry out work in confined spaces in compliance with Provincial Regulations.

1.24 BLASTING

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

1.25 POWDER ACTUATED DEVICES

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

1.26 FIRE SAFETY AND HOT WORK

- .1 Obtain Departmental Representative's authorization before any welding, cutting or any other hot work operations can be carried out on site.
- .2 Hot work includes cutting/melting with use of torch, flame heating roofing kettles, or other open flame devices and grinding with equipment which produces sparks.

1.27 FIRE SAFETY REQUIREMENTS

- .1 Store oily/paint-soaked rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from site on a daily basis.
- .2 Handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.
- .3 Portable gas and diesel fuel tanks are not permitted on most federal work sites. Approval from the DR is required prior to any gas or diesel tank being brought onto the work site.

1.28 FIRE PROTECTION AND ALARM SYSTEM

- .1 Fire protection and alarm systems shall not be:
 - .1 Obstructed.
 - .2 Shut off.
 - .3 Left inactive at the end of a working day or shift.
- .2 Do not use fire hydrants, standpipes and hose systems for purposes other than firefighting.
- .3 Be responsible/liable for costs incurred from the fire department, the building owner and the tenants, resulting from false alarms.

1.29 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.
- .2 When unforeseen or peculiar safety-related factor, hazard, or condition occur during performance of Work, advise Health and Safety co-ordinator and follow procedures in

accordance with Acts and Regulations of Province having jurisdiction and advise Departmental Representative verbally and in writing.

1.30 POSTING OF DOCUMENTS

- .1 Post legible versions of the following documents on site:
 - .1 Site Specific Health and Safety Plan.
 - .2 Sequence of work.
 - .3 Emergency procedures.
 - .4 Site drawing showing project layout, locations of the first-aid station, evacuation route and marshalling station, and the emergency transportation provisions.
 - .5 Notice of Project.
 - .6 Floor plans or site plans.
 - .7 Notice as to where a copy of the Workers' Compensation Act and Regulations are available on the work site for review by employees and workers.
 - .8 Workplace Hazardous Materials Information System (WHMIS) documents.
 - .9 Material Safety Data Sheets (MSDS).
 - .10 List of names of Joint Health and Safety Committee members, or Health and Safety Representative, as applicable.
- .2 Post all Material Safety Data Sheets (MSDS) on site, in a common area, visible to all workers and in locations accessible to tenants when work of this Contract includes construction activities adjacent to occupied areas.
- .3 Postings should be protected from the weather, and visible from the street or the exterior of the principal construction site shelter provided for workers and equipment, or as approved by the Departmental Representative.

1.31 MEETINGS

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

1.32 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 The Departmental Representative may issue a "stop work order" if non-compliance of health and safety regulations is not corrected immediately or within posted time. The General Contractor/subcontractors will be responsible for any costs arising from such a "stop work order".

END OF SECTION

Part 1

1.1 REFERENCES

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

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit Environmental Protection Plan (EPP) for review and approval by Departmental Representative within (14) calendar days of Award of Contract.
- .2 Environmental Protection Plan must include comprehensive overview of known or potential environmental issues to be addressed during construction.
- .3 Address topics at level of detail commensurate with environmental issue and required construction tasks.
- .4 Environmental Protection Plan must include:
 - .1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
 - .2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
 - .3 Names and qualifications of persons responsible for training site personnel.
 - .4 Descriptions of environmental protection personnel training program.
 - .5 Drawings indicating locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.
 - .6 **Sediment Control Plan (ESC)** identifying type and location of erosion and sediment controls provided. Plan to include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
 - .7 **Traffic Control Plans** including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather.
 - .1 Plans to include measures to minimize amount of material transported onto paved public roads by vehicles or runoff.
 - .8 **Work area plan** showing proposed activity in each portion of area and identifying areas of limited use or non-use.
 - .1 Plan to include measures for marking limits of use areas and methods for protection of features to be preserved within authorized work areas.
 - .9 **Spill Control Plan** to include procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.

- .10 **Non-Hazardous solid waste disposal plan** identifying methods and locations for solid waste disposal including clearing debris.
- .11 **Air pollution control plan** detailing provisions to assure that dust, debris, materials, and trash, are contained on project site.
- .12 **Contaminant Prevention Plan** identifying potentially hazardous substances to be used on job site; intended actions to prevent introduction of such materials into air, water, or ground; and detailing provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
- .13 **Waste Water Management Plan** identifying methods and procedures for management and discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.

1.3 FIRES

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

1.4 DRAINAGE

- .1 Provide temporary drainage and pumping required to keep excavations and site free from water.
- .2 Ensure pumped water into waterways or drainage systems is free of suspended materials.
- .3 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.5 SITE CLEARING AND PLANT PROTECTION

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

1.6 WORK ADJACENT TO WATERWAYS

- .1 Construction equipment to be operated on land only.
- .2 Use waterway beds for borrow material only after written receipt of approval from Departmental Representative.
- .3 Waterways to be kept free of excavated fill, waste material and debris.
- .4 Design and construct temporary crossings to minimize erosion to waterways.
- .5 Do not skid logs or construction materials across waterways.

- .6 Avoid indicated spawning beds when constructing temporary crossings of waterways.
- .7 Blasting is allowed only above water and 100 m minimum from indicated spawning beds.

1.7 POLLUTION CONTROL

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

1.8 NOTIFICATION

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

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 21 Construction/Demolition Waste Management and Disposal.
 - .1 Leave Work area clean at end of each day.
- .2 Ensure public waterways, storm and sanitary sewers remain free of waste and volatile materials disposal.
- .3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section. 01 74 21 Construction/Demolition Waste Management and Disposal.

- .4 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Section 01 33 00 - Submittal Procedures

1.2 INSPECTION

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

1.3 INDEPENDENT INSPECTION AGENCIES

- .1 Independent Inspection/Testing Agencies will be engaged and paid for by the Contractor for purpose of inspecting and testing portions of Work.
- .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 or testing, appointed agency will request additional inspection and testing to ascertain full degree of defect. Correct defect and irregularities as advised by Departmental Representative at no cost to Departmental Representative. Contractor to pay costs for retesting and re-inspection.

1.4 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.

1.5 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 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.

1.6 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.

1.7 REPORTS

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

1.8 TESTS AND MIX DESIGNS

- .1 Furnish geotechnical compaction and concrete cylinder test results and mix designs as indicated:
 - .1 Tests including, but not limited to, the following:
 - .1 Sieve analysis of sands and aggregates to be supplied
 - .2 Standard proctor density curves for backfill materials
 - .3 Standard proctor density curves for approved borrow materials
 - .4 Compaction control tests for backfill material including the following:
 - .1 Trench backfill - once per every 30m of trench at 1.0m vertical lifts.
 - .2 Granular base (curbs) - once per 50 lineal metres
 - .3 Granular base (sidewalks) - once per 50 lineal metres
 - .5 Concrete mix design and testing
 - .1 Concrete strength tests (minimum three specimen cylinders in accordance with CSA.A23.1) for the following:
 - .2 Curb and gutter - once per 150 lineal metres (minimum one per day during concrete placing)
 - .3 Sidewalk - once per 150 lineal metres (minimum one per day during concrete placing)
 - .6 Asphalt mix design and testing
 - .7 Asphalt tests for the following:
 - .1 Aggregate gradation tests - one per each 300 tonnes of production (minimum once per day during asphalt placement)
 - .2 Marshall test - three briquettes for every 300 tonnes of production (minimum once per day during asphalt placement)
 - .3 Compaction and thickness - six cores.

1.9 MOCK-UPS

- .1 Prepare mock-ups for Work specifically requested in specifications. Include for Work of Sections required to provide mock-ups.
- .2 Construct in locations acceptable to Departmental Representative.
- .3 Prepare mock-ups for Departmental Representative 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 Remove mock-up at conclusion of Work or when acceptable to Departmental Representative.
- .7 Mock-ups may remain as part of Work.
- .8 Specification section identifies whether mock-up may remain as part of Work or if it is to be removed and when.

1.10 MILL TESTS

- .1 Submit mill test certificates as requested.

1.11 EQUIPMENT AND SYSTEMS

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

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 SUBMITTALS

- .1 Submit temporary facilities plan for review and approval by Departmental Representative within fourteen (14) calendar days of Award of Contract. Plan to show temporary facilities, utility hookups, and staging areas, parking areas for construction personnel, avenues of ingress/egress to fenced areas and details of fence installation.
- .2 Submit Moisture Protection Plan for review and approval by Departmental Representative within twenty-one (21) calendar days of Award of Contract. Plan to describe procedures and controls for protecting materials and construction from water absorption and damage.
- .3 Submit construction site signage proof for review and approval by Departmental Representative within fourteen (14) calendar days of Award of Contract.

1.2 EXISTING SITE CONDITIONS AND ENVIRONMENTAL PROTECTION

- .1 The Contractor shall be held responsible for any damage caused to existing streets or services by construction equipment hauling material to the site. This shall include daily cleaning or sweeping all existing roads or dirt and debris caused by construction activity.
- .2 All work areas, roadways, and site accesses to be restored to as-found or better condition once work is complete.
- .3 Mats or tracked equipment fitted with rubber pads are to be used when operating tracked equipment on all paved areas, with the exception of areas stipulated for re-pavement.

1.3 TEMPORARY HOARDING

- .1 Contractor to provide temporary hoarding as required to secure open excavations and the building site.
- .2 Hoarding to be 2.4m high interlocking steel fence, secured at all corners and ends.
- .3 Secure hoarding as needed to withstand seasonal weather events. Monitor and make good any deficiencies, as needed.

1.4 ACCESS AND DELIVERY

- .1 CCG MCTS Building, ER Building, Helipad and Remote Transmitter Site are 24/7 response facilities used by CCG and partner agencies. Access to these facilities is to be maintained at all times.
- .2 Only the designated entrance off of Coast Guard Road may be used for access to the facility.
 - .1 Maintain for duration of Contract.
 - .2 Make good damage resulting from Contractor's use.

- .3 All contractors are required to use only the designated entrance.
- .4 Any other use of the facility will be granted to the Contractor through the Departmental Representative.
- .5 Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.
- .6 Flares and Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.
- .7 Haul Routes:
 - .1 Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.
 - .2 Confine construction traffic to designated haul routes.
 - .3 Provide traffic control at critical areas of haul routes to regulate traffic, to minimize interference with public traffic.
- .8 Traffic Signs and Signals:
 - .1 Provide signs approaches to site and on site, at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.
 - .2 Provide, operate, and maintain traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control, and areas affected by Contractor's operations.
 - .3 Relocate as Work progresses, to maintain effective traffic control.

1.5 CONTRACTOR LAYDOWN AREA

- .1 The Contractor may use the area specified in the construction documents for a laydown area including equipment and material storage, site offices, first aid facilities, washrooms and or other required site facilities.
- .2 The existing ground surface is to be protected and restored to as-found or better condition once construction is complete.
- .3 Fencing, signage and security are to be provided by the Contractor. Any vandalism is to be removed or repaired within 24-hours.
- .4 The Contractor is responsible for any theft or incidental damage in the laydown area.

1.6 CONSTRUCTION PARKING

- .1 Parking will be permitted within designated Contractor laydown area provided it does not disrupt performance of Work.

- .2 Parking is not permitted along Coast Guard Road or within District of Ucluelet Wild Pacific Trails parking lot.
- .3 Limited parking of up to four stalls for Contractor may be permitted in stalls located in MCTS parking lot as designated by Departmental Representative.
- .4 Provide and maintain adequate access to project site at all times.

1.7 FIRE PROTECTION

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

1.8 TEMPORARY POWER

- .1 Provide and pay for temporary power during construction for temporary lighting and operating of power tools.
- .2 Arrange for connection with appropriate utility company. Pay all costs for installation, maintenance and removal.
- .3 Temporary power for electric cranes and other equipment requiring in excess of above is responsibility of Contractor.
- .4 Provide and maintain temporary lighting throughout project. Electrical power and lighting systems installed under this Contract may be used for construction requirements only with prior approval of Departmental Representative provided that guarantees are not affected. Make good damage to electrical system caused by use under this Contract.

1.9 TEMPORARY HEATING AND VENTILATION

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

- .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
- .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
- .4 Ventilate storage spaces containing hazardous or volatile materials.
- .5 Ventilate temporary sanitary facilities.
- .6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.
- .6 Permanent heating system of building, will not be used when available. Be responsible for damage to heating system if use is permitted.
- .7 On completion of Work for which permanent heating system is used, restore to "new" condition.
- .8 Pay costs for maintaining temporary heat, when using permanent heating system.
- .9 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.
- .10 Be responsible for damage to Work due to failure in providing adequate heat and protection during construction.

1.10 WATER SUPPLY

- .1 Temporary water supply connection is not available at the site. Contractor to arrange for temporary water supply needed for personal or construction use as required. Where temporarily connected to a pressurized water supply, the Contractor shall furnish a certified testable backflow preventer, all necessary pipe and hose extensions to conduct the water to the points of use, and shall exercise due care not to waste water.

1.11 SANITARY FACILITIES

- .1 No washroom facilities are available on construction site. Contractor to provide sanitary facilities for work force in accordance with governing regulations and ordinances.
- .2 The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use; and shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of the CCG, or on adjacent property.
- .3 Use of District of Ucluelet washroom facilities located on Wild Pacific Trail and Amphitrite Point Lighthouse trail by construction work force not permitted.

1.12 SCAFFOLDING

- .1 Scaffolding in accordance with CSA Z797 and CAN/CSA S269.2.

- .2 Provide and maintain scaffolding, ramps, ladders, swing staging, platforms and temporary stairs as required. Remove promptly when no longer required.

1.13 HOISTING

- .1 Provide, operate and maintain hoists/cranes required for moving of workers, materials and equipment.
- .2 Hoists/cranes shall be operated by qualified operator.

1.14 SPILL PROTECTION

- .1 Provide onsite spill kit.
- .2 Kit shall include:
 - .1 45 Gallon plastic drum.
 - .2 100 Sorbent pads of 15" X 19" X 12 oz.
 - .3 5 Sorbent socks 3" X 48".
 - .4 2 Sorbent booms 5" X 10'.
 - .5 1 Epoxy stick.
 - .6 3 Disposal bags 40" X 60" x 6mil.
 - .7 2 pairs of nitrile gloves.
- .3 Spill kits must be maintained on site at all times. Personnel must be familiar with spill recovery equipment and its use.

1.15 CONSTRUCTION SIGNAGE

- .1 Provide and erect project sign, within (21) calendar days of Award of Contract, in a location designated by Departmental Representative to the following:
 - .1 Construction sign 1.2m x 2.4m, of wood frame and plywood construction.
 - .2 Project sign shall be in both official languages.
 - .3 Painted with exhibited lettering as approved by Departmental Representative and produced by a professional sign painter.
- .2 No other signs or advertisements, other than warning signs, are permitted on site.

1.16 SIGNS AND NOTICES

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

1.17 USE CHARGES

- .1 General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use

temporary services and facilities without cost, including, but not limited to Departmental Representative, testing agencies, and authorities having jurisdiction.

1.18 REMOVAL OF TEMPORARY FACILITIES

- .1 Remove temporary facilities from site upon completion of Work.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Within text of each specifications section, reference may be made to reference standards.
 - .1 Conform to these reference standards, in whole or in part as specifically requested in specifications.
 - .2 Unless otherwise noted, all references to codes, standards and standard specifications referred to in these Specifications or used on drawings shall mean and intend to be the currently adopted edition, amendment and revision of such reference standards in effect at the time of Bid closing.
- .2 If there is question as to whether products or systems are in conformance with applicable standards, Departmental Representative reserves right to have such products or systems tested to prove or disprove conformance.
- .3 Cost for such testing will be 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, Departmental

Representative reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

1.4 STORAGE, HANDLING AND PROTECTION

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

1.5 TRANSPORTATION

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

1.6 MANUFACTURER'S INSTRUCTIONS

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

1.7 QUALITY OF WORK

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

Departmental Representative if required Work is such as to make it impractical to produce required results.

- .2 Do not employ anyone unskilled in their required duties. Departmental Representative reserves right to require dismissal from site, workers deemed incompetent or careless.
- .3 Decisions as to standard or fitness of Quality of Work in cases of dispute rest solely with Departmental Representative, whose decision is final.

1.8 CO-ORDINATION

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

1.9 REMEDIAL WORK

- .1 Refer to Section 01 73 00 - Execution Requirements.
- .2 Perform remedial work required to repair or replace parts or portions of Work identified as defective or unacceptable. Co-ordinate adjacent affected Work as required.
- .3 Perform remedial work by specialists familiar with materials affected. Perform in a manner to neither damage nor put at risk any portion of Work.

1.10 LOCATION OF FIXTURES

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

1.11 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.

1.12 FASTENINGS - EQUIPMENT

- .1 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.

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

1.13 PROTECTION OF WORK IN PROGRESS

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

1.14 EXISTING UTILITIES

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

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

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

1.2 MATERIALS

- .1 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 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 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .6 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval.
- .7 Restore work with new products in accordance with requirements of Contract Documents.
- .8 Fit Work to pipes, sleeves, ducts, conduit, and other penetrations through surface.
- .9 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing the entire unit.

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.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 NOT USED

END OF SECTION

Part 1 General

1.1 PROJECT CLEANLINESS

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by Owner or other Contractors.
- .2 Remove waste materials from site at daily regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.
- .3 Clear snow and ice from access to the site, bank/pile snow in designated areas only or remove from site.
- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Provide on-site containers for collection of waste materials and debris.
- .6 Provide and use marked separate bins for recycling. Refer to Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .7 Dispose of waste materials and debris off site in accordance with applicable regulations.
- .8 Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .9 Provide adequate ventilation during use of volatile or noxious substances.
- .10 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .11 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

1.2 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
- .2 Remove waste products and debris other than that caused by others, and leave Work clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery and equipment.
- .4 Remove waste materials from site at regularly scheduled times or dispose of as directed by Departmental Representative. Do not burn waste materials on site, unless approved by Departmental Representative.
- .5 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .6 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
- .7 Remove dirt and other disfiguration from exterior surfaces.
- .8 Sweep and wash clean paved areas.
- .9 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.

1.3 WASTE MANAGEMENT AND DISPOSAL

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

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 Clean Waste: Untreated and unpainted; not contaminated with oils, solvents, sealants or similar materials.
- .2 Construction and Demolition Waste: Solid wastes typically including but not limited to, building materials, packaging, trash, debris, and rubble resulting from construction, re-modelling, repair and demolition operations.
- .3 Hazardous: Exhibiting the characteristics of hazardous substances including, but not limited to, ignitability, corrosiveness, toxicity or reactivity.
- .4 Non-hazardous: Exhibiting none of the characteristics of hazardous substances, including, but not limited to, ignitability, corrosiveness, toxicity, or reactivity.
- .5 Non-toxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.
- .6 Recyclable: The ability of a product or material to be recovered at the end of its life cycle and re-manufactured into a new product for reuse by others.
- .7 Recycle: To remove a waste material from the Project site to another site for re-manufacture into a new product for reuse by others.
- .8 Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.
- .9 Return: To give back reusable items or unused products to vendors for credit.
- .10 Reuse: To reuse a construction waste material in some manner on the Project site.
- .11 Salvage: To remove a waste material from the Project site to another site for resale or reuse by others.
- .12 Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.
- .13 Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.
- .14 Toxic: Poisonous to humans either immediately or after a long period of exposure.
- .15 Trash: Any product or material unable to be reused, returned, recycled, or salvaged.
- .16 Volatile Organic Compounds (VOC): Chemical compounds common in and emitted by many building products over time through outgassing:
 - .1 Solvents in paints and other coatings,
 - .2 Wood preservatives; strippers and household cleaners,
 - .3 Adhesives in particle board, fibreboard, and some plywood; and foam insulation,
 - .4 When released, VOC's can contribute to the formation of smog and can cause respiratory tract problems, headaches, eye irritations, nausea, damage to the liver, kidneys, and central nervous system, and possibly cancer.

- .17 Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.2 WASTE MANAGEMENT GOALS

- .1 Owner has established that this Project shall generate the least amount of waste possible and that processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors shall be employed. The owners goal is to divert 75% of waste materials from the landfill.
- .2 Owner recognizes that waste in any project is inevitable, but indicates that as much of the waste materials as economically feasible shall be reused, salvaged, or recycled.
- .3 Waste disposal in landfills shall be minimized.

1.3 MATERIAL SOURCE SEPARATION PLAN

- .1 Before project start-up, prepare Materials Source Separation Program. Provide separate containers for re-usable and/or recyclable materials of following:
 - .1 Construction waste: including but not limited to following types.
 - .1 Uncontaminated packaging (wood, metal banding, cardboard, paper, plastic wrappings, polystyrene).
 - .2 Wood pallets (recycle or return to shipper).
 - .3 Batt insulation.
 - .4 Metals (pipe, conduit, ducting, wiring, miscellaneous cuttings)
 - .5 Wood (uncontaminated).
 - .6 Gypsum board (uncontaminated).
 - .7 Paint, solvent, oil.
 - .8 Other materials as indicated in technical sections.
 - .2 Administration/worker waste (uncontaminated): including but not limited to following types:
 - .1 Paper, cardboard.
 - .2 Plastic containers and lids marked types 1 through 6.
 - .3 Glass and aluminum drink containers (recycle or return to vendor).
- .2 Implement MSSP for waste generated on project in compliance with approved methods and as approved by Departmental Representative.
- .3 Locate containers in locations, to facilitate deposit of materials without hindering daily operations and as directed by Departmental Representative.
- .4 Locate separated materials in areas which minimize material damage.

1.4 STORAGE, HANDLING AND PROTECTION

- .1 Store, materials to be reused, recycled and salvaged in locations as directed by Departmental Representative.
- .2 Unless specified otherwise, materials for removal becomes Contractor's property.

- .3 All materials for recycling must be source separated into separate bins to be accepted by the local processing authority.
- .4 Separate non-salvageable materials from salvaged items. Transport and deliver non-salvageable items to licensed disposal facility.
- .5 Protect surface drainage, storm sewers, sanitary sewers, and utility services from damage and blockage.

1.5 PREPARATION

- .1 Handle waste materials not reused, salvaged, or recycled in accordance with appropriate regulations and codes.

1.6 USE OF SITE AND FACILITIES

- .1 Execute work with least possible interference or disturbance to normal use of premises.

1.7 WASTE MANAGEMENT IMPLEMENTATION

- .1 Manager: Contractor to designate an on-site party responsible for instructing workers and overseeing the results of the Waste Management Plan for the Project.
- .2 Instruction: Contractor shall provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the Project.
- .3 Separation facilities: Contractor shall lay out and label a specific area to facilitate separation of materials for potential recycling, salvage, reuse, and return. Recycling and waste bin areas are to be kept neat and clean and clearly marked in order to avoid contamination of materials.
- .4 Hazardous wastes: Hazardous wastes shall be separated, stored, and disposed of according to local regulations.

1.8 DISPOSAL OF WASTE

- .1 Burying of rubbish and waste materials is prohibited.
- .2 Burning of rubbish and waste materials is prohibited.
- .3 Disposal of waste into waterways, storm, or sanitary sewers is prohibited.

1.9 CLEANING

- .1 Remove tools and waste materials on completion of work, and leave work area in clean and orderly condition.
- .2 Clean-up work area as work progresses.
- .3 Source separate materials to be reused/recycled into specified sort areas.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 – Closeout Submittals

1.2 ADMINISTRATIVE REQUIREMENTS

- .1 Acceptance of Work Procedures:
 - .1 Contractor's Inspection: Contractor: conduct inspection of Work, identify deficiencies and defects, and repair as required to conform to Contract Documents.
 - .2 Notify Departmental Representative in writing of satisfactory completion of Contractor's inspection and submit verification that corrections have been made.
 - .3 Request Departmental Representative inspection.
 - .4 Departmental Representative Inspection: Departmental Representative and Contractor to inspect Work and identify defects and deficiencies.
 - .5 .2 Contractor to correct Work as directed.
 - .6 Completion Tasks: submit written certificates that tasks have been performed as follows:
 - .1 Work: completed and inspected for compliance with Contract Documents.
 - .2 Defects: corrected and deficiencies completed.
 - .3 Equipment and systems: tested, adjusted and balanced and fully operational.
 - .4 Certificates required by authorities having jurisdiction: submitted.
 - .5 Operation of systems: demonstrated to Owner's personnel.

1.3 FINAL CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Remove surplus materials, excess materials, rubbish, tools and equipment.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 SUBMISSION

- .1 Prepare instructions and data using personnel experienced in maintenance and operation of described products.
- .2 Copy will be returned after final inspection, with Departmental Representative's comments .
- .3 Revise content of documents as required prior to final submittal.
- .4 Two weeks prior to Substantial Completion of the Work, submit to the Departmental Representative, four final copies of operating and maintenance manuals in English.
- .5 An electronic copy Interactive Operating and Maintenance Manual System is required as specified under clause 1.3. Provide a USB drive or DVD the Electronic Interactive Operating and Maintenance Manual System to the Departmental Representative.
- .6 Hard copies of the Operating and Maintenance Manual System is required as specified under clause 1.3. Provide 4 sets of the Hard Copy Operating and Maintenance Manual to Departmental Representative.
- .7 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of same quality and manufacture as products provided in Work .
- .8 If requested, furnish evidence as to type, source and quality of products provided.
- .9 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.
- .10 Pay costs of transportation.

1.2 OPERATING AND MAINTENANCE MANUAL SYSTEM

- .1 In addition to the printed copies, submit provide an Operating and Maintenance Manual System as specified herein.
- .2 System Description and Requirements
 - .1 All as constructed drawings and operation and maintenance (O&M) manuals listed under the Scope of Work shall be converted, where necessary, into Portable Data File (PDF) format for viewing using the Adobe Acrobat Reader.
- .3 O&M data and as constructed drawings shall be classified by their corresponding disciplines, including:
 - .1 Architectural
 - .2 Mechanical
 - .3 Electrical
 - .4 Under each discipline, data shall be grouped into the following four major categories:
 - .5 Basic Documents
 - .1 Basic Documents' shall, according to the type of services or disciplines, include the full contents of each hard copy of the O&M manuals with the

addition of Miscellaneous Maintenance Reports and Records, or as defined by the user. In general the following shall be included unless specifically excluded by the Departmental Representative:

- .1 Introduction
 - .2 Consultant/Contractor/Suppliers List
 - .3 System Description
 - .4 Maintenance and Lubrication Schedules
 - .5 Testing and Commissioning (T&C) Reports
 - .6 Misc. Reports
 - .7 Specifications
 - .8 Equipment and/or point schedules as identified in the hard copy documents
 - .9 Others as stipulated by the Departmental Representative
- .2 All Basic Documents .pdf files shall be enhanced with appropriate bookmarks to facilitate searching of information within the document or linking to other relevant documents for references.
- .4 'As-Constructed' Drawings
 - .1 'As-Constructed' drawings shall be red-mark hardcopy sets and 'As-Constructed' drawings shall be scanned a resolution minimum of 300 dpi and saved in .pdf format. Sprinkler layout 'As-Constructed' shop drawings shall be provided in both .dwg and .pdf formats .
- .5 System Data
 - .1 Building systems shall be identified by their services, disciplines, function, nature and specific scope. System data shall be classified into the following categories:
 - .1 System Description
 - .2 Schematic (where applicable)
 - .3 Equipment List
 - .2 Provide hot key buttons, where applicable, for direct access to drawings/data referenced on the schematics. The same shall be applied to listed equipment for direct links to the corresponding equipment data.
- .6 Equipment Data
 - .1 Equipment data shall be classified into the following categories:
 - .1 Equipment submittals
 - .2 T&C Report
 - .3 Maintenance Data
 - .4 Maintenance Records
 - .5 Photo
 - .2 Provide a summary screen to list all equipment classified under a specific system. On the summary screen, provide direct links to the corresponding equipment data under each category with addition links to the relevant 'As Constructed' drawings.

- .7 The system shall be executed by Professional Engineers with a minimum of 10 years post qualification experience in the field of Building Services Engineering.
- .8 The Contractor shall provide a minimum of 3 past job references as proven record of similar undertakings.

1.3 FORMAT HARD COPY MANUALS

- .1 Organize data in the form of an instructional manual.
- .2 Binders: vinyl, hard covered, 3 'D' ring, loose leaf 219 x 279 mm with spine and face pockets.
- .3 When multiple binders are used, correlate data into related consistent groupings. Identify contents of each binder on spine.
- .4 Cover: Identify each binder with type or printed title 'Project Record Documents'; list title of project and identify subject matter of contents .
- .5 Arrange content by Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 Text: Manufacturer's printed data, or typewritten data.
- .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to. size of text pages.
- .9 Provide 1:1 scaled CAD files in .dwg format on CD.

1.4 CONTENTS - EACH VOLUME

- .1 Table of Contents: provide title of project;
 - .1 date of submission;
 - .2 names, addresses, and telephone and fax numbers of Contractor, Subcontractors,
 - .3 Suppliers with name of responsible parties;
 - .4 schedule of products and systems, indexed to content of volume.
 - .5 copy of hardware schedule and paint schedules, complete with the actual manufacturer, supplier and identification names and numbers.
 - .6 all extended guarantees, warranties, maintenance bonds, certificates, letters of guarantees, registration cards, as called for in the various sections of the specification.
 - .7 complete set of all final reviewed shop drawings.
 - .8 certificates of inspection by authorities having jurisdiction.
 - .9 test reports and certificates as applicable.
 - .10 complete set of as constructed drawings.
- .2 For each product or system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.

- .3 Product Data: mark each sheet to clearly identify specific products and component parts, and data applicable to installation; delete inapplicable information.
- .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
- .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in Section 01 45 00 - Quality Control.

1.5 'AS CONSTRUCTED' DRAWINGS AND SAMPLES

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

1.6 RECORDING ACTUAL SITE CONDITIONS

- .1 Record information on set of black line opaque drawings, provided by Departmental Representative.
- .2 Provide felt tip marking pens, maintaining separate colours for each major system, for recording information .
- .3 Record information concurrently with construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and shop drawings: legibly mark each item to record actual construction, including:
 - .1 Measured depths of elements of foundation in relation to finish first floor datum.

- .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements .
- .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction .
- .4 Field changes of dimension and detail.
- .5 Changes made by change orders.
- .6 Details not on original Contract Drawings.
- .7 References to related shop drawings and modifications .
- .5 Specifications: legibly mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed, particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain manufacturer's certifications, inspection certifications, field test records, required by individual specifications sections.

1.7 EQUIPMENT AND SYSTEMS

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

- .14 Include test and balancing reports as specified in Section 01 45 00 - Quality Control and Division 22 to 25.
- .15 Additional requirements: As specified in individual specification sections.

1.8 MATERIALS AND FINISHES

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

1.9 SPARE PARTS

- .1 Provide spare parts, in quantities specified in individual specification sections .
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in Maintenance Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.10 MAINTENANCE MATERIALS

- .1 Provide maintenance and extra materials, in quantities specified in individual specification sections.
- .2 Provide items of same manufacture and quality as items in Work.
- .3 Deliver to location as directed; place and store.
- .4 Receive and catalogue all items. Submit inventory listing to Departmental Representative. Include approved listings in the Operating and Maintenance Manuals.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.11 STORAGE, HANDLING AND PROTECTION

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration .
- .2 Store in original and undamaged condition with manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures .
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Departmental Representative.

1.12 WARRANTIES AND BONDS

- .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
- .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
- .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers within ten days after completion of the applicable item of work .
- .4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined .
- .5 Verify that documents are in proper form, contain full information, and are notarized.
- .6 Co-execute submittals when required.
- .7 Retain warranties and bonds until time specified for submittal.

1.13 COMPLETION

- .1 Submit a written certificate that the following have been performed:
 - .1 Work has been completed and inspected for compliance with the Contract documents.
 - .2 Defects have been corrected and deficiencies have been completed.
 - .3 Equipment and systems have been tested, adjusted and balanced, and are fully operational.
 - .4 Certificates required by the utility companies have been submitted.
 - .5 Operation of systems has been demonstrated to the personnel indicated by the Departmental Representative.
 - .6 Work is complete and ready for final inspection.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 General requirements relating to commissioning of project's components and systems, specifying general requirements to PV of components, equipment, sub-systems, systems, and integrated systems.
- .2 Acronyms:
 - .1 Cx - Commissioning.
 - .2 EMCS - Energy Monitoring and Control Systems.
 - .3 O M - Operation and Maintenance.
 - .4 PI - Product Information.
 - .5 PV - Performance Verification.
 - .6 TAB - Testing, Adjusting and Balancing.

1.2 GENERAL

- .1 Cx is a planned program of tests, procedures and checks carried out systematically on systems and integrated systems of the finished Project. Cx is performed after systems and integrated systems are completely installed, functional and Contractor's Performance Verification responsibilities have been completed and approved. Objectives:
 - .1 Verify installed equipment, systems, assemblies and integrated systems operate in accordance with contract documents and design criteria and intent.
 - .2 Ensure appropriate documentation is compiled into the Systems Manual.
 - .3 Effectively train O M staff.
- .2 Contractor assists in Cx process, operating equipment and systems, troubleshooting and making adjustments as required.
 - .1 Systems to be operated at full capacity under various modes to determine if they function correctly and consistently at peak efficiency. Systems to be tested interactively with each other as intended in accordance with Contract Documents and design criteria.
 - .2 During these checks, adjustments to be made to enhance performance to meet environmental or user requirements.
- .3 Design Criteria: as per client's requirements or determined by designer. To meet Project functional and operational requirements.

1.3 COMMISSIONING OVERVIEW

- .1 For Cx responsibilities refer to Section 01 91 31 - Commissioning (Cx) Plan.
- .2 Cx activities supplement field quality and testing procedures described in relevant technical sections.

- .3 Cx is conducted in concert with activities performed during each stage of project delivery.
- .4 Cx identifies issues in Planning and Design stages which are addressed during Construction and Cx stages to ensure the built facility is constructed and proven to operate satisfactorily under operational loading, weather, environmental and occupancy conditions to meet functional and operational requirements. Cx activities includes transfer of critical knowledge to facility operational personnel.
- .5 Departmental Representative will issue Interim Acceptance Certificate when:
 - .1 Completed Cx documentation has been received, reviewed for suitability and approved by Departmental Representative.
 - .2 Equipment, components and systems have been commissioned.
 - .3 O M training has been completed.

1.4 NON-CONFORMANCE TO PERFORMANCE VERIFICATION REQUIREMENTS

- .1 Should equipment, system components, and associated controls be incorrectly installed or malfunction during Cx, correct deficiencies, re-verify equipment and components within the unfunctional system, including related systems as deemed required by Departmental Representative, to ensure effective performance.
- .2 Costs for corrective work, additional tests, inspections, to determine acceptability and proper performance of such items to be borne by Contractor. Above costs to be in form of progress payment reductions or hold-back assessments.

1.5 PRE-CX REVIEW

- .1 Before Construction:
 - .1 Review Contract Documents, confirm in writing to Departmental Representative.
 - .1 Adequacy of provisions for Cx.
 - .2 Aspects of design and installation pertinent to success of Cx.
- .2 During Construction:
 - .1 Co-ordinate provision, location and installation of provisions for Cx.
- .3 Before start of Cx:
 - .1 Have completed Cx Plan up-to-date.
 - .2 Ensure installation of related components, equipment, sub-systems and systems is complete.
 - .3 Fully understand Cx requirements and procedures.
 - .4 Have Cx documentation shelf-ready.
 - .5 Understand completely design criteria and intent and special features.
 - .6 Submit complete start-up documentation to Departmental Representative.
 - .7 Have Cx schedules up-to-date.
 - .8 Ensure systems have been cleaned thoroughly.

- .9 Complete TAB procedures on systems, submit TAB reports to Departmental Representative for review and approval.
- .10 Ensure "As-Built" system schematics are available.
- .4 Inform Departmental Representative in writing of discrepancies and deficiencies on finished works.

1.6 CONFLICTS

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

1.7 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit no later than (28) calendar days after Award of Contract:
 - .1 Name of Contractor's Cx agent.
 - .2 Draft Cx documentation.
 - .3 Preliminary Cx schedule.
 - .2 Request in writing to the Departmental Representative for changes to submittals and obtain written approval at least (8) weeks prior to start of Cx.
 - .3 Submit proposed Cx procedures to the Departmental Representative where not detailed in the sections listed in paragraph 1.1 and obtain written approval at least (8) weeks prior to start of Cx.
 - .4 Provide additional documentation relating to Cx process required by the Departmental Representative.

1.8 COMMISSIONING DOCUMENTATION

- .1 Refer to Section 01 91 33 - Commissioning (Cx) Forms: Installation Check Lists and Product Information (PI) / Performance Verification (PV) Forms for requirements and instructions for use.
- .2 Departmental Representative to review and approve Cx documentation.
- .3 Provide completed and approved Cx documentation to the Departmental Representative.

1.9 COMMISSIONING SCHEDULE

- .1 Provide detailed Cx schedule as part of construction schedule in accordance with Section 01 32 16 - Construction Progress Schedule.
- .2 Provide adequate time for Cx activities prescribed in technical sections and commissioning sections including:
 - .1 Approval of Cx reports.
 - .2 Verification of reported results.
 - .3 Repairs, retesting, re-commissioning, re-verification.

.4 Training.

1.10 COMMISSIONING MEETINGS

- .1 Preconstruction Commissioning Conference: Departmental Representative will schedule a preconstruction commissioning conference with the Commissioning Team before installation of assemblies, systems and components to be commissioned, but no later than 30 days after execution of the Agreement with the Contractor. Allow for the conference to be held at Project site or another convenient location. The Departmental Representative will conduct the meeting to review commissioning responsibilities and personnel assignments.
 - .1 Agenda: Discuss items of significance that could affect progress, including the following:
 - .1 Commissioning plan
 - .2 Tentative construction schedule.
 - .3 Phasing.
 - .4 Critical work sequencing and long-lead items.
 - .5 Designation of key personnel and their duties.
 - .6 Procedures for testing and inspecting.
 - .7 Submittal procedures.
 - .8 Preparation of Record Documents.
 - .9 Owner's occupancy requirements.
 - .10 Security.
 - .2 Minutes: Departmental Representative will record and distribute meeting minutes.
- .2 Convene Cx meetings following project meetings in accordance with 01 32 16 - Construction Progress Schedule, and as specified herein.
- .3 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to Cx.
- .4 Continue Cx meetings on regular basis until commissioning deliverables have been addressed.
- .5 At 60% construction completion stage, and in accordance with the 01 32 16 - Construction Progress Schedule, the Departmental Representative shall call a separate Cx scope meeting to review progress, discuss schedule of equipment start-up activities and prepare for Cx. Issues at meeting to include:
 - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
 - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .6 Thereafter Cx meetings to be held until project completion and as required during equipment start-up and functional testing period.
- .7 Meeting will be chaired by the Departmental Representative, who will record and distribute minutes.

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

1.11 STARTING AND TESTING

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

1.12 WITNESSING OF STARTING AND TESTING

- .1 Provide (14) calendar days' notice prior to commencement.
- .2 Start Cx after elements of building affecting start-up and performance verification of systems have been completed.
- .3 Contractor's Cx Agent to be present at tests performed and documented by sub-trades, suppliers and equipment manufacturers, unless noted in the Commissioning Plan.
- .4 The Departmental Representative shall witness selected testing.

1.13 MANUFACTURER'S INVOLVEMENT

- .1 Factory testing: manufacturer to:
 - .1 Coordinate time and location of testing.
 - .2 Provide testing documentation for approval by the Design Consultants and the Departmental Representative.
 - .3 Arrange for Design Consultants to witness tests, where appropriate.
 - .4 Obtain written approval of test results and documentation from the Design Consultants before delivery to site.
- .2 Obtain manufacturers installation, start-up and operations instructions prior to start-up of components, equipment and systems and review with Commissioning Agent and Departmental Representative.
 - .1 Compare completed installation with manufacturer's published data, record discrepancies, and review with manufacturer.
 - .2 Modify procedures detrimental to equipment performance and review same with manufacturer before start-up.
- .3 Integrity of warranties:
 - .1 Use manufacturer's trained start-up personnel where specified elsewhere in other divisions or required to maintain integrity of warranty.
 - .2 Verify with manufacturer that testing as specified will not void warranties.
- .4 Qualifications of manufacturer's representative:
 - .1 Experienced in design, installation and operation of equipment and systems.
 - .2 Ability to interpret test results accurately.
 - .3 To report results in clear, concise, logical manner.

1.14 PROCEDURES

- .1 Verify that equipment and systems are complete, clean, and operating in normal and safe manner prior to conducting start-up, testing and Cx.
- .2 Conduct start-up and testing in following distinct phases:
 - .1 Included in delivery and installation:
 - .1 Verification of conformity to specification, approved shop drawings and completion of PI report forms.
 - .2 Visual inspection of quality of installation.
 - .2 Start-up: follow accepted start-up procedures.
 - .3 Operational testing: document equipment performance.
 - .4 System PV: include repetition of tests after correcting deficiencies.
 - .5 Post-substantial performance verification: to include fine-tuning.
- .3 Correct deficiencies and obtain approval from Departmental Representative after distinct phases have been completed and before commencing next phase.
- .4 Document require tests on approved PV forms.
- .5 Failure to follow accepted start-up procedures will result in re-evaluation of equipment by an independent testing agency selected by Departmental Representative. If results reveal that equipment start-up was not in accordance with requirements, and resulted in damage to equipment, implement following:
 - .1 Minor equipment/systems: implement corrective measures approved by Departmental Representative and Design Consultants.
 - .2 Major equipment/systems: if evaluation report concludes that damage is minor, implement corrective measures approved by Departmental Representative Design Consultants.
 - .3 If evaluation report concludes that major damage has occurred, Design Consultants shall reject equipment.
 - .1 Rejected equipment to be remove from site and replace with new.
 - .2 Subject new equipment/systems to specified start-up procedures.

1.15 START-UP DOCUMENTATION

- .1 Assemble start-up documentation and submit to Departmental Representative for approval before commencement of commissioning.
- .2 Start-up documentation to include:
 - .1 Factory and on-site test certificates for specified equipment.
 - .2 Pre-start-up inspection reports.
 - .3 Signed installation/start-up check lists.
 - .4 Start-up reports,
 - .5 Step-by-step description of complete start-up procedures, to permit Commissioning Agent to repeat start-up at any time.

1.16 OPERATION AND MAINTENANCE OF EQUIPMENT AND SYSTEMS

- .1 After start-up, operate and maintain equipment and systems as directed by equipment/system manufacturer.
- .2 With assistance of manufacturer develop written maintenance program and submit to Departmental Representative for approval before implementation.
- .3 Operate and maintain systems for length of time required for commissioning to be completed.
- .4 After completion of commissioning, operate and maintain systems until issuance of certificate of interim acceptance.

1.17 TEST RESULTS

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

1.18 INSTRUMENTS / EQUIPMENT

- .1 Submit to Departmental Representative for review and approval:
 - .1 Complete list of instruments proposed to be used.
 - .2 Listed data including, serial number, current calibration certificate, calibration date, calibration expiry date and calibration accuracy.
- .2 Provide the following equipment as required:
 - .1 Ladders.
 - .2 Equipment as required to complete work.

1.19 COMMISSIONING PERFORMANCE VERIFICATION

- .1 Carry out Cx:
 - .1 Under actual operating conditions, over entire operating range, in all modes.
 - .2 Simulated conditions will be accepted if operating loads are not available or weather conditions do not permit. Obtain approval of simulated testing conditions from the Departmental Representative before testing under simulated loads.
 - .3 On independent systems and interacting systems.
- .2 Cx procedures to be repeatable and reported results are to be verifiable.
- .3 Follow equipment manufacturer's operating instructions.
- .4 EMCS trending to be available as supporting documentation for performance verification.

1.20 AUTHORITIES HAVING JURISDICTION

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

1.21 EXTRAPOLATION OF RESULTS

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

1.22 EXTENT OF VERIFICATION

- .1 Provide manpower and instrumentation to verify up to 30% of reported results, unless specified otherwise in other sections.
- .2 Number and location to be at discretion of Departmental Representative.
- .3 Conduct tests repeated during verification under same conditions as original tests, using same test equipment, instrumentation.
- .4 Review and repeat commissioning of systems if inconsistencies found in more than 20% of reported results.
- .5 Perform additional commissioning until results are acceptable to Departmental Representative.

1.23 REPEAT VERIFICATIONS

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

1.24 SUNDRY CHECKS AND ADJUSTMENTS

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

1.25 DEFICIENCIES, FAULTS, DEFECTS

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

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

1.26 COMPLETION OF COMMISSIONING

- .1 Upon completion of Cx leave systems in normal operating mode.
- .2 Except for warranty and seasonal verification activities specified in Cx specifications, complete Cx prior to issuance of Interim Certificate of Completion.
- .3 Cx to be considered complete when contract Cx deliverables have been submitted and accepted by Departmental Representative.

1.27 ACTIVITIES UPON COMPLETION OF COMMISSIONING

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

1.28 MAINTENANCE MATERIALS, SPARE PARTS, SPECIAL TOOLS

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

1.29 OCCUPANCY

- .1 Cooperate fully with Facility Manager during stages of acceptance and occupancy of facility.

1.30 INSTALLED INSTRUMENTATION

- .1 Use instruments installed under Contract for TAB and PV if:
 - .1 Accuracy complies with these specifications.
 - .2 Calibration certificates have been submitted to the Departmental Representative. Calibrated EMCS sensors may be used to obtain performance data provided that sensor calibration has been completed and accepted.

1.31 PERFORMANCE VERIFICATION TOLERANCES

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

1.32 OWNER'S PERFORMANCE TESTING

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

END OF SECTION

Part 1 General

1.1 PURPOSE

- .1 This Commissioning Plan describes the methodology to be used for commissioning of the Canadian Coast Guard Amphitrite Point Equipment Building systems. The commissioning process is the systematic method of documenting:
 - .1 Verifying that Owner's design requirements have been met.
 - .2 Verifying the physical installation of the system,
 - .3 The results of a defined start-up procedure for equipment,
 - .4 Verifying the performance of the entire system, and
 - .5 Demonstration to and training of building operations staff on both the equipment and the integrated system.
- .2 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, Operations and Maintenance personnel have been fully trained in aspects of installed systems.
 - .3 Complete documentation relating to installed equipment and systems.
- .3 This Commissioning Plan is to be used as master planning document for Commissioning:
 - .1 Outlines organization, scheduling and allocation of resources pertaining to the implementation of Commissioning.
 - .2 Communicates roles, responsibilities, expectations and deliverables of team members involved in Commissioning.
 - .3 Communicates the scope and standards, verification procedures and documentation requirements for Commissioning.

1.2 COMMISSIONING PLAN DEVELOPMENT

- .1 The Commissioning Plan is a dynamic document, and will be updated during project construction to take into account:
 - .1 Approved shop drawings and product data.
 - .2 Approved changes to contract.
 - .3 Contractor's project schedule.
 - .4 Commissioning schedule.
 - .5 Contractor's, sub-contractor's, suppliers' requirements.
 - .6 Project construction team's and Commissioning team's requirements.
- .2 The Commissioning Plan is to be updated and submitted to the Departmental Representative for approval at the following project milestones:
 - .1 100% contract documentation
 - .2 2 months after project award (to allow for updates due to addenda, changes, contractor's project schedule and shop drawing reviews)

- .3 One month before the verification of each of the following systems:
 - .1 Building envelope
 - .2 Electrical and mechanical systems

1.3 REFERENCES

- .1 Related Specification Requirements
 - .1 Section 01 91 13 General Commissioning Requirements.
 - .2 Section 01 91 33 Commissioning Forms
 - .3 Section 01 91 41 Commissioning Training
- .2 Related Codes, Standards and Guidelines
 - .1 Canadian Standards Association (CSA)
 - .1 CSA Z320-11 Building Commissioning
- .3 Public Works and Government Services Canada (PWGSC)
 - .1 PWGSC - Commissioning Guidelines CP.1 (4th Edition, Nov. 2006)
- .4 American Society of Heating, Refrigeration and Air Conditioning (ASHRAE)
 - .1 Guideline 0-2013 The Commissioning Process

1.4 DEFINITIONS

- .1 Acronyms:
 - .1 Cx - Commissioning.
 - .2 EMCS - Energy Monitoring and Control Systems.
 - .3 ICL - Installation Check List
 - .4 MMS - Maintenance Management System
 - .5 MSDS - Material Safety Data Sheets.
 - .6 O M, or O&M - Operation and Maintenance
 - .7 PI - Product Information.
 - .8 PV - Performance Verification.
 - .9 TAB - Testing, Adjusting and Balancing.
 - .10 WHMIS - Workplace Hazardous Materials Information System.
- .2 Commissioning terms used in this Section:
 - .1 Basis of Design
 - .1 A document that records the concepts, assumptions, decisions and system selections used to meet the Owner's Project Requirements, applicable regulatory requirements, standards and guidelines.
 - .2 Bumping
 - .1 Short term start-up to prove ability to start and prove correct rotation.
 - .3 Commissioning
 - .1 A systematic verification, documentation and training process applied to a facility and all of its systems and assemblies to ensure they are

designed, installed, tested, operated and maintained to meet the Owner's Project Requirements.

- .4 Commissioning Authority
 - .1 An individual or company retained by and responsible to the Owner who leads, plans, schedule and coordinates the commissioning team to implement the commissioning process.
- .5 Commissioning Agent
 - .1 An individual or company retained by a contractor, supplier or manufacturer to start up, test, verify and document the performance of installed systems and equipment.
- .6 Commissioning Logs
 - .1 A record of issues encountered during the commissioning process, describing the actions taken to resolve the issue.
- .7 Commissioning Manager
 - .1 See Commissioning Authority.
- .8 Commissioning Plan
 - .1 A document that outlines the organization, schedule, allocation of resources and documentation requirements of the Commissioning Process.
- .9 Commissioning Process
 - .1 See Commissioning
- .10 Commissioning Report
 - .1 A document that contains all completed tests, reports, verifications and certifications of the commissioned project. The Commissioning Report includes the completed Commissioning Checklists, a record of the Commissioning Logs, and recommendations for future building operation, optimization and re- commissioning.
- .11 Commissioning Specifications (Division 01)
 - .1 Describe the commissioning procedures and documentation requirements for the project.
- .12 Commissioning Specifications (Other Divisions)
 - .1 Describe specific testing and verification requirements for systems and equipment to be carried out by the contractor or the Commissioning Agent within the scope of the contract. Specific testing and verifications are to be reviewed by the contractor, the design consultants and the Commissioning Authority.
- .13 Deferred Commissioning
 - .1 Commissioning activities delayed for reasons beyond Contractor's control due to lack of occupancy, weather conditions, need for heating/cooling loads.
- .14 Master Commissioning Checklist
 - .1 A checklist of commissioning activities and documentation to be submitted by all parties involved in commissioning. The Master

Commissioning Checklist is used and distributed for tracking Commissioning Progress.

- .15 Owner's Project Requirements
 - .1 A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, success criteria and supporting information.
- .16 Systems Manual
 - .1 A document containing information of use to the Owner during the occupancy and operations phase that describes:
 - .2 Operation of systems and equipment
 - .3 Modes of operation
 - .4 Sequences of operation
 - .5 Interaction between systems

1.5 COMMISSIONING ROLES AND RESPONSIBILITIES

- .1 The Departmental Representative shall maintain overall responsibility for project commissioning.
- .2 Owner's Commissioning Authority is responsible for:
 - .1 Ensuring implementation the Cx Plan.
 - .2 Provide Project-specific construction checklists and commissioning process test procedures.
 - .3 Monitoring Cx activities.
 - .4 Writing and distributing Cx progress reports.
 - .5 Chair Cx meeting (s).
 - .6 Writing and distributing Cx meeting minutes.
 - .7 Updating the Master Cx Checklist.
 - .8 Reviewing test records, make recommendations for their approval, and compile the test records for inclusion into the final commissioning report.
 - .9 Witnessing, certifying accuracy of selected reports.
 - .10 Development of the Training Plan.
 - .11 Developing Systems Manual.
 - .12 Compiling and writing the Commissioning Report.
- .3 Departmental Representative ensures Cx activities are carried out to ensure delivery of a fully operational project including:
 - .1 Review of Cx documentation from operational perspective.
 - .2 Review for performance, reliability, durability of operation, accessibility, maintainability, operational efficiency under conditions of operation.
 - .3 Protection of health, safety and comfort of occupants and O M personnel.
 - .4 Monitoring of Cx activities, training, development of Cx documentation.
 - .5 Work closely with members of Cx Team.
 - .6 Conduct periodic site reviews to observe general progress.

- .4 General Contractor:
 - .1 Implements the commissioning process, and coordinates the work of the installation contractors and equipment vendors.
 - .2 Leads the coordination and scheduling of the installation work and the commissioning work.
- .5 Contractors Commissioning Agent:
 - .1 Each discipline may have a separate, specialized Commissioning agent.
 - .2 Prepares and submits test reports.
 - .3 Completes the PI and PV forms and reports.
 - .4 Participates in the scheduling of commissioning and construction activities
 - .5 Cooperates with equipment vendors in preparing systems for start-up and participates in start-up activities.
 - .6 Executes inspections and verifications of the following systems in accordance with check list requirements:
 - .1 Building enclosure
 - .2 Electrical systems
 - .3 Mechanical systems
 - .7 Witnesses all testing.
 - .8 Report issues that require resolution and participate in the resolution of those issues.
 - .9 Witness demonstrations.
 - .10 Coordinates the training activities of contractors, sub-contractors, suppliers and manufacturer's representatives.
 - .11 Gathers O&M manuals and data on all equipment, and assemble in binders as specified.
- .6 Third party and specific testing companies:
 - .1 Manufacturer's representative, to start-up and test the equipment in accordance with their own instructions and those of the commissioning specifications.
 - .2 Mechanical TAB: conducts the Testing, Adjusting and Balancing program.
- .7 Installation Contractors
 - .1 The contractor is responsible for the installation, start-up and placing into service the various systems.
 - .2 Completion of ICLs.
 - .3 Coordination: ensure cooperation and participation of sub-contractors, and participation of major equipment manufacturers in appropriate testing and training activities.
 - .4 Scheduling: confirm schedules for systems orientation and review, O&M manual submission, training sessions, systems testing, equipment start-up, specialty testing, and completion of deficiency work.
 - .5 Notify the Commissioning Authority for up-coming tests.
 - .6 Implement the test procedures, and record results including provision of supporting test documentation and manufacturer's start-up and test procedures.

- .7 Equipment Documentation: Include requirements for submittal data, start-up and testing, O&M data, and training in each purchase order or sub-contract written.
- .8 Provide training on equipment, using either direct skilled technicians, or provide the services of manufacturer service personnel and sub-contractors as required and/or specified.
- .9 Submits O&M manual information and data on all equipment and systems for the Commissioning Authority to compile into the O&M Manual.
- .8 Equipment Suppliers and Miscellaneous Contractors
 - .1 Provide submittals and appropriate O&M manuals.
 - .2 Attend initial commissioning coordination meetings scheduled by the Commissioning Authority.
 - .3 Participate in training sessions as scheduled by the Installation Contractor.
 - .4 Demonstrate performance of equipment as applicable. This includes in-season and out of season testing depending on time of year of Substantial Completion.
 - .5 Provide written and signed start-up reports and submit to the Installation Contractor.
- .9 Building Enclosure Component Suppliers and Installers
 - .1 Provide submittals (e.g., shop drawings, warranty information).
 - .2 Provide schedule of field quality control tests and inspections required by the Contract Documents to Owner's Commissioning Authority.
 - .3 Update schedule monthly throughout the construction period.
 - .4 Attend construction-phase coordination meetings.
 - .5 Participate in testing-procedures meetings and assist with resolution of concerns as required.
 - .6 Participate in testing of installed systems, subsystems, and construction.
 - .7 Submit field quality control testing and inspection reports on exterior enclosure construction to the Owner's Commissioning Authority.
 - .8 Submit operation and maintenance data for systems, subsystems, and components to the Owner's Commissioning Authority.
 - .9 Participate in operation and maintenance training sessions.
 - .10 Participate in final review at acceptance meeting.
- .10 Design Consultants
 - .1 The commissioning work does not replace the design consultants' role and responsibilities with regards to construction review.
 - .2 Conduct periodic construction reviews to determine that the work is in general conformance with the contract documents.
 - .3 Review shop drawings for general conformance to the contract documents.
 - .4 Attend initial meeting with TAB or similar testing contractor(s) to review testing methodology and acceptance criteria.
 - .5 Assist in resolving technical problems during installation, start-up and operating the equipment / systems.
 - .6 Review as-built records as required to the contract documents.

- .7 Review Operating and Maintenance manuals.
- .8 Participate in the Systems training sessions, by providing information on the design intent and other design implications not shown in the contract documents.
- .9 Conduct final construction reviews, identify deficiencies and monitor project completion status.
- .10 Arrange for, or conduct, testing to assess wall resistance to water ingress and window resistance to wind-driven rain, at an appropriate performance level.
- .11 Facility Manager: represents lead role in Operation Phase and onwards and is responsible for:
 - .1 Receiving the facility.
 - .2 Day-To-Day operation and maintenance of the facility.
 - .3 Ensuring the attendance of buildings operations staff at training sessions.
 - .4 Providing manpower during the performance verification testing stage when such testing is conducted after Substantial Completion.

1.6 COMMUNICATIONS

- .1 All Commissioning communications shall follow the chain of communication listed below.
 - .1 Departmental Representative
 - .2 Owner's Commissioning Authority.
 - .3 General Contractor.
 - .4 Subcontractor.
 - .5 Commissioning Agent.
- .2 This chain of communication shall run parallel to and does not replace the chain of communication established by the construction team.

1.7 SITE MEETINGS

- .1 The Departmental Representative will attend selected planning and job-site meetings in order to remain informed on construction progress and to update parties involved in commissioning.
- .2 The Construction Manager and the General Contractor will provide the Departmental Representative with information regarding substitutions, change orders, and any Engineer / Architect supplemental instructions that may affect the commissioning of the various systems and assemblies or the commissioning schedule.

1.8 COMMISSIONING SCHEDULE

- .1 The General Contractor is responsible for integrating, optimizing, and maintaining/updating the commissioning schedule and scheduling commissioning activities in the overall construction schedule.
- .2 The General Contractor shall prepare a detailed Cx Schedule and submit to the Departmental Representative for review and approval. The Commissioning Schedule shall include:

- .1 Milestones, testing, documentation, training and Cx activities of components, equipment, subsystems, systems and integrated systems, including:
 - .1 Cx procedures and reporting meeting: 3 months after award of contract.
 - .2 Building envelope testing
 - .3 Electrical systems
 - .1 Startup
 - .2 Testing
 - .4 Mechanical systems
 - .1 Startup
 - .2 Testing
 - .5 TAB
 - .6 Training for each system.
 - .7 Deferred Cx.

1.9 COMMISSIONING METHODOLOGY

- .1 The general commissioning methodology is summarized as follows:
 - .1 The Departmental Representative conducts a review of the construction documents near completion of these documents and prior to issuing these documents for construction.
 - .2 The design consultant conducts their final construction reviews and records any noted deficiencies.
 - .3 The Contractor's Commissioning Agent prepares the commissioning check lists.
 - .4 The Commissioning Agent reviews the check list procedures with the installation contractor prior to start-up.
 - .5 The Contractor co-ordinates and schedules the start-up and commissioning testing.
 - .6 The installation contractor, their Commissioning Agent and / or Equipment Vendors conduct their equipment and system start-up, and utilizes the commissioning check lists to test and document the commissioning results.
 - .7 The Commissioning Authority reviews all of the test reports, and randomly witnesses the contractor's test-in-progress. The test results are signed-off by applicable parties.
 - .8 The Commissioning Authority compiles the commissioning test results into a Final Commissioning Report.
 - .9 Certain test procedures may include seasonal test requirements, which will be conducted after Substantial Performance.

1.10 COMMISSIONING PROCESS

- .1 Design Phase
 - .1 The Owner's Project Requirement (OPR) is established and the Basis of Design (BOD) provided by the Consulting Team.
 - .2 Commissioning requirements are developed and incorporated into the Construction document.

- .3 Commissioning Plan is developed by the Commissioning Authority.
- .4 Review of the design development documents of systems and assemblies.
- .5 Review of the construction documents of systems and assemblies.
- .2 Construction Phase
 - .1 Contractor submittals are reviewed.
 - .2 Commissioning meetings are held with the commissioning team to review the commissioning plan and schedule.
 - .3 Building envelope in situ testing and mock-up dates are established and incorporated into the construction schedule.
 - .4 Review of the installation in progress and compliance testing.
 - .5 Review contractor test procedures and witness.
 - .6 Develop and review functional testing and verification procedures and implementation of the procedures.
- .3 Verification and Testing Phase
 - .1 Commissioning check lists are provided by the Commissioning Authority.
 - .2 Each commissioning procedure tests the equipment and systems, and building enclosure, and consists of the following major elements:
 - .1 Installation Verification – Equipment and Systems
 - .2 Installation Verification – Building Enclosure Components
 - .3 Pre-start readiness and Initial Test
 - .4 Functional Verification
 - .5 Controls Verification
 - .6 Appendices
 - .3 Document Sign-Off
 - .1 Each completed check list is signed off by the following parties:
 - .1 Contractor's Commissioning Agent, for testing,
 - .2 Departmental Representative, for review and witnessing,
 - .4 Pre-Start and Initial Test
 - .1 Checklists consisting of: confirmation of completion of installation, authorities inspections, pre-start safety checks (where applicable) and operational readiness.
 - .2 Use of pre-printed manufacturer installation and start-up checklists are required; however, the commissioning procedure checklists may contain supplemental items.
 - .5 Performance Verification
 - .1 Functional performance testing of the systems and assemblies to verify compliance with the design intent.
 - .2 Prescribed performance measurements including but not limited to electrical load data, thermal load data, air and water balancing, and noise and vibration data.`

- .3 Step-by-step testing methodologies to prove the functional operation of control systems, for normal and abnormal operating conditions, and alarm conditions.
 - .4 Review contractor's and independent third party test reports.
 - .4 Post-Construction Phase
 - .1 Review the requirements of the operation and maintenance manuals.
 - .2 Review the as-built drawings.
 - .3 Review the procedures for orientation and training of the operation and maintenance staff.
 - .4 Schedule the training of the maintenance staff.
 - .5 Review warranties of systems and assemblies.
 - .6 Schedule off- season functional performance testing and report on the findings.
 - .7 Review performance of the systems and assemblies with the operating staff prior to end of the warranty period.
 - .8 Prepare the final commissioning report.
 - .9 Provide assistance to CCG in full implementation of MMS identification system of components, equipment, sub-systems, systems In later stages of Cx, before hand- over and acceptance, the Departmental Representative, Contractor, and Commissioning Authority to co-operate to complete inventory data sheets and.

1.11 DELIVERABLES

- .1 Provided by Owner:
 - .1 Owner's Project Requirements
- .2 Provided by Design Consultants:
 - .1 Basis of Design
- .3 Provided by Commissioning Authority:
 - .1 Cx Specifications.
 - .2 Description of Cx activities and documentation.
 - .3 Description of Cx of integrated systems and documentation.
 - .4 Training Plans.
 - .5 Cx Reports.
 - .6 List of commissioning activities to be completed during warranty period.
- .4 Refer to Section 01 91 33 - Commissioning (Cx) Forms for the following forms:
 - .1 Installation Check Lists (ICL)
 - .2 Product Information (PI) forms
 - .3 Performance Verification (PV) forms
- .5 Provided by Commissioning Agent:
 - .1 Completed product information (PI) report forms.

- .2 Completed performance verification (PV) report forms.
- .3 Results of Performance Verification Tests and Inspections.
- .4 Maintenance Management System (MMS) tag list.
- .6 Provided by Contractor and Suppliers:
 - .1 Shop Drawings
 - .2 Completed installation checklists (ICL).
 - .3 Identification of design changes that occurred during the construction phase.
 - .4 Certificate of Completion certifying that assemblies, systems, equipment, and associated controls are complete and ready for testing.
 - .5 Warranties.
 - .6 Project record documentation.
 - .7 Inventory of spare parts, special tools and maintenance materials.
 - .8 WHMIS information.
 - .9 MSDS data sheets.
 - .10 Electrical Panel inventory containing detailed inventory of electrical circuitry for each panel board. Duplicate of inventory inside each panel.

1.12 REPORTING

- .1 Installation Checklists
 - .1 Installation checklists are completed by installing contractors, their Commissioning Agents and by Manufacturer's Representatives. Upon completion of each checklist, the applicable parties sign-off the document as required. Completed checklists are collected by the Commissioning Authority, and collated into the Commissioning Report.
- .2 PV Reports
 - .1 The Commissioning Agent submits witnessed and certified PV reports to the Commissioning Authority who will verify selected results and collate into the Commissioning Report.
- .3 Master Commissioning Checklist
 - .1 The Commissioning Authority maintains the Master Commissioning Checklist of the status of all commissioning documentation to be submitted for the project.
- .4 Commissioning Logs
 - .1 Commissioning Logs are created as required during Start-Up and Performance testing. Commissioning Logs are initiated by the Commissioning Authority.
 - .2 Log information to include:
 - .1 Date of log
 - .2 Description of issue encountered
 - .3 Recommendations for remedial work or change required
 - .4 Communication with design consultants and the Departmental Representative regarding any changes the design.

- .5 Once the issue has been resolved, the implications on system operation shall be documented.
- .5 Monthly Status Report
 - .1 The monthly status report is written by the Commissioning Authority. It provides a general summary of work completed to-date, and upcoming work in the next reporting period. The report includes the following as a minimum:
 - .1 A matrix summary, by system, of the estimated percent of the commissioning program completed.
 - .2 A brief summary of major deficiencies encountered, and resolution status
 - .3 Resources required from the Owner/Operator for commissioning activities in the next reporting period.
- .6 Final Commissioning Report
 - .1 The Final Commissioning Report is written by the Commissioning Authority. It includes:
 - .1 Purpose
 - .2 Conclusions
 - .3 General Remarks
 - .4 Summary of Commissioning Activities
 - .5 Summary of Commissioning Outstanding Items
 - .6 Record Sheets/Documents
 - .7 References
- .7 Alternate Season Report
 - .1 The alternate season report may be required and if so is the final deliverable, and is an updated revision of the Final Commissioning Report.

1.13 PERFORMANCE VERIFICATION (PV):

- .1 Performance verification shall be documented on PV forms and checklists approved by the Commissioning Authority.
- .2 The Commissioning Agent will witness, verify and document performance verification.
- .3 The installing contractors shall assist the Commissioning Agent to conduct performance verification.
- .4 Commissioning Agent will complete PV reports and provide to the Commissioning Authority.
- .5 Use procedures to suit project requirements.
- .6 Repeat when necessary until results are acceptable to Commissioning Authority.
- .7 Commissioning Authority will witness and review selected reported results using approved PI and PV forms.
- .8 Commissioning Authority reserves right to verify up to 30% of reported results at random.

- .9 Failure of randomly selected item shall result in rejection of PV report or report of system start-up and testing.

1.14 TRAINING

- .1 Refer to Section 01 91 41 - Commissioning (Cx) - Training.
- .2 Training for each system is coordinated by the Commissioning Authority, with assistance from the installing contractors, equipment and system manufacturers, commissioning agents, and the design consultants.
- .3 The design consultants will provide information on the basis of design, design intent, general operating strategies, automatic control systems, etc.
- .4 The General Contractor and Installation Contractors shall and organize and schedule the training sessions to achieve the requirements of the Training Plan, scheduled in cooperation with the Owner's Facility Manager.
 - .1 Schedule all training activities, and coordinate with the installation contractors, and with Client staff for dates and resources required.
 - .2 Organize training sessions by trade in accordance with the Owner's requirements.
 - .3 Confirm training topics (breadth and depth) with the Commissioning Authority in accordance with above.
 - .4 Each training session will be schedule to allow for up to two (2) separate training sessions for each topic, to allow for adequate operator shift coverage.
 - .5 Training materials for specific equipment and systems shall be provided by the system or equipment manufacturer, and training provided by a qualified manufacturer's representative.
- .5 Equipment Training
 - .1 The installation contractor is responsible for providing training on the equipment, and with general aspects of the system. This includes providing the services of manufacturer's representatives to provide detailed operating and maintenance instruction.
- .6 Systems Training
 - .1 Training sessions topics will include:
 - .1 Types of installed systems
 - .2 Design intent and design criteria
 - .3 Design constraints
 - .4 Different operating modes – occupied, unoccupied, emergency conditions, etc
 - .5 Seasonal operating modes
 - .6 Energy efficiency
 - .7 System operation
 - .8 Automatic controls
 - .9 Service, maintenance, diagnostics, and repairs (by vendors)
 - .10 Troubleshooting

1.15 EXTENT OF CX

- .1 Electrical systems:
 - .1 Low voltage below 750 V:
 - .1 Low voltage switch gear and transformation equipment.
 - .2 Metering and switchboard requirements
 - .3 Low voltage distribution systems.
 - .4 Ground fault Detection and interruption
 - .5 Wiring devices, receptacles and switches
 - .6 Motor starters
 - .2 Emergency power generation systems:
 - .1 Emergency generator.
 - .2 Automatic transfer switchgear and controllers.
 - .3 Status annunciation,
 - .4 Fuel system by owner.
 - .3 Lighting systems:
 - .1 Lighting equipment.
 - .2 Lighting controls.
 - .3 Emergency lighting systems, including battery packs.
 - .4 Communication Systems
 - .1 To be commissioned by the owner.
 - .1 Contractor to provide the following tests for all installed communications cables: Attenuation, Return Loss, NEXT, Power Sum NEXT, ELFEXT, Power Sum ELFEXT, ACR, Power Sum ACR, Propagation Delay, and Delay Skew. Permanent Link Test is required.
 - .5 Fire alarm systems, equipment:
 - .1 Annunciators.
 - .2 Control panels.
 - .6 Security Systems:
 - .1 To be commissioned by the owner
 - .7 Other systems and equipment:
 - .1 Grounding systems
- .2 Mechanical systems:
 - .1 Plumbing systems
 - .1 Domestic cold and hot water systems, including water heaters, expansion tanks, backflow prevention devices, trap seal primers, fixtures, and equipment.
 - .2 HVAC and exhaust systems
 - .1 Heating and cooling systems.
 - .2 Ventilation and exhaust systems.
 - .3 Ductwork and fire dampers

- .4 Controls
 - .5 Fire protection systems including clean agent systems and fire extinguishers.
 - .6 Noise and vibration control systems for mechanical systems.
 - .7 Seismic restraint and control measures.
 - .3 Also refer to requirements in Section 22 08 00 Commissioning of Plumbing and Section 23 08 00 Commissioning of HVAC Systems.
- .3 Building Envelope Systems:
 - .1 Underslab (slab on grade) System
 - .1 Drainage
 - .2 Membrane
 - .2 Foundation System
 - .1 Drainage
 - .2 Membrane
 - .3 Metal Cladding System
 - .1 Drainage
 - .2 Membrane
 - .3 Sample exterior wall-mock-up
 - .4 Air/vapour retarder
 - .5 Insulation
 - .6 Air space
 - .7 Veneer
 - .4 Roofing Systems

1.16 ELECTRICAL SYSTEMS COMMISSIONING

- .1 General
 - .1 The Commissioning Authority will provide equipment data forms and the commissioning team will complete them.
 - .2 Manufacturer/supplier to submit test forms. Test forms to incorporate all testing and commissioning requirements.
 - .3 All equipment to be started up as per the manufacturers' recommendations and specification requirements.
 - .4 System operation matrix to be submitted by the contractor and reviewed by the Consultant and Commissioning Authority prior to site verification. All operations in the matrix to be tested and verified.
 - .5 Manufacturer to submit startup and test reports to the Consultant and Commissioning Authority for review prior to system operation and performance verification.
 - .6 System operation and performance verification includes the complete system and their interfaces with other systems.

- .7 All documentation such as all testing and commissioning test reports, shop drawings, manuals, as-built, etc., to be submitted for review by the Commissioning Authority.
- .2 Power Distribution System
 - .1 LV power distribution system includes equipment such as switchboards, distribution panels, transformers, generators, automatic transfer switches, distribution cables and panelboards. The Commissioning Authority shall review test reports and to witness certain testing of the equipment and systems by the manufacturers and/or independent testing agent, and to verify the breakers are set according to the Coordination Study for a safe and reliable system operation.
 - .2 All protective devices to be properly set, tested and calibrated. The report is to be submitted to the Consultant and Commissioning Authority for review prior to energizing the equipment.
 - .3 Low voltage distribution systems under 750 V require independent testing agency to perform pre- energization and post-energization tests.
 - .4 Generators and transfer switches: test by simulating loss of power. Verify availability of power at equipment requiring same.
- .3 Lighting Control System
 - .1 The Commissioning Authority shall review the test reports demonstrating that the system has been started up and tested in accordance with manufacturer's and contract requirements, controlled in accordance with ASHRAE 90.1, and to witness the system operation and performance verification.
 - .2 Emergency lighting system tests to include verification of lighting levels and coverage, initially by disrupting normal power.
- .4 Fire Alarm System
 - .1 Fire Alarm System includes fire detection, voice communication system and interface with the other systems. The Commissioning Authority shall review the test reports that the system has been started up and tested in accordance with CSA/ULC S537 requirements. The Commissioning Authority shall witness the fire alarm system operation and performance verification.
 - .2 Fire alarm system testing to include a complete verification in accordance with ULC requirements. After Consultant has reviewed report, devices and zones shall be demonstrated during system training.
- .5 Communication Systems
 - .1 The owner will test and commission data and communication systems.
- .6 Security, Video Surveillance and Access Control Systems
 - .1 The owner will test and commission data and communication systems.
- .7 Other systems and equipment:
 - .1 Grounding systems, ground impedance test to be performed as per Motorola R56 standard to determine system performance.

1.17 MECHANICAL SYSTEMS COMMISSIONING

.1 General

- .1 Commissioning of the Mechanical Systems shall commence once the systems have reached the required level of completeness, tested by the contractor and manufacturer, reviewed by the independent 3rd party inspection and testing firm responsible for field quality testing with test reports submitted for review by the Consultants and Commissioning Authority.
- .2 Test data forms for the equipment will be provided by Commissioning Authority and completed by the commissioning team;
- .3 All equipment to be started up as per the manufacturers recommendations;
- .4 All verification of the systems to be done as part of the building automation system control points testing;
- .5 All shop drawings, manuals, as-builts, are to be submitted for review by the Commissioning Authority

.2 Ventilation Systems

- .1 The ventilation system includes exhaust fans and a heat recovery ventilator. Our intent is to oversee the contractor's testing of the equipment and systems; therefore all components must be operational and tested prior to commissioning.
- .2 Pre-operational duct leakage testing and cleaning to be completed for the air handling systems and reports provided to the Consultant for review.
- .3 Demonstrate correct operation of all fire damper by removing fusible link and witnessing closure of fire damper curtain.
- .4 Test reports to be submitted by the contractor for review by the Commissioning Agent.
- .5 Refer to Section 23 08 00 for additional HVAC requirements.

.3 Heating Systems

- .1 The heating system includes electric resistance baseboard heaters and package wall-mounted exterior DX air conditioning systems. Our intent is to witness the Contractor's testing of the equipment and systems and compare the test results with the Owner's Project Requirements and Basis of Design; therefore all components must be operational and tested prior to commissioning.
- .2 Ensure start-up procedures for AC units are completed by manufacturer's assigned representative.
- .3 Test reports to be submitted by the contractor for review by the Commissioning Agent.
- .4 Refer to Section 23 08 00 for additional HVAC requirements.

.4 Plumbing System

- .1 The plumbing system includes electric hot water tank, plumbing fixtures and all associated accessories storm water roof drains and exterior weeping tile/catch basin and interior sanitary drainage. Our intent is to witness the Contractor's testing of the equipment and systems and compare the test results with the Owner's Project Requirements and Basis of Design; therefore all components must be operational and tested prior to commissioning.

- .2 Pre-operational cleaning to be completed for the plumbing systems and reports provided to the Consultant for review;
- .3 Water test and pipe test reports, laboratory water analysis, to be submitted for review by the Commissioning Agent.
- .5 Mechanical Controls System
 - .1 The controls system field devices, packaged controllers and local controls. The Commissioning Agent shall witness the contractor's testing of the equipment and systems and the associated controls sequences and compare the test results with the Owner's Project Requirements and Basis of Design.
 - .2 Verify all points, sensors and sequence of operation.

1.18 BUILDING ENVELOPE COMMISSIONING

- .1 General
 - .1 Commissioning of the assemblies shall commence once the envelope has reached the required level of completeness, has been tested by the contractor and manufacturer and reviewed by the Consultant of Record.
 - .2 All shop drawings, test reports, field quality control reports, manuals, as-built, etc. to be submitted by the contractor for review by the Commissioning Authority.
 - .3 Minutes of the Pre-installation meeting to be provided for review of the Commissioning Authority.
 - .4 Reports related to the mock-up review and acceptance by the Consultant of record to be provided for review of the Commissioning Authority.
 - .5 Progressive verification of the system to be undertaken by 3rd party inspection and testing firm or Consultant of record.
- .2 Verification
 - .1 Certify that building exterior enclosure systems, subsystems, and construction have been completed according to the Contract Documents.
 - .2 Consultant will witness and document field quality-control tests and reviews.
 - .3 Verify that field quality-control testing of building exterior enclosure has been completed and approved, that discrepancies have been corrected, and corrective work approved.
 - .4 Annotate checklist or data sheet when a deficiency is observed.
 - .5 Deferred Testing:
 - .1 If tests cannot be completed because of a deficiency outside the scope of the Building Exterior Enclosure, the deficiency shall be documented and reported to the Commissioning Authority.
 - .2 Deficiencies shall be resolved and corrected by Contractor and tests rescheduled.
 - .6 If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.
 - .7 Testing Reports:

- .1 Reports shall include measured data, data sheets, and a comprehensive summary describing the building exterior enclosure systems at the time of testing.
 - .2 Prepare a preliminary test report. Deficiencies will be evaluated by Design Consultants.
- .3 Underslab (slab on grade) System
 - .1 The underslab or slab on a grade system includes use of drainage and membrane components to reduce transmission of ground moisture to interior spaces
- .4 Foundation System
 - .1 The foundation system includes use of drainage and membrane components to reduce transmission of ground moisture to interior spaces.
- .5 Whole Building Airtightness
 - .1 Testing to be performed to ASTM E 779 “Standard Test Method for Determining Air Leakage Rate by Fan Pressurization” or USACE Version 3 “Air Leakage Test Protocol for Building Envelopes” with a target for an Envelope Air Leakage Rate (EALR) of 2.0L/s/m² @75Pa.
 - .2 Contractor to perform preparation work, as directed by testing party, including, but not limited to, temporarily sealing HVAC intakes/exhausts that do not have dampers, propping open all interior doors, and shutting down all mechanical systems and deactivating smoke detectors.
 - .3 While performing airtightness test, perform diagnostic testing to ASTM E1186 with tracer smoke to locate any leaks for repair as directed by the testing party and/or owner.
- .6 Metal Cladding System
 - .1 The metal cladding system includes use of drainage and membrane components to manage moisture transmission at the exterior wall. The Owner’s Consultant shall review the mock-up report for the exterior wall assembly compiled by the Contractor (which is anticipated to include examples of relevant transitions). One validation review of the complete exterior wall assembly for integrity will be completed by the Commissioning Authority for conformance with the design intent.
 - .2 Commissioning Authority will undertake one validation review during the compilation of the remaining wall assembly.
- .7 Roofing Systems
 - .1 The specified roofing involves assembly of a designed system of components to manage air and moisture transmission at the roof. The Commissioning Authority shall review the roofing assembly by the Contractor and Consultant review reports, all in conformance with the design intent. The Commissioning Authority intends to complete at least one validation of the installation in progress.
 - .2 The Commissioning Authority will undertake one validation review during the compilation of the remaining roofing system installation.

1.19 TESTS TO BE PERFORMED BY OWNER'S AGENT

- .1 Generator Fuel System.
- .2 Generator.
- .3 Clean-agent fire suppression system.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Section Includes:
 - .1 Commissioning forms to be completed for equipment, system and integrated system.
- .2 Related Requirements
 - .1 Section 01 91 13 General Commissioning Requirements.
 - .2 Section 01 91 31 Commissioning Plan

1.2 INSTALLATION/START-UP CHECK LISTS

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

1.3 PRODUCT INFORMATION (PI) REPORT FORMS

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

1.4 PERFORMANCE VERIFICATION (PV) FORMS

- .1 PV forms to be used for checks, running dynamic tests and adjustments carried out on equipment and systems to ensure correct operation, efficiently and function independently and interactively with other systems as intended with project requirements.

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

1.5 SAMPLES OF COMMISSIONING FORMS

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

1.6 CHANGES AND DEVELOPMENT OF NEW REPORT FORMS

- .1 When additional forms are required, but are not available from the Commissioning Authority, develop appropriate verification forms and submit to the Commissioning Authority for approval prior to use.
- .2 Additional commissioning forms to be in the same format as provided by the Commissioning Authority

1.7 COMMISSIONING FORMS

- .1 Use Commissioning forms to verify installation and record performance when starting equipment and systems.
- .2 Strategy for Use:
 - .1 Commissioning Authority provides Contractor project-specific Commissioning forms with Specification data included.
 - .2 Contractor will provide required shop drawings information and verify correct installation and operation of items indicated on the Commissioning forms.
 - .3 Confirm operation as per design criteria and intent.
 - .4 Identify variances between design and operation and reasons for variances.
 - .5 Verify operation in specified normal and emergency modes and under specified load conditions.
 - .6 Record performance results. Add written comments explaining unusual conditions or incomplete work.
 - .7 Verify reported results as requested by the Commissioning Authority.
 - .8 Form to bear signatures of recording technician and reviewed and signed off by Commissioning Agent.
 - .9 Submit immediately after tests are performed.
 - .10 Reported results in true measured SI unit values.
 - .11 Provide Commissioning Authority originals of completed forms.
 - .12 Maintain copy on site during start-up, testing and commissioning period.
 - .13 Forms to be both hard copy and electronic format with typed written results in the Operation and Maintenance Manual.

1.8 COMMISSIONING VERIFICATION REPORTS

- .1 Refer to specific mechanical, electrical and building envelope specification sections for specific system and equipment testing reports.
- .2 Refer to section 01 91 13 General Commissioning Requirements for a summary of testing and verification reports to be completed and submitted for commissioning.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 11 19 – Insulating Concrete Forms
- .2 Section 03 20 00 – Concrete Reinforcing
- .3 Section 03 30 00 – Cast-in-place Concrete

1.2 REFERENCE STANDARDS

- .1 CSA Group (CSA)
 - .1 CSA A23.1-14/A23.2-14, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CAN/CSA O86-14, Engineering Design in Wood.
 - .3 CSA O121-08(R2013), Douglas Fir Plywood.
 - .4 CAN/CSA O325.0-16, Construction Sheathing.
 - .5 CSA S269.1-16, Falsework and Formwork.
- .2 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: in accordance with Section 01 31 19- Project Meetings, convene pre-installation meeting one week prior to beginning concrete works.
 - .1 Ensure key personnel, site supervisor, Departmental Representative, concrete producer, speciality contractor – concrete reinforcing, finishing, forming attend.
 - .1 Verify project requirements.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit copy of WHMIS SDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures.
- .3 Submission of shop drawings for formwork is not required.
 - .1 Prepare Shop Drawings in accordance with CSA S269.1 for formwork.
 - .2 Indicate formwork design data: permissible rate of concrete placement, and temperature of concrete, in forms.
- .4 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Reduction Workplan and Waste Management Plan highlighting recycling and salvage requirements.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE AND HANDLING

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

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-S269.1, CAN/CSA-O86, and CSA-O121.
 - .2 Rigid insulation board: to CAN/ULC-S701.
- .2 Form ties:
 - .1 For concrete not designated 'Architectural': removable or snap-off metal ties, fixed or adjustable length, free of devices leaving holes minimum 25 mm diameter in concrete surface.
 - .2 For Architectural concrete; snap ties complete with plastic cones and light grey concrete plugs.
- .3 Form liner: medium density overlay Douglas Fir plywood to CSA O121 square edge, 19mm thickness.
- .4 Form release agent: Proprietary, non-volatile material not to stain concrete or impair subsequent application of finishes or coatings to surface of concrete, derived from agricultural sources, non-petroleum containing, biodegradable, low VOC, non-toxic.
- .5 Sealant: to Section 07 92 00 - Joint Sealants.
- .6 Rigid Insulation to be extruded polystyrene board conforming to ASTM C587, structural grade, with a compressive strength of 275 kPa (40 psi).

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 formwork in accordance with CSA S269.1 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.
- .5 Align form joints and make watertight.
 - .1 Keep form joints to minimum.
- .6 Use 25 mm chamfer strips on external corners and 25 mm fillets at interior corners, joints, unless specified otherwise.
- .7 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .8 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.
- .9 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.

3.2 REMOVAL

- .1 Leave formwork in place for following minimum periods of time after placing concrete.
 - .1 2 days for footings and abutments.
- .2 Remove formwork when concrete has reached 70 % of its 28 day design strength or minimum period noted above, whichever comes later.
- .3 Re-use formwork subject to requirements of CSA A23.1/A23.2.

3.3 CLEANING

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 10 00 – Concrete Forming and Accessories
- .2 Section 03 20 00 – Concrete Reinforcing
- .3 Section 03 30 00 – Cast-in-place Concrete
- .4 Section 51 12 23 – Structural Steel for Buildings

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A143/A143M-07(2014), Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .3 ASTM A641/A641M-09a(2014), Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .4 ASTM A1064/A1064M-17, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - .5 ASTM A1064/A1064M-17, Standard Specification for Carbon Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - .6 ASTM C165-07(2017), Standard Test Method for Measuring Compressive Properties of Thermal Insulations.
 - .7 ASTM C177-13, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - .8 ASTM C203-05a(2017), Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
 - .9 ASTM C272/C272M-18, Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions.
 - .10 ASTM C303-10(2016)e1, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
 - .11 ASTM C518-17, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .12 ASTM D1621-16, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - .13 ASTM D2126-15, Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
 - .14 ASTM D2863-17a, Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).
 - .15 ASTM E90-09(2016), Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

- .16 ASTM E96/E96M-16, Standard Test Methods for Water Vapor Transmission of Materials.
- .17 ASTM E33617a, Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings.
- .18 ASTM C920-18, Standard Specification for Elastomeric Joint Sealants.
- .19 ASTM D1751-04(2013)e1, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- .20 ASTM D1752-04a(2013), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-19.24-M90, Multicomponent, Chemical-Curing Sealing Compound.
- .3 CSA Group (CSA)
 - .1 CSA A23.1/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 CSA W186-M1990(R2016), Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .4 Canada Construction Materials Centre (CCMC)
 - .1 Technical Guide for the Evaluation of Modular Expanded-Polystyrene Concrete Forms.
- .5 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
 - .1 WHMIS Safety Data Sheets (SDS).
- .6 ULC Standards (ULC)
 - .1 CAN/ULC S101-14, Standard Methods of Fire Endurance Tests of Building Construction and Materials.
 - .2 CAN/ULC S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
 - .3 CAN/ULC S124-06, Test for the Evaluation of Protective Coverings for Foam Plastic.
 - .4 CAN/ULC S-134-13(R2018), Fire Testing of Exterior Wall Assemblies.
 - .5 CAN/ULC S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering
 - .6 CAN/ULC-S701.1-17, Standard for Thermal Insulation, Polystyrene, Boards.
 - .7 CAN/ULC S717.1-12, Standard for Flat Wall Insulating Concrete Form (ICF) Systems

1.3 SYSTEM DESCRIPTION

- .1 Insulated concrete form building system consists of stay-in-place polystyrene insulation panels, plastic web spacers and inserts designed to integrate formwork, concrete, drainage, insulation, studs/strapping, vapour barrier, air barrier and sheathing into one system.

1.4 ABBREVIATIONS AND ACRONYMS:

- .1 *EPS*- Acronym for “Expanded Polystyrene” when referencing the insulating foam component of the Insulating Concrete Form System.
- .2 *ICF*- Acronym for “Insulating (or Insulated) Concrete Form”

1.5 DEFINITIONS:

- .1 *Form Alignment System*- a form alignment & scaffold system designed exclusively for use with Insulating Concrete Forms.
- .2 *Trained Installer*- An installation contractor, who has received instructional training in the installation of the specified Insulating Concrete Form System and is capable of providing written verification of his designation as such by the specified manufacturer of the system being installed.
- .3 *Technical Associate*- A technical representative, usually a staff member of a Distribution Firm, who has received instructional training in the installation of Insulating Concrete Form system and is in the capacity of supervising an installation crew on site.
- .4 *Window or Door Opening Buck*- a pre-manufactured or site constructed frame assembly consisting of wood or plastic material (or combination thereof) used to frame a rough opening within the forming system that will retain concrete around the opening. The frame can also provide for subsequent anchorage of doors and windows within the wall assembly.

1.6 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 insulated concrete forms, ties, joints, ties, and braces and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit copy of WHMIS SDS in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures.
- .3 Shop Drawings:
 - .1 Submit shop drawings for review by Departmental Representative. For wall heights above 3.6 metres, the form and form alignment system shall be engineered and shop drawings shall be sealed and signed by a Professional Engineering licensed to practice in British Columbia.
 - .2 Before fabrication, submit drawings of insulated concrete form building system.
 - .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.
- .4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .5 Test Reports: submit test reports for thermal resistance, water vapour permeance, flexural compressive strength, and rigidity from approved independent testing laboratories, indicating compliance with specified performance characteristics and physical properties.
- .6 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Management Plan and Waste Reduction Workplan highlighting recycling and salvage requirements.
- .7 Closeout Submittals:
 - .1 Warranty Documentation:
 - .1 Submit product warranty documentation to Departmental Representative upon completion of building construction.
 - .2 Maintenance:
 - .1 Submit pertinent maintenance documentation to Departmental Representative as relates to instruction on post repair, renovation, modification or service work with respect to the form system once occupancy commences.

1.7 QUALIFICATIONS

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

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01 61 00- Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, protected from direct sunlight using light-coloured opaque polyethylene film and ventilated to prevent excessive temperature.
 - .2 Replace defective or damaged materials with new.

- .4 Develop Waste Reduction Workplan and Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .5 Packaging Waste Management: remove for reuse by manufacturer of padding, crates, pallets, packaging materials as specified in Construction Waste Management Plan and Waste Reduction Workplan in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

1.9 WARRANTY

- .1 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 Contract.
- .2 Warranty Period: Insulating concrete forms to be free from manufacturer's defects and will remain free from defects for a period of two (2) years from the date of Certificate of Substantial Completion.

Part 2 Products

2.1 MATERIALS

- .1 Insulation: closed cell expanded polystyrene rigid boards to CAN/ULC-S701.1, Type 2, RSI 0.70 per 25 mm of thickness, 110 kPa compressive strength CCD-016, Ecologo certified.
- .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.
 - .1 Supply one-piece hinged connection ties, corner ties, and T-intersections.
- .4 Inserts: 41 mm moulded inside panels, spaced 200 mm OC, reinforced against bulging, integral slide for web spacers.
- .5 Bracing: Manufacturer's standard internal alignment brace.
- .6 Anchor Bolts: to Section 51 12 23 – Structural Steel for Buildings.
- .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: in accordance with Section 03 30 00 - Cast-in-place Concrete.
- .10 Welded Wire Fabric: in accordance with Section 03 20 00 - Concrete Reinforcing.
- .11 Reinforcing Bars: in accordance with Section 03 20 00 - Concrete Reinforcing.
- .12 Joint Filler: preformed, asphalt saturated fibre to ASTM D1751.
- .13 Sealant: in accordance with Section 07 92 00 - Joint Sealants.
- .14 Adhesive: as recommended by ICF manufacturer.

- .15 Sealing Tape: as recommended by ICF manufacturer.

2.2 COMPONENTS

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

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 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for insulated concrete form installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate.
 - .2 Verify lines, levels and centres before proceeding with form erection.
 - .1 Ensure site dimensions agree Shop Drawings.
 - .3 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .4 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Cover and protect adjacent materials before beginning Work.

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 Keep form joints to minimum.
- .4 Align form joints and make watertight.
- .5 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .6 Build in anchors, sleeves and other inserts required or specified in other Sections and as indicated.

- .1 Ensure anchors and inserts do not protrude beyond surfaces designated to receive applied finishes.
- .7 Include external bracing as indicated on Shop Drawings.
- .8 Include vertical braces every 3.0 m along one side of form and anchor with dimensional lumber.
- .9 Include diagonal bracing to align and support forms as indicated on Shop Drawings.
- .10 Install reinforcing to Section 03 20 00 - Concrete Reinforcing.
- .11 Reinforce service penetrations exceeding 300 x 300 mm in size as indicated on structural drawings.
- .12 Apply adhesive and sealing tape to panel intersections in accordance with ICF manufacturer's instructions.
- .13 Apply protective coating to panel forms in accordance with manufacturer's written recommendations.
- .14 Install concrete in accordance with Section 03 30 00 - Cast-in-place Concrete.

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 Submit manufacturer's reports to Consultant within 3 days of manufacturer representative's review.
- .3 Manufacturer's Field Services:
 - .1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, erecting insulated concrete forms.
 - .2 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Ensure manufacturer's representative is present before and during construction of field joints, testing, and critical periods of installation.
 - .4 Schedule site visits to review Work at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.

3.5 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
 - .1 Remove protective coverings from accessories and components.

- .2 Repair or replace damaged materials.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.6 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 When rigid polystyrene insulation boards will remain exposed to sunlight for more than 60 days, protect insulation from ultra-violet radiation by installing temporary covers.
- .3 Repair damage to adjacent materials caused by insulated concrete form installation.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 10 00 – Concrete Forming and Accessories
- .2 Section 03 11 19 – Insulating Concrete Forms
- .3 Section 03 30 00 – Cast-in-place Concrete

1.2 PRICE AND PAYMENT PROCEDURES

- .1 Measurement and Payment:
 - .1 No measurement made under this Section.
 - .1 Include reinforcement costs in items of concrete work in Section 03 30 00 - Cast-In-Place Concrete.

1.3 REFERENCE STANDARDS

- .1 American Concrete Institute (ACI)
 - .1 SP-66-04, ACI Detailing Manual 2004.
- .2 ASTM International (ASTM)
 - .1 ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A143/A143M-07(2014), Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - .3 ASTM A641/A641M-09a(2014), Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - .4 ASTM A1064/A1064M-17, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .3 CSA Group (CSA)
 - .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 CSA W186-M1990(R2016), Welding of Reinforcing Bars in Reinforced Concrete Construction.
- .4 Reinforcing Steel Institute of Canada (RSIC)
 - .1 RSIC-2004, Reinforcing Steel Manual of Standard Practice.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: in accordance with Section 01 31 19- Project Meetings, convene pre-installation meeting one week prior to beginning concrete works.
 - .1 Ensure key personnel, Departmental Representative, concrete producer, speciality contractors – concrete reinforcing, finishing, forming, site supervisor.
 - .1 Verify project requirements.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00- Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in Cast-In-Place Concrete and additives. Include product characteristics, performance criteria, physical size, finish, and limitations.
 - .2 When Chromate solution used as replacement for galvanizing non-prestressed reinforcement, provide product description for review by Departmental Representative prior to its use.
 - .3 Submit copy of WHMIS Safety Data Sheet (SDS) in accordance with Section 01 35 29.06 - Health and Safety Requirements and Section 01 35 43 - Environmental Procedures.
- .3 Shop Drawings:
 - .1 Submission of shop drawings is not required.
 - .1 Prepare reinforcement drawings in accordance with SP-66 and RSIC Manual of Standard Practice.
 - .2 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 Departmental Representative, with identifying code marks to permit correct placement without reference to structural drawings.
 - .5 Indicate sizes, spacings and locations of chairs, spacers and hangers.
 - .3 Detail lap lengths and bar development lengths to CAN/CSA A23.3, unless otherwise indicated.
 - .1 Provide Class B lap splices unless otherwise indicated.
 - .4 Indicate position and size of openings in slabs and walls. Coordinate with trades requiring openings.
- .4 Sustainable Design Submittals:
 - .1 Construction Waste Management:

- .1 Submit project Waste Reduction Workplan and Waste Management Plan highlighting recycling and salvage requirements.
- .5 Quality Assurance Submittals:
 - .1 Submit in accordance with Section 01 45 00 - Quality Control and as described in PART 2 - SOURCE QUALITY CONTROL.
 - .2 Mill Test Report: Upon request, submit to Departmental Representative certified copy of mill test report of reinforcing steel, minimum 4 weeks prior to beginning reinforcing work.
 - .3 Upon request, submit in writing to Departmental Representative proposed source of reinforcement material.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions and Section 01 61 00 - Common Product Requirements.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan and Waste Reduction Workplan related to Work of this Section and in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Substitute different size bars only if permitted in writing by Departmental Representative.
- .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 A1064/A1064M.
- .5 Deformed steel wire for concrete reinforcement: to ASTM A1064/A1064M.
- .6 Welded steel wire fabric:
 - .1 Plain in accordance ASTM A1064/A1064M, fabricated from as drawn steel wire into flat sheets; sizes as indicated on Drawings.
 - .2 Provide in flat sheets only.
- .7 Galvanizing of non-prestressed reinforcement: to ASTM A123/A123M, Coating Grade 85, minimum zinc coating 610 g/m².

- .1 Protect galvanized reinforcing steel with chromate treatment to prevent reaction with Portland cement paste.
- .2 If chromate treatment 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 minimum 32 degrees and galvanized steels immersed for minimum 20 seconds.
- .3 If galvanized steels at ambient temperature, add sulphuric acid as bonding agent at concentration of 0.5% to 1%.
 - .1 No restriction applies to temperature of solution.
- .4 Chromate solution sold for this purpose may replace solution described above, provided if of equivalent effectiveness.
 - .1 Provide product description as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
- .8 Chairs, bolsters, bar supports, spacers: to CSA A23.1/A23.2.
- .9 Tie wire: 1.5 mm diameter annealed wire.
- .10 Mechanical splices: subject to approval of Departmental Representative.
- .11 Plain round bars: to CSA G40.20/G40.21.

2.2 FABRICATION

- .1 Fabricate reinforcing steel in accordance with RSIC Reinforcing Steel Manual of Standard Practice, SP-66, and CSA A23.1/A23.2.
- .2 Obtain Departmental Representative's written approval for locations of reinforcement splices other than those shown on placing drawings.
- .3 Upon approval of Departmental Representative, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

2.3 SOURCE QUALITY CONTROL

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

Part 3 Execution

3.1 PREPARATION

- .1 Galvanizing to include chromate treatment.
 - .1 Duration of treatment 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 Departmental Representative.
- .2 When field bending authorized, bend without heat, applying slow and steady pressure.
- .3 Replace bars, which develop cracks or splits.

3.3 PLACING REINFORCEMENT

- .1 Cutting or puncturing vapour retarder is not permitted; repair damage and reseal vapour retarder before placing concrete.
- .2 Lap Reinforcing as
- .3 Place reinforcing steel as indicated on placing drawings in accordance with CSA A23.1/A23.2.
- .4 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 Apply thick even film of mineral lubricating grease when paint is dry.
- .5 Prior to placing concrete, obtain Departmental Representative's approval of reinforcing material and placement.
- .6 Maintain cover to reinforcement during concrete pour.
- .7 All reinforcing to be clean free of loose scale oil, dirt, rust, and any other foreign coating that affect bonding capacity.

3.4 FIELD TOUCH-UP

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

3.5 CLEANING

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

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 03 10 00 – Concrete Forming and Accessories.
- .2 Section 03 11 19 – Insulating Concrete Forms.
- .3 Section 03 20 00 – Concrete Reinforcing.

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM C260/C260M-10a(2016), Standard Specification for Air-Entraining Admixtures for Concrete.
 - .2 ASTM C309-11, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - .3 ASTM C494/C494M-16, Standard Specification for Chemical Admixtures for Concrete.
 - .4 ASTM C 881/C881M-15, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
 - .5 ASTM C1017/C1017M-13e1, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - .6 ASTM D412-16, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - .7 ASTM D624-00(2012, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.
 - .8 ASTM D1751[04(2013)e1, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - .9 ASTM D1752-04a(2013), Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-37.2-M88, Emulsified Asphalt, Mineral Colloid-Type, Unfilled, for Dampproofing and Waterproofing and for Roof Coatings.
 - .2 CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .3 CSA Group
 - .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),

1.3 ABBREVIATIONS AND ACRONYMS

- .1 Portland Cement: hydraulic cement, blended hydraulic cement (XXb - b denotes blended) and Portland-limestone cement types:
 - .1 GU, GUb and GUL - General use cement.
 - .2 MS and MSb - Moderate sulphate-resistant cement.
 - .3 MH, MHb and MHL - Moderate heat of hydration cement.
 - .4 HE, HEb and HEL - High early-strength cement.
 - .5 LH, LHb and LHL - Low heat of hydration cement.
 - .6 HS and HSb - High sulphate-resistant cement.
- .2 Fly ash types:
 - .1 F - with CaO content maximum 8%.
 - .2 CI - with CaO content 15 to 20%.
 - .3 CH - with CaO minimum 20%.
- .3 GGBFS - Ground, granulated blast-furnace slag.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-installation Meetings: in accordance with Section 01 31 19 - Project Meetings, convene pre-installation meeting one week prior to beginning concrete works.
 - .1 Ensure concrete producer, testing agency, key personnel, Departmental Representative, site supervisor, speciality contractor - concrete reinforcing, finishing, forming attend.
 - .1 Verify project requirements.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in Cast-In-Place Concrete and additives. Include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit copies of WHMIS SDS in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.
- .3 Site Quality Control Submittals:
 - .1 Provide testing reports for review by Departmental Representative and do not proceed without written approval when deviations from mix design or parameters found.
 - .2 Concrete pours: provide accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken as described in PART 3 - FIELD QUALITY CONTROL.

- .3 Concrete hauling time: provide for review by Departmental Representative deviations exceeding maximum allowable time of 120 minutes for concrete delivered to site of Work and discharged after batching.
- .4 Sustainable Design Submittals:
 - .1 Construction Waste Management:
 - .1 Submit project Waste Reduction Workplan and Waste Management Plan highlighting recycling and salvage requirements.

1.6 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00- Quality Control.
- .2 The concrete supplier to be certified by the BC Ready Mixed Concrete Association
- .3 Provide Departmental Representative, minimum 2 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 meet specified requirements.
- .4 At least 2 weeks prior to beginning Work, inform Departmental Representative of source of fly ash.
 - .1 Changing source of fly ash without written approval of Departmental Representative is prohibited.
- .5 Minimum 2 weeks prior to starting concrete work, provide proposed quality control procedures for review by Departmental Representative on following items:
 - .1 Hot weather concrete.
 - .2 Cold weather concrete.
 - .3 Curing.
 - .4 Finishes.
 - .5 Formwork removal.
 - .6 Joints.
- .6 Quality Control Plan: provide written report to Departmental Representative verifying compliance that concrete in place meets performance requirements of concrete as established in PART 2 - PRODUCTS.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements:
- .2 Concrete hauling time: deliver to site of Work and discharged within 120 minutes maximum after batching.
 - .1 Modifying maximum time limit without receipt of prior written agreement from Departmental Representative and concrete producer as described in CSA A23.1/A23.2. is prohibited.
 - .2 Deviations submitted for review by Departmental Representative.

- .3 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.
- .3 Packaging Waste Management: remove for reuse by manufacturer of padding, pallets, crates, packaging materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

1.8 SITE CONDITIONS

- .1 Placing concrete during rain or weather events that could damage concrete is prohibited.
- .2 Protect newly placed concrete from rain or weather events in accordance with CSA A23.1/A23.2.
- .3 Cold weather protection:
 - .1 Maintain protection equipment, in readiness on Site.
 - .2 Use such equipment when ambient temperature below 5°C, or when temperature may fall below 5°C before concrete cured.
 - .3 Placing concrete upon or against surface at temperature below 5°C is prohibited.
- .4 Hot weather protection:
 - .1 Protect concrete from direct sunlight when ambient temperature above 27°C.
 - .2 Prevent forms of getting too hot before concrete placed. Apply accepted methods of cooling not to affect concrete adversely.
- .5 Protect from drying.

Part 2 Products

2.1 DESIGN CRITERIA

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

2.2 PERFORMANCE CRITERIA

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

2.3 MATERIALS

- .1 Portland Cement: Type GU to CSA A3001.
 - .1 Reduction in cement from Base Mix to Actual Supplementary Cementing Materials (SCMs) Mix, as percentage.
- .2 Blended hydraulic cement: Type GUb to CSA A3001.
- .3 Portland-limestone cement: Type GUL to CSA A3001.
- .4 Supplementary cementing materials: with minimum 20% 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. Do not use recycled aggregate unless approved by Departmental Representative.
- .7 Concrete to be normal density (min. 2300kg/m³). Unless noted otherwise.
- .8 Admixtures:
 - .1 Air entraining admixture: to ASTM C260.
 - .2 Chemical admixture: to ASTM C494 and ASTM C1017. Departmental Representative to approve accelerating or set retarding admixtures during cold and hot weather placing.
 - .3 Admixtures shall not contain chlorides.
- .9 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.
- .10 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 50 MPa at 28 days.
- .11 Curing compound: to CSA A23.1/A23.2 and ASTM C309, Type 1-chlorinated rubber.
- .12 Type 1 Waterstops: ribbed extruded PVC of sizes indicated with shop welded corner and intersecting pieces with legs not less than 600 mm long:
 - .1 Tensile strength: to ASTM D412, method A, Die "C", minimum 48 MPa.
 - .2 Elongation: to ASTM D412, method A, Die "C", minimum 275%.
 - .3 Tear resistance: to ASTM D624, method A, Die "B", minimum 30 kN/m.
- .13 Type 2 Waterstops:
 - .1 Bentonite waterstop.
- .14 Premoulded joint fillers:
 - .1 Bituminous impregnated fibre board: to ASTM D1751.
 - .2 Sponge rubber: to ASTM D1752, Type I, flexible grade.
- .15 Weep hole tubes: plastic.
- .16 Dampproof membrane:
 - .1 Soprema Colphene ICF peel and stick or approved equivalent.
- .17 Polyethylene film: 0.25 mm thickness to CAN/CGSB-51.34.

2.4 MIXES

- .1 Alternative 1 - Performance Method for specifying concrete: to Departmental Representative performance criteria to CSA A23.1/A23.2.
 - .1 Ensure concrete supplier meets performance criteria as established below and provide verification of compliance as in Quality Control Plan.
 - .2 Provide concrete mix to meet following plastic state requirements:
 - .1 Uniformity: uniform density, air content, and slump.

- .2 Workability: free of segregation, surface blemishes, loss of mortar, and colour variations.
 - .3 Finishability: to CSA A23.1/A23.2.
-
- .3 Provide concrete mix to meet following hard state requirements:
 - .1 Mix: Type 1
 - .1 Durability and class of exposure: N.
 - .2 Compressive strength at 28 day age: 25 MPa minimum.
 - .3 Intended application: Typical unless noted otherwise.
 - .4 Aggregate size: 20mm maximum
 - .2 Mix: Type 2
 - .1 Durability and class of exposure: F-2.
 - .2 Compressive strength at 28 day age: 30 MPa minimum.
 - .3 Intended application: Footings and grade beams.
 - .4 Aggregate size: 20mm maximum
 - .3 Mix: Type 3
 - .1 Durability and class of exposure: N.
 - .2 Compressive strength at 28 day age: 30 MPa minimum.
 - .3 Intended application: Insulating concrete form walls.
 - .4 Aggregate size: 13mm maximum
 - .4 Mix: Type 4
 - .1 Durability and class of exposure: C-1.
 - .2 Compressive strength at 28 day age: 35 MPa minimum.
 - .3 Intended application: Structurally reinforced concrete exposed to chlorides with or without freezing and thawing.
 - .4 Aggregate size: 20mm maximum
 - .5 Mix: Type 5
 - .1 Durability and class of exposure: C-2.
 - .2 Compressive strength at 28 day age: 32 MPa minimum.
 - .3 Intended application: Non-structurally reinforced concrete exposed to chlorides and freezing and thawing.
 - .4 Aggregate size: 20mm maximum
 - .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 Departmental Representative's written approval before placing concrete.
 - .1 Provide 5 business days 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 facilitate placing with minimum of re-handling, and without damage to existing structure or Work.
- .4 Pumping of concrete is permitted only after approval of equipment and mix.
- .5 Disturbing reinforcement and inserts during concrete placement is prohibited.
- .6 Prior to placing of concrete obtain Departmental Representative'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, workability, air content, temperature and test samples taken.
- .10 Do not place load upon new concrete until authorized by Departmental Representative.

3.2 INSTALLATION/APPLICATION

- .1 Do cast-in-place concrete work to CSA A23.1/A23.2.
- .2 Crack control joints in slabs-on-grade shall be provided as indicated on the structural drawings or at a maximum of 25 times the slab thickness but not more than 5m on center each way. Provide joints at 6 to 18 hours after placing concrete, saw cut depth to be equal to one quarter of the concrete thickness. Fill joints with semi-rigid two component epoxy filler.
- .3 Convey concrete from truck to final location by methods which will prevent separation or loss of material. Maximum free fall not to exceed 1.5m. Consolidate concrete using mechanical vibrators.
- .4 Sleeves and inserts:
 - .1 Do not permit penetrations, sleeves, ducts, pipes or other openings to pass through walls, except where indicated or approved by Departmental Representative.
 - .2 Where approved by Departmental Representative, set sleeves, ties, pipe hangers and other inserts and openings as indicated or specified elsewhere.
 - .3 Do not eliminate or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain written approval of modifications from Departmental Representative before placing of concrete.
 - .4 Confirm locations and sizes of sleeves and openings shown on drawings.

- .5 Set special inserts for strength testing as indicated and as required by non-destructive method of testing concrete.
- .5 Anchor bolts:
 - .1 Set anchor bolts to templates in co-ordination with appropriate trade prior to placing concrete.
 - .2 Adhesive set anchor bolts in holes drilled after concrete has set only after receipt of written approval from Departmental Representative.
 - .3 Protect anchor bolt holes from water accumulations, snow and ice build-ups.
 - .4 Set bolts and fill holes with epoxy grout.
- .6 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 used, remove them after concrete has set.
 - .2 Install weep hole tubes and drains as indicated.
- .7 Grout under base plates and machinery using procedures in accordance with manufacturer's recommendations which result in 100% contact over grouted area.
- .8 Finishing and curing:
 - .1 Finish concrete to CSA A23.1/A23.2.
 - .2 Use procedures noted in CSA A23.1/A23.2 to remove excess bleed water. Ensure surface not damaged.
 - .3 Use curing compounds compatible with applied finish on concrete surfaces.
 - .4 Finish concrete floor to CSA A23.1/A23.2. Class A.
 - .5 Concrete floor to have finish hardness to CSA A23.1/A23.2.
 - .6 Provide hand screeded, steel trowel finish unless otherwise indicated.
 - .7 Rub exposed sharp edges of concrete with carborundum to produce 3 mm minimum radius edges unless otherwise indicated.
- .9 Waterstops:
 - .1 Install waterstops to provide continuous water seal.
 - .2 Do not distort or pierce waterstop in way as to hamper performance.
 - .3 Do not displace reinforcement when installing waterstops.
 - .4 Use equipment to manufacturer's requirements to field splice waterstops.
 - .5 Tie waterstops rigidly in place.
 - .6 Use only straight heat sealed butt joints in field.
 - .7 Use factory welded corners and intersections unless otherwise approved by Departmental Representative.
- .10 Joint fillers:
 - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Departmental Representative.
 - .2 When more than one piece required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.

- .3 Locate and form construction joints as indicated.
- .4 Install joint filler.
- .11 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 minimum 150 mm larger than puncture and seal.

3.3 SURFACE TOLERANCE

- .1 Concrete tolerance to CSA A23.1 Straightedge Method to tolerance of 8mm in 3000mm.

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 days.
 - .5 Air and concrete temperature.
- .2 Inspection and testing of concrete and concrete materials carried out by testing laboratory approved by Departmental Representative for review to CSA A23.1/A23.2.
 - .1 Ensure testing laboratory certified to CSA A283.
- .3 Ensure test results are distributed for review by Departmental Representative.
- .4 Contractor will retain the testing laboratory and pay for costs of tests.
- .5 Contractor 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 The inspection or testing noted above does not to augment or replace Contractor quality control nor relieve Contractor of contractual responsibility.

3.5 CLEANING

- .1 Progress cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
 - .1 Divert unused concrete materials from landfill to local quarry or facility after receipt of written approval from Departmental Representative.
 - .2 Provide appropriate area on job site where concrete trucks and be safely washed.

- .3 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site as approved by Departmental Representative.
- .4 Disposal of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location to pose health or environmental hazard is prohibited.
- .5 Prevent admixtures and additive materials from entering drinking water supplies or streams.
- .6 Using appropriate safety precautions, collect liquid or solidify liquid with inert, non-combustible material and remove for disposal.
- .7 Dispose of waste in accordance with applicable local, Provincial/Territorial and Federal regulations.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 05 31 00 – Steel Decking

1.2 REFERENCE STANDARDS

- .1 ASTM International Inc.
 - .1 ASTM A36/A36M-14, Standard Specification for Carbon Structural Steel.
 - .2 ASTM A53/A53M-12, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated, Welded and Seamless.
 - .3 ASTM A123/A123M-15, Standard Specification for Zinc (Hot Dip Galvanized) coating on Iron and Steel Products.
 - .4 ASTM A307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - .5 ASTM F3125/ F3125M-15a, Standard Specification for High Strength Structural Bolts, Steel and Allow Steel, Heat Treated, 120 ksi (930 MPa) and 150 ksi (1040 MPa) Minimum Strength, inch and metric dimensions.
 - .6 ASTM F1554-15e1, Standard Specification for Anchor Bolts, Steel 36, 55 and 105 ksi Yield Strength.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-85.10-99, Protective Coatings for Metals.
- .3 Canadian Institute of Steel Construction (CISC)/Canadian Paint Manufacturers Association (CPMA).
 - .1 Handbook of the Canadian Institute of Steel Construction.
 - .2 CISC/CPMA Standard 1-73a, A Quick-drying One-coat Paint for Use on Structural Steel.
 - .3 CISC/CPMA Standard 2-75, Quick-Drying Primer for use on Structural Steel.
- .4 CSA Group (CSA)
 - .1 CSA G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - .2 CSA-S16-14, Limit States Design of Steel Structures.
 - .3 CAN/CSA-S136-16, North American Specifications for the Design of Cold Formed Steel Structural Members.
 - .4 CSA W47.1-19(R2013), Certification of Companies for Fusion Welding of Steel.
 - .5 CSA W48-14, Filler Metals and Allied Materials for Metal Arc Welding.
 - .6 CSA W55.3-08(R2013), Resistance Welding Qualification Code for Fabricators of Structural Members Used in Buildings.
 - .7 CSA W59-13, Welded Steel Construction (Metal Arc Welding).
 - .8 CSA W186-M1990(R2016), Welding of Reinforcing Bars in Reinforced Concrete Construction.

- .5 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International
 - .1 NACE No. 3/SSPC SP-6-07, Commercial Blast Cleaning.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
 - .1 Submit shop drawings for review by Departmental Representative.
 - .2 Shop drawings to show layout, assemblies, components and connections.
- .3 Erection drawings:
 - .1 Submit erection drawings indicating details and information necessary for assembly and erection purposes including:
 - .1 Description of methods.
 - .2 Sequence of erection.
 - .3 Type of equipment used in erection.
 - .4 Temporary bracings.
- .4 Source Quality Control Submittals:
 - .1 Upon request, submit 2 weeks prior to fabrication of structural steel.
 - .1 Mill test reports to show chemical and physical properties and other details of steel to be incorporated in project.
 - .2 Provide mill test reports certified by metallurgists qualified to practise in Province of British Columbia.
- .5 Fabricator Reports:
 - .1 Provide structural steel fabricator's affidavit stating that materials and products used in fabrication conform to applicable material and products standards specified and indicated.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00- Common Product Requirements.
- .2 Deliver materials in manufacturer's original, undamaged containers with identification labels intact.
- .3 Packaging Waste Management: remove for reuse by manufacturer of packaging materials, pallets, padding, crates in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Structural steel: CSA-G40.20/G40.21, grades as indicated.

- .2 Wide Flange Section, Channels, and Angles; Grade 350W
- .3 Plates, and Bars; Grade 300W
- .4 Hollow Structural Sections (HSS); 350W Class "C" or ASTM A1085 Grade 50 (345MPa)
- .5 Anchor bolts: to F1554 Grade 36 or CSA-G40.20/G40.21 300W.
- .6 High strength anchor bolts: to ASTM A193/A193M, Grade B7.
- .7 Bolts, nuts and washers: to ASTM F3125/F3125M, A325.
- .8 Welding materials: to CSA W48 Series and CSA W59, and certified by Canadian Welding Bureau.
- .9 Shop paint primer: to CISC/CPMA2-75 solvent reducible alkyd, grey.
- .10 Hot dip galvanizing: galvanize steel, where indicated, to ASTM A143/A143M, minimum zinc coating of 610 g/m².
- .11 Shear studs: to CSA W59, Appendix H.

2.2 FABRICATION

- .1 Fabricate structural steel in accordance with CSA-S16 and in accordance with reviewed shop drawings.
- .2 Welders to be CWB Certified. Welding to be in Accordance with CSA W59.
- .3 Install shear studs in accordance with CSA W59.
- .4 Continuously seal members by continuous welds, where indicated. Grind smooth.
- .5 Do not oversize anchor rod holes for site tolerances. Use whole sizes suggested in the CISC "Handbook of Steel Construction"

2.3 SHOP PAINTING

- .1 Clean, prepare surfaces and shop prime structural steel in accordance with CSA-S16, except where members to be encased in concrete.
- .2 Clean members, remove loose mill scale, rust, oil, dirt and foreign matter. Prepare surface according to NACE No.3/SSPC-SP-6.
- .3 Apply one coat of primer in shop to steel surfaces except for:
 - .1 Surfaces to be encased in concrete.
 - .2 Surfaces to receive field installed stud shear connections.
 - .3 Surfaces and edges to be field welded.
 - .4 Faying surfaces of slip-critical connections.
 - .5 Below grade surfaces in contact with soil.
- .4 Apply paint under cover, on dry surfaces when surface and air temperatures are above 5 degrees C.
- .5 Maintain dry condition and 5 degrees C minimum temperature until paint is thoroughly dry.
- .6 Strip paint from bolts, nuts, sharp edges and corners before prime coat is dry.

Part 3 Execution

3.1 APPLICATION

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

3.2 GENERAL

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

3.3 CONNECTION TO EXISTING WORK

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

3.4 MARKING

- .1 Mark materials in accordance with CSA G40.20/G40.21. Do not use die stamping. When steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection.
- .2 Match marking: shop mark bearing assemblies and splices for fit and match.

3.5 ERECTION

- .1 Erect structural steel, as indicated and in accordance with CSA-S16 and in accordance with reviewed erection drawings.
- .2 Provide all erection bracing required to keep the structure stable and in alignment during construction
- .3 Field cutting or altering structural members: to approval of Departmental Representative.
- .4 Protect combustible materials and finishes during welding operations.
- .5 Clean with mechanical brush and touch up shop primer to bolts, rivets, welds and burned or scratched surfaces at completion of erection.
- .6 Continuously seal members by continuous welds where indicated. Grind smooth.
- .7 Install grout under base plates as soon as the steel work is completed, in accordance with manufacturer's directions. Provide 100% contact over grouted area. Do not apply any loads to the steel work before grout achieves sufficient strength.

3.6 FIELD PAINTING

- .1 Touch up damaged surfaces and surfaces without shop coat with primer to NACE No.3/SSPC-SP-6 except as specified otherwise.

3.7 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Waste Management: separate waste materials for recycling and reuse in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCE STANDARDS

- .1 ASTM International
 - .1 ASTM A653/A653M-17, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM A780-09(2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.
 - .3 ASTM A792/A792M-10[(2015), Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.181-99, Ready-Mixed Organic Zinc-Rich Coating.
- .3 Canadian Sheet Steel Building Institute (CSSBI)
 - .1 CSSBI 10M-13, Standard for Steel Roof Deck.
 - .2 CSSBI 12M-15, Standard for Composite Steel Deck
- .4 CSA Group
 - .1 CSA S16-14, Design of Steel Structures.
 - .2 CSA S136-16, North American Specification for the Design of Cold Formed Steel Structural Members.
- .5 The Society for Protective Coatings (SSPC) and National Association of Corrosion Engineers (NACE) International
 - .1 SSPC Technology Guide No.14 – Guide for the Repair of Imperfections in Galvanized, Organic or Inorganic Zinc-Coated Steel Using Organic Zinc Rich Coating.
 - .2 SSPC Paint Specification No. 20 – Zinc Rich Coating, Type I – Inorganic and Type II - 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 steel decking and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit WHMIS SDS in accordance with Section 01 35 43 - Environmental Procedures and Section 01 35 29.06 - Health and Safety Requirements.
- .3 Shop Drawings:

- .1 Submit drawings stamped for review by Departmental Representative.
- .2 Indicate deck plan, profile, dimensions, base steel thickness, metallic coating designation, connections to supports and spacings, projections, openings, reinforcement details and accessories.

1.4 DELIVERY, STORAGE AND HANDLING

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

Part 2 Products

2.1 MATERIALS

- .1 Zinc-iron Alloy (ZF) coated steel sheet: to ASTM A653/A653M structural quality Grade 230, with Z275 coating, for interior surfaces not exposed to weather, unpainted finish,
- .2 Closures: in accordance with manufacturer's recommendations.
- .3 Cover plates, cell closures and flashings: steel sheet with minimum base steel thickness of 0.91 mm minimum. Metallic coating same as deck material.
- .4 Primer: zinc rich, ready mix to CAN/CGSB-1.181.

2.2 TYPES OF DECKING

- .1 Steel roof deck: 0.91 mm minimum base steel thickness, 38mm deep profile, non-cellular, screwed side laps.

2.3 DECK FASTENERS

- .1 Fasteners to structural steel framing shall be Hilti X-ENP-19 L15 powder-actuated connector or approved equivalent.
- .2 Fasteners connecting deck side-laps shall be Hilti S-SLC 01 M HWH side-lap connectors or approved equivalent.

- .3 Approved equivalents shall meet CSSBI and SDI design requirements. Diaphragm system strength and stiffness to be provided in factored resistance tables that have been developed from by full scale diaphragm testing to ICC-ES AC43, AISI S907, and ASTM E455.

Part 3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

- .1 Locate bundles of deck materials to prevent overloading of supporting members.

3.3 ERECTION

- .1 Structural steel work: in accordance with CSA S136 and CSSBI 10M.
- .2 Welding of steel deck will not be permitted.
- .3 Erect steel deck as indicated and in accordance with CSA S136 and CSSBI 10M and in accordance with reviewed shop drawings.
- .4 Butt ends: to 1.5 to 3 mm gap. Install steel cover plates over gaps minimum 3 mm wide.
- .5 Lap ends: to 50 mm minimum.
- .6 Install steel deck fasteners as per manufacturer's instructions and as indicated on structural drawings.
- .7 Immediately after deck is permanently secured in place, touch up metallic coated top surface with compatible primer where damaged by connection installation.
- .8 Prior to roofing assembly installation, steel deck free of soil, debris, standing water, loose mil scale and other foreign matter.
- .9 Closures: Install closures in accordance with approved details.
- .10 Openings and Areas of Concentrated Loads
 - .1 No reinforcement required for openings cut in deck maximum 150mm square.
 - .2 Frame deck openings with dimension between 150 to 300 mm as recommended by manufacturer, except as otherwise indicated. Clear spacing between adjacent openings to be a minimum of three times the width of the larger opening.
 - .3 For deck openings with dimension greater than 300, reinforce in accordance with structural framing details, except as otherwise indicated.

- .4 Do not hang concentrated loads from the steel deck unless approved by the Departmental Representative.
- .11 Connections: Install connections as indicated on structural drawings and in accordance with CSSBI recommendations.

3.4 FIELD TOUCH-UP PAINTING

- .1 Upon erection completion, mechanically brush clean bolts, rivets, welds, and burned or scratched surfaces.
- .2 For galvanized steel surface with damage and without shop coat, repair with field touch up primer.

3.5 CLEANING

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

3.6 PROTECTION

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

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Work includes labour, materials, equipment and services necessary for:
 - .1 Treatment of new lumber and plywood.

1.2 REFERENCES

- .1 CAN/CSA 080 Series 080.1-08 – Specification of treated wood.
- .2 CAN/CSA 080 Series 080.2-08 – Processing and treatment
- .3 CAN/CSA 080 Series 080.3-08 – Preservative formulations
- .4 CAN/CSA 080 Series 080.4-08 – Hydrocarbon solvents
- .5 CAN/CSA 080 Series 080.5-08 – Additives
- .6 American Wood Preserver's Association Standards 1996.

1.3 QUALITY ASSURANCE

- .1 Inspection of products treated with preservative by vacuum-pressure impregnation will be carried out by an accredited inspection agency of the Canadian Wood Preservers Bureau (CWPB).
- .2 All treated lumber and plywood shall bear an identifying stamp in accordance with the CWPB requirements.

1.4 CERTIFICATES

- .1 For products treated with preservative by vacuum-pressure impregnation submit following information certified by authorized signing officer of treatment plant:
 - .1 Information listed in AWP.M2 and revisions specified in CAN/CSA-O80 Series, Supplementary Requirement to AWP Standard M2 applicable to specified treatment.
 - .2 Moisture content after drying following treatment with water-borne preservative.
 - .3 Acceptable types of paint, stain, and clear finishes that may be used over treated materials to be finished after treatment.

1.5 ENVIRONMENTAL AND SAFETY

- .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 acceptable to WCB. Ensure that building occupants, as well as adjacent materials including landscaping are thoroughly protected.

Part 2 PRODUCTS

2.1 MATERIALS

- .1 In general all lumber and plywood is to be pressure treated. Exceptions to this include:
 - .1 Plywood below PVC membranes.
 - .2 Plywood below roof membranes that are well vented spaces such as truss framed roofs. Plywood in low slope roof or soffit areas with moderate or little ventilation must be treated.
 - .3 Roof framing or blocking that are part of a well ventilated attic space.
- .2 All wood treatment to meet the requirements of CSA 080.1-08 for specific use and exposure. Where this specification is more strict than the CSA 080.1 standard then this specification will govern.
- .3 All lumber must be pressure treated after final cutting and fabrication whenever possible.
- .4 All wood products to be dried to below 19% moisture content after treatment by kiln drying. Wood products that require air drying instead of kiln dried are subject to the approval of the Departmental Representative. If treated wood becomes wet after treatment and kiln drying it will need to be air dried to below 19% moisture content before installation.
- .5 For the purpose of this specification, the use of borate treated wood products is limited to areas where the wood will not be subject to continual or direct water runoff as noted in the following sections.
- .6 Preservative treatment for new lumber is to be as follows:
 - .1 Framing inside of the moisture barrier and not subject to exterior humidity including stud walls, plates, headers, deck framing members (over living space): Borate (as B₂O₃) 2.7 kg/m³.
 - .2 Framing inside of the moisture barrier but subject to exterior humidity including balcony guards, parapet walls, balcony support posts, balcony and walkway framing (over non-living space): Borate (as B₂O₃) 2.7 kg/m³.
 - .3 Wood plates or studs in contact with grade level concrete: Borate (as B₂O₃) 2.8 kg/m³.
- .7 Preservative treatment for new plywood is to be as follows:
 - .1 Wall and column sheathing inside of the moisture barrier and not subject to exterior humidity including exterior walls and well ventilated attic spaces: Borate (as B₂O₃) 2.8 kg/m³.
 - .2 Walls and fascia sheathing outside of the moisture barrier and subject to exterior humidity including roof overhangs, roof curbs and penetrations: Borate (as B₂O₃) 2.8 kg/m³.
 - .3 Liners for swing and overhead doors: Borate (as B₂O₃) 2.8 kg/m³.
 - .4 Exposed plywood panel elements: CCA 4.0 kg/m³.
- .8 Field treatment of treated lumber is to comply with CSA 080.3. Minimum of two coats.

- .9 Preservative field treatment for ACQ or CCA treated lumber or plywood is to be with an organic solvent such as Copper Napthenate.
- .10 Preservative field treatment borate treated lumber or plywood is to be inorganic borate based insecticide / fungicide.
 - .1 Preservative field treatment to be dyed to allow easy identification of field treated wood areas. Dye additive to be:
 - .1 Sansin P-320
 - .2 Dye Tablets
 - .3 Food Colouring
 - .4 Approved alternative.
 - .2 Acceptable products:
 - .1 Boracol 20-2 BD Inorganic Boron Wood Preservative.
 - .2 Pre-Ser-Vor 25-3 Inorganice Boron Wood Preservative.
 - .3 Shellguard Insecticide and Fungicide Concentrate For Wood.

Part 3 EXECUTION

3.1 FACTORY APPLICATIONS OF PRESERVATIVES

- .1 All new lumber shall be factory treated to obtain an average net retention as specified.
- .2 Incising is to be used as required to obtain a uniform penetration of treatment to the specified retention requirements. Incising to be done prior to treatment.
- .3 Minimum depth of penetration in solid lumber is to meet CSA 080.1 Table 5 requirements but not less than 10mm for wood less than 115mm and not less than 13mm for wood greater than or equal to 115mm.
- .4 Retention values and depth of penetration is to be verified by assay method.
- .5 Composite boards must not be pressure treated with a waterborne preservative. OSB incorporating zinc borate during the manufacturing process may be available if required as directed by Departmental Representative.
- .6 Glulam beams or columns are to be pressure treated after gluing unless the final product is too large for the treatment chamber in which case the laminations will be treated before gluing.
- .7 Following water-borne preservative treatment, dry all dimension lumber and plywood sheathing to maximum moisture content of 19%.

3.2 FIELD APPLICATION OF PRESERVATIVES

- .1 Field treat the following areas with the appropriate product:
 - .1 All cut ends of treated wood products.
 - .2 All bolt holes, chamfers, cuts, notches, etc to be thoroughly coated by submersing into preservative or other means acceptable to Departmental Representative if submersion is not practical.

- .2 Field Application of wood preservatives to be applied by qualified personnel, in accordance with the manufacturers' instructions but not less than:
 - .1 Two coats applied by brush or roller. Underside of plywood decks can be done by spraying in two coats.
 - .2 Minimum 3 minute immersion of wood in preservative.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 The work of this section includes but is not limited to:
 - .1 Wood blocking at interior door perimeter
 - .2 Wood blocking and plywood as shown on the drawings.

1.2 REFERENCES

- .1 CSA B111-1974 Wire Nails, Spikes and Staples.
- .2 CAN/CSA-G164-M92 Hot Dip Galvanizing of Irregularly Shaped Articles.
- .3 CSA O121-M1978 Douglas Fir Plywood.
- .4 CAN/CSA-O141-91 Softwood Lumber.
- .5 CSA O151-M1978 Canadian Softwood Plywood.
- .6 National Lumber Grades Authority (NLGA) Standard Grading Rules for Canadian Lumber 1991.

1.3 QUALITY ASSURANCE

- .1 Lumber identification: by grade stamp of an agency certified by Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: by grade mark in accordance with applicable CSA standards.

Part 2 PRODUCTS

2.1 LUMBER MATERIAL

- .1 Shall be in accordance with NBC Part 9 Requirements as a minimum.
- .2 All wood except cedar to be pressure treated in accordance with Specification 06 05 73.
- .3 Lumber: unless specified otherwise, softwood, S4S, moisture content 19% or less in accordance with following standards:
 - .1 CAN/CSA-O141.
 - .2 NLGA Standard Grading Rules for Canadian Lumber.
- .4 Furring, blocking, nailing strips, cants, curbs, fascia backing and sleepers:
 - .1 Board sizes: No. 2 or better grade.
 - .2 Dimension sizes: No. 2 or better grade.
 - .3 Post and timbers sizes: No. 2 or better grade.

2.2 PANEL MATERIALS

- .1 Douglas fir plywood (DFP): to CSA O121, standard construction grade, 19mm unless specified otherwise.
- .2 Canadian softwood plywood (CSP): to CSA O151, standard construction grade, 19mm unless specified otherwise.

2.3 ACCESSORIES

- .1 Corrosion resistant coatings on connectors and fasteners is as follows:
 - .1 For non-ACQ treated wood and interior of the exterior sheathing plane and moisture barrier, all connectors to be a minimum of G90 hot dipped galvanizing and fasteners to be hot dipped galvanized. Screw fastener coatings are as noted below. Typical application is in stud cavities, heated attics, below decks in heated spaces.
 - .2 For non-ACQ treated wood and in covered unheated areas not subject to direct moisture, all connectors to be a minimum of G185 hot dipped galvanizing and fasteners to be hot dipped galvanized. Screw fasteners are as noted below. Applies to balcony soffits, parapets, roof attics and unheated decks.
 - .3 For non-ACQ treated wood and in exposed conditions subject to direct moisture, all connectors to be a minimum of G185 hot dipped galvanizing and fasteners to be hot dipped galvanized. Screw fasteners are as noted below. Applies to exposed panels, fascia boards, cedar boards, deck boards.
 - .4 For ACQ treated wood in all locations all connectors and fasteners to be stainless steel unless noted otherwise. Do not combine stainless connectors with non-stainless fasteners.
- .2 Hot dipped galvanized fasteners to meet the following requirements:
 - .1 Hot dipped galvanizing to meet CAN/CSA-G164 and ASTM A653. Nails, spikes and lag screws when hot dipped galvanized are to meet ASTM A153 Class D at 1.0 oz of zinc per sq ft of surface area of the fastener. Bolts, washers and nuts are to meet ASTM A153 Class D at 1.25 oz of zinc per sq ft of surface area of the fastener.
- .3 Corrosion protected screws:
 - .1 Corrosion resistant coatings for screws to meet the following requirement:
 - .1 For non-exposed conditions interior of the exterior sheathing plane and moisture barrier:
 - .1 Zinc plated with a yellow chromate conversion coating.
 - .2 Coating to meet 50 hours of salt spray test to ASTM B117.
 - .2 For exposed conditions and in covered unheated areas not subject to direct moisture exterior of the moisture barrier or subject to exterior humidity (not including ACQ wood applications)
 - .1 Zinc rich base coat with conversion coating and a baked on protective barrier coating.
 - .2 Coating to meet 500 hours of salt spray test to ASTM B117.

- .3 Approved products:
 - .1 Grabbergard Exterior All-Weather Screws by Grabber Construction Products.
- .3 For exposed conditions in exposed conditions subject to direct moisture (not including ACQ wood applications)
 - .1 Zinc rich base coat with conversion coating and a baked on protective barrier coating.
 - .2 Coating to meet 1000 hours of salt spray test to ASTM B117.
 - .3 Approved products:
 - .1 Grabbergard Exterior All-Weather Screws by Grabber Construction Products.
 - .2 DT1500 or DT1700 coated screws by Leland Industries
- .4 Stainless steel screws:
 - .1 For exposed and unexposed conditions where screws are in contact with ACQ wood. Can also be used in fully exposed conditions subject to moisture such as deck boards.
 - .1 Approved products:
 - .1 Stainless steel wood screws.
 - .2 DT1700 coated screws by Leland Industries.
 - .3 Approved alternate.
- .5 Stainless steel components to meet the following requirements.
 - .1 Nails and spikes (when stainless steel) are to be, 304 or 316 Series, purpose made for replacement of conventional nails.
 - .2 Stainless steel screws to be 304 or 316 Series.
 - .3 Stainless steel bolts to be 304 or 316 Series.
 - .4 Connectors (hangers, framing anchors) to be stainless steel Type 316L.
- .6 Screws
 - .1 #8 minimum size (length to suit) wood screws with Robertson flat head.
 - .2 Fabricate to ANSI B18.6.4
 - .3 For screws into concrete use hex-head screws complete with washers. Concrete substrate requires predrilling for screw placement. For non-ACQ installations use ITW Buildex Tapcon Hex washer head with Climaseal Coating, 1/4" diameter x 1-3/4" minimum (1-1/2" min. embedment adjust length to suit thickness of material). For ACQ installations use stainless steel pin bolts, minimum of 1/4" x 2" long with minimum of 1" embedment.
- .7 Nails, spikes and staples:
 - .1 Fabricate to CSA B111.
 - .2 Minimum nail length to be 2.5" (64 mm). Refer to Part 9 for other minimum fastener requirements. Refer to the drawings for specific requirements.
- .8 Staples:
 - .1 Fabricate to CSA B111.

- .2 16 ga. 316 Series stainless steel staples compatible with material, sheathing, framing or other substrate being fastened. Length to be 2" (51 mm). Zinc coated staples will not be accepted.
- .9 Bolts:
 - .1 Size to be 1/2" (12.5 mm) minimum diameter unless indicated otherwise, complete with nuts and washers
- .10 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws, explosive actuated fastening devices, recommended for purpose by manufacturer and as approved by the Departmental Representative.
- .11 Deck/balcony sheathing waterproof adhesive to CGSB 71-GP-26M, cartridge loaded.
 - .1 Acceptable products:
 - .1 PL400 by PL Adhesives and Sealants
 - .2 Alternate product approved by Departmental Representative.
- .12 Sill gasket: Polyfoam by Foampak or approved equal.

Part 3 EXECUTION

3.1 PREPARATION

- .1 All new plywood sheathing and dimension lumber, including blocking, furring and cants are to be treated at an approved facility.

3.2 INSTALLATION

- .1 Comply with requirements of AHJ, supplemented by the following paragraphs.
- .2 Install furring and blocking as required to space-out and support windows, doors, fascia, and other work as required.
- .3 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work. All liners must be attached to the structural substrate around the rough opening with fasteners appropriate for the substrate at a maximum spacing of 12" oc. Ensure all new screws do not penetrate adjacent gas lines or electrical conduits.
- .4 Install all screws and other fasteners to be flush with the wood surface whenever the wood is being covered by sheathing or membrane.
- .5 Install wood fascia backing, nailers, and other wood supports as required and secure using galvanized steel fasteners.

3.3 ERECTION

- .1 Frame, anchor, fasten, tie and brace members to provide necessary strength and rigidity.
- .2 Countersink bolts where necessary to provide clearance for other work.
- .3 Provide temporary support and shoring in accordance with WCB for the structure while working on structural members.

END OF SECTION

Part 1 GENERAL

1.1 SUMMARY

- .1 Work described in this section includes but is not limited to the following.
 - .1 All labour, materials, equipment and services necessary for the application of self-adhesive membrane for below grade waterproofing.

1.2 REFERENCES

- .1 ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials.
- .2 ASTM D903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds.
- .3 ASTM D1876 Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
- .4 ASTM D5147 Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.
- .5 ASTM D5602 Standard Test Method for Static Puncture Resistance of Roofing Membrane Specimens.

1.3 STORAGE AND HANDLING

- .1 Provide and maintain dry, off-ground weatherproof storage.
- .2 Store rolls of membrane in upright position.

1.4 ENVIRONMENTAL REQUIREMENTS

- .1 Do not install membrane system when ambient temperatures are at or below -10°C (for winter grade) for 24 hours before application, and only during dry conditions.
 - .1 Use cold weather products where required by manufacturers guidelines.
- .2 Minimum temperature for installation of primer is -4°C.
 - .1 Use cold weather products where required by manufacturer's guidelines.
- .3 Install membrane on dry substrates, free of snow and ice, use only dry materials and apply only during weather that will not introduce moisture into membrane system.
- .4 If water penetrates through the membrane assembly due to inadequate protection including from interior sources, Contractor to cut and inspect damages, remove and replace all materials at his own cost, to eliminate all trace of water in the assembly.
- .5 Do not allow membrane to remain exposed longer than 3 weeks

1.5 QUALITY ASSURANCE

- .1 Applicator: Company specializing in performing the work of this section with minimum two years documented experience. Provide list of previous projects and references upon request by the Departmental Representative.

1.6 SUBMITTALS

- .1 Submit two (2) copies of the most current technical data sheets. These documents must describe the physical properties of the material, and include installation instructions, including techniques, restrictions, limitations and other manufacturer recommendations.

1.7 WARRANTIES

- .1 Provide warranty certificate, written and signed in the name of the owner, from product manufacturer, certifying the product will meet all the physical characteristic published by the manufacturer, for a period of 10 years, starting from the date of substantial completion.

Part 2 PRODUCTS

2.1 WATERPROOFING MEMBRANE

- .1 A self-adhesive waterproofing membrane composed of SBS modified bitumen and a Tri-Laminate Woven Polyethylene facer. The self-adhesive side is covered by a silicone release paper.
 - .1 Membrane is to be 1.0 mm thick (excluding release film).
 - .2 The membrane system must not show any signs of softening, flow or deterioration at temperatures 70 °C or below.
 - .3 Acceptable products:
 - .1 Colphene ICF, manufactured by Soprema
 - .2 Pre-approved alternate

2.2 PRIMER FOR SELF-ADHESIVE WATERPROOF MEMBRANES

- .1 A water-base polymeric primer that contain no bitumen which is used to enhance adhesion of self-adhesive membranes on most surfaces. For use when solvent based primer are not recommended.
 - .1 Acceptable products:
 - .1 Elastocol Stick H₂O, by Soprema
 - .2 Pre-approved equivalent.

2.3 ACCESSORIES

- .1 Drainage board: Dimpled high-density polyethylene panel.
 - .1 Acceptable products:
 - .1 Sopradrain 10G by Soprema.
 - .2 Pre-approved equivalent.
- .2 Mastic sealant

- .1 Acceptable products:
 - .1 Sopraseal LM 200 T by SOPREMA.
 - .2 Pre-approved equivalent.
- .3 Termination bars (if required):
 - .1 Minimum 18 Ga. for steel, 1/16" for aluminium
 - .2 G200 galvanized steel or aluminum
 - .3 1.5" (38 mm) wide x continuous lengths where possible.
 - .4 Fasteners: Series 3XX stainless steel screws.
 - .5 or approved alternative.
- .4 Sealant: Refer to 07 92 00 Joint Sealants

Part 3 EXECUTION

3.1 EXAMINATION OF SURFACES

- .1 Surface examination and preparation must be completed in conformance with recommendations in the Manufacturer Specifications Manual.
- .2 Before waterproofing work begins, the membrane contractor's foreman will inspect and approve substrate condition and ensure that related work has been properly executed. If necessary, a non-conformity notice will be issued to the contractor so that required corrections can be made. The start of the membrane application will mean that substrate conditions are acceptable for work completion.
- .3 Before commencing work, all surfaces must be smooth, dry, clean and free of ice and debris as per manufacturer's recommendations.

3.2 PREPARATION

- .1 Protect adjacent surfaces not designated to receive membrane:
- .2 Clean and prepare surfaces to receive membrane in accordance with manufacturer's recommendations. Surfaces are to be clean, dry and free of foreign matter.
- .3 No materials will be installed during rain or snowfall.
- .4 Verify the compatibility of all membrane components with curing compounds, coatings or other materials which are already installed on the surfaces to be treated.
- .5 Any cracks over 3 mm wide should be reported to the design professional. Obtain approval from qualified authority, fill cracks with solid backing or waterproofing mastic. Install a 150 mm (6 inches) wide strip of membrane, centered over the crack.

3.3 INSTALLATION

- .1 Prime all prepared surfaces to accept self-adhered waterproofing membrane in accordance with manufacturers recommendations. Primed surfaces which have been left exposed for a period greater than 24 hours should be re-primed.

- .2 Install membrane in accordance with manufacturer's instructions. Observe temperature and humidity limitations for application, contact manufacturer representative if temperature and humidity limitations are exceeded.
- .3 Small protrusions (pipes, etc.) through the waterproofing membrane, should be pre-stripped with a membrane and sealed with waterproofing mastic.
- .4 Roll out sheets. Discard wrinkled or bubbled membrane.
- .5 Align the first roll at a level line.
- .6 Pre-strip all edges with 150 mm (6in) wide strip of membrane centred on the corner. The membrane must be installed in continuous contact with the substrate, voids between the membrane and substrate are unacceptable.
- .7 Remove release paper layer. Roll out on primed substrate with a mechanical roller to encourage full contact bond. Use heat gun as required to achieve adequate continuous bond.
- .8 Laps at sides must be minimum 75 mm (3in) and end laps must be minimum 150 mm (6in) in accordance with manufacturer's instructions.
- .9 All exposed laps except shingle laps to have mastic sealant applied.
- .10 Holes and tears in the membrane must be repaired with the appropriate membrane material. The repair must exceed the affected surface area by at least 75 mm (3in). The membrane piece applied for the repair must be sealed around its edges with mastic sealant. Extend membrane onto items protruding to or penetrating assembly and seal termination with mastic sealant.
- .11 Verify, meticulously, the membrane installation at the end of each day of work and before backfilling.
- .12 All inside corner overlaps should be sealed with a bead of mastic sealant after membrane installation.
- .13 Any waterproofing membrane left exposed after backfilling shall be protected from u.v. and mechanical damages.
- .14 Terminate membrane above grade as indicated. Utilize base of wall flashing as termination bar. Extend the membrane vertically past the flashing to provide minimum 75 mm transition to sheathing membrane.
- .15 Seal leading edge with mastic at the end of each day's work.
- .16 Drape the drainage board and secure without fastening through the waterproofing membrane or tape to the waterproofing membrane.

3.4 CLEAN UP AND PROTECTION

- .1 Clean off drips and smears of bituminous material and primers off adjacent materials immediately.
- .2 At end of each day's work, provide protection for completed work and materials out of storage.

END OF SECTION

Part 1 GENERAL

1.1 DESCRIPTION

- .1 Work described in section includes but is not limited to:
 - .1 Exterior wall insulation including insulation at penetrations as required.
 - .2 Exterior roof insulation including sealings seams as indicated.
 - .3 Mineral fibre insulation to fill space between sheathing and slab edge and at penetrations.
 - .4 Spray foam insulation at selected locations.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA).
 - .1 CSA A101-[M1983] Thermal Insulation, Mineral Fibre, for Buildings.
- .2 Canadian General Standards Board (CGSB).
 - .1 CAN/CGSB-51.20-[M87] Thermal Insulation, Polystyrene, Boards and Pipe Covering.
 - .2 CAN/CGSB-51.38-[92], Cellular Glass Thermal Insulation.
 - .3 CGSB 71-GP-24M-[77] Adhesive, Flexible, for Bonding Cellular polystyrene Insulation.
- .3 CAN-UC-S705.1-98 Spray-Applied Rigid Polyurethane Cellular Plastic Thermal Insulation.
- .4 CAN/ULC-S705.2-98 The Installation of Spray Foam-in-Situ Urethane Insulation for Residential Building Construction.
- .5 Canadian Urethane Foam Contractors Association Inc. Spray Applied Rigid Insulation Handbook.
- .6 American Society for Testing and Materials (ASTM).
 - .1 ASTM E 96-[96] Test Methods for Water Vapor Transmission of Materials.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to the job site in manufacturer's original packaging, containers and bundles with manufacturer's brand name and identification intact and legible.
- .2 Store level and handle materials to protect against contact with damp and wet surfaces, exposure to weather, breakage and damage to edges. Provide air circulation under covering and around stacks of materials.

1.4 MOCK-UPS

- .1 Construct one mock-up minimum 10 m² of each type of insulation, including, but not limited to, insulation retaining pins, insulation spacers, Z-girts, clips, one inside corner,

one outside corner, and one window as requested by the Departmental Representative. Mock-up may be part of the finished work.

1.5 WARRANTIES

- .1 Provide product warranty to include insulation material to be free of any defects affecting performance and adjacent elements.

1.6 CONDITIONS

- .1 The Contractor is to be aware that the design intent is to provide Z-girt support for the new metal wall cladding at a maximum spacing of 406 mm.
- .2 The Contractor is to be aware that the design intent is to provide fiberglass clip, complete with cross strapping, support for the new metal roof cladding. Spacing of fiberglass clips and cross strapping to be designed in accordance with Section 07 61 13.
- .3 The Contract is expected to consider the need for cutting and fitting of the rigid insulation.

Part 2 PRODUCTS

2.1 INSULATION

- .1 Type and thickness of insulation required is as specified in the drawings and wall schedules. Minimum insulation thickness if not specified is 2-1/2 inches.
- .2 Insulation types are not to be mixed in a given wall/roof assembly.
- .3 Insulation Types:
 - .1 Rigid Insulation at roofs:
 - .1 Extruded polystyrene: to CAN/CGSB-51.20, Type 3.
 - .2 Minimum 5 year aged R value of 5.8 per inch at 4 degrees C.
 - .3 Acceptable material:
 - .1 Styrofoam Cavitymate Ultra by The Dow Chemical Company.
 - .2 Approved equivalent.
 - .2 Spray Applied Polyurethane Insulation at wall perimeter above ICF wall and at steel below roof overhangs:
 - .1 To CAN-UC-S705.1, thickness as required to meet R value.
 - .2 Minimum 28 day oven aged R value of 5.9 per inch.
 - .3 Acceptable materials
 - .1 WALLTITE Eco V.3
 - .2 POLARFOAM PF-7300-0 SOYA
 - .3 Approved equivalent.
 - .3 Semi-rigid Mineral Fibre Insulation for wall penetrations, door jambs, and miscellaneous insulation locations:
 - .1 Non-combustible as tested to CAN4-S114 and ASTM E-136.

- .2 Minimum R value of 4.35 per inch.
- .3 Density of 4.5 lbs/cu ft as per ASTM C 303.
- .4 Water adsorption less than 0.1% when test in accordance with ASTM C553, Section 14.
- .5 Surface burning characteristics when tested to CAN4-S102.
 - .1 Flame Spread less than 5
 - .2 Smoke developed none
- .6 Acceptable materials:
 - .1 Fibrex Cavity Wall CWB-45.
 - .2 Roxul Cavity Rock
 - .3 Approved equivalent.

2.2 ACCESSORIES

- .1 Adhesive: to CGSB 71-GP-24.
- .2 Insulation Tape: Tape to seal joints in rigid insulation, width to suit. Acrylic adhesive, with UV resistant backing.
 - .1 Approved products:
 - .1 Weathermate Construction Tape, by The Dow Chemical Company.
 - .2 3M Air and Vapour Barrier 3015, by 3M.
 - .3 Preapproved alternate.

Part 3 EXECUTION

3.1 SURFACE PREPARATION

- .1 Prepare all surfaces in strict accordance with manufacturers written instructions.
- .2 Surface to receive insulation shall be smooth, level, dry, clean, free from dust, dirt and other detrimental materials.
- .3 Examine substrates and immediately inform Departmental Representative in writing of defects.

3.2 INSTALLATION

- .1 Rigid Extruded Polystyrene:
 - .1 At roof, install polystyrene insulation boards on outer surface of waterproof roof sheathing with intermittent clips attached to the steel deck as indicated and specified. Adhere polystyrene insulation boards to the waterproof membrane and between layers of polystyrene insulation boards using adhesive as recommended by manufacturer.
 - .2 At slab, install polystyrene insulation boards below polyethylene air and vapour barrier at underside of slab and extend to outer surface of self-adhesive air barrier inside of insulated concrete wall (ICF) below grade.
 - .3 Cut and fit insulation tight around intermittent clips, electrical boxes, plumbing and heating pipes and ducts, and other protrusions.

- .4 Keep rigid insulation minimum 75 mm from heat emitting devices such as recessed light fixtures. Use mineral fiber insulation at these locations.
- .5 Cut and trim insulation neatly to fit spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.
 - .1 Rigid boards that are not tight fitting will not be accepted and Departmental Representative will identify non-tight fitting insulation for replacement.
- .6 Offset both vertical and horizontal joints in multiple layer applications.
- .7 Seal all joints in rigid boards using insulation tape and seal to penetrations through the insulation.
- .8 Provide semi-rigid fibre insulation in the narrow slots adjacent to the door and penetration assemblies.
- .2 Spray Applied Polyurethane Insulation
 - .1 Install in conformance with CAN/ULC-S705.2 with qualified installers. Coat outer Z girt flanges with oil to prevent bonding.
 - .2 Review and prepare substrates including membranes and galvanized steel supports to provide continuous bond of insulation.
 - .3 Remove excess insulation to ensure minimum drainage cavity depth of 3/8".
 - .4 Ensure no spray applied insulation is in contact with door or penetration assembly. Provide semi-rigid fibre insulation in the narrow slots adjacent to door and penetration assemblies prior to applying spray insulation.
- .3 Mineral fiber insulation:
 - .1 At penetration assemblies infill wall cavity with mineral fiber insulation as detailed.
 - .2 In all cases, the mineral fiber insulation is to be within 1/8" of the surface of the self adhered membrane. No gaps in the insulation is permitted that exceed 1/8" and should generally be snug fitting at seams and girts.
 - .3 Cut and fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.
 - .1 Cut and trim insulation neatly to fit spaces.
 - .4 Offset both vertical and horizontal joints in multiple layer applications.
 - .5 Provide mineral fiber insulation in the narrow slots adjacent to the penetration and door assemblies
- .4 Do not enclose insulation until it has been reviewed and approved by Departmental Representative.

3.3 CLEAN UP

- .1 Upon completion of the work of this section clean-up all insulation and debris associated with work.

END OF SECTION

Part 1 GENERAL**1.1 SUMMARY**

- .1 Labour, materials and equipment to complete installation of self-adhesive sheet applied air barrier membrane system as indicated on drawings and as specified in this section to bridge and seal air leakage pathways and gaps.
- .2 Include treatment of wall penetrations, transition membranes and accessories.
- .3 Related Sections:
 - .1 Section 03 11 00 – Insulated Concrete Form.

1.2 REFERENCE STANDARDS

- .1 CAN/ULC S-741: Standard for Air Barrier Materials - Specification.
- .2 CAN/ULC S-742: Standard for Air Barrier Assemblies - Specification.
- .3 ASTM D5034 - Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test).
- .4 ASTM E96/E 96M - Test Methods for Water Vapor Transmission of Materials.
- .5 ASTM E398 Standard Test Method for Water Vapor Transmission Rate of Sheet Materials Using Dynamic Relative Humidity Measurement.
- .6 ASTM E2178 - Standard Test Method for Air Permeance of Building Materials.
- .7 ASTM E2357 - Standard Test Method for Determining Air Leakage of Air Barrier Assemblies.
- .8 ASTM E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- .9 ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
- .10 ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
- .11 International Code Council Evaluation Service, Inc. (ICC-ES): ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers.

1.3 PERFORMANCE REQUIREMENTS

- .1 Install air barrier membrane system to perform as a continuous air barrier with a water resistive drainage plane flashed to discharge to the exterior any incidental condensation or water penetration.
- .2 Install system to accommodate movements of building elements and materials.
- .3 Provide continuity of air seal materials and assemblies in conjunction with materials described in related sections.

1.4 SUBMITTALS

- .1 Product Data:

- .1 Submit manufacturer's current product data, details and installation instructions for each product including membrane, primers, sealants, and auxiliary materials.
- .2 Include manufacturer's instructions for evaluating, preparing, and treating substrate, temperature and other limitations of installation conditions, technical data, and tested physical and performance properties.
- .2 Submit samples of following Submittals:
 - .1 Water resistive vapour permeable air barrier sheet, minimum 200 x 250 mm
 - .2 Manufacturer's instructions

1.5 QUALITY ASSURANCE

- .1 Single-Source Responsibility:
 - .1 Single Source: Self-adhered water-resistive vapor permeable air barrier membrane components and accessories must be obtained as a single-source membrane system to ensure total system compatibility and integrity.
- .2 Manufacturer Qualifications:
 - .1 Manufacturer of specified products listed in this Section to have minimum 5 years of continued experience in the manufacture and supply of highly vapor permeable water resistive air barrier products successfully installed in similar project applications.
 - .2 Manufacturer of specified products listed in this Section to have experienced in-house technical and field observation personnel qualified to provide expert technical support.

1.6 Installer Qualifications:

- .1 Contractors to be competent with 5 years experience and trained installer for installation of products, systems, and assemblies.
- .2 Contractors to provide a continuous plane of water and air tightness during installation.

1.7 MOCK-UP

- .1 Where directed by Departmental Representative, construct typical exterior wall panel, 6 foot long by 6 foot wide incorporating the substrate, door rough opening preparation or flashing method, door frame and cladding attachment components, and detailing of water-resistive vapor permeable air barrier membrane application and lap seams.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Refer to current Manufacturer's Product Installation Instructions and SDS for proper storage and handling.
- .2 Deliver materials to the job site in undamaged and original packaging indicating the name of the manufacturer and product.
- .3 Store roll materials on end in original packaging. Protect rolls from direct sunlight and inclement weather until ready for use.

- .4 Waste Management and Disposal:
Separate and recycle waste materials.

1.9 COORDINATION

- .1 Ensure continuity of the fully self-adhered water-resistive vapor permeable air barrier system throughout the scope of this section.
 - .1 Air barrier vapor permeable membrane to include self-adhered air barrier, transition membranes and sealants at penetrations.
 - .2 Drainage plane to include drainage cavity, water resistive barrier and flashings to the exterior.

1.10 PROJECT CONDITIONS

- .1 Ensure substrate is clean, sound, free of excess water and loose materials, grease and any contaminants, which may compromise the performance of the product.

1.11 WARRANTY

- .1 Provide manufacturer's standard material warranty in which manufacturer agrees to provide replacement material for the fully self-adhered water-resistive vapor permeable air barrier sheets installed in accordance with manufacturer's instructions that fail due to material defects within 20 years of the date of Purchase.

Part 2 PRODUCTS

2.1 MATERIALS

- .1 Primary fully self-adhered water-resistive vapor permeable air barrier membrane components and accessories must be obtained from a single-source manufacture to ensure total system compatibility and integrity.
 - .1 Approved Products:
 - .1 Sopraseal Stick VP as manufactured by Soprema
 - .2 Approved alternate.
- .2 Self-Adhered Membrane Primer:
 - .1 As recommended by manufacturer. Confirm compatibility with substrate prior to use.

Part 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

- .1 Verify that substrate work is complete, clean and dry before beginning installation of air barrier materials.
 - .1 Ensure:

- .1 Surfaces are sound, dry, even, and free of oil, grease, dirt, excess concrete or other contaminants.

3.2 PREPARATION

- .1 Remove rough or sharp projections, loose particles, and foreign matter detrimental to adhesion and application of the VPAB.
- .2 Clean and prepare surfaces to receive the VPAB in accordance with manufacturer's instructions.
- .3 Seal penetrations and cracks, and reinforce changes in substrate and other areas as recommended by manufacturer.
- .4 Apply manufacturer's recommended primer when required for substrate application.
- .5 Fill voids as recommended by manufacturer.

3.3 INSTALLATION

- .1 Primer for Self-Adhered Membrane (only if required for adhesion):
 - .1 Apply primer for self-adhering membranes at rate recommended by manufacturer.
 - .2 Apply primer to all areas to receive transition sheet and / or through-wall flashing membrane, as indicated on drawings by roller or spray and allow minimum 30 minute open time. Primed surfaces not covered by self-adhered membrane during the same working day must be re-primed.
- .2 Self-Adhered Membrane:
 - .1 Position self-adhered membrane for alignment and remove protective film. Press or roll firmly into place. Ensure minimum 2" overlap at all sides and 3" minimum at end laps. Promptly roll all laps with a counter top roller to effect seal. When installed horizontally, do so in a shingle fashion
 - .2 Tie-in to door frames, roofing system and at the interface of dissimilar materials as indicated in drawings. Refer to manufacturer's standard details.
 - .3 Provide gussets and darts at all transitions in plane.
 - .4 Terminate at below grade waterproofing membrane as indicated. Ensure air barrier continuity between the two membranes.
 - .5 Inspection: Notify contractor when sections of work are complete so as to allow for review prior to covering with insulation.

3.4 PROTECTION

- .1 Protect air barriers from damage during installation and while left exposed during construction. Repair damage before proceeding with subsequent construction.
- .2 Cover membrane as soon as possible. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air barrier and at protrusions according to air barrier manufacturer's written instructions.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Work includes: labour, materials, equipment and services necessary to provide metal wall panels as indicated.

1.2 REFERENCES

- .1 Canadian Sheet Steel Building Institute (CSSBI) S8-2001: Quality and Performance Specification for Prefinished Sheet Steel Used for Building Products.
- .2 AAMA 621 Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
- .3 ASTM A792 /A792M Specification for Steel Sheet, Aluminum-Zinc Alloy-Coated by the Hot-Dip Process with a minimum zinc coating designation Z150.
- .4 ASTM A653/653M Specification for Sheet Steel, Zinc-Coated or Zinc-Iron Alloy Coated by the hot dip process, with a minimum zinc coating designation Z275
- .5 ASTM D523 Test Method for Specular Gloss.
- .6 ASTM B32 Specification for Solder Metal.
- .7 Aluminium Association Designation System for Aluminium Finishes.
- .8 Aluminium Association Aluminium Sheet Metal Work in Building Construction.
- .9 CSA B111 Wire Nails, Spikes and Staples.
- .10 CAN/CGSB-93.1 Sheet, Aluminum Alloy, Prefinished, Residential.
- .11 SMACNA Architectural Sheet Metal Manual.
- .12 CGSB 1-GP-171M, Type 1 Inorganic Zinc Rich Primer
- .13 SSPC Paint 20, Type 1-B Inorganic Zinc Rich Primer

1.3 SUBMITTALS

- .1 Submit duplicate 300 mm x product width, samples of each type of sheet metal material, colour and finish.
- .2 Submit documentation identifying sheet metal source, testing results to specified standards and finish.

1.4 MOCK-UPS

- .1 Provide for approval prior to fabrication and installation and as part of the exterior wall assembly, mock-up for review by the Consultant, a sample of each flashing assembly detailed for the project, including cap and through wall flashing, door head, jamb, and sill flashing, base and drip edge flashing, and custom flashing fabrications.

1.5 DESIGN REQUIREMENTS

- .1 General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- .2 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - .1 Temperature Change: [Low of -20 deg C to a high of 80 deg C] for material surfaces.

1.6 SHOP DRAWINGS

- .1 Submit shop drawings to Departmental Representative.
- .2 Submit Shop Drawings for review by Consultant indicating:
 - .1 Plans and details of typical assembly, profiles, furring and cross furring spacing, fastening, and perimeter and interface conditions.
 - .2 All materials to be used.
 - .3 Design loading for wind.
 - .4 Loads and their locations to be transferred to supporting structure.
 - .5 Engineer's seal covering the design of the wall cladding system.
- .3 Letters of Assurance: The Engineer who sealed the shop drawings shall submit to the Departmental Representative the APEG BC/AIBC Schedule S-B Assurance of Design and Commitment for Field Review. The Engineer who sealed the shop drawings shall provide field review of the installation. On completion of the installation the Engineer shall submit to the Consultant Schedule S-C Assurance of Professional Field Review and Compliance

1.7 WARRANTY ON FINISHES

- .1 Manufacturer agrees to repair finish or replace sheet metal cladding that shows evidence of deterioration of factory-applied finishes within specified warranty period.
- .2 Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - .1 Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - .2 Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - .3 Film Integrity: there shall be no evidence of cracking, chipping, peeling, crazing, spotting, flaking, checking or loss of adhesion.
- .3 Finish Warranty Period: 20 years from date of Substantial Completion.

Part 2 PRODUCTS

2.1 PREFINISHED SHEET STEEL

- .1 General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- .2 Base Metal Base Metal to be:
 - .1 Aluminium-zinc coated (Galvalume) steel sheet conforming to the requirements of ASTM A792 (or A792M) with a minimum coating of AZ50(AZM150).
 - .2 24 gauge thickness.
- .3 Exposed Coil-Coated Finish:
 - .1 Two-Coat Fluoropolymer: AAMA 2605-13. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Dry film thickness of not less than 1.7 mil (0.043 mm) for primer and topcoat.
 - .1 Preapproved product:
 - .1 Flurothane Coastal coating system by Valspar
 - .2 Approved alternate
- .4 Color: [As selected by Canadian Coast Guard from Manufacturer's standard colour range]. Both top and underside of flashing exposed to view to be finished with the same colour.
- .5 Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

2.2 METAL CLADDING

- .1 Profile to be concealed fastener 406 mm (16") coverage panel with 49 mm (1-7/8") rib and snap in place rib closure.
 - .1 Preapproved product:
 - .1 Snap Rib 16" as manufactured by Vicwest.
 - .2 Preapproved alternate.
- .2 Metal cladding attachment system must be able to attach to metal clip assembly in accordance with section 09 20 50.

2.3 UNFINISHED STEEL

- .1 Form all customized flashings and other unfinished steel flashing products including vents, saddles, etc. in accordance with Section 07 62 00 Sheet Metal and Trim.

2.4 ACCESSORIES

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Washers: of same material as sheet metal, 1 mm thick with rubber packings.

- .3 Touch-up paint: as recommended by prefinished material manufacturer.
 - .4 Cleats, clips, and splice plates: of same material, coating, and temper as sheet metal, minimum 50mm wide. Thickness same as sheet metal being secured.
 - .5 Fasteners:
 - .1 Into masonry, concrete, stone:
 - .1 One piece steel screw set into predrilled hole in concrete or masonry for medium duty connections.
 - .1 1/4" diameter x 1-3/4" long Kwik Con II Stainless by Hilti. Hex head for easier installation, Philips head for softer materials such as concrete block. Provide stainless steel washers to hold metal securely. Minimum 5/8" diameter.
 - .2 For exposed conditions, provide stainless steel washer with bonded neoprene gasket.
 - .2 Steel pan head screws with stainless steel washers set into plastic plugs predrilled into concrete or masonry for lighter duty connections. Plastic plug version is required in softer materials such as brick or stucco.
 - .1 #8 x 1" long stainless steel pan head screws with 5/8" diameter stainless steel washers. For exposed conditions, provide washers with bonded neoprene gaskets. Stainless to be 300 Series when exposed otherwise 300 or 400 Series is acceptable.
 - .2 Plastic plugs to be 1-1/8" long Mungo plugs, MUN 6 by UCAN.
 - .2 Into sheet steel:
 - .1 Steel pan head screws with fine thread for metal. Can be self tapping or self drilling.
 - .1 #8 x 1/2" (minimum) long stainless steel suitable for metal flashing application. Stainless to be 300 Series when exposed otherwise 300 or 400 Series is acceptable.
 - .2 For exposed conditions use pan head stainless steel screws, with neoprene washer, heads coloured to match flashing.
 - .3 Into structural steel (non-exposed): Self drilling screws, corrosion resistant capable of salt spray testing per ASTM B117 providing 2000 hours red rust and 30 cycles Kesternich SO₂.
 - .1 Hilti Corporation Bi-Metal Kwik-Flex SS screw with Kwik-cote coating - #10 diameter, complete with washers as required.
 - .2 Provide washers to match the screw coating or stainless. In exposed conditions, provide washers with bonded neoprene gaskets. Minimum 5/8" diameter washers.
 - .6 Solder: to ASTM B32 Standard Specifications For Metal Solders
- Touch-up paint: as recommended by prefinished material Manufacturer.

Part 3 EXECUTION

3.1 FABRICATION

- .1 Fabricate metal flashings and sheet metal work other than aluminium in accordance with applicable CRCA 'FL' series details and SMACNA Architectural Sheet Metal Manual.
- .2 Fabricate aluminium flashings and other sheet aluminium work in accordance with Aluminium Association Aluminium Sheet Metal Work in Building Construction.
- .3 Form panels in one piece whenever possible. Make allowance for expansion at joints. Use maximum length sections possible to minimize joints.
- .4 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.
- .5 All exposed or visible metal flashing and trim to be finished in selected colour as indicated including exposed rear faces of end dams, joints, etc. No exposed or visible steel or aluminium flashing work to be unfinished.

3.2 INSTALLATION

- .1 Install sheet metal work in accordance with shop drawings, SMACNA Architectural Sheet Metal Manual and Aluminium Sheet Metal Work in Building Construction as shown.
- .2 Conceal field cuts wherever possible.
- .3 Install adjacent flashing and trim in accordance with Section 07 62 00 Sheet Metal and Trim.
- .4 Use concealed fastenings except where approved before installation.

END OF SECTION

Part 1 GENERAL

1.1 SUMMARY

- .1 Work includes labour, materials, equipment and services necessary to provide roof / deck waterproofing membrane assemblies

1.2 REFERENCES

- .1 Applicable municipal by-law and building code.
- .2 CSA A123.3-M1979 Asphalt or Tar Saturated Roofing Felt.
- .3 CSA A123.4-M1979 Bitumen for Use in Construction of Built-Up Roof Coverings and Dampproofing and Waterproofing Systems.
- .4 Roofing Contractors' Association of B.C., Roofing Practices Manual.
- .5 CGSB 37.50-M89 Hot Applied, Rubberized Asphalt for Roofing and Waterproofing.
- .6 CGSB 37-GP-9Ma Primer, Asphalt, Unfilled, for Asphalt Roofing, Dampproofing and Waterproofing.
- .7 CGSB 37-GP-15M Application of Asphalt Primer for Asphalt Roofing, Dampproofing and Waterproofing.
- .8 37-GP-19M Cement, Plastic, Cutback Tar.
- .9 CGSB 37.29-M89 Rubber-Asphalt Sealing Compound.
- .10 CGSB 37-GP-56M Membrane, Modified, Bituminous, Prefabricated, and Reinforced for Roofing.
- .11 CAN/CGSB-51.20-M87 Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .12 ASTM D412 Tension Test for Vulcanized Rubber and Thermoplastic Elastomers.

1.3 Warranty

- .1 Two-ply SBS Base and Cap Sheets
 - .1 Provide the Departmental Representative with a warranty stating the roof waterproof system shall remain watertight and free from material and workmanship defects for a total of ten (10) years after the final completion date. The warranty shall be a term type, without deductibles or limitations on coverage amount, and shall be issued at no additional cost to the Owner. This warranty shall not exclude random areas of ponding from coverage.
- .2 Prior to shipment of materials to site the Contractor shall make application for warranty to the membrane manufacturer.

1.4 LABORATORY TESTING

- .1 If required by Departmental Representative, manufacturers of Elastomeric Asphalt materials to provide, at no cost, the results of tests and chemical analysis on the Elastomeric Asphalt materials supplied.

- .2 Tests are conducted to verify conformance to CGSB 37-GP-56M.

1.5 QUALIFICATIONS

- .1 Roof/deck waterproof membrane Contractor is required to submit evidence that the contractor has successfully completed similar work over a period of not less than 5 years.
- .2 The Contractor must be officially recognized as an authorized installer by the waterproofing materials' manufacturer.

1.6 MOCK-UP

- .1 Fabricate, install and pay for mock-ups as required. Mock-ups will be typically used to confirm details and may remain as part of the finished product if deemed acceptable by the Departmental Representative.

1.7 QUALITY ASSURANCE

- .1 Installer Qualifications: Only competent, qualified tradesmen experienced with membranes shall execute the work of this section.
- .2 A crew of qualified tradesmen is defined as follows:
 - .1 The foreman shall hold a three-year Apprenticeship Certificate; at least one other man shall hold a three year Apprenticeship Certificate; the balance of the crew should have completed some portion of the Apprenticeship program, but shall at least have submitted application for the certification as "Roofer". A Journeyman Certificate is acceptable in lieu of an Apprenticeship Certificate.
 - .2 The foreman and one other member of the crew must have attended an Application Seminar provided by the membrane manufacturer.
- .3 Confirm that surfaces to which modified membrane is to be applied are in a condition suitable for this application. Notify the Departmental Representative in writing if substrate is unacceptable.
- .4 Unless otherwise specified, comply with manufacturer's latest printed instructions for materials and installation methods.
- .5 Notify Departmental Representative in writing of any conflict between these specifications and manufacturers instructions. Departmental Representative will designate which document is to be followed.

1.8 SUBMITTALS

- .1 Submit shop drawings in accordance with Section [01 00 10 – General Requirements: Shop Drawings, Product Data, Samples and Mock-ups].
- .2 Provide bills of lading to the Departmental Representative, as requested.
- .3 Letter from the proposed primary roof/deck membrane manufacturer confirming that the roof/deck membrane contractor is authorized to install the proposed system.
- .4 Letter from the primary roof/deck membrane manufacturer stating that the proposed application will comply with the manufacturer's requirements in order to qualify the project for the specified warranty.

- .5 Upon completion of the waterproofing work submit executed warranty to Departmental Representative.

1.9 STORAGE AND HANDLING

- .1 Deliver and store all materials in their original packaging, bearing the manufacturer's name, related standards and any other specifications or reference standards.
- .2 Store materials out of direct exposure to the elements.
- .3 Store materials delivered in rolls carefully on end, with selvage edges up.
- .4 Store roll goods on a clean, flat and dry surface. All material stored on the roof/deck shall be stored on pallets.
- .5 As required, materials stored on the roof/deck shall be weighted to prevent "blow off" due to wind.
- .6 Store materials on the roof/deck in a manner so as to preclude overloading of roof/deck and building structure.
- .7 Maintain storage location at minimum +5°C.
- .8 Store all materials such as solvents, membranes, adhesives and asphalt cutback products away from open flames, sparks or excessive heat.
- .9 Protect and permanently store all materials in a dry, well-ventilated and weatherproof location. Remove from this location only materials to be used the same day. Cover all material using a breathable cover such as a canvas. Polyethylene or other non-breathable plastic coverings are not acceptable.
- .10 Prevent water-based materials from freezing.
- .11 Place plywood runways or similar over completed work to prevent damage to roof/deck membrane during the course of the work.

1.10 ENVIROMENTAL REQUIREMENTS

- .1 Install roof/deck membrane on dry substrate, free of water, snow and ice, use only dry materials and apply only during weather that will not introduce moisture into roof/deck waterproofing system.
- .2 Before commencing work, Contractor to ensure that forecasted meteorological conditions shall permit work to be carried out without interruption during the course of the day.
- .3 Do not install roof/deck membrane when temperature remains below +1°C for torch, or an equivalent temperature allowing for wind-chill factor.
- .4 Minimum temperature for solvent-based adhesive is -5°C.
- .5 All exposed areas of the work shall be protected at the end of each working day or during any interruption of work.
- .6 If water penetrates through the assembly due to inadequate protection, Contractor to cut and inspect damages, remove, replace and re-install all materials to eliminate all traces of water in the assembly. All costs to be borne by the Contractor.
- .7 Membrane system must be watertight at end of each shift.

1.11 PROTECTION

- .1 Protect all adjacent surfaces from any damage that may result from the work of this section. This includes the installation of fireguard protection, as required and/or as directed by the Departmental Representative. The roof/deck membrane contractor shall make good any damage resulting from the work.
- .2 When working with Torch Applied Materials:
 - .1 Fire Extinguishers: maintain one cartridge operated type with shut-off nozzle, ULC labeled for A, B and C class protection. Size 2.25 kg on roof/deck per torch applicator, within 10m of torch applicator.
 - .2 A fire watch shall be maintained in conformance with roof/deck membrane contractor's insurance provider after each day's roof/deck waterproofing operations cease or as required to satisfy the requirements for all insurance providers involved with the building and/or the work.
- .3 Provide a written roof/deck fall protection plan in conformance with WorkSafe BC and OH&S Regulations. A copy of the fall protection plan must be available at the workplace before work with a risk of falling begins. The plan shall include but is not limited to the following:
 - .1 A roof/deck plan sketch indicating the fall hazards expected in each work area.
 - .2 The fall protection system or systems to be used in each area.
 - .3 The procedures to assemble, maintain, inspect, use and disassemble the fall protection system or systems.
 - .4 The procedures for rescue of a worker who has fallen and is suspended by a personal fall protection system or safety net, but is unable to effect self rescue.
 - .5 Location of nearest medical facility, complete with shortest route directions.

1.12 MANUFACTURER'S REPRESENTATIVE

- .1 Manufacturer Requirements:
 - .1 The primary roof/deck waterproofing materials' manufacturer shall provide direct trained company personnel to attend necessary job meetings, perform base sheet and cap sheet inspections and conduct a final inspection upon successful completion of the project.
 - .2 Manufacturer's representative to provide a written copy of the report to the Departmental Representative after each visit to the site.
- .2 Contractor to permit and facilitate access to site and roofs/decks, at all times, by above mentioned manufacturer's representative.

Part 2 PRODUCTS

2.1 MEMBRANE SYSTEM DESIGNATIONS

- .1 Two-Ply SBS Modified Bitumen Uninsulated Exposed System:
 - .1 Acceptable systems:
 - .1 By Soprema:
 - .1 Base sheet: Sopraflash Flam Stick

- .2 Cap sheet: Sopralene Flam 180
- .2 Approved alternative system:
 - .1 Request for alternative system must be submitted to the Departmental Representative in writing and must include product data sheets, warranty provisions and cost implications.

2.2 SBS MODIFIED BITUMEN MEMBRANE MATERIALS

- .1 Base sheet conforming to CGSB 37-GP-56M, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, random fibrous glass mat reinforcement. The membrane must also meet the following minimum criteria:
 - .1 Thermofusible elastomeric asphalt: Mix of selected bitumen and SBS thermoplastic polymer. Minimum 12% polymer content.
 - .2 Topside to be protected with perforated polyolefin film.
 - .3 Bottom surfaces shall be protected by a silicone release paper.
 - .4 Average thickness:
 - .1 2.5 mm
 - .5 Acceptable product:
 - .1 Sopraflash Flam Stick as manufactured by Soprema
 - .2 Approved alternative:
 - .1 Requests for alternative must be submitted to the Departmental Representative in writing and must include product data sheet.
- .2 Cap sheet and cap sheet flashing conforming to CGSB 37-GP-56M, Styrene-Butadiene-Styrene (SBS) elastomeric polymer, prefabricated sheet, polyester mat reinforcement. The membrane must meet the following minimum criteria:
 - .1 Top side to be protected with ceramic coloured granules from manufacturers standard color range.
 - .2 Bottom surfaces shall be protected by a thermofusible polyolefin film.
 - .3 Thermofusible elastomeric asphalt: Mix of selected bitumen and SBS thermoplastic polymer. Minimum 12% polymer content.
 - .4 Average thickness at seldge:
 - .1 4.0 mm
 - .5 Acceptable material:
 - .1 Sopralene Flam 180 as manufactured by Soprema
 - .2 Approved alternative:
 - .1 Requests for alternative must be submitted to the Departmental Representative in writing and must include product data sheet.
- .3 Roof/Deck Membrane Accessories:
 - .1 As recommended by membrane manufacturer.

2.3 ACCESSORY MATERIALS

- .1 Mechanically Fastened Overlay Board:
 - .1 In accordance with Section 09 21 20 Exterior Gypsum Sheathing.

- .2 Sealant: For sealing SBS membrane leading edges at penetrations.
 - .1 Acceptable product:
 - .1 Flexseal by AC Products.
 - .2 Approved alternative:
 - .1 Requests for alternative must be submitted to the Departmental Representative in writing and must include product data sheet.

Part 3 EXECUTION

3.1 WORKMANSHIP

- .1 Install roof/deck waterproof membrane in accordance with applicable standard in R.C.A.B.C. Roofing Practices Manual, the membrane manufacturer's requirements, or this specification; whichever is more stringent.
- .2 Install primer for asphalt waterproof membrane in accordance with CGSB 37-GP-15M.
- .3 Install waterproofing elements on clean dry substrate in accordance with the manufacturer's written instructions. Where there is a discrepancy between the manufacturers' recommendations and the specifications, the more stringent will govern.
- .4 Waterproofing work shall be scheduled and performed in a sequence such that no component of the assembly is left unprotected when operations are interrupted.

3.2 PROTECTION

- .1 Cover adjacent work where materials are hoisted or used.
- .2 Use warning signs and barriers. Maintain in good order until completion of work.
- .3 Clean off drips and smears of bituminous material immediately.
- .4 Ensure installed membrane is protected during the course of the work. Place plywood runways, or similar, over completed work as required to ensure the movement of materials and other traffic does not damage completed work. Comply with precautions deemed necessary by Departmental Representative.
- .5 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for work areas and materials out of storage. Maintain area in a watertight condition at all times.

3.3 EXAMINATION OF ELEMENTS

- .1 Examine work areas and immediately inform Departmental Representative in writing of any defects.
- .2 Prior to commencement of work ensure:
 - .1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.
 - .2 Sweep or vacuum all surfaces, removing all loose aggregate and foreign substances prior to commencement of the roof/deck membrane work.

- .3 Ensure substrate is adequately sloped to minimize the potential for ponding water.

- .3 Contractor shall inspect and approve substrate condition prior to commencement of work. Commencement of work implies acceptance of the surface condition.

3.4 ROUGH CARPENTRY

- .1 Prepare wood surfaces as indicated. No cutting of structural members is permitted unless approved by the Departmental Representative.

3.5 MODIFIED BITUMINOUS MEMBRANE SYSTEMS

- .1 Details of waterproof membrane are for schematic purposes. Membrane systems to be installed in accordance with intent of details, along with manufacturer's recommendations and RCABC guidelines. The most stringent shall apply.
- .2 Use materials in accordance with manufacturer's recommendations.
- .3 Prime all metal to receive direct membrane application. All metal surfaces to receive membrane must be buffed or etched prior to asphalt primer application.
- .4 At the conclusion of each day's work provide water tight "night seals" that facilitate the continuation of the roof/deck membrane work the next day.
- .5 Install SBS primer for the extent of substrate to receive the base sheet. Provide fireguard protection at perimeters, as required. Ensure primer is dry prior to application of base sheet.
- .6 Installation of base ply sheet:
 - .1 Starting at low point of roof/deck, unroll base sheet dry on deck, align, and reroll from both ends. Care must be taken to ensure good alignment of the first roll.
 - .2 Install the base sheet by removing silicone release paper and rolling the membrane to ensure good adhesion.
 - .3 Provide minimum 75 mm side laps and 150 mm end laps. Weld (butter) all laps.
 - .4 Cut a dog ear angle at the end laps on overlapping selvage edges.
 - .5 Seal T-laps immediately following sheet application by applying pressure with a round nosed trowel.
 - .6 End laps to be staggered a minimum of 900mm.
 - .7 Cover strips at tie-in or night seal locations to be a minimum of 12" wide.
 - .8 Application shall provide a smooth surface without air pockets, wrinkles, fishmouths or tears.
 - .9 After installation of the base sheet, check all lap seams on the base sheet.
- .7 Installation of cap sheet:
 - .1 Once the base sheet has been applied, reviewed and approved, the cap sheet can then be laid.
 - .2 Cap sheet shall be unrolled starting from the low point on the roof/deck. Cap sheet shall be rerolled from both ends prior to torching. Care must be taken to ensure alignment of the first roll.

- .3 Cap sheet shall be torch welded in accordance with the recommendations of the membrane manufacturer, to the base sheet membrane. During this application, both surfaces shall be simultaneously melted, forming an asphalt bead that shall be pushed out in front of the cap sheet.
- .4 Care must be taken not to burn the membranes, and their respective reinforcements.
- .5 Base and cap sheet seams shall be staggered a minimum of 300 mm.
- .6 Cap sheet shall have side laps of 75 mm and end laps of 150 mm. Surface granules on end laps shall be embedded prior to installation of following sheet. Touch up seams with loose granules.
- .7 Ensure cap sheet is properly welded, without air pockets, wrinkles, fishmouths or tears.
- .8 After installation of the cap sheet, check all lap seams on the cap sheet.
- .9 During installation, ensure a minimum of 2mm bleed out at all seams.

3.6 FIELD QUALITY CONTROL

- .1 The contractor is responsible to notify the Departmental Representative and membrane manufacturer 48 hours prior to the commencement of the work.
- .2 The membrane manufacturer will provide periodic review during the waterproofing applications and submit field reports to the Departmental Representative after each visit.
- .3 The membrane manufacturer is to be notified upon the completion of the waterproofing work.
- .4 All deficiencies are to be corrected.
- .5 Submit executed warranty upon completion of waterproofing work.

3.7 CLEANING

- .1 At completion of work, all debris and remaining materials resulting from the work of this Section are to be removed from site in a timely manner.
- .2 Clean all adjacent surfaces affected during the course of work.

END OF SECTION

Part 1 GENERAL

1.1 SUMMARY

- .1 Work includes labour, materials, equipment and services necessary to install new metal roof and metal soffit, complete with edge and penetration flashings, and accessories as required
- .2 Work includes all roof perimeter flashings which extend from the roof surface onto adjoining surfaces.

1.2 REFERENCES

- .1 AMAA 621 Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
- .2 ASTM A525M-87 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process Metric.
- .3 ASTM A526M-85 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
- .4 ASTM A792-89 Specification for Steel Sheet, Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .5 ASTM D523-85 Test Method for Specular Gloss.
- .6 CAN/CGSB-37.5-M89 Cutback Asphalt Plastic Cement.
- .7 CAN/CGSB-37.29-M89, Rubber-Asphalt Sealing Compound.
- .8 Aluminum Association Aluminum Sheet Metal Work in Building Construction-1971.
- .9 SMACNA Architectural Sheet Metal Manual.

1.3 DESIGN REQUIREMENTS

- .1 General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight
- .2 Provisions for Thermal Movement: New metal roofing and cladding systems shall be fabricated and installed so that they provide for expansion and contraction of the component materials without oil canning, buckling, hole elongation, fastener failure or excess stress loading situations developing at any time during the temperature cycle. Allowance shall be set for the temperature occurring at the time of installation of the metal roofing. Base calculations on surface temperatures of materials due to both solar heat gain and night-time-sky heat loss but not less than specified below. Clips shall be designed and installed to resist rotation and to avoid shear stress when roofing material expands and contracts.
 - .1 Temperature Change: [Low of -20 deg C to a high of 80 deg C] for material surfaces.

- .3 Water Infiltration: The metal roof and wall system to be designed and installed to not allow any infiltration of water into the building interior. All laps of metal flashing and connections of roof panels shall be installed to allow moisture to run over and off the material. Where possible, install continuous sheets of metal roofing with no laps.
- .4 Venting: Metal roof system shall be vented via the drainage space between insulation and underside of metal roof panel assembly.
- .5 Sheet metal roofing and cladding shall be designed to resist positive and negative wind loads in accordance with the 2015 National Building Code of Canada, local wind pressures 1 in 50 years without failure or permanent set.
- .6 Sheet metal roofing and cladding shall be designed to resist snow and rain loads in accordance with the 2015 National Building Code of Canada, for the 1 in 50 year return period without failure or permanent set. Roof system to be anchored at continuous horizontal line for drag loads caused by retained snow and ice load. Determination of the retained snow and ice load is by the Engineer engaged by the roofing contractor.
- .7 Provisions for Ice Damming: Details at the eaves and valleys shall be designed to accommodate the build-up of ice without back-up of moisture into the seams or under roofing. Roof seams and supporting clips to be designed to resist the effects of sliding snow and ice.
- .8 Provide for positive drainage, to the exterior face of the wall, any water entering at joints and/or any condensation occurring within the wall construction.
- .9 The roof system shall accommodate, by means of expansion joints, any movement in the roof itself and between the roof and the building structure, caused by structural movements (deflection and racking, etc.) and/or thermal expansion and contraction without permanent distortion, damage to infills, cracking of joints, breakage of seals, or water penetration.
- .10 Maintain following tolerances:
 - .1 Maximum variation from plane: 10mm/10m of length.
 - .2 Maximum offset from true alignment between two adjacent members abutting end to end, in line: 0.75mm.
- .11 Design roof openings, flute and batten closures, thermal clips and other flashings and accessories in accordance with the manufacturer's recommendations.

1.4 SHOP DRAWINGS

- .1 Submit Shop Drawings for review by Departmental Representative indicating:
 - .1 Plans and details of typical assembly, profiles, Fiberglass spacer and cross furring spacing, fastening, and perimeter and interface conditions.
 - .2 All materials to be used.
 - .3 Design loading for wind and snow.
 - .4 Loads and their locations to be transferred to supporting structure below the roof cladding including drag forces.
 - .5 Engineer's seal covering the design of the roof cladding system.

- .2 Letters of Assurance: The Engineer who sealed the shop drawings shall submit to the Departmental Representative the APEG BC/AIBC Schedule S-B Assurance of Design and Commitment for Field Review. The Engineer who sealed the shop drawings shall provide field review of the installation. On completion of the installation the Engineer shall submit to the Departmental Representative Schedule S-C Assurance of Professional Field Review and Compliance

1.5 SUBMITTALS

- .1 Submit Shop Drawings for review by Departmental Representative .
- .2 Submit 300 x 300 mm samples of each sheet metal material and colour including a typical finished seam.
- .3 Submit samples of fasteners and anchoring assemblies for both the new metal roof, and existing metal roof to be reinstalled.

1.6 MOCK-UP

- .1 Prior to starting the installation of the metal roof system provide a mockup of typical roof components for review by the Departmental Representative.

1.7 WARRANTY ON FINISHES

- .1 Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
- .2 Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - .1 Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - .2 Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - .3 Film Integrity: there shall be no evidence of cracking, chipping, peeling, crazing, spotting, flaking, checking or loss of adhesion.
- .3 Finish Warranty Period: 20 years from date of Substantial Completion.

1.8 QUALITY ASSURANCE

- .1 Roofing installers must have a minimum of 3 years experience with the respective roofing product on this project.

Part 2 PRODUCTS

2.1 PREFINISHED SHEET STEEL

- .1 General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- .2 Base Metal Base Metal to be:
 - .1 Aluminium-zinc coated (Galvalume) steel sheet conforming to the requirements of ASTM A792 (or A792M) with a minimum coating of AZ50(AZM150).
 - .2 24 gauge thickness.

- .3 Exposed Coil-Coated Finish:
 - .1 Two-Coat Fluoropolymer: AAMA 2605-13. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Dry film thickness of not less than 1.7 mil (0.043 mm) for primer and topcoat.
 - .1 Preapproved product:
 - .1 Flurothane Coastal coating system by Valspar
 - .2 Approved Alternate.
 - .4 Color: As selected by Departmental Representative from Manufacturer's standard colour range. Both top and underside of flashing exposed to view to be finished with the same colour.
 - .5 Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

2.2 UNFINISHED STEEL

- .1 Form all customized flashings and other unfinished steel flashing products including vents, saddles, etc. of 24 Ga. minimum sheet steel according to the following:
 - .1 Base Metal to be:
 - .1 Aluminium-zinc coated (Galvalume) steel sheet conforming to the requirements of ASTM A792 (or A792M) with a minimum coating of AZ50(AZM150).
 - .2 Formed flashings to be typically folded and sealed and as approved by Departmental Representative. Avoid soldering flashings. Use clinched joints whenever possible.
 - .3 Paint off site after fabrication to match prefinished flashing. Type and method of paint application must be preapproved by the Departmental Representative. Paint must be a baked on finish.

2.3 METAL ROOFING

- .1 Profile to be concealed fastener 406 mm (16") coverage panel with 49 mm (1-7/8") rib and snap in place rib closure.
 - .1 Preapproved product:
 - .1 Snap Rib 16" as manufactured by Vicwest.
 - .2 Preapproved alternate.
 - .2 Roofing attachment system must be able to attach to metal clip assembly above thermal layer in accordance with section 09 20 50.

2.4 METAL SOFFIT

- .1 Profile to be concealed fastener 300 mm (12") coverage panel
 - .1 Preapproved product:
 - .1 AD 275-R as manufactured by Vicwest.

.2 Preapproved alternate.

.2 Roofing attachment system must be able to attach to metal clip assembly above thermal layer in accordance with section 09 20 50.

2.5 ACCESSORIES

.1 Isolation coating: alkali resistant bituminous paint.

.2 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Minimum thickness same as sheet metal being secured.

.3 Intermittent Clips: in accordance with Section 09 20 50 Furring and Lathing.

.4 Cross furring: in accordance with Section 09 20 50 Furring and Lathing.

.5 Access path: from preformed and reinforced sheet metal fastened to upright ribs of metal roof. Details to be reviewed during shop drawing review.

.6 Fasteners:

.1 Fasteners:

.1 Hilti Corporation Bi-Metal Kwik-Flex SS screw with Kwik-cote coating - #10 diameter, complete with washers as required and coloured head to match prefinished metal.

.2 Approved Alternate.

.2 Sheathing fasteners:

.1 In accordance with Section 09 21 20 Exterior Gypsum Sheathing.

.7 Butyl tape: Butyl tape to meet TT-C-1796-A or approved equivalent.

.8 Closures: Custom made metal Z closure clips. Perforated when required.

.9 Sealants: Colour matched to roof cladding. Refer to Section 07 92 00.

.10 Drainage Mat: Lightweight 3-dimensional turf reinforcement mat (TRM) made of nylon with continuous monofilaments fused at their intersection. 95% of drain mat to be open for drainage.

.1 Preapproved product:

.1 Enkamat 7003

.2 Approved Alternate.

.11 Zinc Rich Primer / Paint:

.1 Zinc rich, to CGSB 1-GP-181M. To be applied in accordance with manufacturer's recommendations.

.2 Acceptable Products:

.1 ClovaZinc 1 by Cloverdale Paint

.2 Aervoe #141 Zinc Rich Galvanize

.12 Touch up paint: Liquid applied from can using small applicator. Paint to be colour and gloss matched to the roof metal. Submit sample of touched up sheet metal for review by Departmental Representative.

.13 SBS waterproof membrane: As per section 07 52 16.

- .14 Roof insulation: As per Section 07 21 00.

2.6 FABRICATION

- .1 Fabrication shall be in accordance with the applicable requirements of CAN/CSA-S136, *Cold Formed Steel Structural Members*. Care shall be taken to protect exposed surfaces and other features that are important to the appearance.
- .2 Fabricate all components of the system in the factory, ready for field installation. Make allowances for expansion at all joints.
- .3 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .4 Apply minimum 0.2 mm dry film thickness coat of isolation coating to both faces of dissimilar metals in contact.
- .5 Penetrations through the roof planes are to be fabricated and installed to allow for expansion and contraction of the roof sheet without buckling.
- .6 Exterior corners of same profile, material and finish as adjacent material, shop cut and brake formed to right angle, concealed corner brace, hairline exposed joint, pop rivet connections with painted head to match siding.
- .7 Accessories: cap flashings, drip flashings, internal corner flashings, copings and closures for head, jamb, sill and corners, to match cladding, brake formed to shape, thickness as required to prevent failure due to loads or distortion. Provide stainless steel clips, proprietary items to suit siding profile and wall system.

Part 3 EXECUTION

3.1 ROOF AND SOFFIT WORK PROCEDURE

- .1 Install sheathing over the entire roof surface observing the required edge details and vents. Refer to Section 09 21 20. Coordinate installation with perimeter sub flashing and other flashings required for the support of the sheathing.
- .2 Install waterproof membrane system as indicated. Refer to the Section 07 52 16. Refer to details for detailing at roof penetrations and edge flashings.
- .3 Install intermittent clips and furring in accordance with Section 09 20 50 Furring and Lathing.
- .4 Install insulation in accordance with Section 07 21 00. Tape seal all joints and seal to intermittent clips.
- .5 Install drainage mat in accordance with manufacturer recommendations and as indicated.
- .6 Install new roof cladding system complete with associated accessories.
- .7 Install gutter and rainwater leader system. Refer to section 07 62 00.
- .8 Clean roof surface.

3.2 INSPECTION

- .1 Prior to installation of metal roof, confirm site conditions are compatible with manufacturer's recommendations and the roof cladding shop drawings. Inspect existing assemblies and ensure all conditions will provide satisfactory performance of the replacement roof (such as framing, sheathing, self adhesive membrane, clearances for perimeter seals, and adequate ventilation, etc.). Notify the Departmental Representative in writing of any discrepancies.
- .2 All membrane surfaces shall be firm and dry, without ridges, warps or voids, defects and shall be fully adhered to the supporting sheathing.

3.3 METAL ROOF AND SOFFIT WORK

- .1 Fabricate and install metal roofing in accordance with the approved shop drawings. Follow RCABC recommended practices.
- .2 Remove any strippable protective coating on the panels and flashings prior to installation and in any case do not allow the strippable coating to remain on the panels in extreme heat, cold, or in direct sunlight or other UV source.
- .3 Install all perimeter flashings and transitions to other building components. Provide self adhered membrane tie-ins as detailed.
- .4 Discrepancies between job site conditions and drawings as approved shall be brought to the attention of the Departmental Representative or their representative for resolution.
- .5 All panels to be continuous from top to eave.
- .6 Flash roof penetrations with material matching roof panels, and make watertight.
- .7 Form seams in direction of water flow and make watertight.
- .8 Install closures as required and complete with colour matching sealants.
- .9 Provide sub and cap flashings as indicated in details.

3.4 PROTECTION

- .1 All persons working on or around metal roofing surfaces must wear soft rubber-soled footwear.
- .2 During metal roof work, the membrane surface must be continually protected from damage by workers, ladders and other construction activity. Any damage must be repaired promptly.
- .3 Any metal roofing material, surfaces or finishes damaged, disfigured, marred or scratched, are to be replaced at no cost to the owner.

3.5 CLEAN-UP AND CLOSE-OUT

- .1 As work progresses, remove excess scrap and keep working surface free from debris on a daily basis.
- .2 Touch-up areas as required or directed with manufacturer's standard touch-up paint. Follow instructions for application carefully.
- .3 Leave project at completion free from stains and scrap. Wash panel surface with water if necessary.

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END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Work includes: labour, materials, equipment and services necessary to provide flashings and trim as indicated including: cross cavity, base, door, roof, and counter flashings.

1.2 REFERENCES

- .1 Canadian Sheet Steel Building Institute (CSSBI) S8-2001: Quality and Performance Specification for Prefinished Sheet Steel Used for Building Products.
- .2 AAMA 621 Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
- .3 ASTM A792 /A792M Specification for Steel Sheet, Aluminum-Zinc Alloy-Coated by the Hot-Dip Process with a minimum zinc coating designation Z150.
- .4 ASTM A653/653M Specification for Sheet Steel, Zinc-Coated or Zinc-Iron Alloy Coated by the hot dip process, with a minimum zinc coating designation Z275
- .5 ASTM D523 Test Method for Specular Gloss.
- .6 ASTM B32 Specification for Solder Metal.
- .7 Aluminium Association Designation System for Aluminium Finishes.
- .8 Aluminium Association Aluminium Sheet Metal Work in Building Construction.
- .9 CSA B111 Wire Nails, Spikes and Staples.
- .10 CAN/CGSB-93.1 Sheet, Aluminum Alloy, Prefinished, Residential.
- .11 Canadian Roofing Contractors Association (CRCA).
- .12 SMACNA Architectural Sheet Metal Manual.
- .13 CGSB 1-GP-171M, Type 1 Inorganic Zinc Rich Primer
- .14 SSPC Paint 20, Type 1-B Inorganic Zinc Rich Primer
- .15 Roofing Contractors Association of British Columbia (RCABC).

1.3 SUBMITTALS

- .1 Submit duplicate 150 x 150 mm samples of each type of sheet metal material, colour and finish.
- .2 Submit documentation identifying sheet metal source, testing results to specified standards and finish.

1.4 MOCK-UPS

- .1 Provide for approval prior to fabrication and installation and as part of the exterior wall assembly, mock-up for review by the Departmental Representative, a sample of each

flashing assembly detailed for the project, including cap and through wall flashing, door head, jamb, and sill flashing, base and drip edge flashing, and custom flashing fabrications.

1.5 DESIGN REQUIREMENTS

- .1 General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- .2 Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - .1 Temperature Change: [Low of -20 deg C to a high of 80 deg C] for material surfaces.

1.6 WARRANTY ON FINISHES

- .1 Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
- .2 Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - .1 Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - .2 Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - .3 Film Integrity: there shall be no evidence of cracking, chipping, peeling, crazing, spotting, flaking, checking or loss of adhesion.
- .3 Finish Warranty Period: 20 years from date of Substantial Completion.

Part 2 PRODUCTS

2.1 PREFINISHED SHEET STEEL

- .1 General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- .2 Base Metal Base Metal to be:
 - .1 Aluminium-zinc coated (Galvalume) steel sheet conforming to the requirements of ASTM A792 (or A792M) with a minimum coating of AZ50(AZM150).
 - .2 24 gauge thickness.
- .3 Exposed Coil-Coated Finish:
 - .1 Two-Coat Fluoropolymer: AAMA 2605-13. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat,

and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions. Dry film thickness of not less than 1.7 mil (0.043 mm) for primer and topcoat.

- .1 Preapproved product:
 - .1 Flurothane Coastal coating system by Valspar
 - .2 Approved alternate
- .4 Color: [As selected by Canadian Coast Guard from Manufacturer's standard colour range minimum 20 colours]. Both top and underside of flashing exposed to view to be finished with the same colour.
- .5 Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil (0.013 mm).

2.2 UNFINISHED STEEL

- .1 Form all customized flashings and other unfinished steel flashing products including vents, saddles, etc. of 24 Ga. minimum sheet steel according to the following:
 - .1 Base Metal to be:
 - .1 Aluminium-zinc coated (Galvalume) steel sheet conforming to the requirements of ASTM A792 (or A792M) with a minimum coating of AZ50(AZM150).
 - .2 Formed flashings to be typically folded and sealed and as approved by Consultant. Avoid soldering flashings. Use clinched joints whenever possible.
 - .3 Paint off site after fabrication to match prefinished flashing. Type and method of paint application must be preapproved by the Consultant. Paint must be a baked on finish.

2.3 ACCESSORIES

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
- .3 Touch-up paint: as recommended by prefinished material manufacturer.
- .4 Cleats, clips, and splice plates: of same material, coating, and temper as sheet metal, minimum 50mm wide. Thickness same as sheet metal being secured.
- .5 Fasteners:
 - .1 Into wood:
 - .1 Steel pan head screws with coarse thread for wood.
 - .1 #8 x 1" (minimum) long stainless steel suitable for metal flashing application. Stainless to be 300 Series when exposed otherwise 300 or 400 Series is acceptable.
 - .2 For exposed conditions use hex-head stainless steel screws, with neoprene washer, hex heads coloured to match flashing.
 - .2 Into masonry, concrete, stone:

- .1 One piece steel screw set into predrilled hole in concrete or masonry for medium duty connections.
 - .1 1/4" diameter x 1-3/4" long Kwik Con II Stainless by Hilti. Hex head for easier installation, Philips head for softer materials such as concrete block. Provide stainless steel washers to hold metal securely. Minimum 5/8" diameter.
 - .2 For exposed conditions, provide stainless steel washer with bonded neoprene gasket.
- .2 Steel pan head screws with stainless steel washers set into plastic plugs predrilled into concrete or masonry for lighter duty connections. Plastic plug version is required in softer materials such as brick or stucco.
 - .1 #8 x 1" long stainless steel pan head screws with 5/8" diameter stainless steel washers. For exposed conditions, provide washers with bonded neoprene gaskets. Stainless to be 300 Series when exposed otherwise 300 or 400 Series is acceptable.
 - .2 Plastic plugs to be 1-1/8" long Mungo plugs, MUN 6 by UCAN.
- .3 Into sheet steel:
 - .1 Steel pan head screws with fine thread for metal. Can be self tapping or self drilling.
 - .1 #8 x 1/2" (minimum) long stainless steel suitable for metal flashing application. Stainless to be 300 Series when exposed otherwise 300 or 400 Series is acceptable.
 - .2 For exposed conditions use pan head stainless steel screws, with neoprene washer, heads coloured to match flashing.
- .4 Into structural steel (non-exposed): Self drilling screws, corrosion resistant capable of salt spray testing per ASTM B117 providing 2000 hours red rust and 30 cycles Kesternich SO₂.
 - .1 Hilti Corporation Bi-Metal Kwik-Flex SS screw with Kwik-cote coating - #10 diameter, complete with washers as required.
 - .2 Provide washers to match the screw coating or stainless. In exposed conditions, provide washers with bonded neoprene gaskets. Minimum 5/8" diameter washers.
- .6 Solder: to ASTM B32 Standard Specifications For Metal Solders
Touch-up paint: as recommended by prefinished material Manufacturer.

Part 3 EXECUTION

3.1 FABRICATION

- .1 Fabricate metal flashings and sheet metal work other than aluminium in accordance with applicable CRCA 'FL' series details and SMACNA Architectural Sheet Metal Manual.
- .2 Fabricate aluminium flashings and other sheet aluminium work in accordance with Aluminium Association Aluminium Sheet Metal Work in Building Construction.
- .3 Form pieces in 2400 mm maximum lengths. Make allowance for expansion at joints. Use maximum length sections possible to minimize joints.

- .4 Hem exposed edges on underside 12 mm. Mitre and seal corners with sealant.
- .5 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .6 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.
- .7 Form joints between lengths of flashing sections with standing seams whenever possible. S-locks can only be used if approved by the Consultant.
- .8 All exposed or visible metal flashing and trim to be finished in selected colour as indicated including exposed rear faces of end dams, joints, etc. No exposed or visible steel or aluminium flashing work to be unfinished.
- .9 Fabricate custom flashing details and saddles to minimize solder joints.
- .10 Install sealant at flashing joints.
- .11 Metal Flashings including door head, jamb, and sill flashing, through wall flashing, drip edge flashing, base flashing, etc.
 - .1 Form all flashing surfaces as shown on drawings. Minimum slope of 1 in 4 to the exterior to be used where not shown.
 - .2 Form flashings, copings and fascias to profiles indicated.
- .12 Reglets And Cap Flashings
 - .1 Prefinished sheet metal as detailed and in accordance with RCABC Roofing Practices Manual and SMACNA Architectural Sheet Metal Manual details. Provide slotted fixing holes and hot dipped galvanized steel/plastic washer fasteners.
- .13 Custom flashing fabrications
 - .1 Shop fabricate custom flashing as indicated.
 - .2 Form custom flashing fabrications to minimize the number of metal seams and joints. Whenever possible form flashing with standing or breadpan seams.
 - .3 Use clinched joints whenever possible to avoid soldering.
 - .4 Soldered joints must be preapproved by the Consultant.
 - .1 Fully solder joints.
 - .2 Neutralize solder flux with neutralizing bath prior to painting.
 - .5 Paint off site after fabrication to colour specified. Type and method of paint application must be preapproved by the Consultant. Paint must be a baked on finish application after fabrication.

3.2 INSTALLATION

- .1 Install sheet metal work in accordance with RCABC details, SMACNA Architectural Sheet Metal Manual and Aluminium Sheet Metal Work in Building Construction as shown.
- .2 Use concealed fastenings except where approved before installation.
- .3 Provide underlay under sheet metal as required. Secure in place and lap underlayment joints 100 mm.

- .4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock and standing seams forming tight fit over hook strips.
- .5 Lock end joints and caulk with sealant.
- .6 Install surface mounted reglets true and level, and caulk top of reglet with sealant.
- .7 Install head and sill flashings at windows and doors in one continuous piece wherever possible.
- .8 Install flashings lapped “shingle” style with membranes to divert water to the exterior.
- .9 Install all flashings so that all surfaces have a minimum slope of 1:4 to the exterior.
- .10 Cross Cavity Wall Flashings
 - .1 Fit flashings together so that one end of each section is free to move in the joint.
 - .2 Provide end dams when flashings terminate. Caulk end dam to flashing and adjacent material to make watertight.
 - .3 Provide crickets where required to divert moisture to the exterior face of cladding assemblies.
- .11 Custom flashing fabrications
 - .1 Install custom soldered flashing fabrications as indicated.

END OF SECTION

Part 1 GENERAL

1.1 SUMMARY

- .1 Work described in this section includes but is not limited to the following:
 - .1 Sealing of interior finishes including at metal, wood and gypsum around penetration and door perimeters.
 - .2 Sealing of all exterior doors and other penetration perimeters at new rainscreen metal panel assemblies.
 - .3 Sealing of cladding joints in new rainscreen assemblies.
 - .4 Sealing of joints in control joints and expansion joints.
 - .5 Caulking and sealants not specified in other Sections.

1.2 REFERENCES

- .1 CAN/CGSB-19.24 Multi-component, Chemical Curing Sealing Compound.
- .2 CAN/CGSB-19.13, Sealing Compound, One Component, Elastomeric, Chemical Curing.
- .3 ASTM C 1193, Standard Guide for Use of Joint Sealers.
- .4 ASTM C920 Standard Specification for Elastomeric Joint Sealants.
- .5 Sealant, Waterproofing and Restoration Institute, Sealants: The Professional Guide.

1.3 SAMPLES

- .1 Prior to starting the work contractor shall submit.
 - .1 Manufacturer's product data and specifications for each sealant required.
 - .2 Sealant manufacturer's project recommendations stating recommended surface preparation for each substrate, and type of primer required (if necessary) for proposed sealant.
 - .3 Submit samples of each type of material and colour,

1.4 MOCK-UPS

- .1 Construct mock-up of each typical condition to show location, joint preparation, colour, size, shape and depth of joints complete with back-up material, primer, caulking and sealant. Typical conditions include but are not limited to door perimeters and cladding joints. Mock-up may be part of finished work.
- .2 Provide 48 hours notification to Departmental Representative and sealant manufacturer prior to application of mock-up for review. Cured adhesion and application to be reviewed by Departmental Representative and manufacturer before proceeding with sealant work.
- .3 Manufacturer to review mock-ups as required.

1.5 ENVIRONMENTAL AND SAFETY

- .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 acceptable to WCB.
- .2 Conform to manufacturer's recommended temperatures, relative humidity, and substrate moisture content for application and curing of sealants including special conditions governing use.

Part 2 PRODUCTS

2.1 SEALANT MATERIALS

- .1 Sealants acceptable for use on this project to be listed on CGSB Qualified Products List issued by CGSB Qualification Board for Joint Sealants. Where sealants are qualified with primers use only those primers.

2.2 SEALANT MATERIAL DESIGNATIONS

- .1 Interior Sealant
 - .1 Type 1- Interior Air Seal
 - .1 Interior perimeter seal of doors to prepared rough openings: Single component neutral cure silicone to CAN/CGSB 19.13. Colour to match adjacent finish unless sealant is not visible. When required colour to be selected by the owner from the range of manufacturer's standard colours.
 - .1 Metal and non-porous surfaces: Low- or medium-modulus silicone sealant
 - .1 Acceptable products:
 - .1 Dow Corning 795
 - .2 Tremco Spectrum 2
 - .3 G.E. Silpruf SCS 2000
 - .4 Pre-approved alternate
 - .2 Porous surfaces: Low-modulus silicone sealant
 - .1 Acceptable products:
 - .1 Dow Corning 790
 - .2 Tremco Spectrum 1
 - .3 G.E. Silpruf SCS 2700 low modulus
 - .4 Pre-approved alternate
 - .3 For house wraps and self adhered non-foil face membranes
 - .1 See Type 6
 - .2 Type 2: Interior finish sealant
 - .1 Acrylic sealant for interior finish. Confirm compatibility with finish. Colour to match adjacent finish and to be selected by the owner from the range of manufacturer's standard colours.

- .2 Acceptable products:
 - .1 Tremco 555
 - .2 Dap – Dynaflex 230
 - .3 Pre-approved alternate
- .2 Exterior sealant:
 - .1 Type 3a: Exterior Joints
 - .1 Single component neutral cure silicone to CAN/CGSB 19.13, colour to match adjacent finish and to be selected by the owner from the range of manufacturer’s standard colours.
 - .2 Acceptable materials:
 - .1 Dow Corning 795 (where both sides consist of non-porous surfaces).
 - .2 Dow Corning 790 Low modulus (where both sides consist of cementitious substrates).
 - .3 Dow 756 SMS (where both sides consist of natural stone substrates).
 - .4 Tremco Spectrum 2
 - .5 Tremco Spectrum 1 Low modulus
 - .6 G.E. Silpruf SCS 2000
 - .7 G.E. Silpruf SCS 2700 low modulus
 - .2 Type 4: Gutter applications
 - .1 One part elastomeric sealant made for submerged conditions and bonding to metal.
 - .2 Acceptable materials:
 - .1 Tremco Gutter Seal
 - .2 Pre-approved alternate
 - .3 Type 5: Fireplace sealant:
 - .1 High heat silicone
 - .2 Acceptable materials
 - .1 G.E. IS806
 - .2 Pre-approved alternate
 - .4 Type 6: Air barrier sealant (for poor bonding surfaces)
 - .1 To adhere to spun bonded polyolefin and fibrous or woven air barrier sheet material and poly faced self adhered membranes.
 - .2 Acceptable materials
 - .1 Dow Corning 758.
 - .2 Pre-approved alternate
 - .5 Type 7: Butyl sealant
 - .1 Non-curing, flexible polyisobutylene sealant.
 - .2 Acceptable products:
 - .1 Tremco Butyl sealant.
 - .2 Pre-approved alternate.t

- .3 Silicone Strips: Preformed low modulus fully cured silicone strips capable of +200/-75% movement capability.
 - .1 Width as required.
 - .2 Custom colour to match existing substrate unless noted otherwise.
 - .3 Acceptable products:
 - .1 Simple Seal by Tremco
 - .2 1-2-3 Strip by Dow Corning
 - .4 Bonding sealant: neutral cure silicone as recommended by manufacturer.
- .4 Preformed Compressible and Non-Compressible back-up materials.
 - .1 Backer Rod:
 - .1 Compressible closed cell standard foam backer rod (hard) for use with all types of sealants not requiring curing from backside. Use closed cell foam backer rod at EIFS panel joints with acrylic coatings in the joint area.
 - .2 Compressible closed and open cell foam backer rod (soft) for use with all types of sealants not requiring curing the backside and not in joints that are subject to submergence. Rod must not be susceptible to outgassing if cut.
 - .3 Open cell foam backer rod for use with any sealant type requiring curing from backside such double sealed joints. Do not use in joints subject to submergence in water.
 - .4 Size: oversize 30 to 50%
 - .2 Refer to the Sealant Manufacturer for specific products that are recommended with their sealants.
 - .3 Bond Breaker Tape.
 - .1 Polyethylene bond breaker tape that will not bond to sealant.

2.3 SEALANT SCHEDULE

- .1 Sealant and primer selection to be approved by the Departmental Representative and manufacturer during mock-ups prior to the undertaking of the work.
 - .1 Interior perimeter sealant joints of doors: (Type 1) (Type 6 option).
 - .2 Seal interior finish joints: Type 2
 - .3 Perimeters of exterior openings where frames or penetrations meet exterior facade of building – new rainscreen assemblies: (Type 3).
 - .4 Exterior cladding surface joints – new rainscreen assemblies: (Type 3).
 - .5 Transitions in metal roof assemblies: Type 3.
 - .6 Sealant joints in eavestroughs and gutters. Type 4.
 - .7 Air barrier sealant at spun bonded polyolefin and fibrous or woven air barrier sheet material: Type 6.
 - .8 Lap joints or moving joints at metal-to-metal contact surfaces: Type 7.

2.4 JOINT CLEANER

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

2.5 PRIMERS

- .1 As recommended by the sealant manufacturer for specific surfaces and environmental conditions. Primers are assumed to be required unless sealant manufacturer's installation instructions state otherwise for the specific application. Primers can only be omitted if the site testing has verified the bond is adequate without primers and must be approved by the sealant manufacturer and Departmental Representative.

Part 3 EXECUTION

3.1 PROTECTION

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

3.2 PREPARATION OF JOINT SURFACES

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

3.3 TESTING

- .1 Sealant bond tests are typically required for all exterior sealants and air barrier sealants to each type of interface and material. Contractor to provide sealant installation representative of the finished product in locations determined by the Departmental Representative for review and testing. The bond is to be confirmed by Contractor, Manufacturer and Departmental Representative prior to large scale sealant installation.

3.4 BACKUP MATERIAL

- .1 Install joint filler to consistently achieve correct joint depth and shape, with approximately 30% compression. Install backer rod without stretching, twisting,

braiding or puncturing its outer skin. For high heat locations use high heat resistant foam backer rod.

- .2 Apply bond breaker tape where required and to manufacturer's instructions.

3.5 PRIMING

- .1 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.
- .2 Prime only as much area as can be sealed in the same day.

3.6 MIXING

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

3.7 APPLICATION

- .1 Sealant
 - .1 Apply sealant as detailed and in accordance with manufacturer's written instructions.
 - .2 Refer to RDH sealant profile details.
 - .3 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
 - .4 Apply sealant in continuous beads.
 - .5 Apply sealant using gun with proper size nozzle.
 - .6 Use sufficient pressure to fill voids and joints solid.
 - .7 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, embedded impurities.
 - .8 Tool exposed surfaces before skinning begins to ensure firm full contact at joint interfaces, to give slightly concave and uniform shape free of ridges, wrinkles, sags, air pockets and embedded impurities. Care must be taken when using tooling aids to prevent contamination of substrates and sealant
 - .9 Minimum exterior sealant joint width to be $\frac{3}{8}$ inch, with minimum sealant depth to be $\frac{1}{4}$ inch.
 - .10 Minimum exterior fillet beads to be $\frac{3}{8}$ by $\frac{3}{8}$ inch, with bond breaker used at all exterior joint locations.
 - .11 Remove excess compound promptly as work progresses and upon completion.
 - .12 Remove masking tape immediately after tooling of joints.
- .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 Silicone Strips
 - .1 Prepare existing substrate similar to the sealant procedure.
 - .2 Install masking tape on border of silicone strip. Select strip width to achieve minimum sealant bond of $\frac{1}{2}$ " on each side of the joint with a minimum free width between sealant beads of $\frac{1}{2}$ ".

- .3 Apply sealant and then apply silicone strip to fresh sealant followed by hand and roller contact to fully bond the sealant and the silicone strip.
- .4 Remove masking tape.
- .5 Shingle lap all seams in silicone strip with a minimum 1" lap.
- .4 Cleanup
 - .1 Clean adjacent surfaces immediately and leave work neat and clean.
 - .2 Remove excess and droppings, using recommended cleaners as work progresses.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 This Section includes insulated hollow metal door products, including panels and frames as indicated.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A653/A653M-15e1, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Coated (Galvanealed) by Hot-Dip Process.
 - .2 ASTM A780/A780M-09(2015), Standard Practice for Repair or Damaged and uncoated areas of Hot Dip Galvanized Coatings.
 - .3 ASTM A879/A8790M-12 (2017), Standard Specifications for Steel Sheet, Zinc Coated by Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface,
 - .4 ASTM A924/A924M-17, Standard Specification for General Requirements for Steel Sheet, Metallic Coated by the Hot-Dip process.
 - .5 ASTM B29-14, Standard Specification for Refined Lead.
 - .6 ASTM B749-14, Standard Specification for Lead and Lead Alloy Strip, Sheet and Plate Products.
 - .7 ASTM D6386-16a, Standard Practice for preparation of Zinc (Hot Dip Galvanized) Coated Iron and Steel Product and Hardware Surface Painting.
 - .8 ASTM D7396-14, Standard Guide for Preparation of New, Continuous Zinc-Coated (Galvanized) Steel Surfaces for Painting.
- .2 Builders Hardware Manufacturers Association (BHMA)
 - .1 ANSI/BHMA A156.16-2013, Auxiliary Hardware.
- .3 Canadian Standards Association (CSA International).
 - .1 CSA-G40.20/G40.21-13, General Requirements for Rolled or Welded Structural Quality Steel, includes U No. 1 (2014)
 - .2 CSA W47.1-09 (R2014), Certification of Companies for Fusion Welding of Steel.
 - .3 CSA W59-13, Welded Steel Construction (Metal Arc Welding), includes Update No. 1 (2014), Update No. 3 (2015), Update No. 4 (2015)
- .4 Canadian Steel Door Manufacturers' Association (CSDMA)
 - .1 CSDMA, Guide Specification for Installation and Storage of Hollow Metal Doors and Frames, 2012.

- .2 CSDMA, Recommended Specifications for Commercial Steel Doors, 2009.
- .5 National Fire Protection Association (NFPA)
 - .1 NFPA 80 (2007) Standard for Fire Doors and Other Opening Protectives.
 - .2 NFPA (Fire) 252-Fire Tests of Door Assemblies, 2017 Edition.
- .6 The Society of Protective Coatings (SSPC)
 - .1 SSPC-PS 12.01, One Coat Zinc-Rich Painting System (includes 2004 Revisions)
 - .2 SSPC-PS Guide 12.00, Guide to Zinc-Rich Coating Systems.
- .7 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC S104-15, Standard Method for Fire Tests of Door Assemblies
 - .2 CAN/ULC S105-09, Standard Specification for Fire Door Frames Meeting the Performance Required by CAN/ULC-S104.

1.3 SUBMITTALS

- .1 Provide Submittals to Departmental Representative.
- .2 Product Data:
 - .1 Submit manufacturer's printed instructions, printed product literature, specifications and data sheets for each type of door and frame specified.
 - .2 Submit test and engineering data, and installation instructions.
- .3 Submit Shop Drawings:
 - .1 Indicate general construction of each type of door and frame, configuration, material, material thickness, jointing methods, mortises, reinforcements, anchors, arrangement of hardware, fire ratings, finish and special features.
 - .2 Reference door and frame types to Door Schedule.

1.4 QUALITY ASSURANCE

- .1 Manufacturer/Fabricator to be a member in good standing of the Canadian Steel Door and Frame Manufacturer's Association.
- .2 Installer to be experienced with the installation of hollow metal doors and frame of similar complexity and extent to that required of the Project,
- .3 Provide fire labelled frame products for those openings requiring fire protection ratings, as scheduled:
 - .1 List nationally recognized agency having factory inspection service and construct as detailed in Follow-up Service Procedures/Factory Inspection Manuals issued by listing agency to individual manufacturers.
 - .2 Fabricate all rated doors and frames to labelling authority standard.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, handle, store and protect materials in accordance with manufacturer's written instructions.
- .2 Adequately protect surfaces from damage during moving, handling and storage.

Part 2 PRODUCTS

2.1 PERFORMANCE/DESIGN CRITERIA

- .1 Level 'A' grade in tested in accordance with ANSI A250.4 test procedures.
- .2 Meets or exceeds ANSI/SDI A250.6
- .3 Meets the requirements of ANSI A250.8
- .4 Listed for fire door installations requiring positive or negative pressure testing (UBC-7-2-97, UL10 B, and UL 10C)

2.2 MATERIAL

- .1 Doors, Frames and Hardware:
 - .1 Door Construction:
 - .1 Manufactured hollow metal doors to be constructed of 20 gauge cold rolled steel.
 - .2 Core:
 - .1 At exterior doors and in semi conditioned spaces, install doors with solid slab of polystyrene insulation, bonded permanently to inside of skin, providing R6 thermal factor and sound deadening qualities.
 - .2 At interior conditioned spaces, install doors with high density honeycomb core, laminated under pressure with interlocking lock seam edges for durability.
 - .3 Listing: 1 ½ hour fire rating
 - .4 Single door sizes: Refer to Door Schedule
Double door sizes: Refer to Door Schedule
 - .5 Hinge location: NAAMM locations (5-10 equal; 38" (96.5mm) strike centre line)
 - .6 Inverted top and bottom channels for additional stability and protection.
 - .7 Interlocking seams to enhance structural rigidity and durability
 - .8 Beveled Lock Edge at handed door
 - .9 Square hinge and lock edge at non-handed door
 - .10 Heavy gauge closer reinforcement to exceed Steel Door Institute recommendations.

- .11 Hinge reinforcement with dimpled construction for heavy weight hinges.
- .2 Frame construction:
 - .1 Standard Profile - Expandable knock down frame, A40 paintable galvaneal steel
 - .2 Gauge: 16 Gauge
 - .3 1 ½ hour fire rating (ITS/WHI)
 - .4 1 ½" (38mm) pair – 4 ½" (114mm) high frequency hinge reinforcements
 - .5 ASA (4 7/8" (12.4mm) strike prep
 - .6 Bumper/silencer holes (3 @ strike jambs & 2 @ double heads)
 - .7 All double heads undersized by 1/8" from nominal width.
 - .8 Mechanical K.D. corner connection
 - .9 Faces punched & dimpled for wall anchoring
 - .10 #7 x 2 ½" for fastening
 - .11 WHI label embossment standard on 6'-8" (2030mm) hinge jambs
 - .12 Pre-punched label holes on non-embossed hinge jambs
 - .13 Adjustable jamb depths from 5 ½" to 8 ¾" (140mm x 222mm)
 - .14 Hinge reinforcement with dimpled construction for heavy weight hinges.
- .3 Hardware:
 - .1 To be determined
- .4 Primer: Touch-up primer: to ASTM A780/A780M and SSPC-PS 12.01
- .5 Paint: Prepare Surfaces for field painting to ASTM D6386 and ASTM D7396.
 - .1 Field paint steel doors and frame in accordance with Section 09 90 00. Protect weatherstrips from paint. Provide final finish free of scratches or other blemishes.
- .6 Approved Product:
 - .1 Baron Insulated Steel Door & Frames

Part 3 EXECUTION

3.1 MANUFACTURER'S INSTRUCTION

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

3.2 GENERAL INSTALLATION

- .1 Install doors and frames to CSDMA Guide Specification for installation and Storage of Hollow Metal Doors and Frames.
- .2 Install fire rated doors and frames in accordance with the requirements of NFPA 80.

3.3 FRAME INSTALLATION

- .1 Set frames plumb, square, level and at correct elevation.
- .2 Secure anchorages and connections to adjacent construction.
- .3 Brace frames rigidly in position during installation. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200mm wide. Remove temporary spreaders after frames are built in.
- .4 Make allowance for deflection of structure to ensure structural loads are not transmitted to frames.
- .5 Install door silencers.
- .6 Apply sealant at perimeter of frames as indicated in details.

3.4 DOOR INSTALLATION

- .1 Install door and associated hardware in accordance with hardware templates and manufacturer's instructions.
- .2 Provide even margins between doors and jambs, and doors and finished floor and threshold as follows:
 - .1 Hinge side: 1.0mm
 - .2 Latchside and Head: 1.5mm
 - .3 Finished Floor and thresholds: 6mm; 13mm at openings in non fire rated separations where undercuts are indicated.

3.5 FINISH REPAIRS

- .1 Touch up areas where coating has been removed or damaged with primer.
- .2 Fill exposed frame anchors and surfaces with imperfections with metallic paste filler and sand to uniform smooth finish.

3.6 FIELD PAINTING

- .1 Prepare surface for field painting to ASTM D6386 and ASTM D7396. Ensure all surfaces (protected and exposed) of doors and frames are primed and painted.

3.7 ADJUSTING AND CLEANING

- .1 Proceed in accordance with Section 01 11 00 General Requirements
- .2 Adjust doors for smooth and balanced door movement.
- .3 Clean doors and frames.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Sectional overhead doors of the following types:
 - .1 Flush steel doors, thermally-broken, polystyrene insulated. (Model 3220)
 - .2 Electric door operators

1.2 RELATED SECTIONS

- .1 Section 06 10 00 - Rough Carpentry: Rough wood framing and blocking for door opening.
- .2 Division 16 Sections: Electrical service and connections for powered operators.

1.3 REFERENCES

- .1 ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .2 ASTM A 924/A 924M - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .3 ASTM B 209/209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .4 ASTM B 221/221M - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

1.4 SUBMITTALS

- .1 Provide Submittals in accordance with Section 01 11 00 General Requirements.
- .2 Product Data:
 - .1 Submit Manufacturer's data sheets for sectional overhead doors and each associated product to be used, including:
 - .1 Preparation instructions and recommendations.
 - .2 Storage and handling requirements and recommendations.
 - .3 Installation methods.
 - .4 Operation and maintenance data.
 - .5 Nameplate data and ratings for motors.
 - .2 Submit Shop Drawings: Include opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.
 - .3 Selection Samples: For each finish specified, provide two complete sets of color chips representing manufacturer's full range of available colors and patterns.
 - .4 Verification Samples: For each finish specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.5 WIND PERFORMANCE REQUIREMENTS

- .1 Design doors to withstand positive and negative wind loads as calculated in accordance with applicable building code.
 - .1 Design Wind Load: 63 lb/sf (3.1 kPa)
 - .2 Safety Factor: 1.5 times design wind load.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the types of doors specified in this section, with not less than ten years of documented experience.
- .2 Installer Qualifications: Company specializing in installing the types of products specified in this section, with minimum of five years of documented experience, and approved by the door manufacturer

1.7 WARRANTY

- .1 Finish Warranty: Provide manufacturer's standard finish warranty against rust through.
 - .1 Warranty period: 10 years.
- .2 Delamination Warranty: Provide manufacturer's standard warranty against delamination.
 - .1 Warranty period: 10 years.

Part 2 PRODUCTS

2.1 MATERIAL

- .1 Flush Steel Doors, Thermally Broken, Polystyrene Insulated
 - .1 Door Construction:
 - .1 Panels: Sandwich construction of exterior and interior steel skins pressure bonded to an expanded core, with skins separated by a continuous silicone filling forming a thermal break.
 - .2 Steel Skins: Formed from roll formed commercial or drawing quality steel sheet, hot-dip galvanized per ASTM A 924/A 924M and ASTM A 653/A 653M, pre-painted with primer and baked-on polyester topcoat; sections formed to create weather tight tongue-in-groove meeting joint, unless otherwise specified.
 - .3 Reinforcing: Galvanized and primed steel reinforcement located under each hinge location, pre-punched for hinge attachment.
 - .4 Handle: High impact polymer step plate/lift handle on bottom panel section.
 - .5 Size: Refer to Architectural Drawings.
 - .6 Overall Panel Thickness: 2 inches (51 mm).

- .7 Steel Skin Thickness: Minimum 20 gauge 0.034 inch (0.86 mm) exterior; minimum 28 gauge 0.015 inch (0.38 mm) interior.
- .8 Stiles: Steel prepainted end stiles, minimum 0.049 inch (1.25 mm) thick, engineered for easy hardware attachment through prepunched holes.
- .9 Bottom panel section reinforced with continuous 0.050 inch (1.27 mm) aluminum astragal retainer with U-shaped flexible PVC astragal.
- .10 Thermal Resistance (R-value): 9.1 deg F hr sq ft/Btu (1.6 (K sq m)/W); calculated door section R-value in accordance with DASMA TDS-163
- .11 Windows: None.
- .12 Finish: Stucco embossed texture, white interior, exterior as follows:
 - .1 White
- .13 Locking: No Lock.
- .14 Locking: Inside spring loaded slide bolt lock on end stile that engages slot in track.
 - .1 Provide two inside slide lock.
- .15 Weatherstripping: Provide complete perimeter seals. Provide flexible top seal, flexible jamb seal and U shaped bottom seal.
- .16 Tracks: Vertical tracks minimum 0.061 inch (1.55 mm) galvanized steel tapered and mounted for wedge type closing. Horizontal tracks minimum 0.075 inch (1.91 mm) galvanized steel, reinforced with minimum 0.0897 inch (2.28 mm) galvanized steel angles as required:
 - .1 Track Width: 3 inches (75 mm).
 - .2 Provide standard lift tracks with 15 inches (381 mm) radius track as indicated.
- .17 Spring Counterbalance: Torsion spring counterbalance mechanism sized to weight of the door, with a helically wound, oil tempered torsion spring mounted on a steel shaft; cable drum of die cast aluminum with high strength galvanized aircraft cable with minimum 7 to 1 safety factor.
 - .1 Standard Cycle Spring: 10,000 cycle.
- .18 Break-Away Bottom Section: Integral part of door; with fiberglass or 1/8 inch (3 mm) polycarbonate lined bottom section with flexible neoprene rubber side edges; exterior to match door face.
 - .1 Break-away bottom section for doors up to 14 feet (4.3 m) wide.
 - .2 Approved Product:
 - .1 Clopay Commercial - Model 3220 Polystyrene Insulated Flush Steel Door.
 - .2 Approved Alternate.

.2 ELECTRIC DOOR OPERATORS

- .1 General: Provide electric door operator provided by door manufacturer for door with operational life specified complete with electric motor and factory pre-wired motor controls, starter, gear-reduction unit, clutch,

remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation. Comply with NFPA 70.

- .1 Solenoid-operated brake.
- .2 Disconnect Device: Provide hand-operated disconnect or mechanism for emergency manual operation while disconnecting motor, without affecting timing of limit switch. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.
- .3 Design operator so motor may be removed without disturbing limit switch adjustment and without affecting emergency auxiliary operator.
- .4 Provide control equipment complying with NEMA ICS1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V, AC or DC.
- .5 Electric Motors: Provide high-starting torque, reversible, continuous-duty, Class A insulated, electric motor, complying with NEMA MG 1, with overload protection, sized to start, accelerate, and operate door in either direction, from any position, at not less than 2/3 fps (0.2 m/s) and not more than 1 fps (.03m/s), without exceeding nameplate ratings or considering service factor.
 - .1 Type: Solid State.
 - .2 Type: Jackshaft
 - .3 HP:
 - .1 1/2 hp (373 W).
 - .4 Power Characteristics:
 - .1 115 V.
 - .2 1 phase
 - .5 Service Factor:
 - .1 NEMA MG 1
 - .6 Coordinate wiring requirements and electrical characteristics of motors with building electrical system.
- .6 Remote Control Station: Provide continuous contact, 3-button control station with push - button controls labeled "Open", "Close" and "Stop".
- .7 Provide interior units, fully guarded, surface mounted, heavy-duty type, with general-purpose NEMA ICS 6 enclosure in one of the following types:
 - .1 Enclosure Type: Type 1.
- .8 Obstruction Detection Device: Provide each motorized door with indicated external automatic safety sensor able to protect full width of door opening. Activation of sensor immediately stops and reverses downward door travel.
 - .1 Sensor Edge: Provide each motorized door with an automatic safety sensing edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor immediately stops

and reverses downward door travel. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cord. Sensing edge shall be operated by:

- .1 Electric.
- .9 Limit Switches: Provide adjustable switches, interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.
 - .1 Wiring to receiver to enhance radio control reception.
- .10 Provide auxiliary chain hoist: for emergency manual operation while disconnecting motor, without affecting timing of limit switch. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

Part 3 EXECUTION

3.1 EXAMINATION

- .1 Examine wall and overhead areas, including opening framing and blocking, with installer present, for compliance with requirements for installation tolerances, clearances, and other conditions affecting performance of Work in this Section.
 - .1 Proceed with installation only after unsatisfactory conditions have been corrected.
- .2 If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- .1 Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- .1 Install overhead doors and track in accordance with approved shop drawings and the manufacturer's printed instructions.

3.4 PROTECTION

- .1 Protect installed products until completion of project.
- .2 Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

Part 1 General

1.1 DESCRIPTION

- .1 The work of this section includes the supply and installation of lathing and metal furring to support the rainscreen stucco and thin brick assembly and metal panel assembly.
- .2 Includes all metal panel or accessories for exterior metal panel or stucco application including but not limited to the following:
 - .1 Z-girts c/w insulation retaining clip
 - .2 Hat track channels.
 - .3 Special U or C Channels
 - .4 Double angles as shown
 - .5 Double (back to back) angle furring
 - .6 Flatstock

1.2 REFERENCES

- .1 National Building Code
- .2 Association of Wall and Ceiling Contractors Specification Manual (latest edition).
- .3 British Columbia Wall and Ceiling Association Stucco Resource Guide (latest edition).
- .4 CSA CAN3-S136 Cold Form Steel Structural Members
- .5 ASTM C1063, Installation of Lath and Furring for Portland Cement Plaster
- .6 ASTM A653, Standard Specification for Steel Sheet, Zinc Coated (Galvanised) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot Dip Process
- .7 ASTM A123, Standard Specification for Zinc (Hot Dip Galvanised) Coatings on Iron and Steel Products
- .8 ASTM C833-96a Standard Specification for Welded Wire Lath
- .9 Canadian Sheet Steel Building Institute CSSBI 50M, Lightweight Steel Framing Manual
- .10 Canadian Sheet Steel Building Institute CSSBI 51M, Lightweight Steel Framing Design Manual

1.3 QUALITY ASSURANCE – STANDARDS SPECIFICATIONS

- .1 Section 9.1 - Lathing and Metal Furring of Assurance - Standard the Association of Wall and Ceiling Contractors (A.W.C.C.) Specification Standards Manual, together with authorized additions and amendments, shall be used as a reference standard when applicable and shall form part of this project specification.
- .2 Where modifications to the A.W.C.C. Specification Standards Manual are included in this project specification and results in a conflict, then the more stringent shall apply unless indicated otherwise by the Departmental Representative.

1.4 COOPERATION WITH OTHER TRADES

- .1 Co-operate with other trades to allow for proper sequence of installation and properly accommodate diffusers, grilles, light fixtures, outlet boxes, access doors and other penetrations in furred surfaces.
- .2 Layout of the furring and cement board support is to be coordinated with the masonry trade. Mockups of the completed thin brick assembly are required prior to installing the remainder of the furring.

1.5 PRODUCT DELIVERY / STORAGE /HANDLING

- .1 Deliver and store material undamaged in original wrappings or containers, with manufacturer's labels and seals intact.
- .2 Handle and store materials to prevent damage, inclusion of foreign matter, and rusting of metals.
- .3 Corner beads, casing beads, reveals and such trim shall be shipped in rigid packages to avoid damage. Bent or deformed materials will be rejected by the Departmental Representative.

1.6 MOCK-UP

- .1 A mock-up is required at a location selected by the Departmental Representative. The Mock-up shall be completed and accepted prior to cement board sheathing work proceeding. The mock-up shall include self-adhesive membrane, flashing, insulation, insulation retaining clips, furring, fiberglass spacers, fasteners, z-girts, custom subflashing for window returns and corners. The mock-up may remain as part of the finished work once approved by Departmental Representative.
- .2 The completed mockup for the thin brick assembly must include all components including pre-approved furring layout, cement board sheathing and masonry.

1.7 JOB CONDITIONS

- .1 Examine the underlying surfaces and adjoining work and report visible defects at time of installation that might impair the lathing work to the Contractor in writing.
- .2 Commencement of work shall imply acceptance of surfaces to receive lath and metal furring.
- .3 Do not commence lathing or metal furring work until the work that is to receive it and site conditions is satisfactory.

1.8 SUBMITTALS

- .1 Submit certified copies of mill reports covering chemical and mechanical properties and all coating designation of steel used.

Part 2 PRODUCTS

2.1 ACCESSORIES

- .1 All metal accessories manufactured of stainless steel. Minimum thickness of material is 18 gauge unless noted otherwise. All accessories to be of the same material for the project unless otherwise approved by the Departmental Representative.
- .2 Sheet metal thicknesses without coating thicknesses are defined as
 - .1 25ga is 0.0188"
 - .2 20ga is 0.0346"
 - .3 18ga is 0.0451"
 - .4 16ga is 0.0566"
 - .5 In no case is the supplied sheet steel to be less than 95% of the required thickness not including any coatings.

2.2 FASTENERS

- .1 Z-girt, hat section, C or U furring channels, double angle furring, and flat stock to steel substrate:
 - .1 Self drilling self tapping screws, stainless steel screws 302 or 304 series:
 - .1 Approved products:
 - .1 Kwik-Flex stainless steel, manufactured by Hilti.
 - .2 Alternate screws will be reviewed if samples submitted with mechanical information and corrosion protection test data.
- .2 Z-girt, hat section, C or U furring channels, double angle furring, and flat stock at concrete substrates:
 - .1 Hex-head screws complete with washers. Concrete substrate requires predrilling for screw placement.
 - .1 1/4" diameter x 1-3/4" long Kwik Con II Stainless by Hilti. Hex head for easier installation, Philips head for softer materials such as concrete block. Provide stainless steel washers to hold metal securely. Minimum 5/8" diameter.
 - .2 Approved alternate

2.3 FURRING

- .1 Material Description:
 - .1 For metal furring, base steel to CAN/CSA-S136, fabricated from ASTM A446M, Grade A to D steel. Steel to be identified as to specification, types, grade and mechanical properties.
 - .2 Sheet metal thicknesses without coating thicknesses are defined as:
 - .1 25ga is 0.0188"
 - .2 20ga is 0.0346"
 - .3 18ga is 0.0451"
 - .4 16ga is 0.0566"

- .5 In no case is the supplied sheet steel to be less than 95% of the required thickness not including any coatings.
- .3 Hat Track Furring Channels:
 - .1 Rolled formed, 18 ga (min). channel shaped “hat section”. Size: 4” x 3/4” min or as indicated in drawings. Depth of section may vary to suit cavity wall requirements. Refer to drawings for specific gauge and size.
- .4 Z-Girt Furring:
 - .1 Rolled formed, 0.048” (18 ga) (min) Z-Girt section.
- .5 Miscellaneous Furring:
 - .1 Stainless steel flatstock to support intermittent clips attached to ICF form fixing points (ICF web locations). Flatstock to be continuous, 50mm (2”) wide x 18 gauge.
 - .2 Miscellaneous C or U and corner channel support to be 18 gauge (min).

2.4 INTERMITTENT CLIPS

- .1 Intermittent Clips: Stainless steel adjustable clip. Minimum 18 gauge thickness, 38mm depth to support wall cladding and 140 mm to support metal roof panels.
 - .1 Adjustable Clip (A-Clip), by ACS Composite Systems Inc.
 - .2 Preapproved alternate.
- .2 Fasteners: Hex head washer head with fused and hardened steel tip, length to suit spacer depth and substrate.
 - .1 Fastener for steel framing: Hex head 1/4 - 14 x length to suit self drilling screws. Minimum penetration into steel framing is 1/2”.
 - .1 Acceptable material: Hilti, Kwik-Flex stainless steel.
 - .2 Fastener for cast-in-place concrete: Hex head 1/4 - 15 x length to suit concrete screw.
 - .1 Acceptable material: Hilti Kwik Con II, stainless steel, 1/4” by 1-3/4” (1-1/2” min. embedment)
 - .2 Embedment depth: 1-1/2” (38 mm).
 - .3 Gasket Sealant for spacer flange to wall membrane contact.
 - .1 Neutral cure silicone as per Section 07 92 00.

Part 3 EXECUTION

3.1 INSTALLATION - FURRING

- .1 Erect vertical Z – girt, hat track and double angle furring members:
 - .1 Vertically to the face of air-barrier membrane at the face of the exterior wall in alignment for attachment with exterior steel studs at maximum 400 mm o.c. in accordance with the drawings as shown.
 - .2 Shim and adjust furring and furring angles to achieve true, plumb and flush with adjacent surfaces. Double angles may be preferable to allow adjustability to ensure that completed construction is aligned true and plumb.

- .2 Erect double (back to back) angles:
 - .1 Vertically as required.
 - .2 Angles to be installed and adjusted in alignment to provide and maintain a true and plumb plane for attachment of metal or cladding assemblies.
- .3 Erect miscellaneous furring angle supports to the face of the air-barrier membrane as required.
- .4 Fasten Z-girt, hat track furring and miscellaneous furring angle support members at intervals not exceeding 12" (300 mm) along support.
- .5 Isolation Coating: At locations where galvanized furring (Z-girt, hat track furring or miscellaneous furring angle) are installed in direct contact with concrete, apply a coating of bituminous paint between the furring member and the substrate

3.2 INSTALLATION OF INTERMITTENT CLIPS

- .1 Intermittent Clip Installation: Install in accordance with manufacturer's written recommendations unless indicated or noted otherwise. In case of conflict the more stringent of requirements will apply.
- .2 Intermittent Clip spacing:
 - .1 Refer to drawings for clip spacing at walls and roof assemblies.
- .3 Each clip is to have a gasket sealant placed around each screw penetration at the roof membrane surface. Apply sealant to clip flange before installation.

3.3 ADJUST AND CLEAN

- .1 Ensure all components are assembled in a manner to achieve clean, straight, true, plumb and flush finishes. Adjust as required.
- .2 Clean daily and keep site in clean and acceptable condition at all times.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCE STANDARDS

- .1 AWCC - Association of Wall and Ceiling Contractors of British Columbia.
- .2 ASTM C36 - Standard Specification for Gypsum Wallboard.
- .3 ASTM C442 - Standard Specification for Gypsum Backing Board, Gypsum Coreboard, and Gypsum Shaftliner Board.
- .4 ASTM C475 - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- .5 ASTM C630 - Standard Specification for Water-Resistant Gypsum Backing Board.
- .6 ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
- .7 ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
- .8 ASTM C954 - Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.84 mm to 2.84 mm in Thickness.
- .9 ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .10 ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
- .11 GA-214-10E - Gypsum Association Recommended Levels of Finish.
- .12 CAN/ULC-S102, Standard Method of Test of Surface Burning Characteristics of Building Materials and Assemblies.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit for review and acceptance of each unit.
 - .2 Samples will be returned for inclusion into work.
 - .3 Submit 300 mm long samples of corner and casing beads.

1.4 DELIVERY, HANDLING AND STORAGE

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store gypsum board assemblies materials level off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect gypsum board from nicks, scratches, and blemishes.
 - .3 Protect from weather, elements and damage from construction operations.
 - .4 Handle gypsum boards to prevent damage to edges, ends or surfaces.
 - .5 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.5 AMBIENT CONDITIONS

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

Part 2 PRODUCTS

2.1 GYPSUM BOARD

- .1 Standard gypsum board:
 - .1 To ASTM C36, tapered longitudinal edges thickness 16 mm as indicated 1219 mm wide longest length for minimum joints.
- .2 Fire rated gypsum board:
 - .1 To ASTM C36, Type X, 16 mm thick x widths to suit framing centres x maximum practical lengths, wrapped tapered edges, square cut ends, fire rated ULC labelled.
- .3 Damage resistant gypsum board:
 - .1 High impact resistant and indent resistant boards with high density cellulosic fibres and gypsum dispersed evenly throughout panel thickness , reinforced with a fibre mesh backing and face coating for abrasion resistance, Type X, thickness indicated x widths to suit framing centres x maximum practical lengths, tapered edges, square cut ends, fire rated ULC labelled.

2.2 FASTENINGS AND ADHESIVES

- .1 Screws: to ASTM C954
- .2 Nails: to ASTM C514.
- .3 Laminating compound: asbestos-free.

2.3 ACCESSORIES

- .1 Casing beads: fill type, galvanized metal and vinyl extrusion types, perforated flanges, full length pieces to ASTM C1047.
- .2 Corner beads: 0.5 mm metal thickness commercial grade sheet steel with Z275 designation zinc finish, fill type, expanded wing style, full length pieces ASTM C1047.
- .3 Jointing compound and tape: to ASTM C475.
- .4 Acoustical/air barrier sealants:
 - .1 Concealed: sealing and bedding compound to CAN/CGSB 19.21.
 - .2 Exposed: to CAN/CGSB 19.17 one component, acrylic emulsion base in accordance with Section 07 90 00.

Part 3 EXECUTION

3.1 EXAMINATION

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

3.2 ERECTION

- .1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.
- .2 Do application of gypsum sheathing to ASTM C1280.
- .3 Install work level to tolerance of 1:1200.
- .4 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers, grilles.
- .5 Install furring channels parallel to, and at exact locations of steel stud partition header track.
- .6 Furr above suspended ceilings for gypsum board fire and sound stops and to form plenum areas as indicated.

- .7 Install wall furring for gypsum board wall finishes to ASTM C840, except where specified otherwise.
- .8 Furr duct shafts, beams, columns, pipes and exposed services where indicated.

3.3 APPLICATION

- .1 Apply gypsum board after bucks, anchors, blocking, sound attenuation, electrical and mechanical work have been approved.
- .2 Apply gypsum board to metal furring or framing using screw fasteners, screw fasteners.
- .3 Maximum spacing of screws 300 mm on centre.
- .4 Apply 12 mm diameter bead of acoustic sealant continuously around periphery of each face of partitioning to seal gypsum board/structure junction where partitions abut fixed building components. Seal full perimeter of cut-outs around electrical boxes, ducts, in partitions where perimeter sealed with acoustic sealant.
- .5 Install gypsum board on walls vertically to avoid end-butt joints. At stairwells and similar high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.
- .6 Install gypsum board with face side out.
- .7 Do not install damaged or damp boards.
- .8 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

3.4 INSTALLATION

- .1 Erect accessories straight, plumb or level, rigid and at proper plane. Use full length pieces where practical. Make joints tight, accurately aligned and rigidly secured. Mitre and fit corners accurately, free from rough edges. Secure at 150 mm on centre.
- .2 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .3 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .4 Install access doors to electrical and mechanical fixtures specified in respective sections.
 - .1 Rigidly secure frames to furring or framing systems.
- .5 Finish face panel joints and internal angles with joint system consisting of joint compound, joint tape and taping compound installed according to manufacturer's directions and feathered out onto panel faces.
- .6 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI Levels of Gypsum Board Finish:
 - .1 Levels of finish:
 - .1 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable, in areas where the walls or ceiling are concealed

- .2 Level 2: embed tape for joints and interior angles in joint compound and apply one separate coat of joint compound over joints, angles, fastener heads and accessories; surfaces free of excess joint compound; tool marks and ridges are acceptable, where aesthetic appearance is not a primary concern.
- .3 Level 4: embed tape for joints and interior angles in joint compound and apply three separate coats of joint compound over joints, angles, fastener heads and accessories; surfaces smooth and free of tool marks and ridges, where paint finish is specified.
- .7 Finish corner beads, control joints and trim as required with two coats of joint compound and one coat of taping compound, feathered out onto panel faces.
- .8 Fill screw head depressions with joint and taping compounds to bring flush with adjacent surface of gypsum board so as to be invisible after surface finish is completed.
- .9 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .10 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.
- .11 Mix joint compound slightly thinner than for joint taping.

3.5 PROTECTION

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

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.
- .2 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 Work Included in this section includes but is not limited to:
 - .1 Supply and installation of exterior wall sheathing.
 - .2 Supply and installation of roof deck sheathing.

1.2 REFERENCES

- .1 BC Building Code
- .2 Association of Wall and Ceiling Contractors Specification Manual
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-51.34-[M86], Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
- .4 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S102-[1988], Building Materials and Assemblies, Standard Method of Test for Surface Burning Characteristics of.
- .5 American Society for Testing and Materials (ASTM)
 - .1 ASTM A 653M-[94], Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .2 ASTM C 954-[93], Specification for Steel Drill Screws for the Application of Gypsum Board.
 - .3 ASTM C 1177-[91], Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - .4 ASTM C 1178-[93], Specification for Glass Mat Water-Resistant Gypsum Backing Board (in bath and shower areas)
 - .5 ASTM D 3273, Standard Test Method for Resistance to Growth of Mold

1.3 SUBMITTALS

- .1 Submit manufacturer's descriptive literature indicating material composition, thickness, sizes and fire resistance.
- .2 Submit manufacturer's written certificate that product meets specified requirements

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver materials to the job site in manufacturer's original packaging, containers and bundles with manufacturer's brand name and identification intact and legible.
- .2 Store level and handle materials to protect against contact with damp and wet surfaces, exposure to weather, breakage and damage to edges. Provide air circulation under covering and around stacks of materials.

Part 2 PRODUCTS

2.1 MATERIALS

- .1 Sheathing board
 - .1 Gypsum sheathing board that is non-combustible, fire resistant, water resistant and mould resistant in accordance with ASTM C 1177. Board to contain a moisture resistant core with glass mats both sides and long edges, ½" (13 mm) thick, 1200 mm wide x maximum practical length. (Provide 5/8" thick ULC tested Type X sheathing board as indicated on the drawings.)
 - .2 Mold resistance to meet ASTM D 3273, minimum score of 10.
 - .3 Acceptable Products:
 - .1 ½" DensGlass Gold by Georgia Pacific
 - .2 ½" Securock Glass-Mat by CGC Inc
 - .3 Preapproved alternate.
- .2 Roof board
 - .1 Non-structural, non-combustible, fibreglass-embedded, moisture resistant gypsum core panel in accordance with ASTM C 1177, Minimum thickness of 13 mm thick unless noted otherwise, 1200 mm wide x maximum practical length.
 - .2 Acceptable Product: Dens Deck Roof Board by Georgia Pacific
 - .3 Preapproved alternate
- .3 Screws, metal framing:
 - .1 Type S-12, #6 min., bugle head, self-tapping, corrosion protected, fine thread for heavy steel gauge (12 – 22)
 - .2 Type S, bugle head, corrosion protected sharp point, fine thread for light gauge metal framing or furring.
 - .1 ITW Buildex Rock-On.
 - .2 Approved alternate.
- .4 Screws, concrete substrate:
 - .1 Self tapping screws complete with washers.
 - .1 ITW Buildex Scots Tapcon with Climaseal Coating ¼" by 1-3/4" (1-1/2" min. embedment)
 - .2 Approved alternate.
- .5 Sheathing Support
 - .1 As shown on drawings or provide metal support to fasten edge of boards to Z-girt framing at slab edge conditions.
 - .2 Material to be galvanized steel, 22 Gauge, to ASTM A653 G90 coating.
- .6 Mineral Fibre Insulation: as specified in Specification 07 21 00.
- .7 Cementitious Filler: Primus by Dryvit. 100% Polymer based product site mixed with Portland cement to form patching compound for filling joints in sheathing.

Part 3 EXECUTION

3.1 PREPARATION

- .1 Examine subframing; verify that surface of framing and furring members to receive sheathing does not vary more than 6 mm from the face of adjacent members. Notify Departmental Representative of any deviations or unacceptable conditions.
- .2 Do application and finishing of gypsum board in accordance with ASTM C 840 except where specified otherwise.
- .3 Install blocking as indicated.
- .4 Install mineral fibre insulation as indicated.

3.2 INSTALLATION

- .1 Do not apply sheathing board until steel framing, anchors and blocking work are approved.
- .2 Install sheathing to metal framing with screws spaced at 200 mm o.c. at perimeter and 300 mm o.c. in field (200mm o.c. in field for soffit locations and when girts are not used).
- .3 Perimeter screws shall not be less than 9mm nor more than 12mm from edges and ends and shall be opposite the screws on adjacent boards.
- .4 Drive fasteners to bear tight against and flush with surface of sheathing. Do not countersink.
- .5 Use maximum lengths possible to minimize number and placement of joints. Locate edge joints parallel to and with vertical orientations on framing. Stagger intermediate end joints of adjacent lengths of sheathing. Make joints tight, accurately aligned and rigidly secured. Particular care to taken at wall corners which are not at 90 degrees to obtain snug joint with maximum gap of 3mm.
- .6 Typical board joints to be tight to provide continuous support for the waterproof membrane. Board joints at base of slab to provide 3/8" joint for deflection or as required, and to be supported by metal supports and blocking as indicated.
- .7 For sheathing supporting self adhered membrane, fill all joints greater than 5/16" (8mm) with cementitious filler.

END OF SECTION

Part 1 General

1.1 RELATED WORK

- .1 Section 09 21 16 – Gypsum Board Assemblies

1.2 REFERENCE STANDARDS

- .1 Association of Wall and Ceiling Contractors (AWCC) of British Columbia.
- .2 Canadian Sheet Steel Building Institute (CSSBI) Lightweight Steel Framing Manual.
- .3 CSA W59 Series, Welded Steel Construction (Metal Arc Welding).
- .4 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .5 CAN/ULC-S101, Standard Methods of Fire Endurance Tests of Building Construction and Materials.
- .6 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating
- .7 CAN/CGSB-7.1, Lightweight Steel Wall Framing Components.
- .8 ASTM A924/A924, Standard Specification for General Requirements for Steel Sheet, Metallic- Coated by the Hot-Dip Process Document Number.
- .9 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc- Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process Document Number.
- .10 ASTM C645, Standard Specification for Nonstructural Steel Framing Members Document Number.
- .11 BC Building Code, including Clause 4.1.9.1.15 and Table 4.1.9.1.D.

1.3 DESIGN CRITERIA

- .1 Interior studs:
 - .1 Limit deflection to L/120 for gypsum board finishes.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Waste Management and Disposal: Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Project 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 for recycling in accordance with Waste Management Plan.
- .4 Divert unused metal materials from landfill to metal recycling facility approved by Departmental Representative.
- .5 Divert unused gypsum materials from landfill to recycling facility approved by Departmental Representative.

Part 2 PRODUCTS

- .1 Interior studs:
 - .1 Non-load bearing channel stud framing: to ASTM C645, roll formed hot dipped galvanized steel sheet, 25 ga. thickness for stud lengths up to 3500 mm, 20 ga. thickness for stud lengths greater than 3500 mm, unless indicated otherwise on the drawings, for screw attachment of gypsum board. Knock-out service holes at 460 mm centres.
 - .2 Material: ASTM C645 sheet steel.
 - .3 Finish: electro-galvanized finish or ASTM A653/A653M - Z120 (G40) designation zinc coating.
 - .4 Stud sizes: refer to wall schedules.
- .2 Top and bottom tracks: widths to accept stud depths x 32 mm flange height, same material/metal thickness/finish as respective studs, unless indicated/scheduled otherwise.
- .3 Metal channel stiffeners: 19 mm size x 2 mm base metal thickness cold rolled steel channel profile, rust inhibitive finish.
- .4 Sill gasket: pre-cut 6 mm thick x plate width x roll length closed cell polyethylene foam material.
- .5 Acoustical sealant: to CGSB 19-GP-21M.
- .6 Zinc rich paint and touch-up primer for interior surfaces: meeting requirements of Green Seal Standard GS-11, Paints and Coatings, for VOC content to be less than 250 g/l.

Part 3 EXECUTION

3.1 INSTALLATION - GENERAL

- .1 Align partition tracks at floor and ceiling and secure at 600 mm on centre maximum.
- .2 Install damp proof course under stud shoe tracks of partitions on slabs on grade.
- .3 Erect studs to 1:1000 tolerance and no more than 3 mm out of face alignment measured from stud to adjacent stud.

- .4 Position studs in top and bottom tracks. Cross brace as required to produce rigid installations; do not use surface applied straps.
- .5 Fix studs to top and bottom tracks using screws or crimping tool. Co-ordinate installation of studs with installation of service lines/bracing. Ensure that knock-out holes align.
- .6 Co-ordinate installation of studs with installation of door and window frames and special supports for work stated on other sections.
- .7 Co-ordinate with applicable trades for installation of blocking and backing for wall hung items.
- .8 Alter stud metal thickness (gauge) and spacings as required to be within design criteria deflection requirements.

3.2 INSTALLATION - INTERIOR STUDS

- .1 Place studs vertically at maximum 400 mm centres, at each side of openings and corners. Place studs no more than 50 mm from abutting walls.
- .2 Alter stud metal thickness (gauge) and spacings as required to be within design criteria deflection requirements.
- .3 Use minimum 20 ga. studs at walls supporting abuse resistant gypsum board, plywood, MDF, or cement boards, refer to board manufacturers design criteria for minimum gauge requirements.
- .4 Extend studs to structure above, unless noted otherwise.
- .5 Install 20 ga. jamb studs at interior door/window openings. Use double studs at openings up to 4 times stud spacing and minimum triple studs at openings exceeding 4 times stud spacing.
- .6 Extend from floor to structure over.
- .7 Provide continuous horizontal channel reinforcement at 1200 mm above finished floor. Provide horizontal channel reinforcement above each door opening; extend minimum 2 stud spaces both sides of opening.
- .8 Provide track at head of interior door/window openings and at sills of interior sidelight/window openings to accommodate intermediate studs. Secure track to studs at each end in accordance with manufacturer's directions. Install intermediate studs above and below openings in same manner and spacings as wall studs.
- .9 Frame openings and around built-in equipment, cabinets and access panels on 4 sides. Extend framing into reveals. Check clearances with equipment suppliers.
- .10 Provide furring channels or heavy gauge studs between studs for attachment of fixtures behind lavatory basins, vanities, toilet and bath accessories, door stops and other wall hung/wall braced items, including Owner installed washroom accessories.
- .11 Provide furring channels or studs between wall studs for attachment of service/device boxes.

END OF SECTION

Part 1 General

1.1 SUMMARY

- .1 The work described in this section includes exterior paint application for, exterior doors, frames, and associated accessories.

1.2 REFERENCES

- .1 Master Painters and Decorators Association of B.C. Reference Manuals (Painting Specification Manual):
 - .1 New Surfaces - CPCA/MPDA Painting Specification Manual, latest edition

1.3 REQUIREMENTS INCLUDED

- .1 This section of work shall include all labour, materials, tools, scaffolds and other equipment services and supervision required to cover with paint the surfaces of the building or structure, the building services and accessories not otherwise protected or covered, as shown on the “Finish Schedule”, to the full intent of the drawings and specifications.
- .2 All finished areas that are affected by the work (new and existing) are to be fully prepared and painted in accordance with this specification in colours to match existing.
- .3 All surfaces to receive painting are to be fully finished, suitable for the application of pre-treatments, surface preparation, priming and coating in accordance with the Painting Specification Manual

1.4 QUALITY CONTROL

- .1 Retain purchase orders, invoices and other documents to prove that material used in contract meets requirements of specification and produce when requested by Consultant.

1.5 FIELD CONDITIONS

- .1 Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- .2 Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

1.6 QUALITY ASSURANCE

- .1 Conform to MPI’s Painting Architectural Specification Manual and the Maintenance Repainting Manual, latest editions.
- .2 Qualification of the Manufacturer: The paint products of the Paint Manufacturer shall be listed in the Painting Specification Manual under “Paint Product Recommendation” section, or approved equivalent.
- .3 Qualification of Applicators: The contractor shall have a minimum of five (5) years proven satisfactory experience. This contractor shall maintain a qualified crew of

painters throughout the duration of the work who shall be qualified to fully satisfy the requirements of this specification.

1.7 SAMPLES AND MOCK-UPS

- .1 Provide samples to Departmental Representative.
- .2 When requested by the Departmental Representative, prepare and repaint designated surface, area or room to workmanship standards of the MPI Repainting Manual for review and approval. When approved, surface, area, room and/or items shall become acceptable standard of finish quality for similar on-site repainting work.
- .3 Apply coating test area to an agreed mock-up location to confirm method of application, material compatibility, adherence, bond, texture, finish and colour for each paint colour and type. Test area to be a minimum of 1 square metre.

1.8 SUBMITTALS

- .1 Submit list of all painting materials to the Departmental Representative for review prior to ordering materials
- .2 When requested, submit invoice list of all paint materials ordered for project work indicating manufacturer, types and quantities for verification and compliance with specification and design requirements.
- .3 At project completion, provide an itemized list complete with manufacturer, paint type and colour coding for all colours used for Owner's later use in maintenance.

1.9 DELIVERY AND STORAGE

- .1 Deliver and store materials in manufacturer's original container, sealed with labels intact.
- .2 Ensure dry delivery and storage of materials and equipment at site.
- .3 Indicate on containers or wrappings:
 - .1 Manufacturer's name and address.
 - .2 Type of paint.
 - .3 Compliance with applicable standard.
 - .4 Colour number in accordance with established colour schedule.
- .4 Store materials and equipment in a well ventilated place with temperature range 10 to 30° C.

1.10 ENVIRONMENTAL REQUIREMENTS

- .1 Safety: comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
- .2 Apply paint finishes only when temperature and ventilation at location of installation can be satisfactorily maintained within manufacturer's recommendations.
- .3 Substrate, ambient temperature and humidity must be within limits prescribed by manufacturer.
- .4 Provide temporary heating where permanent facilities are not available to maintain minimum recommended temperatures.

- .5 Apply paint finish only in areas where dust is no longer being generated by related construction operations such that airborne particles will not affect the quality of the finished surface.
- .6 Apply paint only when surface to be painted is dry, properly cured and adequately prepared.

1.11 EXISTING CONDITIONS

- .1 Investigate structural problems related to safe execution of preparation of structure to be painted and report unsatisfactory conditions to Departmental Representative before beginning work.
- .2 Report to Departmental Representative conditions of deteriorated materials found during preparation, not previously disclosed.
- .3 The exposed concrete elements of the building have some delaminated coatings and must be identified at the start of the work to ensure repairs are made well in advance of painting.

1.12 PROTECTION

- .1 Protect paint and painting equipment before use and during length of contract from climatic elements.
- .2 Protect structure from markings and other damage. Protect completed work from paint droppings. Use non-staining coverings.
- .3 Remove all electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area. No solvent shall be used to clean hardware that will affect the finish of the hardware.
- .4 Provide for protection of passing pedestrians and the general public.

1.13 SCHEDULING OF WORK

- .1 Submit work schedule starting and final completion dates for approval by Departmental Representative.
- .2 Take measures necessary to complete work within approved scheduled time. Change in schedule must be approved by Departmental Representative.
- .3 Co-ordinate execution with other work at site.

1.14 ALTERNATIVES

- .1 Products conforming to this specification must be identified in writing by contractor for approval by Departmental Representative.
- .2 Changing manufacturers' brands, sources of supply of painting materials from those previously approved must be approved by Departmental Representative.
- .3 Request for alternative approval must be submitted in writing and be accompanied by full literature and recommendations from manufacturers concerned.

1.15 MAINTENANCE MATERIALS

- .1 At project completion, provide 4 litres (1 gallon) of each type and colour of paint from same production run (batch mix) used in unopened cans, properly labelled and identified for Owner's last use in maintenance. Store where directed.

Part 2 PRODUCTS

2.1 MANUFACTURER

- .1 Basis-of-Design Product: Subject to compliance with requirements, provide products from one of the following:
- .2 Preapproved manufacturer:
 - .1 Samhwa Paint
 - .2 Preapproved alternate
- .3 Source Limitations: Obtain paint materials from single source from single listed manufacturer for each paint system.
 - .1 Manufacturer's designations listed on a separate colour schedule are for colour reference only and do not indicate prior approval.

2.2 PAINT, GENERAL

- .1 MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- .2 Material Compatibility:
 - .1 Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - .2 For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- .3 VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.
- .4 Colours: As indicated in the Colour schedule.

2.3 SOURCE QUALITY CONTROL

- .1 Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - .1 Owner may engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - .2 Testing agency will perform tests for compliance with product requirements.
 - .3 Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove

rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

2.4 TOOLS AND EQUIPMENT

- .1 Painting equipment to best trade standards for type of product and application.
- .2 Departmental Representative will determine areas where power tools or equipment may be used for both preparing and painting of substrate.

2.5 Mixing and tinting

- .1 Unless otherwise specified, paints shall be ready-mixed. Re-mix prior to application to ensure colour and gloss
- .2 Paste, powder or catalysed paint mixes shall be mixed in strict accordance with manufacturer's written instructions
- .3 Perform all colour tinting operations prior to delivery of paint to site.
- .4 Where thinner is used, addition shall not exceed paint manufacturer's recommendations
- .5 Confirm with manufacturer that the addition of tinting components will not significantly affect performance characteristics

2.6 GLOSS / SHEEN

- .1 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following values:
 - .1 Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523, a matte flat finish.
 - .2 Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523, a high-side sheen flat, velvet-like finish.
 - .3 Gloss Level3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523, an eggshell finish.
 - .4 Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523, a satin-like finish.
 - .5 Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523, a semi-gloss finish.
 - .6 Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523, a gloss finish.
- .2 Finish (i.e. gloss level) of all painted surfaces shall be as indicated by Departmental Representative.

2.7 PAINTING AND FINISH SCHEDULE

- .1 Paint exterior surfaces in accordance with the following MPI Manual requirements:

Location and Substrate	DSD No.	Paint Code and MPI #	Gloss Level
EXT 5.3L – G6 Galvanized metal doors and frames	0	EXT 5.3L – G6	6

Part 3 EXECUTION

3.1 CONDITION OF SURFACES

- .1 Prior to commencement of work of this section, thoroughly examine all conditions and surfaces scheduled to be repainted and report in writing to the Consultant any conditions or surfaces that will adversely affect work of this section.
- .2 No repainting or painting work to commence until all such adverse conditions and defects have been corrected and surfaces and conditions are acceptable to the Consultant.
- .3 The degree of surface deterioration (DSD) shall be assessed using the assessment criteria indicated in the MPI Maintenance Repainting Manual. In general the MPI DSD ratings and descriptions are as follows:

Condition	Description
DSD-0	Sound Surface (may include visual (aesthetic) defects that do not affect films protective properties).
DSD-1	Slightly Deteriorated Surface (may show fading; gloss reduction, slight surface contamination, minor pin holes scratches, etc.) / Minor cosmetic defects (runs, sags, etc.).
DSD-2	Moderately Deteriorated Surface (small areas of peeling, flaking, slight cracking, staining, etc.).
DSD-3	Severely Deteriorated Surface (heavy peeling, flaking, cracking, checking, scratches, scuffs, abrasion, small holes and gouges).
DSD-4	Substrate Damage (repair or replacement of surface required by others).

3.2 SURFACE PREPARATION

- .1 Prepare all surfaces in accordance with the requirements of MPI Manuals.
- .2 Protect all adjacent surfaces and areas from painting operations and damage by drop cloths, shields, masking, templates, or other suitable protective means and make good any damage caused by failure to provide such protection
- .3 Remove and securely store all miscellaneous hardware and surface fittings and fastenings including by not limited to electrical plates, mechanical louvers, light fixtures and trim, mouldings, etc. prior to repainting and replace upon completion. Carefully clean and replace all such items upon completion of repainting work in each area. Do not use solvent or reactive cleaning agents on items that will mar or remove finishes.
- .4 Sand, clean dry etch, neutralize and/or test all surfaces under adequate illumination, ventilation and temperature requirements.
- .5 Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - .1 SSPC-SP 3, "Power Tool Cleaning."

3.3 PAINT APPLICATION

- .1 Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
- .2 Do not paint unless substrates are acceptable and/or until all environmental conditions (heating, ventilation, lighting, weather conditions and precipitation, or completion of other work) are acceptable for application of products.
- .3 Cold weather painting, when temperatures are less than 10 degrees C, is only permitted when paints formulated for lower temperatures are used and manufacturer's limitations are observed for maximum humidity levels and minimum temperatures. Contractor to submit technical information regarding paint manufacturer's recommendations for cold weather work and protection.
- .4 Paint and repaint all surfaces requiring paint, stain or coating to minimum MPI Manual finish requirements with application methods in accordance with best trade practices for type and application of materials used.
- .5 Painting coats specified are intended to cover surfaces satisfactorily when applied at proper consistency and in accordance with manufacturer's recommendation
- .6 Method of application and uniform coats of specified film thickness be in agreement with paint supplier and Consultant.
- .7 Apply each coat at the proper consistency.
- .8 Sand lightly and dust between coats to achieve an anchor for the next coat and to remove defects visible from a distance up to 1000 mm.
- .9 Do not apply finishes on surfaces that are not sufficiently dry. Unless manufacturer's directions state otherwise, each coat shall be sufficiently dry and hard before a following coat is applied.

3.4 FIELD QUALITY CONTROL

- .1 Painted, repainted and primed surfaces shall be considered to lack uniformity and soundness if any of the following defects are apparent:
 - .1 Runs, sags, hiding or shadowing by inefficient application methods
 - .2 Evidence of poor coverage at rivet heads, plate edges, lap joints, crevices, pockets, corners and re-entrant angles
 - .3 Damage due to touching before paint is sufficiently dry or any other contributory cause
 - .4 Damage due to application on moist surfaces are caused by inadequate protection for the weather
 - .5 Damage and/or contamination of paint due to window blown or air born contaminants
 - .6 Evidence of poor paint bonding.
 - .7 Painted, repainted or primed surfaces rejected by the Departmental Representative shall be made good at the expense of the Contractor
- .2 Examine surface for adequate preparation.
- .3 Check all materials for correctness.

3.5 CLEAN-UP

- .1 Removal of all paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
- .2 Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris
- .3 Remove combustible rubbish material and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.
- .4 Clean equipment and dispose of wash water / solvents as well as all other cleaning and protective materials, paints, thinners, paint removers/strippers, in accordance with the safety requirements of authorities having jurisdiction.
- .5 Protect area where paint has been applied and avoid scuffing newly applied paint.

END OF SECTION

1. GENERAL

1.1 General

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.
- .2 General Conditions, Supplements, Amendments and this section shall govern plumbing sections (i.e. 22 00 00 to 22 99 99 sections) of work (read in conjunction with the Instructions to Tenderers or Bidders). This section covers items common to 22 00 00 series sections and is intended only to supplement the requirements of Division 1.
- .3 Plumbing drawings are diagrammatic and approximately to scale. They establish scope of plumbing work and general location and orientation of plumbing facilities. Plumbing facilities shall be installed generally in locations and generally along routings shown, close to building structure with minimum interference with services. Piping shall be concealed within walls, ceilings or other spaces and shall be routed to maximize head room and intended use of space through which they pass, unless specifically noted otherwise.
- .4 Coordinate with the Electrical Contractor for all required electrical connections to plumbing equipment and accessories. Where alternate or substituted equipment requires an electrical connection, the contractor shall include all costs to provide a complete operating system.

1.2 Related Work

- .1 Electrical Division 26

1.3 Codes, Standards and Approvals

- .1 Installation, workmanship and testing shall conform to the following standards:
 - .1 The National Building Code of Canada Latest Edition.

1.4 Shop Drawings

- .1 Shop drawings are required for all materials and equipment including, but not limited to, the following:
 - .1 Cleanouts and access panels.
 - .2 Floor drains.
 - .3 Hot water tanks and heaters.
 - .4 Hydrants/hose bibbs.
 - .5 Plumbing fixtures.
 - .6 Pumps and controls.
 - .7 Roof drains.
 - .8 Trap primers.
 - .9 Valves.
 - .10 Water hammer arrestors.
 - .11 Compressor units.
 - .12 Fire stopping.

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1.5 Maintenance Data

- .1 Refer to Section 23 05 00 Common Work Results for HVAC.
- .2 Comprehensive description of operation of systems, including function of each item of equipment within systems.
- .3 Operating electrical switchgear schedule indicating location of equipment.
- .4 Lubrication schedule indicating recommended lubricants and grades (grease or oil) for lubricated equipment components.

1.6 Record Drawings (As Built Drawings)

- .1 Section 23 05 00 Common Work Results for HVAC shall apply to Plumbing Systems.
- .2 In addition, as a minimum, during the construction period, keep on site clean set of drawing marked up, IN COLOUR, to reflect as built state, for examination by Consultant on regular basis. Include elevations, rough-in details and details and detailed locations of hidden services, including locations of maintenance items and their associated identification code (i.e. Values). Underground services and/or concealed piping shall be dimensionally located and noted (use gridlines or structure as the reference).
- .3 At the time of 'Substantial Completion' submit to Consultant one complete full-sized COLOUR photocopy of Record Drawing information produced as per above section.

1.7 Temporary Usage of Plumbing Equipment

- .1 Plumbing equipment and systems shall not be used without written permission of Consultant and under no circumstances shall be used prior to testing and inspection.

1.8 Seismic Protection

- .1 Refer to Section 22 05 49 Seismic Restraint Systems for Plumbing Piping and Equipment.

2. PRODUCTS

2.1 Access Doors

- .1 Design:
 - .1 Plaster or wet wall construction: 14 ga (1.99 mm) thick bonderized steel flush with wall or ceiling type with concealed flange, complete with gasket.
 - .2 Masonry or drywall construction: 16 ga (1.61 mm) thick for 16" (400 mm) x 16" (400 mm) and smaller, 14 ga (1.99 mm) for 18" (450 mm) x 18" (450 mm) and larger bonderized steel face of wall type with exposed flange, complete with gasket. - Acceptable Product: Acudor UF-5000.
 - .3 Water resistant finished walls, tile, ceramic tile, water resistant drywall, plaster or wet wall construction in washroom and other wet areas: 14 ga (1.99 mm) thick stainless-steel flush with wall or ceiling type with concealed flange, complete with gasket - Acceptable Product: Acudor PS-5030 stainless.
 - .4 Acoustic tile ceiling and similar block materials: 14 ga (1.99 mm) thick bonderized steel recessed ceiling type. Acceptable Product: AT-5020.

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- .5 Feature wall construction: Recessed wall type that is selected to complement and conform with architectural module, treatment, or panelling, complete with gasket. Size shall conform to adjacent finishes.
- .2 Minimum Requirements:
 - .1 Materials:
 - .1 Concealed hinges.
 - .2 Adjustable anchoring straps or lugs to suit construction.
 - .3 Gasket.
 - .2 Finish:
 - .1 Prime coat bonderized steel type.
 - .2 Brushed stainless steel for stainless steel type.
 - .3 Size:
 - .1 8" (200 mm) x 8" (200 mm) for cleanout access.
 - .2 12" (300 mm) x 12" (300 mm) for hand access.
 - .3 24" (600 mm) x 24" (600 mm) for body entry access.
 - .4 Locking Devices
 - .1 Screwdriver cam locks.
- .3 Access panels in fire separations and fire walls shall have compatible fire rating and ULC label (i.e. Acudor Fire Rated FW-5050 or FB-5060).
- .4 Submit shop drawings.
- .5 Supply and locate access doors under this section of work. Installation shall be by Prime Contractor - Acceptable Products: Acudor, Can-Aqua, Mifab, Milcor, Nystrom, Van-Met.

2.2 Cleanouts

- .1 Cleanouts shall be full size for pipe sizes up to 4" (100 mm) and not less than 4" (100 mm) on larger sizes. Cleanouts installed inside finished areas shall all be of same shape, either round or square.
- .2 Cleanouts passing through waterproofed floor or slab on grade subject to hydrostatic pressure shall have a clamping collar clamped to floor membrane.
- .3 Pipe Manufacturers' cleanouts are acceptable for vertical installation at base of soil and waste stacks or rainwater leaders only.
- .4 Make cleanouts with Barrett type fitting with bolted cover plate and gasket, fitting that has threaded plug, or cleanout ferrule installed in wye or extended wye.
- .5 Outside area and vehicle area cleanouts shall be heavy duty construction and have fully exposed scoriated cover. Acceptable Product: Zurn Z1400, Jay R Smith 4231 Series, Wade 6000-Z Series.
- .6 Lino or lino-tiled area cleanouts shall have centre portion of cover recessed to receive tile that matches adjoining tile. Acceptable Product: Zurn DNE 1400-X or ZN 1400-TX, Jay R Smith 4140, Wade 6000-1 Series.

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- .7 Ceramic tile floor area cleanouts shall have fully exposed scoriated cover. Acceptable Product: Zurn DNE 1400 or ZN 1400-T, Jay R Smith 4020, Wade 6000-1 Series.
- .8 Terrazzo tile floor area cleanouts have centre portion cover to receive terrazzo to match adjoining terrazzo finish. Acceptable Product: Zurn ZN 1400-Z, Jay R Smith 4180, Wade 6000-1 Series.
- .9 Carpet area cleanouts shall be fully concealed with a small raised marker. Acceptable Product: Zurn ZN 1400-CM, Jay R Smith 4020-Y, Wade 6000-1 Series.

2.3 Hangers and Supports

- .1 Refer to Section 22 05 29 for Hangers and Supports for Plumbing Piping and Equipment.

2.4 Pipe Sleeves and Escutcheons

- .1 Provide and locate pipe and duct sleeves.
- .2 Provide detailed information on openings required in pre-cast members for mechanical work. Cast holes larger than 4" (100 mm) diameter and field cut holes smaller than 3-1/2" (90 mm) diameter.
- .3 Provide separate sleeves for piping passing through walls, floors, roof and ceilings. Sleeves shall be 20 ga (1.00 mm) galvanized iron and standard weight steel piping sleeves in concrete beams, foundation walls and footings. Plastic sleeves may be used in concrete wall form work where permitted by Authorities having Jurisdiction.
- .4 Sleeves shall be sized large enough to allow for movement due to expansion and to provide for continuous pipe insulation where not passing through fire rated assemblies.
- .5 Sleeves passing through basement walls or potentially wet floors shall be set with integral "puddle flanges".
- .6 Provide Link Seal wall gasket to seal exposed sides of opening between pipe and sleeve on foundation walls with caulking fill. Provide water proofing mastic seal on concealed side of opening.
 - .1 Acceptable Sealing Products: Metraflex MetraSeal
- .7 For finished floor areas, provide pipe sleeves 1" (25 mm) above floor with annular fin.
- .8 Install chrome-plated escutcheons with set screws where insulated or uninsulated piping passes through finished floor, ceiling and wall surfaces. Copper piping shall not be in contact with ferrous metals. Use cast-iron or galvanized sheet metal escutcheons for equipment rooms.
- .9 Coordinate installation of concrete curbs around duct openings in mechanical room floors with General Contractor.
- .10 Provide plastic grommets, equivalent to Pipe Tytes or Greenlee 712-M, for pipes passing through metal stud partitions.

2.5 Pipe Bedding

- .1 All buried piping inside the building below floors and slabs, except for footing drains, shall be supported on a bed of well compacted sand (i.e. 95% Modified Proctor Density). Bedding shall extend 6" (150 mm) below pipe and support pipe barrel, not joints and/or couplings. Before backfilling, complete line shall be inspected and approved by Authorities Having Jurisdiction.

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3. EXECUTION

3.1 Pressure Piping Installation

.1 General

- .1 Install piping straight, parallel and close to walls and ceilings, with fall of not less than 1:50 for gravity piping and with slope to drain cocks, fixtures or equipment for pressure piping, unless otherwise indicated on drawings. Use standard fittings for direction changes. Provide drain cocks as required.
- .2 Install groups of piping parallel to each other, spaced to permit application of insulation, identification and service areas, on trapeze hangers.
- .3 Where pipe size differs from connection size to equipment, install reducing fitting close to equipment. Reducing bushings are not permitted.
- .4 Brass and copper pipe and tubing shall be free from surface damage. Replace damaged pipe or tubing.
- .5 Ream ends of pipe and tubes before installation.
- .6 Install copper pipe to not contact with dissimilar metal and not be crimped or collapsed. Joints on cast or ductile iron pressure service piping shall be made electrically conductive.
- .7 Install flanges or unions and shut-off valves to permit removal of equipment without disturbing piping systems.
- .8 Clean ends of pipes or tubing and recesses of fittings to be jointed. Assemble joints without binding.
- .9 Install piping to connections at fixtures, equipment, outlets and other appurtenances requiring service. Trap and vent waste connections to fixtures. Grade all vents to drain back to waste piping.
- .10 Plug or cap pipe and fittings to keep out debris during construction.
- .11 Joint material shall be compatible with type of pipe used.
- .12 Non-corrosive lubricant or Teflon tape shall be applied on male thread of threaded joints.
- .13 Flush and clean out piping systems after testing.

.2 Equipment Drainage:

- .1 Install drain valves at low points.
- .2 Extend equipment drain piping to discharge into floor or hub drain.

.3 Expansion and Contraction and Building Seismic Joints:

- .1 Support piping to prevent stress or strain.
- .2 Install pressure piping with loops and offsets to permit expansion and contraction without damaging pressure piping system.

.4 Buried Piping:

- .1 Lay pipe on compacted bedding of clean, coarse sand, free from clay, snow or ice, organic matter or stones.
- .2 Do not lay pipe in water or when conditions are unsuitable.

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3.2 Access Doors

- .1 Install access doors at concealed cleanouts, traps, unions, expansion joints, valves, control valves, air vents, water hammer arrestors, special equipment, trap primers, vacuum breakers and other equipment for which periodic access will be required.
- .2 Locate access doors so concealed items are accessible for adjustment, operation, maintenance and replacement.
- .3 Do not locate access doors in feature walls or ceilings without prior approval of Consultant. Locate in service areas and storage rooms wherever possible.

3.3 Cleanouts

- .1 Install cleanouts at the following locations:
 - .1 Building drain leaving building on upstream side of exterior wall.
 - .2 Changes of direction of more than 90° in drainage piping.
 - .3 Nominally horizontal branch or building drain at intervals of not more than 25'-0" (7.5 m) for pipe sizes 2-½" (65 mm) and less, 50'-0" (15 m) for 3" (75 mm) and 4" (100 mm) pipe sizes, and 100'-0" (30 m) for pipe sizes larger than 4" (100 mm).
 - .4 Fixture drain of a sink, kitchen piping or grease waste piping at intervals not exceeding 25'-0" (7.5 m).
 - .5 Base of soil or waste stacks and rainwater leaders.
 - .6 As called for by British Columbia Plumbing Code and the Canadian Plumbing Code.
- .2 Locate wall cleanouts 3" (75 mm) minimum above top of base board or minimum 8" (200 mm) above finished floor level where no baseboard.
- .3 Coordinate cleanout location with millwork and other obstructions; place in accessible location with sufficient clearance for rodding and cleaning.
- .4 Extend cleanouts to finished floor or wall unless exposed in basement room, pipe tunnel or accessible crawlspace.
- .5 Extend cleanouts in wet floor areas above floor in walls, or provide with gasketted, waterproofed tops.
- .6 Bring cleanouts on outside drains to grade and anchor in a concrete collar.

3.4 Hangers and Supports

- .1 Refer to section 22 05 29 for Hangers and Supports for Plumbing Piping and Equipment.

3.5 Pipe Sleeves and Escutcheons

- .1 Install chrome-plated escutcheon plate on exposed piping passing through walls, floors and ceilings in finished areas.
- .2 Sleeves shall be concentric with pipe and, except at fire separations, shall be sized to allow for the continuity of insulation.
- .3 Extend sleeves 2" (50 mm) above floor slabs in wet areas. Wet areas include equipment rooms, janitor's rooms, kitchen areas, utility rooms, bath areas and washrooms.

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- .4 Extend sleeves through outside walls to 1" (25 mm) beyond the exterior face and caulk with flexible caulking compound.
- .5 Remove removable plastic sleeves are used prior to pipe penetration and sleeve the resulting hole.
- .6 Extra high vertical risers for cold water and hot water systems with many horizontal branch takeoffs passing through sleeves set in rigid structure adjacent to main risers, set sleeves to accommodate long term structural movement to avoid imposing stress on these systems.
- .7 Refer to Section 23 05 05 Firestopping for firestop requirements.

3.6 Core Drilling and Cutting

- .1 Arrange and pay for cost of core drilling and cutting for plumbing systems.
- .2 Penetrations up to 6" (150 mm) nominal pipe size in precast concrete may be cored on site by plumber. Locate larger penetrations and arrange to have pre-cored with pre-cast Manufacturer prior to shipping to construction site.

3.7 Piping Expansion

- .1 Install piping systems, including all take-offs, so that the piping and connected equipment will not be distorted by expansion, contraction or settling.
- .2 Install anchors where necessary to control expansion. Install expansion joints or loops on hot water piping where required.

3.8 Testing and Inspection

- .1 Refer to Section 22 05 93 – Testing, Adjusting and Balancing for Plumbing.
- .2 Furnish labour, materials, instruments, etc. necessary for required tests. Work shall be inspected by local plumbing inspector and review by Consultant.
- .3 Correct leaks by remaking joints. Retest systems until no leaks are observed.
- .4 Do not cover any plumbing system before being inspected and approved by Plumbing Inspector.
- .5 If plumbing system or part thereof is covered before being inspected or approved, Contractor will uncover system upon the direction of the Plumbing Inspector or Consultant.

3.9 Project Photographs

- .1 Provide digital photographs of all systems prior to covering.
- .2 Provide digital photographs in "jpeg" format to Consultant complete with text description of each photograph, including date, system type, materials used, and location/direction for sections of underground piping prior to backfilling. Submit photographs via email and/or disc as requested by Consultant. Individual email sizes not to exceed 7MB in size.
- .3 Provide additional digital photographs of work as requested by Consultant to assist in resolution of RFIs, prior to covering work.

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3.10 Substantial Completion Requirements

- .1 The following items must be completed, with documentation, prior to the date of Substantial Completion:
 - .1 All pipe expansion compensators and flexible connections checked by Supplier with an inspection report submitted to the Commissioning Agent and this Consultant.
 - .2 Seismic restraints reviewed and inspected by the Suppliers/Contractors' British Columbia Registered Professional Engineer, with a report submitted to the Commissioning Agent and this Consultant, with supporting Schedule S/Schedule C Letters of Assurance.
 - .3 All plumbing fixtures have been tested, adjusted, cleaned and in proper operation.
 - .4 All plumbing access doors and panels are in place and not painted closed.
 - .5 Potable water systems have been cleaned, flushed, chlorinated, and copies of final chlorination and water quality tests have been submitted to the Commissioning Agent and this Consultant.
 - .6 All backflow prevention stations and devices have been tested, with test reports submitted to the Commissioning Agent and this Consultant.
 - .7 Final plumbing Inspectors sign-off to be submitted to this Consultant.
 - .8 Final gas inspection sign-off to be submitted to this Consultant.
 - .9 Final As-built Record drawings have been submitted for review to this Consultant.

END OF SECTION 22 05 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

- .1 Provide thermometers and pressure gauges on plumbing piping systems and equipment including the following:
 - .1 Domestic cold water
 - .2 Domestic hot water.
- .2 Provide thermometers in brass or stainless-steel wells at water heaters, and other equipment intended to change temperature of fluid.
- .3 Provide pressure gauges complete with isolation ball valves on both sides of pressure reducing valves, backflow prevention stations, pumps, compressors and other equipment intended to change pressure of fluid. Provide snubbers for pressure gauges located adjacent to pumps or compressors. Provide vacuum gauges at vacuum units.

2. PRODUCTS

2.1 General

- .1 Select thermometers and pressure gauges so that their operating range falls in middle half of scale range.

2.2 Thermometers - Piping

- .1 Acceptable Manufacturers:
 - .1 Marsh, Moeller, Trerice, Weiss, Weksler, Winters.
- .2 Minimum Requirements:
 - .1 Thermometers to be in accordance with Canadian General Standards Board CGSB 14.4 - M88.
 - .2 Pipe mounted stem type - mercury actuated, adjustable angle type.
 - .3 Refer to flow schematics for location of pipe mounted thermometers and wells.
- .3 Case:
 - .1 Stem type – Stainless Steel. Case shall be provided with clear glass or heat resistant plastic window.
- .4 Scale:
 - .1 Stem type - 9" (225 mm) scale length.
 - .2 White background with temperature range in black.
 - .3 Dual Celsius and Fahrenheit scale.

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2.3 Thermometers - Duct/Panel Mounted

- .1 Acceptable Manufacturers:
 - .1 Moeller, Terice, Weiss, Weksler, Winters.
- .2 Minimum Requirements:
 - .1 Thermometers to be in accordance with Canadian General Standards Board CGSB 14-GP-2a.
 - .2 Duct mounted dial type - solid liquid filled with remote capillary element.
 - .3 Panel mounted dial type (surface) type - vapour filled direct mounting.
 - .4 Panel mounted dial type (flush) type - remote liquid filled capillary element.
- .3 Case:
 - .1 Dial type - cast aluminum, black enamel steel or stainless steel with stainless steel or chrome-plated face ring.
- .4 Scale:
 - .1 Dial type - nominal 4-½" (115 mm) unless otherwise indicated.
 - .2 White background with temperature range in black.
 - .3 Dual Celsius and Fahrenheit scale.

2.4 Pressure Gauges - Piping

- .1 Acceptable Manufacturers:
 - .1 Marsh, Moeller, Terice, Weiss, Winters.
- .2 Minimum Requirements:
 - .1 Gauges to be in accordance with ANSI B40.1 Grade "A" level.
 - .2 4-½" (115 mm) cast aluminum, black steel or stainless-steel case, with stainless steel or chrome-plated face ring.
 - .3 White background with pressure range in black.
 - .4 Dual kPa and psig scale.
 - .5 Phosphor bronze bourdon tube, silver brazed tip and socket ¼" (6 mm) NPT lower connection.
 - .6 Rotary type bushed movement, silicone dampened to prevent pointer oscillation.
 - .7 ULC listed for use on fire protection systems.
 - .8 Accuracy shall be 1% off full scale over the middle half of the scale.
- .3 Accessories:
 - .1 Install needle valve ahead of each gauge.
 - .2 Install an anti-syphon loop (suitable for steam pressure) ahead of each gauge on steam systems.

2.5 Test Plugs for Pressure/Temperature

- .1 Provide ¼" (6 mm) NPT solid brass test plug fitting complete with brass chain where indicated.

- .2 Test plugs shall be capable of receiving either pressure or temperature $\frac{1}{8}$ " (3.2 mm) OD Dual seal core shall be Nordel suitable for temperature of 350°F (177°C) and shall be rated zero leakage from vacuum to 1,000 psi (6,895 kPa).
- .3 Provide 1 master test kit containing 2 test pressure gauges of suitable range, 1 gauge adaptor, $\frac{1}{8}$ " (3.2 mm) OD probe and 2 stem pocket testing thermometers of suitable range.
- .4 Acceptable Products:
 - .1 Sisco P/T Plugs.
 - .2 Tetrice

2.6 Thermometer Wells

- .1 For copper pipe use copper or bronze. For steel pipe use brass, separable socket, $\frac{3}{4}$ NPT.
- .2 Thermowell to be registered with Provincial Boiler and Pressure Vessels Safety Branch with CRN number.

3. **EXECUTION**

3.1 General

- .1 Install thermometers and gauges to be easily read from floor or platform. If this cannot be accomplished, install remote reading thermometers and gauges.
- .2 Install engraved lamicoid nameplates as specified in Section 23 05 53 - Identification (identifying medium).

3.2 Thermometers

- .1 Install in wells on piping.
- .2 Install separable well to minimize restriction to flow and, if necessary, install in section of oversized pipe.
- .3 Install wells where indicated for use with test thermometers.
- .4 Install in locations as indicated.
- .5 Use extensions where thermometers are installed through insulation.

3.3 Pressure Gauges

- .1 Install the following locations:
 - .1 Suction and discharge of pumps.
 - .2 Upstream and downstream of PRVs.
 - .3 Inlet and outlet of waterside of coils (excluding terminal unit coils) and heat exchangers
 - .4 In other locations indicated.
- .2 Use extensions where pressure gauges are installed through insulation.
- .3 Where single gauge is used to measure multiple points, provide needle valves to isolate each point, including pressure gauge.

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END OF SECTION 22 05 20

Section 22 05 20
THERMOMETERS AND PRESSURE
GAUGES FOR PLUMBING
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1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.
- .2 Refer to Section 22 05 49 Seismic Restraint Systems for Plumbing Piping and Equipment.

1.2 Scope of Work

- .1 Refer to Section 23 05 29 Hangers and Supports for HVAC Equipment. Comply with requirements of Section as related to general requirements, products and execution.
 - .1 Acceptable Products: Hubbard Enterprises – Holdrite Systems.
- .2 In addition to piping, equipment and systems listed in Section 23 05 29 provide hangers and supports complying with requirements of Section 23 05 29 on plumbing piping and equipment including:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Sanitary waste and venting.
 - .4 Storm drainage.

END OF SECTION 22 05 29

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

- .1 Refer to Section 23 05 49 Seismic Restraint Systems for HVAC Equipment. Comply with requirements of Section as related to general requirements, products and execution.
- .2 In addition to piping, equipment and systems listed in Section 23 05 49 provide seismic restraints complying with requirements of Section 23 05 49 on plumbing piping and equipment, including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Sanitary waste and venting.
 - .4 Storm drainage.

1.3 Document Submittals

- .1 Provide Letters of Assurance signed and sealed by Contractor's specialist Registered Professional Engineer.
- .2 Submit Schedule S-B Letters of Assurance or in accordance with the BC Building Code, National Building Code, BC Fire Code, and National Fire Code to Consultant and local Authority Having Jurisdiction at time of shop drawing submission.
- .3 Submit 'Schedule S-C: Assurance of Professional Field Review and Compliance' in accordance with the BC Building Code, National Building Code, BC Fire Code, and National Fire Code to Consultant and to local Authority Having Jurisdiction minimum of 10 working days prior to Occupancy.

END OF SECTION 22 05 49

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

- .1 Refer to Section 23 05 53 Identification for HVAC Equipment. Comply with requirements of Section as related to general requirements, products and execution.
- .2 In addition to piping, equipment and systems listed in Section 23 05 53, provide identification on plumbing piping, valves and equipment, including the following:
- .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Sanitary waste and venting.
 - .4 Storm drainage.
 - .5 Trap primer access points.

1.3 Pipe Identification Colour Schedule

Service	Identification Lettering	Primary Colour	Secondary Colour
Domestic Cold Water	D.C.W.	light blue	-
Domestic H.W. Supply	D.H.W.	yellow	black
Sanitary Drain	SAN	None	None (-)
Plbg. Vent	VENT	None	(-)
Storm Drain	STW	None	(-)

END OF SECTION 22 05 53

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.
- .2 Refer to Section 22 08 00 Commissioning of Plumbing.

1.2 Scope of Work

- .1 Refer to Section 23 05 93 Testing, Adjusting and Balancing for HVAC. Comply with requirements of Section as related to general requirements, products and execution.
- .2 In addition to the piping, equipment and systems listed in Section 23 05 93 provide testing adjusting and balancing complying with requirements of Section 23 05 93 for plumbing piping, equipment and systems including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Sanitary waste and venting.
 - .4 Storm drainage.
 - .5 Trap primers.
- .3 Pressure test plumbing piping systems in accordance with specific requirements of specification sections for those systems.

END OF SECTION 22 05 93

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

- .1 Provide piping insulation on plumbing piping systems including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Storm drainage piping (interior only) and underside of drain bodies.
 - .4 Offset waste piping, P-traps and supplies under wheelchair accessible lavatories and sinks.
 - .5 Provide foil faced flexible insulation on components requiring adjustment or servicing including meter sets, pressure reducing valves, valve bodies, strainers, etc.
 - .6 Sanitary vent stacks for last 10'-0" (3.0 m) prior to penetrating roof.

1.3 General

- .1 Provide thermal insulation on piping, valves and fittings as called for and as scheduled. Note items listed that do not require insulation.
- .2 Be responsible for ensuring sufficient space is provided to allow proper installation of insulation materials.
- .3 Minimum insulation thickness and insulating values shall be in accordance with ASHRAE Std 90.1 latest edition or as per the schedule in this section, whichever is most stringent.

1.4 Regulatory Requirements

- .1 Flame spread ratings and smoke developed classifications shall be as required by National Building Code, CAN/ULC S102 and NFPA 90A. Generally, the flame spread rating throughout the material shall not exceed 25 and the smoke developed classification shall not exceed 50. Materials shall not flame, smoulder, glow, or smoke at temperature they are exposed to at service.
- .2 Minimum insulation thickness and insulating values shall be in accordance with ASHRAE Std 90.1 latest edition or as per the schedule in this section, whichever is most stringent.
- .3 Fibreglass pipe insulation shall comply with:
 - .1 CAN/ULC S102-M88.
 - .2 CCG F1-304 (plain only).
 - .3 CBSB 51-GP-9M.
 - .4 CGSB 51-GP52M (jacket).
 - .5 ASTM C 547, Type I, Type IV.
 - .6 STM C 585 – Standard for inner and outer diameters.
 - .7 ASTM C 795 – Insulation in contact with austenitic stainless steel.
 - .8 ASTM C 1136 (jackets; Type I, II, III, IV).

- .9 ASTM E-84, Surface Burning Characteristics, 25/50 Flame/Smoke.
 - .10 CAN/ULC-S102-07 "Test for Surface Burning Characteristics of Building Materials".
 - .4 PVC Fittings and Jacketing shall comply with:
 - .1 CAN/CGSB – 51.53-95
 - .2 CAN/ULC S102.
 - .5 All insulation products shall be formaldehyde-free.
- 1.5 Qualifications and Samples
- .1 Submit Manufacturer's documentation (and samples when requested) for materials, applications and finishing methods to establish they satisfy this specification and meet applicable code requirements, before commencing work.
 - .2 Refer to Section 23 05 05 Firestopping for firestop requirements.
- 1.6 Quality Assurance
- .1 Installer qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program.
 - .2 Surface-Burning Characteristics: For insulation and related materials, UL/ULC Classified per UL723 or meeting ASTM E 84, by testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesives, mastic, tapes and cement material containers, with appropriate markings of applicable testing agency.
 - .1 Insulation installed indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - .2 Insulation installed outdoors: Flame spread index of 75 or less, and smoke-developed index of 150 or less.
 - .3 Formaldehyde free: Third party certified with UL Environment Validation.
 - .4 Recycled content: A minimum 50 percent recycled glass content.
 - .5 Bio soluble: As determined by research conducted by the International Agency for Research on Cancer (IARC) supported by revised reports from the National Toxicology Program (NTP) and the California Office of Environmental Health Hazard Assessment. Certified by European Certification Board for Mineral Wool Products (EUCB).
 - .6 Low emitting materials: For all thermal and acoustical applications of Glass Mineral Wool Insulation Products, provide materials complying with the testing and products requirements of UL Greenguard Gold Certification.
- 1.7 Definitions
- .1 "CONCEALED" means insulated mechanical services in trenches, chases, furred spaces, shafts and hung ceilings.
 - .2 "EXPOSED" will mean not concealed, and include piping inside the building in unheated zones, and on roof or outside the walls.

2. PRODUCTS

2.1 Materials

- .1 Products shall not contain lead, mercury or mercury compounds, if possible. They shall be UL Greenguard Gold or Indoor Advantage Gold, if possible.
- .2 Products shall be validated by UL/E to be formaldehyde free.
- .3 Products shall contain no less than 50% recycled content.

2.2 Pre-Formed Pipe Covering

- .1 Mineral Fibre - Low and Medium Temperature:
 - .1 Type I (849°F (454°C)) or Type IV (982°F (528°C)); Thermal conductivity at 75°F – 0.019 BTU/hr/ft/°F (24°C – 0.033 W/M/°C)
 - .2 Glass mineral wool bonded with a bio-based thermosetting resin.
 - .3 UL/ULC classified for Earthwool, FHC 25/50 per ASTM E84 for Redi-Klad. Living building challenge-declare red list free for Rediklad pipe or unjacketed earthwool pipe only.
 - .4 Comply with ASTM C585, ASTM C411, ASTM C795 and ASTM C547, Type I and Type IV, with factory-applied ASJ+ or ASJ.
 - .5 Products shall be validated by UL/E to be formaldehyde free and have an EPD.
 - .6 With integral vapour barrier jacketed and longitudinal lap.
 - .7 Acceptable products: Subject to compliance with requirements, provide Knauf Insulation; or comparable product by one of the following:
 - .1 Mason Alley K, Owens Corning ASJ/SSL-II, Johns Manville Micro-Lok AP-T Plus.
- .2 Calcium Silicate - High Temperature:
 - .1 Without integral jacket.
 - .2 Thermal Conductivity at 199°F – 0.034 BTU/hr/ft/°F (93°C - 0.059 W/m/°C).
 - .3 Acceptable Products:
 - .1 IIG Thermo-12 Gold.
- .3 Mineral Fibre - High Temperature (over 662°F (350°C)):
 - .1 With integral vapour barrier jacket and longitudinal lap.
 - .2 Thermal conductivity at 199°F – 0.023 BTU/hr/ft/°F (93° C - 0.040 W/m/°C).
 - .3 Acceptable Products:
 - .1 Johns Manville Micro-Lok AP-T Plus, Roxul ASJ/SL, ESLIN (Energy Savings Layered Insulation) by Visionary Industrial Insulation.

2.3 Fire Stopping and Smoke Seal Materials

- .1 Refer to Section 23 05 05 Firestopping for firestop requirements.

2.4 Accessories

- .1 Insulation Fastenings:

- .1 16 ga (1.61mm) galvanized wire or 16 ga (1.61 mm) thick copper wire as commercially available.
- .2 Jacket Fastenings:
 - .1 Thermocanvas and All Service:
 - .1 Staples (flare type), compatible jacket finishing tape, contact adhesives recommended by the jacket manufacture.
 - .2 Metal Jackets
 - .1 Sheet metal screws, pop rivets, bands.
 - .3 PVC Jacket and Fitting Covers:
 - .1 PVC self-adhesive tape, plastic pop rivets, bonding cement.
- .3 Adhesives:
 - .1 Flexible elastomeric and flexible closed cell insulation adhesive:
 - .1 Armstrong 520, Thermacell 1590, Rubatex R-373, Zipcoat 8A.
 - .2 Vapour barrier jacket adhesive:
 - .1 Bakelite 230-39, Childers CP-82, Epolux Cadoprene 400, Foster 85-20.
 - .3 Fabric adhesive, to insulation pipe covering:
 - .1 Bakelite 120-18, Childers CP-52, Epolux Cadalag 336, Foster 30-36, Robson White Lag.
- .4 Coatings:
 - .1 Vapour barrier coating on reinforcing membrane or on insulating cement:
 - .1 Bakelite 120-09, Childers Chil-Out CP33/Chil-Perm CP35; Epolux Cadalag 336; Foster Vapour out 30-33/Vapor-Fas 30-65.
 - .2 Childers CP-30 (refrigeration suction lines only).
 - .2 Flexible elastomeric and flexible closed cell insulation finish coating:
 - .1 Armstrong, Bakelite 120-13, Rubatex, Zipcoat.
- .5 Finish Jackets:
 - .1 Thermocanvas Jacket:
 - .1 Fattal's Thermocanvas, Robson Flamex FR Canvas or Tai-Can Canvas.
 - .2 All Service Jacket (with 0.0019" (0.3 mm) minimum thick foil):
 - .1 Fattal's Fat-Lock ASJ, Fibreglass ASJ, Knauf ASJ, Kingspan ASJ, Manson SPT, Johns Manville AP-T Plus, Owens Corning ASJ, Roxul ASJ.
 - .3 PVC Finishing Jacket (minimum 0.015" (0.38 mm) thick):
 - .1 Shur-Fit Products SSL PVC Jacket, Proto PVC, Speedline PVC, Zeston PVC.
 - .4 Aluminum Jacket:
 - .1 22 ga (0.64 mm) thick stucco embossed or smooth aluminum jacketing with longitudinal slip joints and 0.0019" (0.3 mm) end laps with factory applied protective liner on interior surface.
 - .1 Shur-Fit Aluminum Jacket, ITW, Ideal products or other as commercially available.

- .2 Pacific Pressed fitting covers (available from Shur-Fit Products) for the following:
 - .1 Grooved pipe fittings
 - .2 Insulated and cladded refrigerant lines
- .6 Reinforcing Membrane:
 - .1 Glass reinforcing membrane as commercially available: Foster Mast-A-Fab; Childers Chil-Glas #10; Pittsburgh Corning PC-79
- .7 Insulating Cement:
 - .1 Ryder Thermokote MW high temperature, or as commercially available.
- .8 Finishing Cement:
 - .1 Ryder Thermokote 1 FW.
- .9 Pre-Formed Fitting Covers:
 - .1 Aluminum Fitting Covers:
 - .1 22 ga (0.64 mm) thick, die shaped components with factory applied protective liner on interior surface.
 - .1 Pacific Pressed Fitting Covers (Available from Shur-Fit Products), Childers Ell-Jacs, Ideal Weatherjacs, Shield-Ells or other as commercially available.
 - .2 PVC Fitting Covers:
 - .1 0.02" (0.50 mm) thick pre-moulded one-piece covers.
 - .1 Childers, Proto PVC, Speedline PVC, Zeston PVC, Fattal PVC.
- .10 Insulated balancing valves, strainers, or shut-off valves on DCW, CWS-R & CHWS-R lines:
 - .1 Provide KEEN Insulated Fitting service covers (available from Shur-Fit Products)

2.5 Scope of Insulation

- .1 Plumbing pipes, fittings, valves:
 - .1 Insulate the following systems, unless otherwise noted:
 - .1 Domestic cold-water system including meter body.
 - .2 Domestic hot water supply piping.
 - .3 Rainwater leaders and cast-iron fittings for the full length from the roof drain body to connection to below grade storm sewer, using preformed fibreglass pipe insulation complete with continuous vapour barrier.
 - .4 Water valves, flanges, PRVs strainers, check valves.
 - .5 Interior irrigation/hose bibb supply piping.
 - .2 DO NOT insulate the following, unless otherwise noted:
 - .1 Piping used exclusively for fire protection (unless in unheated spaces).
 - .2 Soil stacks, vents, etc.
 - .3 All special service piping, e.g. gas, compressed air, etc.
 - .4 Unions.
 - .5 Flexible connections or expansion joints (unless noted on drawings).
 - .6 Check valve covers.

- .7 Strainer leg and basket covers.
- .8 Flexible fixture connections.
- .2 Generator Exhaust Piping and Silencer
- .3 Pipe penetrations through walls and floors:
 - .1 Material for stuffing, sealing and caulking of pipe penetrations shall be supplied and installed under this section.

2.6 Pipe Insulation Schedule and Thickness Table – inches (mm)

- .1 'Inside' means within the heated building envelope. Everywhere else is considered outside and unheated space.

Service	Design Operating Temperature	NOMINAL PIPE SIZE (NPS)				
		<1"	1" to <1-½"	1-½" to <4"	4" to < 8"	>8"
Generator Exhaust Pipe and Silencer	900°F (482°C)	3" (76 mm)	3" (76 mm)	3" (76 mm)	3" (76 mm)	3" (76 mm)
Domestic Cold Water	Below 65°F (18°C)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)
Domestic Hot Water	105°F (40°C) - 140°F (60°C)	1" (25 mm)	1" (25 mm)	1-½" (38 mm)	1-½" (38 mm)	1-½" (38 mm)
Buried and Exterior Rainwater Storm Drainage	90°F (32.2°C)	None	None	None	None	None
Above Grade Interior Rainwater Storm Drainage	Below 65°F (18°C)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)	½" (12 mm)

Note 1: All piping forming part of the HVAC and plumbing systems and located outside the building envelope shall be insulated.

3. **EXECUTION**

3.1 Application

- .1 Apply insulation to piping only after tests have been made and systems accepted.
- .2 Apply insulation and insulation finish so finished product is smooth in finish, with the longitudinal seams concealed from view. Apply piping insulation materials, accessories and finishes in accordance with Manufacturer's recommendations. Pre-formed pipe fitting insulation sections shall be used on all elbows, tees and pipe joint/flange fittings. Where pre-formed insulation sections cannot be used or sourced, including oversize insulation at mechanical pipe joints.
 - .1 Provide KEEN Fabricated Fittings (available from Shur-Fit Products) for grooved pipe fittings.

- .3 On piping NPS 2-½ and larger with insulation and vapour barrier, install high density insulation above hanger shield. Insert to be slightly longer than length of shield. Maintain integrity of vapour barrier over full length of pipe without interruption at sleeves, fittings and supports. Provide oversize Clevis hangers as required. See Section 23 05 29.
 - .1 Provide Pro-Pipe supports (available from Shur-Fit Products).
 - .2 Provide Seismic Pro-Pipe supports (available from Shur-Fit Products) for all vertical/horizontal anchor locations.
- .4 Insulation and vapour barrier shall be continuous through both rated and non-rated separations.
- .5 Provide sealed bevelled cut-outs at all ball valve handles to allow free movement of handle without tearing insulation.
- .6 Provide high density insulation and shields at all riser clamps/seismic sway bracing connection locations for all cold piping with continuous vapour barrier.
 - .1 Provide Seismic Pro-Pipe supports (available from Shur-Fit Products).

3.2 Insulation Termination Points

- .1 Terminate insulation 3" (75 mm) back from all uninsulated fittings to provide working clearance and terminate insulation at 90° and finish with reinforced scrim cloth vapour barrier mastic system. Cover onto pipe and over the insulation vapour barrier. On concealed hot services terminate insulation 3" (75 mm) back from uninsulated fittings, cut off at 90° and apply reinforce scrim cloth and breather mastic systems. The use of pre-formed PVC end caps and pre-formed PVC fittings are also acceptable.
- .2 Cut back insulation at 45° and finish with silicone caulking sealant around base of thermometer wells, pressure gauges, flow switches and pressure and control sensors.

3.3 Vertical Risers

- .1 On vertical pipe over 3" (75 mm) provide insulation supports welded or bolted to pipe, directly above lowest pipe fitting. Thereafter, locate on 15'-0" (4.5 m) centres.

3.4 Hot Application 80°F (26.7°C) and Over

- .1 Piping:
 - .1 Install medium temperature pipe insulation with integral jacket to pipe and hold in place by stapling flap, with spreading staples at 3" (75 mm) centres. Pipe insulation with integral self-sealing jacket will not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints and secure with reinforcing tape and mastic.
- .2 Fittings:
 - .1 Insulate fittings, to thickness of adjacent pipe insulation, with sections of pipe insulation mitred to fit tightly, or with pre-formed insulation fittings (Shur-Fit) or from insulation fabricator.
 - .2 Provide KEEN Insulated Fittings (available from Shur-Fit Products) for insulated grooved pipe fittings.
- .3 Valves, Strainers:

- .1 Insulate valve bodies and strainers with fitted pipe insulation, or mitred blocks to thickness of adjacent pipe insulation or insulate with pre-formed insulation fittings (Shur-Fit) or from insulation fabricator. Drains, blow-off plugs and caps shall be left uncovered.
- .2 Provide KEEN Insulated Fittings (available from Shur-Fit Products) for insulated pipe fittings.
- .4 Flanges and Unions:
 - .1 Insulate flanges with oversized pipe insulation or mitred blocks to thickness of adjacent pipe insulation. Insulation to overlap adjoining insulation at least 3" (75 mm).
 - .2 Provide KEEN Insulated Fittings (available from Shur-Fit Products) for insulated grooved pipe fittings.

3.5 Cold Application 50°F (10°C) and Less

- .1 Piping:
 - .1 Install low/medium temperature pipe insulation with integral vapour barrier jacket to pipe and hold in place by securing jacket flap. Seal flaps with vapour barrier adhesive. Pipe insulation with integral self-sealing vapour barrier jacket does not require additional fastening.
 - .2 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive. Over wrap butt strips by 50% for insulation OD 12" (300 mm) and above apply strip on 10" (250 mm) centres for additional securement.
 - .3 Install strips of vapour barrier jacket over butt joints with vapour barrier adhesive. Over wrap butt strips by 50% for insulation OD 12" (300 mm) and above apply strip on 10" (250 mm) centres for additional securement. (Note: accessory items such as, but not limited to, thermometers, probes, actuators, etc. shall be insulated and sealed. Hangers shall be insulated from where they carry the pie to the point of attachment to the structure).
- .2 Fittings:
 - .1 Insulate fittings to thickness of adjacent pipe insulation with section of pipe insulation mitred to fit tightly, or pre-formed insulation fittings (Shur-Fit), apply reinforcing membrane embedded barrier coating and apply finish vapour barrier coating.
 - .2 Provide KEEN Insulated (available from Shur-Fit products) fittings for insulated grooved pipe fittings.
 - .3 Alternatively insulate fittings with tightly placed flexible insulation and apply vapor barrier, and apply pre-moulded 20/50 rated PVC fitting covers. Apply vapor-barrier adhesive and tape on joints and overlaps of PVC covers.
- .3 Valves, Strainers:
 - .1 Insulate pump bodies, valve bodies, bonnets and strainers with fitted pipe insulation to the same thickness as the pipe insulation, or mitred blocks to thickness of adjacent pipe insulation, apply reinforcing membrane embedded in barrier coating. Alternately, insulate with pre-formed insulation fittings (Shur-fit) covered with reinforcing membrane, stapled in place and covered with barrier coating. Drains, blow-off plugs and caps shall be left uncovered.
- .4 Flanges and Unions:

- .1 Insulate cold unions and flanges with oversized pipe insulation or mitred blocks to thickness of adjacent pipe covering, apply reinforcing membrane embedded in barrier coating and final coating of vapour barrier mastic.

3.6 Pipe Insulation Finishes

- .1 “Concealed” insulation in horizontal and vertical service spaces will require no further finish.
- .2 “Exposed” insulation inside building shall be finished as follows:
 - .1 Premium PVC Jacket:
 - .1 Apply pipe insulation with integral all-service type jacket (ASJ). Cover longitudinal and circumferential joints with jacket finishing tape neatly applied. Alternately, secure jacketing longitudinal joint using integral self-sealing lap.
 - .2 Over ASJ, install PVC finishing jacket and fitting covers. Cover circumferential joints with jacket finishing butt strips. Over wrap strips by 50%. For insulation OD 12” (300 mm) apply trips on 10” (250 mm) centres for additional securement. PVC 0.02” (0.50 mm) thick should not be used as vapour barrier alone, and shall have ‘ASJ’ or mastic system under it. Over insulation on short pipe runs and piping adjacent to fittings, valves, etc., jacket to be field applied.
 - .3 Over insulated fittings apply tack coat of vapour barrier mastic and embed reinforcing membrane and cover with same mastic. Over insulated valve bodies, valve bonnets, strainers and flanges, apply all-service jacketing using necessary fastenings and jacket finishing tape and with reinforced mastic system on irregular surfaced.

3.7 High Temperature Piping - Over 392°F (200°C)

- .1 Install high temperature pre-formed pipe insulation, 3” (75 mm) thick, on the emergency generator exhaust piping upstream from thimble, including muffler. Secure in place with galvanized steel bands or 16 ga (1.61 mm) galvanized wire at 12” (300 mm) on centres. DO NOT insulate flexible connection to manifold.
- .2 Where concealed or exposed, insulate fittings with moulded 2-piece covers or mitred pipe insulation to cover fittings to thickness of adjoining insulation.
- .3 Insulate flanges and unions. Install section of oversized pre-formed pipe insulation to overlap adjoining insulation at least 3” (75 mm).
- .4 At insulation termination points, cut back insulation at 45° and finish with hard coat of insulating cement to match adjacent insulation.
- .5 Finish:
 - .1 Apply vinyl foil laminate vapour barrier jacket ASJ.
 - .2 Where exposed inside building, cover the vapour barrier jacket with aluminum jacket, to BCICA PF-4 Standard.
 - .3 Where exposed outside building, apply 0.016” (0.41 mm) thick aluminum weather jacket with longitudinal seams located to shed water. Overlap seams 2” (50 mm) and secure with metal banding 10” (250 mm) centres and at overlaps.

3.8 Fire Stopping and Smoke Seals

- .1 Refer to Section 23 05 05 Fire Stopping for firestop requirements.

3.9 Insulation Packing of Pipe Sleeves

- .1 Tightly pack space between pipe sleeves and pipe or between pipe sleeve and pipe insulation with mineral wool insulation - Thermal Ceramics “Cerafibre” or Carborundum “Fibrefrac” to full depth of sleeve to prevent transmission of sound and/or passage of smoke.

END OF SECTION 22 07 19

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

- .1 Refer to Section 23 08 00 Commissioning of HVAC. Comply with requirements of Section as related to general requirements, products and execution.
- .2 In addition to piping, equipment and systems listed in Section 23 08 00 provide commissioning complying with requirements of Section 23 08 00 plumbing piping, equipment and systems including the following:
 - .1 Domestic cold water.
 - .2 Domestic hot water.
 - .3 Sanitary waste and venting.
 - .4 Storm drainage.

END OF SECTION 22 08 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

- .1 Domestic water systems include domestic cold water and domestic hot water.
- .2 Domestic water piping shall be provided as depicted on drawings to all plumbing fixtures, appliances and equipment that require domestic water service.
- .3 New domestic water piping shall be connected to exterior cold water building service as indicated on drawings.

1.3 Cross Connection and Backflow Control

- .1 Provide cross connection in accordance with CSA B64.10 and the AWWA Cross Connection Control Manual.
- .2 Vacuum breakers shall conform to the requirements of CSA B64.5.
- .3 Following installation, test report completed by certified tester shall be submitted to Owner, indicating satisfactory operation of each device.
- .4 Provide one repair kit for every cross-connection control device installed.

1.4 Freeze Protection

- .1 Provide freeze-proof hose bibbs where required due to ambient temperatures.

2. PRODUCTS

- 2.1 General Standards: Piping and fittings shall be in accordance with current edition or applicable revisions of applicable codes or governing regulations. Pipe and pipe fittings must be of the same manufacturer for PVC, ABS, PEX and CPVC systems. All products shall be UL/ULC classified in accordance with ANSI/NSF-16 for potable water service and certified to the no/low lead standard of NSF-372.

Ucluelet, B.C.

2.2 Pipe and Fittings

Size	Pipe	Fittings
Domestic Water Piping Below Grade (Inside and Outside Building)		
½” (12 mm) - 2” (50 mm)	Schedule 10 Stainless Steel	Schedule 10 Stainless steel pipe may be used as an alternative material on sizes ½” (12 mm) - 2” (50 mm) if acceptable to Local Authority having jurisdiction. Pipe shall be IPS sized, conforming to ASTM-A-312, Type 304/304L or 316/316L. Tube is not acceptable. Stainless steel fittings ½” (12 mm) - 2” (50 mm) shall be precision cold drawn austenitic stainless-steel housing complete with pipe stop and Vic press and connections, rated to 500 psi (3,450 kPa), with HNBR gasket, rated for -20°F (-29°C) - 210°F (98°C), ANSI/NSF 61 compliant. Standard of Acceptance: Vic-Press Schedule 10S Fittings and Valves.
Up to 2-½” (65 mm)	Class 150 or Series 200 PVC	Solvent Joints/Schedule 40 fittings
3” (75 mm) and Up	Class 150 or Series 200 PVC	Hub and spigot with retainer glands and harness restraint devices at each thrust point. All rods and fasteners below grade shall be 306 stainless steel.
Domestic Water Piping Above Grade		
Up to 1-½” (38 mm)	Certified Type “L” or Type “K” hard copper	Wrought copper or cast bronze with stainless steel components and EPDM O-ring seals. Victaulic ‘Permalynx’ or Viega Pro-Press.
All sizes	Certified Type “L” or Type “K” hard copper	Wrought bronze or cast brass with Silvabrite 100 lead free solder.

2.3 Metal Protection: All ferrous metal work buried underground shall be of stainless steel construction. Retainer rod, washers and nuts on underground water/pressure mains shall be 316 stainless steel, hangers shall be 316 stainless steel where used for piping supported below grade.

2.4 Valves

.1 Gate (for shut-off and isolation):

.1 2" (50 mm) and smaller, bronze body, solid wedge disc, bronze or stainless-steel trim, non-rising stem, 125 psi (860 kPa) rating.

.1 Acceptable Products:

.1 Solder Joint Type: NHA-42, Kitz 41, Red and White/Toyo 281A.

.2 Threaded Joint Type: NHA-40, Jenkins 810J, Kitz 40, Red and White/Toyo 280A.

.2 2-1/2" (65 mm) and larger, flanged ends cast-iron body, solid wedge disc, bronze or stainless-steel trim, rising stem, outside screw and yoke.

.1 Acceptable Products: Jenkins 404, Kitz 72, Red and White/Toyo 421A/MAS W-10.

.2 Ball (in lieu of gate valves or as specified):

.1 2" (50 mm) and smaller, brass two-piece body, blow-out proof stem, PTFE seats, brass chrome plate ball, lever handle operator, 150 psi (1,034 kPa) rating.

.1 Acceptable Products:

.1 Solder Joint Type: Red and White/Toyo 5049A, Jenkins-1999, 1979, Kitz 59.

.2 Threaded Joint Type: Red and White/Toyo 5044A, Jenkins-1969F, R650, Kitz 58.

.3 Push-to-Connect Joint Type or Grooved: Victaulic PL-300.

.4 Pex Pipe clamp connection: Red and white 5017AB, 5015AB.

.5 Vic-press joint type series P589 (P569 with stainless steel body).

.3 Butterfly (in lieu of gate valves or as specified):

.1 2-1/2" (65 mm) and larger, 200 psi (1,380 kPa) rating, wafer style, threaded lug style cast-iron body, EPDM seat liner, bronze disc, 403 stainless steel stem, 10 position lever lock handle operator on 6" (150 mm) diameter and smaller, handwheel worm gear operator on 8" (200 mm) diameter and larger, for installation between Class 125/150 flanges.

.1 Acceptable Products:

.1 Wafer Style: Apollo 141, Center Line L200W/G200W (EPDM), Grinnell 7721, Metraflex, MAS-D, Kitz DJ, Toyo 17.

.2 Lug Style: Apollo 143, Center Line L200L/G200L (EPDM), Metraflex, MAS-D, Kitz DJ, Toyo 17.

.4 Globe (for throttling, bypass and make-up applications):

.1 2" (50 mm) and smaller, bronze body, bronze or stainless-steel trim, 125 psi (860 kPa) rating.

.1 Acceptable Products:

.1 Solder Joint Type with Bronze Bevel Type Disc: NH A51, Kitz 12, Red and White/Toyo 212.

.2 Threaded Joint Type with Composition Type Disc: NH A50, Kitz 03, Red and White/Toyo 220.

- .2 2-½" (65 mm) and larger, flanged ends, cast-iron body, bronze or cast-iron bevel-type disc, bronze or stainless-steel trim, rising stem, outside screw and yoke, 125 psi (860 kPa) pressure rating.
 - .1 Acceptable Products: NH T731, Jenkins 2342J, Kitz 76, Red and White/Toyo 400A.
- .5 Check (for horizontal installation):
 - .1 2" (50 mm) and smaller, threaded joint type, bronze body, bronze or stainless-steel swing disc holder with Teflon disc, 125 psi (860 kPa) rating.
 - .1 Acceptable Products: Jenkins 4037, Kitz 04, Red and White/Toyo 236.
 - .2 2-½" (65 mm) and larger, grooved or flanged ends, ductile or cast-iron body, bronze or ductile/cast-iron swing disc, bronze or stainless-steel trim, 125 psi (860 kPa) rating.
 - .1 Acceptable Products: Victaulic 717PPS, Jenkins 587, Kitz 78, Red and White/Toyo 435A, MAS W-30.
- .6 Vacuum Relief (for hot water tanks installation):
 - .1 Up to ½" (12 mm), 125 psi (860 kPa) rating.
 - .1 Acceptable Products: ½" (12 mm) Watts 36A, Cash Acme VR-801.
 - .2 ¾" (19 mm) and larger, 125 psi (860 kPa) rating.
 - .1 Acceptable Products: ¾" (19 mm) Watts 36A, Cash Acme VR-801.
- .7 Pressure Reducing:
 - .1 Potable Water System Pressure Reducing Valve:
 - .1 Provide pilot operated globe type pressure reducing valve with bronze strainer assembly to limit static water pressure to 85 psi (585 kPa) on incoming water line to Plumbing Code requirements. PRV shall be epoxy lined WATTS Model PV-10M with Y strainer to sizes indicated.
 - .2 Domestic Hot Water Applications: Pressure reducing valve shall be rated to 225°F (107°C) minimum at required pressure.
 - .2 Acceptable Products:
 - .1 ¼" (6.0 mm) to ⅜" (9.5 mm), 125 psi (860 kPa) rating: Watts 215, Singer.
 - .2 ½" (12 mm) to 2" (50 mm), 125 psi (860 kPa) rating: Watts 223, Braukmann, Conbraco, Cash Acme, Singer, Beeco, Zurn ZW 209.
 - .3 2-½" (65 mm) and larger, 125 psi (860 kPa) rating: BCA 317 PR, Clayton 90 or 90B, Singer 106PR, Beeco, Zurn ZW 209.
 - .4 All sizes: Cash Acme EB-25 Pressure Regulator.
- .8 Pressure Reducing Valve with Integral Low Flow Bypass:
 - .1 1-½" (38 mm) and larger, 125 psi (860 kPa) rating: Acceptable Products: USB-Z3, Clayton, Singer, Wilkins, Beeco.
- .9 Drain Valves and Hose Bibbs:
 - .1 Hose Bibbs: Lockshield globe type with bronze body and trim suitable for maximum system operating pressure. Acceptable Products: Dahl 2316.
 - .2 Drain Valves: Ball type with brass body, cap and chain and chrome-plated brass ball. Acceptable Products: Kitz 58CC, Dahl 50430 Series.

.3 Stop and Drain Valves: Emco 10151, RW5046A or Dahl 521 Series.

.10 Solenoid:

.1 Slow closing solenoid valve, forged brass body, Buna "N" disc, stainless steel parts, enclosure to suit environmental conditions, UL and CAS approved, 120 V. Acceptable Products: ASCO

.11 Mixing:

.1 On both upstream hot and cold supplies, in accessible location, provide positive swing check valves and strainers. This requirement in addition to check valve device common to mixing valve. Where required, provide access panel to check valves and strainers. Mixing valve to be equal to Watts LFUSG-B or Caleffi 5213 Series, Powers Hydroguard LFE480.

.2 On both upstream hot and cold supplies, in accessible location, provide positive swing check valves and strainers. This requirement in addition to check valve device common to mixing valve. Where required, provide access panel to check valves and strainers. Mixing valve to be equal to Moen 104451 adjustable thermostatic mixing valve or Caleffi 5213 Series, Powers Hydroguard Series LFLM496 Adjustable.

.3 On both upstream hot and cold supplies, in accessible location, provide positive swing check valves and strainers. This requirement in addition to check valve device common to mixing valve. Where required, provide access panel to check valves and strainers. Cabinet type mixing valve to be equal to Moen 15440 or Cash Acme Heatguard 145 Series thermostatic mixing valve complete with valving in stainless steel cabinet.

.1 Acceptable Product: Powers Hydroguard LFLM490 Series.

2.5 Vacuum Breakers

.1 Pressure Type:

.1 CSA approved, mechanically independent, spring loaded poppet type check valve with a downstream spring-loaded air inlet valve, with upstream and downstream isolation valves and test cocks. Acceptable Products: Cla-Val 38-VB/AR, Conbraco 4V-500, Febco 765, Watts 800M4FR, Wilkins 720A.

.2 Atmospheric Type:

.1 CSA approved, bronze body, chrome plate finish where exposed. Acceptable Products: Conbraco 38-100, Febco 710/715A, Watts 288A, 288AC, Wilkins 35, Cash Acme V-101 Series.

.3 Vacuum breakers size to match.

2.6 Backflow Preventers

.1 Double check valve assembly (DVA), factory assembled station to CSA B64.5. Acceptable Products: Watts Series 709, Ames 200 Series, CXm F-72, Cla-Val D, D2, Conbraco 40-100, Febco 805, Wilkins 950, MBD-10.

.2 Reducing pressure principle backflow prevention device (RPBP), with inlet and outlet shut-off valves, double check valve assembly, and differential relief outlet and repair/maintenance kit to CSA B64.10-M1984. Acceptable Products: Watts Series 909, Ames 4000 Series, CLA-Val RP, Conbraco 40-200, Febco 860, 867, 835YD, 825, Neptune 575, Wilkins 975, Beeco FRP Series.

2.7 Strainers

- .1 Provide 4 to 1 ratio of basket open area to connecting pipe cross-sectional area, 'Y' pattern, 304 stainless steel screen.
- .2 ¼" (6.0 mm) to 2" (50 mm), threaded ends, bronze body, 150 psi (1,034 kPa) rating.
 - .1 Acceptable Products: Red and White/Toyo 380, Crane 988-½, Armstrong, Sarco (Canada), Kitz 15, Metraflex Style BSFT.
- .3 2-½" (65 mm) and larger, grooved or flanged ends, ductile or cast-iron body, 860 kappa rating.
 - .1 Acceptable Products: Victaulic Style 732PPS, Red and White/Toyo 381A, Crane 989-½, Armstrong, Sarco (Canada), Kitz 80, Metraflex Style TF-125, MAS W-40.

2.8 Water Hammer Arrestors

- .1 Bellows or piston manufactured style with stainless steel casing and welded stainless steel besting bellow if of the bellows style. Site fabricated air chambers are unacceptable. Acceptable Products: Zurn Z-1700 Series bellows style, Jay R. Smith 5000 Series, Amtrol-Mini-Trol, Watts SS-Series, Precision Plumbing Products Inc. 316 piston type, Wade Bellows or Piston Type Shockstops.

2.9 Thermometers and Pressure Gauges

- .1 Refer to Section 22 05 22 Thermometers and Pressure Gauges for Plumbing.

2.10 Temperature and Pressure Relief Valves

- .1 Design: ASME rated for energy input to system and pressure rating of equipment.
- .2 Acceptable Products: Watts, Cash Acme.

2.11 Pipe Joints

- .1 Solders and fluxes having lead content and self-cleaning acid type fluxes shall not be used.
- .2 Copper to steel or iron and flanged adaptors shall be brass, not copper.
- .3 All unions or similar interconnections between dissimilar metals shall be di-electric couplings.
 - .1 Copper silicon casting conforming to UNS C87850 with grooved and or/threaded ends. UL classified in accordance with NSF-61 for potable water service, and shall meet the low-lead requirements of NSF-372.
 - .1 Standard of Acceptance: Victaulic Series 647.
 - .2 Acceptable Products: Victaulic di-electric waterway.
- .4 Grooved Joints Lubricants: Lubricate gaskets with products supplied by the coupling manufacturer in accordance with published installation instructions. The lubricant shall be specifically for the gasket elastomer and system media.

2.12 Air Vents

- .1 Design: Automatic float type, 150 psi (1,034 kPa) maximum operating pressure.
- .2 Acceptable Products: Armstrong 11-AV, Maid-o-Mist 71, Taco 426, Amtrol, Metraflex Style MV-15, Caleffi 5020 MINICAL.

- 2.13 Hydrants and/or Hose Bibbs: Refer to Schedule on drawings
- .1 Acceptable Products: Zurn, Watts, Jay R Smith, Mifab, Wade.
- 2.14 Trap Seal Primers
- .1 Provide flow actuated type priming device piped to nearest fixture so device will introduce regulated amount of water into trap whenever fixture is used. Acceptable Products: Watts A200-T, Zurn, Watts, J R Smith 2699, Wade 2400 Series.
 - .2 Provide pressure actuated type priming device piped when nearest fixture is remote to the floor drain requiring trap priming. Acceptable Products: Precision Plumbing Products Model P-1.
- 2.15 Water Heater and Tank (Electric)
- .1 Glass-lined, electric hot water heater and tank, CSA listed, rated for 150 psi (1,034 kPa) working pressure.
 - .2 Plated copper elements, fully automatic controls, manually adjustable thermostat, 120 V control circuit powered by fused transformer.
 - .3 Extra density, vermin proof, glass fibre insulation with heavy gauge steel jacket finished with baked enamel finish over bonderized undercoat.
 - .4 Magnesium anode protection, heavy duty magnetic contactors and fuse protection against excessive current flows.
 - .5 Refer to Schedule on drawings.
 - .6 Acceptable Products: AO Smith, Ruud, Rheem, State, PVI, Bradford-White.
- 2.16 Expansion Tank for Domestic Hot Water System
- .1 Welded carbon steel expansion tank, ASME construction, stainless steel connection, heavy duty butyl diaphragm, rigid polypropylene liner and integral floor stand, NSF-61 listed for potable water systems.
 - .2 Refer to Schedule on drawing.
 - .3 Acceptable Products: Amtrol ST-60V-C Therm-x-trol, State, Sparco, Flexcon, Wessels.
- 2.17 Thermostatic Water Controllers
- .1 Provide factory tested and assembled high/low flow thermostatic mixing valves complete with check valve, pressure reducing valve, volume control, shutoff valve and stem type thermometer on outlet; strainer stop check on inlet, mounted in lockable cabinet of 16 ga (1.61 mm) prime coated steel. Capacity, model and locations as scheduled.
 - .2 Field assembled systems will be accepted only where Manufacturer's Representative provides setup services after assembly and certifies in writing that valve has been properly adjusted and assembled. Manufacturers shall provide a seven-year warranty against all failures on the thermostatic elements.
 - .3 For local thermostatic water controller with integral check stops, wall mounting bracket, rough chrome finish, removable cartridge with strainer and thermal motor. Provide one spare cartridge for each valve size on individual units.

- .4 Inlet hot temperature to valves will be 140°F (60°C) to 160°F (70°C). Outlet temperature shall be set to 105°F (40°C).
- .5 Acceptable Products: Lawler, Leonard, Symmons, Armstrong Digital Water Temperature Control, Cash Acme, Caleffi, Powers, Guardian.

3. EXECUTION

3.1 Supply Piping (General)

- .1 Upon completion, flush water piping systems with water before installing fixtures to remove any foreign material in piping. Clean plumbing fixtures and equipment and leave in good operating condition.
- .2 Provide connections as required, including shutoff valves with unions or flanges to equipment installed by other trades.
- .3 Ream pipes and tubes. Clean scale and dirt, inside and outside, before assembly. Remove foreign material from piping.
- .4 Clamp cast-iron water pressure pipe at fittings with ¾" (19 mm) 316 stainless steel threaded rods and fasteners complete with required pipe retainer glands, adapters and harnesses to secure pipe sections and fittings together; [OR provide proper anchors, thrust blocks and supports throughout].
- .5 Reduce horizontal piping with eccentric reducer fittings installed to provide drainage and eliminate air pockets.
- .6 Wherever dissimilar metals are joined or supported, provide non-conducting type connections or hangers to prevent galvanic corrosion. Brass adapters and valves are acceptable for pipe connections.
- .7 Install piping to allow for expansion and contraction without stressing pipe or connected equipment.
- .8 Provide clearance for insulation and access to valves, air vents, drains and unions.
- .9 For Pex or Pex-Al Pex potable water piping, use only the pipe manufacturers matched connection and coupling accessories. Provide supplier training and sample inspection by supplier's representative for initial installation and mock-ups.

3.2 Concealed Supply Piping

- .1 Install concealed water supply piping to plumbing fixtures, trim items, equipment, hose bibbs, etc. using cast brass 90° drop ear elbow or drop ear tees, as the piping design dictates.
- .2 Provide blocking within the concealed space and the elbows and tees shall be secured to the blocking using brass screws to provide a rigid installation.
- .3 Do not install pipe in any part of wall where temperature is less than 9°F (5.5°C) under winter design conditions.
- .4 Under no circumstances shall domestic cold-water piping be routed in topping or floor slab.

3.3 Valve Installation

- .1 General:

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- .1 Where possible, disassemble solder end joint valves before soldering.
- .2 Where disassembly and the subsequent reassembly are impossible, give special regard to solder jointing. Ensure valve parts are not melted or deformed during soldering.
- .2 Shut-Off Valves:
 - .1 Install shut-off or isolation valves at the following locations:
 - .1 Where water service enters building.
 - .2 At each main branch supply point. Provide valve on each outlet leg from tee or cross.
 - .3 At each single plumbing fixture. Satisfied by provision of fixture stop where called up.
 - .4 At each piece of equipment.
 - .5 At points indicated on drawings.
 - .6 Where required by plumbing code.
- .3 Pressure Reducing Valves:
 - .1 Set main pressure reducing valve at 60 psi (415 kPa) outlet pressure.
- .4 Drain Valves:
 - .1 Provide drain valves at low points in system.
 - .2 Install drain valves, $\frac{3}{4}$ " (19 mm) minimum, or line size where piping is smaller than $\frac{3}{4}$ " (19 mm).
 - .3 Install hose-end adaptor, cap and chain on discharge side of each drain valve or pipe to drain where indicated.
- .5 Mixing:
 - .1 On up-stream hot and cold supplies, in accessible location, provide positive swing check valves and strainers. This requirement in addition to check valve device that is integral to mixing valve or downstream in mixed supply. Provide access panel to check valves and strainers.

3.4 Vacuum Breaker Installation

- .1 Install at each fixture or item of equipment where contamination of domestic water system can occur and with CSA B64.10 requirements.
- .2 Vacuum breaker installation shall be in accordance with manual "Cross Connection Control Manual" published by Pacific Northwest Section of American Water Works Association.
- .3 Atmospheric type vacuum breakers shall be installed at least 12" (300 mm) above flood level rim of fixture.
- .4 Vacuum breakers serving fume hoods shall be installed outside fume hood.
- .5 Provide drain pan with water deflection enclosure on concealed pressure type vacuum breakers with drain line to appropriate drain.
- .6 Complete testing of vacuum breakers prior to final acceptance of plumbing systems. Certificate shall be submitted, signed and witnessed that testing was satisfactory.

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3.5 Backflow Prevention Station Installation

- .1 Install at each fixture or item of equipment where contamination of the water system can occur and in accordance with CSA B64.10 requirements.
- .2 Pipe differential relief outlet to drain.
- .3 Backflow prevention station shall be in accordance with manual "Cross Connection Control" published in the BC Section of American Water Works Association.
- .4 Complete testing of reduced pressure principle backflow prevention devices shall be carried out under this section of work prior to final acceptance of plumbing systems. Certificate shall be submitted signed and witnessed that testing was satisfactory.

3.6 Strainer Installation

- .1 Install strainer blow-off connections.
- .2 Blow-off connections shall be full drain size and shall include:
 - .1 Up to 2" (50 mm) - nipple and cap (hot services).
 - .2 2-½" (65 mm) and larger - nipple, globe valve and nipple (hot services).
 - .3 All sizes (cold services) - plug blow-off connection only.

3.7 Flanges and Unions

- .1 Provide on connections to pumps, reducing valves, control valves, fixtures, and equipment.
- .2 Connections up to and including 2" (50 mm) size shall be bronze union, 150 psi (1,034 kPa) rating with ground seat. All larger connections shall be flanged.
- .3 Unions not required in installations using grooved mechanical joint couplings. (Couplings shall serve as unions and disconnect points.)

3.8 Pressure Gauges

- .1 Install pressure gauge at all pump suction and discharge points at inlet and outlet of all major equipment having more than a 4 psi (25 kPa) pressure drop and at each pressure reducing station inlet and outlet.

3.9 Water Hammer Arrestors

- .1 Size in accordance with the Plumbing and Drainage Institute PD1-WH-201 sizing procedures.
- .2 Install on branch lines to flush valves, solenoid valves, self-closing faucets, quick closing valves on refrigeration, kitchen, laundry and other equipment incorporating solenoid valves.
- .3 Install at the tops of all domestic water vertical risers, and as shown on the drawings.

3.10 Thermometers

- .1 Install at domestic hot water storage tank inlet and outlet, and at heat exchanger inlet and outlets.
- .2 Locate for ease of readability with sensing elements directly in contact with flowing medium and immediately adjacent to sensing elements.

- .3 When installed to sense the water temperature in a pipe, install its sensing element in a non-ferrous, separable well filled with a heat conduction paste. Install the separable well in a form which minimizes the restriction to water flow, if necessary, in a section of oversized pipe.

3.11 Pipe Joints

- .1 Install di-electric type couplings or fittings where copper piping and accessories connect to plumbing equipment such as steel storage tanks, pressure reducing stations and ductile iron pipe.
- .2 Where water service enters building, terminate at edge of building with Smith Blair standard sleeve coupling having stainless steel nuts and bolts. Bridge excavation with ductile iron pipe.
- .3 Tie rods shall only be used in conjunction with fittings possessing integral tie lugs.
- .4 Tie rods complete with their associated nuts and bolts shall be coated with two coats of asphaltic paint after installation.
- .5 Where plastic PEX piping systems are being used, the complete pipe joining "System" shall be entirely provided by the pipe Manufacturer (Uponor AquaPEX, PureLink/AquaLink).

3.12 Air Vents

- .1 Install on tees. Do not install on horizontal piping or radiused elbows.
- .2 Install ½" (12 mm) minimum isolating gate valve ahead of each air vent.
- .3 Pipe air vent discharge connections separately to nearest building drain using ¼" (6.0 mm) hard drawn copper.

3.13 Hydrants and/or Hose Bibbs

- .1 Provide operating keys to Owner for hose bibbs without attached handle.
- .2 Provide isolating shut-off valve upstream of hose bibbs.
- .3 Set exterior ground type hose bibb boxes flush and anchor in 18" (450 mm) square x 8" (200 mm) thick concrete collar set at 1" (25 mm) above surrounding grade.
- .4 Connect drain ports on floor mount type hose bibbs indirectly to drainage system where such drainage ports are located within confines of building.
- .5 Seal around perimeter of hose bibbs with silicone caulk. Where waterproof membrane is present, provide hose bibb with membrane clamp.

3.14 Trap Seal Primer Valves

- .1 Provide floor drain trap primers in water closet rooms and other areas connected to sanitary sewer in accordance with Provincial Plumbing Code and as designated on drawings. Pipe material shall be Type L copper, NSF approved, polypropylene tubing or aquapex for buried and in-slab pipe connections.
- .2 Locate where readily accessible by maintenance staff.
- .3 Provide shutoff upstream to allow service without affecting other fixtures.
- .4 Provide minimum of 12"x12" access door at each trap primer location to access shutoff and primer.

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- .5 Where electronic trap primers are used, the contractor shall include and allow for the complete installation and coordination with the electrical trade.

3.15 Hot Water Tanks and Heaters

- .1 Provide temperature and pressure relief valves. Install so that probe properly senses temperature. Pipe relief port full outlet size to drain. Position discharge at drain to prevent splash-over.
- .2 Provide vacuum relief valve and check valve on cold water supply.
- .3 Provide isolating valves at tank and heater water connections.
- .4 Provide corrosion resistant water tight pan under any hot water storage tank and/or hot water heater/storage tank in compliance with the BC Plumbing Code.

3.16 Testing and Inspection

- .1 Testing shall consist of hydraulic pressure testing at 200 psi (1,380 kPa) for 8 hours.
- .2 Comply with all requirements of Section 22 05 93 Testing, Adjusting and Balancing for Plumbing.

3.17 Flushing and Chlorination of Water Lines

- .1 Thoroughly flush water piping until free from scale, sediment and debris as soon as possible after system filled with water.
- .2 On completion of laying and testing, all water piping shall be pre-flushed, chlorinated and flushed again in accordance with AWWA C-651.
- .3 Retain firm, qualified to supervise and inspect chlorination and flushing procedures and perform chemical biological tests as required.
- .4 Mains shall be chlorinated to chlorine residual of not less than 10 ppm after standing for 24 hours. Hypochlorite and water is recommended as disinfectant. AWWA C-651 recommends amount of chlorine required.
- .5 Submit to Consultant certificate from testing firm that chlorination and flushing has been successfully completed.

END OF SECTION 22 11 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Scope of Work

- .1 Interior sanitary waste and vent piping shall be provided as indicated on drawings from plumbing fixtures to the
 - .1 Exterior sanitary building service as indicated on drawings.
- .2 Interior storm drainage piping and rainwater leaders shall be provided as indicated on drawings from roof drains, area drains, planter drains and catch basins to the
 - .1 Exterior storm building service as indicated on drawings.

2. PRODUCTS

2.1 Interior Drain Waste and Vent Pipe and Fittings

- .1 Buried Pipe and Fittings:
 - .1 Class 4000 cast-iron mechanical joint pipe and fittings with mechanical joint stainless-steel couplings to CAN/CSA-B70.
 - .2 Polyvinyl Chloride (PVC) Drain Waste and Vent Pipe and Pipe Fittings conforming to CAN/CSA-B181.2.
- .2 Above Ground Pipe and Fittings:
 - .1 Class 4000 cast-iron mechanical joint pipe and fittings with mechanical joint stainless-steel couplings to CAN/CSA-B70 up to 8" (200 mm).
 - .2 DWV copper drainage pipe with cast brass or wrought copper drainage pattern fittings with 50/50 Sn/Pb recessed Solder joints.
 - .3 IPEX System 15 for PVC DWV piping.
 - .4 Manufacturer of cast iron piping shall be certified to current standards of ISO-9001, ISO-14001, OHSAS-18001 Standards, and must be made in North America, with recycled content stated on submission materials.
 - .1 Acceptable Manufacturers: Bibby Ste-Croix, Tyler Pipe, AB+I.
 - .5 No HUB couplings shall be certified to the current standard of CSA B602 and 3rd party listed to the current standard of CAN ULC/S102.2.
 - .1 Acceptable Products: Bibby St-Croix, Anaco, Tyler.
 - .6 Heavy duty stainless steel couplings shall be composed of a fully corrugated shield, neoprene gaskets and certified to the current standard of CSA B602 and 3rd party listed to the current standard of CAN ULC/S102.2.
 - .1 Acceptable products: Anaco/Husky HD2000, Tyler Wide Body, Clamp All 125.

.3 Additional Requirements:

- .1 Cast iron DWV system shall be connected with couplings that are certified to CSA-B-602 and third party listed to current ULC/S102.2 for flame and smoke spread ratings. Heavy-Duty, Shielded, Stainless Steel Couplings composed of a fully corrugated shield, a clamp assembly with a 3/8 inch gear screw tightened to 80 inch pounds, neoprene gaskets and listed to comply with CSA-B60 and Third party listed to current standard of CAN ULC/S102.2 ULC S102.2-10.
 - .1 Manufacturers: Anaco/Husky HD 2000 (Bibby Ste-Croix) or equal.
- .2 Plastic (PVC or ABS) piping where used underground shall adapt to approved non-plastic material prior to penetration above the building slab.
- .3 Copper to cast-iron joints shall be male brass adaptors to tapped fittings.
- .4 Nipples shall be cast-iron or heavy brass.

2.2 Drains

- .1 Floor drains connected to the sanitary system shall include trap primer connections from local water supply points at sinks, lavatories and as shown on the drawings.
- .2 Provide drains as specified in Hose Bibb and Drain Schedule with lacquered cast-iron body (except as noted otherwise) and clamping collar.
- .3 Provide drains by single Manufacturer throughout.
- .4 Drains shall be 4" (100 mm) unless noted otherwise. Provide heavy duty H-20 bearing strength drain grates at all locations where vehicles and heavy traffic areas are located (including but not limited to entry vestibules, loading docks and aprons, maintenance garage bays, auto shop bays, metal shop bays, garbage rooms) and as indicated on the drawings.
- .5 Roof drains shall include domes, screens, drainage grids, etc. Plastic component parts are not acceptable.
- .6 Acceptable Products: Ancon, Enpoco, Jay R. Smith, Zurn, Mifab, Wade, Watts.

3. EXECUTION

3.1 Floor Drains

- .1 Install floor drains at low points to provide proper drainage.
- .2 Water piping from trap primer to floor drain shall be PEX tubing where cast into concrete and protected in a polyethylene sleeve where buried below slab. Provide Type L copper where exposed within building.

3.2 Roof Drains

- .1 Install roof drains at low points on roof to provide proper drainage. Coordinate with roofing Contractor.
- .2 Install in accordance with RCABC standards to maintain integrity of roof guarantee.
- .3 Install integral expansion joints where roof drains are installed directly above rainwater leaders.
- .4 Verify style of roof drain with roofing details prior to submitting shop drawings.

3.3 Safes, Flashing and Vent Terminals

- .1 Terminate vent terminals minimum of 1" (25 mm) above water level at which roof drainage overflows through roof overflow scuppers or drains.
- .2 Cleanouts passing through walls or floors subject to hydrostatic pressure and waterproofed by means other than membrane shall be provided with clamping collars and flashings, tied directly to the cleanout clamping collar.
- .3 Chloraloy 240 lining material may be used as alternate to lead under built-up floor sinks and showers, and at floor drains and cleanouts. Materials shall be solvent welded to Manufacturer's installation instruction. Lead shall not be used on roofs where roofing material is applied by torch-on method. Dow reinforced sheeting 45R may be used as alternate to lead in applications except where rubberized or plastic membrane clamped to drain.
- .4 Supply flashings to cleanouts and drains. Securely fix flashing clamps and extend 12" (300 mm) beyond edge of cast-iron fittings.
- .5 Supply and install waterproofing membrane under built-up showers and mop sinks on floor not slab-on-grade. Safes shall extend across floors and up walls and curb to minimum height of 6" (150 mm) and shall be turned into floor drain flange, unless specifically noted otherwise. Seams shall be completed sealed. Treat both sides of safe with two coats of water waterproof sealant compatible with membrane.
- .6 Vent flashing minimum 18" (450 mm) x 18" (450 mm) base dimension shall terminate flush with top of 12" (300 mm) high vent pipe and gap between flashing and pipe shall be closed with aluminum cap 3" (75 mm) high. Main flashing shall not be turned over pipe. Vent installation detail to be compliant with RCABC Standard Construction Detail 10.3.5.
- .7 Securely fix all roof drains and tie into roof membrane using membrane clamping collars. Installation to comply with RCABC Standard Construction Detail 10.3.6.

3.4 Piping

- .1 Do not install piping with glued joints at temperatures below those recommended by solvent Manufacturer.
- .2 Refer to Section 23 05 05 Firestopping for firestop requirements.
- .3 Joints to be connected with couplings as per Section 2.1.3.
- .4 Support horizontal runs and brace at intervals and points as recommended by the Manufacturer and/or local Authority Having Jurisdiction.
- .5 Support vertical stacks and assemblies and brace as recommended by the Manufacturer and/or local Authority Having Jurisdiction.

3.5 Testing and Inspection

- .1 Tests on sanitary and storm systems shall consist of hydraulic pressure testing of 5 ft water column (30 kPa) minimum and 25 ft water column (75 kPa) maximum for 8 hours. Check for proper grade and obstruction with ball test.
- .2 Air test in accordance with Plumbing Code may be used during freezing conditions.

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END OF SECTION 22 13 00

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1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Codes and Standards

- .1 Fixtures shall display CSA approval where CSA standard is available.
- .2 Plumbing fittings shall be to CAN/CSA B125, Plumbing Fittings.
- .3 Plumbing fixtures shall be to CAN/CSA B45, 'General Requirements for Plumbing Fixtures'.
- .4 Vitreous china plumbing fixtures shall be to CAN/CSA B45.1, 'Ceramic Plumbing Fixtures'.
- .5 Stainless steel plumbing fixtures shall be to CAN/CSA B45.4, 'Stainless Steel Plumbing Fixtures'.

1.3 Colour

- .1 Vitreous china fixtures shall be white unless otherwise noted.
- .2 Stainless steel fixtures shall be satin and/or mirror finish or combination thereof.
- .3 Exposed plumbing brass and metal work shall be heavy triple chromium plated.

1.4 Quality

- .1 Similar plumbing fixtures shall be by one manufacturer.
 - .1 Standard of Acceptance: American Standard, Crane, Kohler, Caroma, Zurn Toto, Moen-Commercial.
- .2 Plumbing fixture supply brass shall be of one Manufacturer, unless otherwise specified.
 - .1 Standard of Acceptance: American Standard, Crane, Kohler, Caroma, Zurn, Toto, Moen-Commercial, Delta-Commercial, Sloan.
- .3 Fixtures shall be free from flaws or blemishes. Surfaces shall be clear, smooth and bright and have dimensional stability.
- .4 Plumbing fixtures and trim shall be new, unless otherwise noted.
- .5 Visible or exposed parts, trim, supplies traps, tubing, nipples, escutcheons, check valves on diverter supply lines and valves to sanitary and/or kitchen fixtures shall be chrome-plated finish, unless otherwise noted.
- .6 Fittings shall have heavy duty stems.
- .7 Roof drains, floor drains: Standard of Acceptance: J.R. Smith, Zurn, Wade, Watts, Ancon.

2. PRODUCTS: REFER TO SCHEDULE ON DRAWINGS

3. EXECUTION

3.1 Fixture Installation

- .1 Connect fixtures complete with specified trim supplied, drains, accessory piping, vented traps, stops or valves, reducers, escutcheons and fittings for proper installation of fixtures and supply fittings.
- .2 Provide necessary hangers, supports, brackets, reinforcements, steel back-up plates and floor flanges to set fixtures level and square. Mount fixtures so 200 lb (90 kg) mass will not loosen or distort mounting.
- .3 Provide minimum 18 ga (1.27 mm) circular stainless steel shrouds for concealing services dropping to island or bench fixtures from ceiling spaces complete with ceiling and counter flanges. Diameter shall be to accommodate services; however, shrouds shall be same diameter in one room or area.
- .4 Provide chrome-plated quarter turn mini ball valves for lavatories, sinks and tank type water closets.
- .5 ABS P-traps and waste arms are not permitted.
- .6 Water Closets:
 - .1 Floor mounted water closets shall be connected to waste utilizing brass or cast-iron floor flanges with lead stub or mechanical joint connections and wax seals.
 - .2 Polished chrome flexible pipe supplied with metal compression rings are acceptable for tank type water closets. Supply shall incorporate ½" (12 mm) inlet x ¾" (9.5 mm) compression outlet angle stop complete with 12" (300 mm) long flexible riser to fixture. PEX or other plastic supplies are not acceptable.
 - .3 Provide 4" (100 mm) drain pipe connections and branch drains from all water closets. Use staggered wye connections at toilet branch drain connections; avoid flat double wye connections.
 - .4 Provide extended spud pieces on handicapped water closets to accommodate closed toilet seat being raised.
- .7 Lavatories and Sinks:
 - .1 Polished chrome flexible pipe supplied with metal compression rings are acceptable. Supply shall incorporate ½" (12 mm) inlet x ¾" (9.5 mm) compression outlet angle stop complete with 20" (500 mm) long flexible riser to fixture.
 - .2 Double waste fittings for lavatories and sinks shall be double sanitary tee.
 - .3 Control handles for two handle mixing faucets shall be positioned with cold control on right and hot control on left. Activation by rotating cold control handle clockwise and hot control handle counter clockwise.
 - .4 Faucets shall be complete with nuts and tailpieces.
 - .5 Provide gaskets and/or sealing washers to prevent entry of water into fixture trim, faucet holes or punchings in millwork.
 - .6 Gooseneck spouts shall have clearance of 8" (200 mm) from nozzle tip to countertop, unless otherwise specified.

- .7 Plastic control handles and spouts are unacceptable.
 - .8 Lavatory and sink P-traps shall be complete with either a cleanout or slip joint connection.
- .8 Urinals:
 - .1 Piping, fittings and P-traps from urinals shall not be copper; vents above urinal rim may be copper.
 - .2 Urinals shall have individual wastes.
- 3.2 Fixture Trim Holes or Punchings
 - .1 Fixture punchings for faucets or other trim shall match holes necessary for specified trim.
 - .2 Provide fixture and templates to applicable trades for holes and cut outs required in millwork.
- 3.3 Walls and Floors
 - .1 Fixtures mounted on glazed tile surfaces shall have ground faces to finished surface.
 - .2 Plumbing fixtures in contact with walls and floors, shall be sealed with Dow Corning anti-mildew 786 building sealant, made watertight and beaded smooth.
- 3.4 Water Hammer Arrestors
 - .1 Provide water hammer arrestors or shock absorbers on fixtures with flush valves and/or quick closing valves or solenoid valves.
- 3.5 Handicap Fixtures
 - .1 Water Closets:
 - .1 Install wall hung water closets designed for handicap use with top of seat 16" (400 mm) to 18" (450 mm) above finished floor.
 - .2 Install offset on handicap water closet flush valve connection to eliminate interference with grab bar mounting.
 - .3 Install flush valve so handle is facing transfer or non-grab bar side of water closet.
 - .4 Install flush valve so that hands free flush is coordinated to flush with the seat cover up.
 - .2 Lavatories and Sinks:
 - .1 Provide offset P-traps.
 - .2 Supplies shall accommodate offset P-trap.
 - .3 P-traps and waste arms shall be insulated with manufactured insulation kit or ½" (12 mm) of fibreglass insulation and finished with polyvinyl chloride jacket.
 - .4 Acceptable Manufactured Products: Truebro 'Handi Lav-Guard,' Brocar Products Inc. 'Trap Wrap,' Sexauer 'Handi Lav-Guard' Plumberex 'Handy Shield'.

END OF SECTION 22 40 00

1. GENERAL

1.1 Conformance

- .1 General Conditions, Supplements and Amendments shall govern this Division (read in conjunction with Instruction to Tenderers / Bidders). This section covers items common to all sections of Mechanical work and is intended to supplement requirements of Division 01. Refer also to Sections 21 05 06 and 22 05 00.

1.2 Work Included

- .1 Provide complete, fully tested and operational mechanical systems to meet requirements described herein, in complete accordance with applicable codes and ordinances.
- .2 “Provide” shall mean “Supply and Install” products and services specified.
- .3 Provide materials, equipment and plant, of specified performance and quality, with current models with published, certified ratings for which replacement parts are readily available.
- .4 Provide project management and on-site supervision to undertake administration, meet schedules, ensure performances, and coordination, and establish orderly completion and delivery of fully commissioned installation.
- .5 Follow Manufacturer’s recommendations for installation, safety, access for inspection, maintenance and repairs. Provide access to motors, belts, filters and lubricating points. Install equipment to permit maintenance and disassembly with minimum disturbance to connecting piping or duct systems.
- .6 Most stringent requirements of this and other mechanical sections shall govern.
- .7 Work shall be in accordance with the Drawings and Specifications and their intent, complete with necessary components, including those not normally shown or specified, but required for complete installation.
- .8 Provide seismic restraints for required equipment, piping and ductwork.
- .9 Connect mechanical services to equipment furnished by Owner or other Sections, including start-up and test.

1.3 Standard of Acceptance

- .1 Means that item named and specified by Manufacturer and/or catalogue number forms part of specification and sets standard regarding performance, quality of material and workmanship and when used in conjunction with referenced standard, shall be deemed to supplement standard.
- .2 Acceptable product Manufacturers are listed within section where they are specified or in equipment schedules.
- .3 Where two or more items of equipment and/or material, of the same type, are required, provide products of single Manufacturer.
- .4 Visible Manufacturer’s nameplate shall indicate Manufacturer’s name, model number, serial number, capacity data, electrical characteristics and approval stamps.

- .5 Provide new materials and equipment not less than quality specified and of current models with published ratings and available replacement parts. Equipment shall have ULC, CSA or ASME nameplates as required by Authorities having jurisdiction.
- .6 Use same brand of Manufacturer throughout, unless otherwise specified, for each specification application of equipment or material.
- .7 Replace materials less than specified quality and relocate work incorrectly installed as determined by Consultant.

1.4 Addition of Acceptable Manufacturers

- .1 Equipment/material considered to satisfy specification, but of Manufacturer other than those named in section specifying equipment/material may be submitted in writing to Consultant for consideration not later than five working days prior to close of tender or bid depository Sub-Trade tender, whichever is earlier.
- .2 Addition of Manufacturer's names to specifications shall be by addendum only.
- .3 Provide complete technical and performance equivalency comparison to specified equipment to show that proposed equipment is equal to, or better than the specified equipment. At a minimum, provide a checklist or side by side comparison with the following information:
 - .1 Physical dimensions and installed weight.
 - .2 Electrical characteristics.
 - .3 Performance data.
 - .4 Acoustical data.
 - .5 Service space requirements.
 - .6 Components specifications breakdown (Fins material, tube material, casing material, operating components specifications, etc.)
 - .7 Maintenance requirements.
 - .8 Use the technical specifications of the equipment in this specification as a checklist to show compliance/non-compliance.

1.5 Tender Inquiries

- .1 Contractor queries during tender period shall be made in writing to Consultant. Contractor queries will be collected and suitable addenda issued for clarification. No verbal information will be issued by Consultant's office during tender. Tender queries may be emailed, faxed, mailed, or couriered to Consultant's office. No telephone questions will be answered.

1.6 Equipment List/Sub-Trades

- .1 Unless requested otherwise, submit within seven days of contract award a list naming Sub-Contractors and Manufacturers of equipment to be used.
- .2 Equipment list shall be full list of materials intended for installation.

1.7 Responsibilities

- .1 Responsibility as to Division providing equipment or materials rests solely with General Contractor. Extras shall not be considered based on difference in interpretation of specifications as to which trade provides certain equipment or materials.

- .2 Visit site before tendering. Examine local and existing conditions on which work is dependent. No consideration will be granted for any misunderstanding of work to be done resulting from failure to visit site.
- .3 Ensure equipment does not transmit noise and/or vibration to other parts of building, as a result of poor installation practice.
- .4 Where Contract Documents do not contain sufficient information for proper selection of equipment for bidding, notify Consultant during tendering period.
- .5 Examine Consultants' (architectural, structural, civil, electrical) drawings plus Code Consultant's report and work of other trades to ensure work can be carried out. Conflicts or additional work not covered by drawings and specifications shall be brought to attention of Consultant before start of work.
- .6 During freezing weather, protect materials such that no harm can be done to installations already in place and/or to materials and equipment on project.
- .7 On completion of work, tools and surplus waste materials shall be removed and work left clean and operating correctly.
- .8 Advise Consultant of specified equipment, material or installation which violates laws, ordinances or regulations.

1.8 Coordination and Supervision

- .1 Check drawings of trades to verify space and headroom limitations for work to be installed. Coordinate work with trades and make changes to facilitate satisfactory installation.
- .2 Drawings are diagrammatic and approximately to scale unless detailed otherwise. They are not intended to show structural details or architectural features. Contract Documents establish scope, material and installation quality and are not detailed installation instructions.
- .3 Install distribution systems and equipment generally in locations and routes shown, close to building structure avoiding interference with other services or free space.
- .4 Work out interference problems on site with other trades and coordinate work before fabricating, or installing any material or equipment. Where necessary, produce interference drawings. Ensure materials and equipment fit into allotted spaces and equipment can be properly serviced and replaced. Extras for improper coordination and removal of equipment to permit remedial work shall not be considered.
- .5 When open web structural joists are used, obtain structural shop drawings to ensure adequate space is available for installation of pipes and ductwork.
- .6 Coordinate with other divisions including, but not limited to the following:
 - .1 Electrical requirements for mechanical equipment and devices requiring electrical power and connection to fire alarm/annunciator panels for mechanical equipment.
 - .2 Mechanical services connection locations with kitchen, laundry and irrigation equipment.
- .7 Mechanical Contractor shall provide following services:
 - .1 Coordinate mechanical work.
 - .2 Follow up on material and equipment deliveries, review shop drawings and produce interference drawings.
 - .3 Ensure Sub-Trades are installing work properly.

- .4 Ensure interconnecting phases with Mechanical are covered.
- .5 Review cost breakdown, progress claims and cost submissions for mechanical work.
- .6 Resolve and direct responsibility for warranty.
- .7 Provide digital photographs of progress as specified.

1.9 Inspection of Work

- .1 Consultant Representative shall review work prior to being concealed. Piping below ground must be reviewed prior to covering.
- .2 Work shall be approved by authorities having jurisdiction.
- .3 Openings shall be sealed, in particular in fire rated walls and floors. Sealing shall be inspected prior to covering.

1.10 Permits

- .1 Obtain required permits and pay fees and comply with Provincial, Municipal and other legal regulations and bylaws applicable to work.
- .2 Arrange for inspection of work by departmental representative or their designate.

1.11 Codes, Regulations and Standards

- .1 Mechanical work shall conform to the following codes, regulations and standards, and other codes in effect at time of award of Contract, and any others having jurisdiction. The applicable version of each code and standard shall apply unless otherwise specified in the contract documents:
 - .1 Bylaws.
 - .1 Local Building Bylaws.
 - .2 National Research Council of Canada
 - .1 National Building Code of Canada.
 - .2 National Fire Code of Canada.
 - .3 SMACNA Publications
 - .1 HVAC Duct Construction Standards.
 - .2 Fire, Smoke and Radiation Damper Installation Guide.
 - .3 Guidelines for Seismic Restraints of Mechanical Systems.
- .2 Where specifications specifically indicate requirements more onerous than aforementioned codes, these requirements shall be incorporated.

1.12 Warranty

- .1 Equipment and systems shall be warrantied for one year. Provide written certifications to Owner. Provide extended warranty certificates on equipment as applicable and specified.
- .2 Use of equipment or systems during construction shall not alter warranty period or represent acceptance of work or equipment.
- .3 Warranty coverage shall include labour and material to correct defective equipment, workmanship, material and building damage caused by failure of same.

- .4 Warranties shall be effective from date of Substantial Completion

1.13 Workmanship

- .1 Workmanship shall be in accordance with established practice and standards accepted and recognized by Consultant and Contractor.
- .2 Tradesmen engaged in installation of work covered within Mechanical shall be qualified in accordance with requirement of Tradesmen Qualification Act and pertinent licensing requirement required by Ministry of Municipal Affairs.

1.14 Performance Verification of Installed Equipment

- .1 Installed mechanical equipment may be subject to performance verification as specified herein if required by Consultant.
- .2 When performance verification requested, equipment shall be tested to determine compliance with specified performance requirements.
- .3 Consultant will determine by who shall carry out testing. When requested, Contractor shall arrange for services of independent testing agency.
- .4 Testing procedures shall be reviewed by Consultant.
- .5 Maintain building comfort condition when equipment removed from service or testing purposes.
- .6 Promptly provide Consultant with test reports.
- .7 Should test results reveal that originally installed equipment meets specified performance requirements, Owner will pay costs resulting from performance verification procedure.
- .8 Should test results reveal equipment does not meet specified performance, equipment will be rejected, and the following shall apply:
 - .1 Remove rejected equipment. Replace with equipment which meets requirements of Contract Documents, including specified performance requirements.
 - .2 Replacement equipment may be subject to performance verification as well, using same testing procedures on originally installed equipment.
 - .3 Contractor shall pay costs resulting from performance verification procedure.

1.15 Drawings and Measurements

- .1 Drawings are diagrammatic and are intended to indicate scope and general arrangement of work and are not detailed installation drawings. Do not scale drawings. Obtain accurate dimensions from Architectural and Structural drawings.
- .2 Consult Architectural drawings and details for exact locations of fixtures and equipment. Obtain this information from Consultant where definite locations are not indicated.
- .3 Take field measurements where equipment and material dimensions are dependent upon building dimensions.

1.16 Shop Drawings

- .1 Submit shop drawings in the format and quantity specified in the general conditions for all equipment indicated and proposed for as ACCEPTABLE PRODUCT in the section where they are specified or in the equipment schedules. A comprehensive listing of mechanical equipment and materials complete with the expected submission dates shall be submitted to Consultant within 30 days of contract award. Consultant reserves right to modify list.
- .2 Eight sets of shop drawings shall be submitted in photocopied form as discussed with Consultant in accordance with British Columbia MCA format including the following information:
 - .1 Cover sheet.
 - .2 Physical and dimensional data.
 - .3 Service space requirements.
 - .4 Electrical requirement data.
 - .5 Performance data.
 - .6 Manufacturers' specifications.
 - .7 Installation instructions.
 - .8 Starting instructions.
 - .9 Maintenance instructions.
 - .10 Operating instructions.
- .3 Fan and pump submissions shall include performance curves (charts are not acceptable).
- .4 Include radiated, discharge and inlet sound power levels for major pieces of mechanical equipment.
- .5 Do not include non-applicable information. Non-applicable information shall be removed entirely or crossed out from shop drawing.
- .6 Cover sheet shall include the following information:
 - .1 Title, number of pages, Contractor, Supplier, Manufacturer, date of submission.
 - .2 Place for Consultant's review stamp 4" (100 mm) x 3" (75 mm)
 - .3 Related parties involved in Contractor's pre-submission review (Mechanical and General Contractors).
 - .4 Related parties involved in Consultant's review.
 - .5 Area allocated for comments.
- .7 Maintain one complete copy of reviewed shop drawings on site in indexed 3-ring binder.
- .8 Shop drawings not prepared as described above shall not be reviewed by Consultant.
- .9 Do not order equipment or materials until shop drawings have been accepted by Consultant.
- .10 Related mechanical equipment and materials shall be submitted together (e.g. coils, heat exchangers, glycol pump, furnaces complete with cooling coil and condensing unit). Shop drawings not properly submitted with related equipment shall be held until related shop drawings submitted.
- .11 Submit in imperial (SI Metric) units to match those specified.

- .12 Consultant's review of shop drawings shall not relieve Contractor from compliance with specified requirements. Installed materials and equipment shall meet specified requirements whether or not shop drawings are reviewed by Consultant.
- .13 Shop drawing review by Consultant shall provide the following certification: "Reviewed for general design and compliance with the contract documents. Dimensions and suitability for site condition are the responsibility of the Contractor. Coordinate electrical requirements with the Electrical Contractor. This review of drawing shall not relieve the Contractor from complying with the conditions of the contract documents."

1.17 Duct and Pipe Mounted Control Equipment

- .1 The following automatic control equipment will be supplied by Controls Contractor but installed by appropriate trade sections of Mechanical Contract:
 - .1 Automatic control dampers.

1.18 Temporary Heating

- .1 Do not use permanent systems for temporary heat without written permission from Consultant.
- .2 Clean and overhaul equipment used during construction. Restore to original working condition. Replace equipment or components not operating properly. Replace mechanical seals in pumps used for temporary heating regardless of condition.
- .3 Use of permanent systems for temporary heat shall not modify terms of warranty.
- .4 Operate systems under conditions which ensure no permanent damage with safety devices and controls installed and fully operational.
- .5 Operate fans at design resistance with temporary 60% dust spot efficiency filters installed and filter media on return and exhaust air outlets. Change filters at regular intervals. Clean dirty ducts with industrial power vacuum equipment as directed by Consultant.
- .6 Provide alarm indicating system failure on systems used for temporary heat.

1.19 Temporary or Trial Usage

- .1 Temporary or trial usage by Owner of mechanical equipment supplied under this contract shall not represent acceptance.
- .2 Repair or replace permanent equipment used temporarily.
- .3 Repair or otherwise rectify damage caused by defective materials or workmanship during temporary or trial usage.

1.20 Spare Parts

- .1 Provide spare parts as follows:
 - .1 One set of V-belts for each piece of machinery.
 - .2 One filter cartridge for each filter installed (pre- and final filters).

1.21 Project Close-Out Requirements

- .1 The project closeout requirements are specifically listed in each section of this specification. Refer to detailed specifications in each section for further, detailed requirements.

1.22 Semi Final Inspection

- .1 Perform the following before semi-final field review:
 - .1 HVAC systems capable of operation with automatic controls in operation with alarms functional.
 - .2 Tests on systems and equipment completed and certificates of approval obtained from Authorities.
 - .3 Rough balance of air systems completed.
 - .4 Firestopping completed. Refer to Section 23 05 05 Firestopping for firestop requirements.
 - .5 Valve tagging completed, and equipment, ductwork and piping identified. Escutcheons installed.
 - .6 Equipment lubricated in accordance with Manufacturer's data.
 - .7 Extended warranty form mailed to Manufacturer and copy provided to Owner.
 - .8 Systems chemically cleaned and flushed, strainers cleaned, and water treatment initiated. Equipment drains installed.
 - .9 Submit sample of Operating and Maintenance Manuals. Arrange for Operation and Maintenance Instruction Seminar and submit schedule for approval.
 - .10 Ensure access doors suitably located and equipment accessible.
 - .11 Seismic sway bracing and restraint systems installed.
 - .12 Check operation of plumbing systems and fixtures. Ensure fixtures are solidly supported.
 - .13 Fan plenums cleaned and permanent filters installed.
 - .14 Ensure electrical connections to mechanical equipment are complete and motor rotation correct.
 - .15 For packaged, self-contained HVAC equipment, Manufacturer's checkout list completed. Copies forwarded to Consultant and included in Maintenance Manuals.
 - .16 Turn all digital photography files over to Consultant with dates of photos and locations taken from.

1.23 Substantial Completion Requirements

- .1 Consultant shall issue checklist for completion by Contractor before Substantial Completion Field Review. Provide written declaration that work is complete. The following items shall be complete before Substantial Completion Field Review:
 - .1 Seismic restraints inspected by Suppliers' Professional Engineer and report has been filed with Commissioning Agent. Schedule S Letter of Assurance from Seismic Consultant submitted.
 - .2 All access doors and panels are in place and not painted closed.
 - .3 Ductwork has been cleaned, provide letter of verification to Commissioning Agent and this Consultant.
 - .4 Balancing reports have been submitted to this consultant.
 - .5 Fire Damper Test Certificate provided.
 - .6 Cooperate with Clean Agent Fire Suppression Contractor to verify interlocks with mechanical equipment and motorized damper for room isolation and pressure test.

- .7 Commissioning Checklists for operational readiness and safety checks have been submitted to this Consultant.
 - .8 Controls pre-operational readiness checklists (end to end checks and sequences of operation) have been verified and submitted to this Consultant.
 - .9 All control devices have been calibrated and checked for proper operation. Submit report through Commissioning Agent.
 - .10 Final draft Mechanical Maintenance Manuals have been submitted for review to this Consultant.
 - .11 Draft Record drawings (marked up whiteprints or ACAD files) have been submitted to this Consultant for review.
 - .12 The most recent Site Review (inspection) Report has been re-submitted to this Consultant with all outstanding items either crossed off and initialled as “Done”, and outstanding items noted with “Time to Complete” or “by others” with a clear statement of who the “others” are and that they have been alerted to perform the rectification of the deficient work.
 - .13 Confirmation that training sessions have been arranged and set up for the Owners’ operating personnel for Controls and Systems Operation.
 - .14 Refer to requirements in Section 22 05 00 for plumbing systems.
- 1.24 Deficiency Holdbacks and Deficiency Inspections
- .1 Work under this Division, which is still outstanding when substantial completion is certified, will be considered deficient and a sum equal to minimum twice the estimated cost of completing that work will be held back.

2. PRODUCTS

2.1 Operating and Maintenance Manuals

- .1 Provide services to prepare proper documentation and instruction to Owner in operation and preventative maintenance of mechanical equipment and systems. Complete and turn over documentation one month before Substantial Completion. Provide proposed table of contents and first draft of General Systems Description to the consultant for review prior to preparing full O&M Binders.
- .2 Provide three 8.5” (216 mm) x 11” (280 mm) capacity extension type (ACCO Model P5426-E to suit thickness required) catalogue binders with hot stamped lettering front and spine. Binders are available from Vancouver Bookbinding Ltd. (Phone: 604-872-8132). One copy of final manuals to remain with Consultant during warranty period. Provide electronic format for Maintenance Manuals, to contain all of the same content as the hard copy. The electronic format shall be arranged in a searchable, segmented format using ADOBE.pdf with both Page Content and Bookmark formatting. Scanned material will not be accepted. Provide the electronic format Maintenance data on CD-ROM disks with labels to match the hard copy format. Where possible and as available, include Maintenance and Operation videos from equipment Suppliers and Manufacturers that demonstrate Maintenance procedures

- .3 Each binder shall be indexed with custom made tab dividers (9 point oriole Bristol divider paper stock) with sequentially numbered colour index tabs of laminated Mylar plastic as available from Vancouver Book Binding Ltd. (Phone: 604-872-8132). Tab colours shall be orange for 1.0, 1.1, 1.2, 1.2 ... series tabs, green for 2.0, 2.1, 2.2... series tabs, yellow for 3.0, 3.1, 3.2... series tabs, red for 4.0, 4.1... series tabs. The following indexing system shall be used:
 - .1 Tab 1.0 - Mechanical Systems: title page with clear plastic protection cover.
 - .2 Tab 1.1 - List of Mechanical Drawings: provide list of mechanical drawings.
 - .3 Tab 1.2 - Description of Systems: provide description of each system with summer or winter operating variances and controller operating setpoints.
 - .4 Tab 1.3 - Operating Division: provide operating description of each major component and how components interface with other components, operation of controls including operational sequences for summer or winter, troubleshooting sequences and safeguards to check if equipment goes offline.
 - .5 Tab 1.4 - Maintenance and Lubrication Division: provide preventative maintenance and lubrication schedule for each major component including weekly, monthly, semi-annual, and maintenance schedule requirements or pneumatic, electronic, and DDC systems.
 - .6 Tab 1.5 - List of Equipment Suppliers and Contractors: provide list of equipment suppliers and Contractors, including addresses and telephone numbers. Furnish list of spare parts for each piece of equipment such as bearings, seals v-belts, filters, etc.
 - .7 Tab 2.0, 2.1, etc. - Certification: provide copies of WHMIS safety data sheets. Include copy of test data, cleaning and chemical treatment program, analysis of system water taken at time system was put into operation, hydrostatic or air tests performed, equipment alignment certificates, copy of valve tag and pipe colour identification schedules and inspection approval certificates for plumbing systems.
 - .8 Tab 3.0, 3.1, etc. - Shop Drawings and Maintenance Bulletins: provide materials received in compliance with Shop Drawings.
 - .9 Tab 4.0 - Balance Reports: provide copies of balance reports.
 - .10 Tab 5.0 – Commissioning Report: provide copy of final commissioning report.
- .4 Submit documents to Consultant for review before turning over to Owner.
- .5 Obtain shop drawing information for Mechanical equipment and include in appropriate section.

2.2 Record Drawings and Digital Photographs

- .1 Digital photographs of project shall be taken before covering or concealing underground piping and/or service in walls, concealed ceilings, furring or shafts. Photographs shall be emailed to the Consultant at achong@integralgroup.com with the Consultant's job number and project name clearly indicated on the email. Identify each photo with the date and location the photograph was taken from within the same email.
- .2 Prior to each FIELD REVIEW, the Contractor shall ensure one set of white prints clearly marked (for Consultant inspection) indicating any changes and deviations from Contract Documents, including any work by change orders and job instructions plus:
 - .1 Alterations to ductwork, piping, mechanical equipment and associated work.

- .2 Inverts of services at key points within building, entering and leaving building and at property line. Dimension to services in relation structure and building, entering and leaving building grid lines for buried services, manholes, catch basins and outside shutoff valves.
- .3 Locations of concealed piping, conduit and equipment such as fire dampers, cleanouts, service valves and access doors.
- .3 Before substantial completion, turn marked up white prints over to Consultant to transfer site changes to AutoCAD files and provide two sets of white prints marked "Record Drawings" and electronic AutoCAD files on a CD ROM disk to the Owner.

2.3 Access Doors

- .1 Acceptance Products: Zurn, Wade, Acudor, Can-Aqua, Milcor, Maxam, Van-Met.
- .2 Supply flush mounted access doors, for installation in ceilings and walls, to permit servicing of mechanical equipment and accessories, inspection of life safety or operating devices, and where specifically indicated.
- .3 Unless otherwise noted, access doors shall be minimum: 24" (600 mm) x 24" (600 mm) for body entry, 12" (300 mm) x 12" (300 mm) for hand entry, 8" (200 mm) x 8" (200 mm) for cleanout access. Access doors in building surfaces shall be at least as large as duct access panels accessed through them and shall be oversized when necessary. Size to suit masonry modules when located in masonry wall.
- .4 Locate access doors so concealed items are readily accessible for adjustment, operation and maintenance. Locate in service and storage areas wherever possible. Do not locate in paneled, feature or special finish walls, without prior approval of Consultant.
- .5 Access doors in fire separations of $\frac{3}{4}$ hour rating and higher, and firewalls shall have compatible fire rating and ULC label with tamper-proof latch and be self-closing.
- .6 Minimum Requirements:
 - .1 180 degree door swing, mitered rounded safety corners flush welded, concealed hinges, screwdriver latches, and anchor straps or lugs to suit construction, steel prime coated.
 - .2 Plaster or wet wall construction: 14 ga (1.99 mm) bonderized steel flush with wall or ceiling type with concealed flange.
 - .1 Acceptable Product: Acudor PS-5030.
 - .3 Masonry or drywall construction: 16 ga (1.61 mm) for 16" (400 mm) x 16" (400 mm) and smaller, 14 ga (1.99 mm) for 18" (450 mm) x 18" (450 mm) and larger bonderized steel face of wall type with exposed flange.
 - .1 Acceptable Product: Acudor UF-5000.
 - .4 Tile, ceramic tile, marble, terrazzo, plaster or wet wall construction in washrooms and other special areas: 14 ga (1.98 mm) stainless steel flush with wall or ceiling with concealed flange.
 - .1 Acceptable Product: Acudor PS-5030 stainless.
 - .5 Acoustical tile ceiling and similar block materials: 14 ga (1.99 mm) bonderized steel recessed ceiling type.
 - .1 Acceptable Product: Acudor AP-5010 or AT-5020.
 - .6 Feature wall construction: Recessed wall type selected to complement and conform with architectural module, treatment, or paneling, size shall conform to adjacent finished areas.

3. EXECUTION

3.1 Concealment

- .1 Conceal piping, ductwork and conduit in partitions, walls, crawlspace and ceiling spaces, unless otherwise noted.
- .2 Do not install piping and conduit in outside walls or roof slabs unless specifically indicated. When required, install them inside the building insulation.

3.2 Access

- .1 Install work to be readily accessible for adjustment, operation and maintenance. Furnish access doors where required in building surfaces for installation by building trades.
- .2 Provide 3/4" (19 mm) diameter brass/aluminum/stainless steel number tags or "Allflex" plastic tags with type or service and valve number stamped in black, secured to valve wheel with key chain for all valves. Provide typewritten valve directory giving number, service and location. For valves hidden in suspended ceilings, provide flexible plastic film with permanent pressure-sensitive adhesive type label on the ceiling grid indicating location of valves. Include in Maintenance Manuals and under glass, wall mounted, location determined by Consultant.

3.3 Protection of Work

- .1 Protect equipment and materials, stored or in place, from weather, moisture, dust and physical damage.
- .2 Mask machine surfaced finishes and edges. Secure covers over equipment openings and open ends of piping, ductwork and conduits, as installation progresses.
- .3 Equipment having operating parts bearing on machined surfaces, showing signs of rusting, pitting or physical damage will be rejected.
- .4 Refinish damaged or marred factory finish.
- .5 Air systems shall have temporary air filters installed before fans are operated. Install new air filters before system acceptance.

3.4 Cutting, Patching, Digging, Canning and Coring

- .1 Lay out cutting, patching, digging, canning and coring required to accommodate mechanical services. Coordinate with other Divisions.
- .2 Refer to Structural drawings for permissible locations of openings and permissible opening sizes in concrete floors and walls. Openings through Structural members shall not be made without approval of Consultant.
- .3 Be responsible for correct location and sizing of openings required under Mechanical, including pipe sleeves and duct openings. Allow oversized openings for fire dampers and pipe penetrations where insulation is specified.

3.5 Fastening to Building Structure

- .1 General:
 - .1 Do not use inserts in base material with compressive strength less than 2,000 psi (13,790 kPa).

- .2 Inserts shall have factor of safety of 4.
- .3 Power/powder actuated fastenings and drop-in anchors are not permitted to be used for tensile loading (i.e. suspension of mechanical equipment) or for seismic anchorage and/or restraint.
- .2 Types:
 - .1 Cast-in-place type:
 - .1 Channel type - Burndy, Canadian Strut, Unistrut, Cantruss or Hilti Channel.
 - .2 Cast-in Anchor: Hilti HCI-MD.
 - .3 Wedge type galvanized steel concrete insert, Grinnell Fig. 281 for up to 8" (200 mm) pipe size.
 - .4 Universal type malleable iron body insert, Grinnell Fig. 282 for up to 8" (200 mm) pipe size.
 - .5 Screw concrete insert, Grinnell Fig. 152 for up to 12" (300 mm) pipe size.
 - .2 Drilled, mechanical expansion type:
 - .1 Hilti HSL-3 or UCAN LHL heavy duty anchor for using in concrete with compressive strength not less than 2,840 psi (19.6 kPa).
 - .2 Hilti Kwik-Bolt-3 or UCAN WED stud anchor for concrete (do not use in seismic restraint applications).
 - .3 Hilti HDI or UCAN IPA drop-in anchor for concrete. Where ever possible, HDI's or drop-in anchors shall be avoided in tension zones of concrete (i.e. underside) due to cracking of concrete and reduct holding value.
 - .4 Hilti or UCAN Sleeve Anchor (medium and light duty) for concrete and masonry.
 - .5 Hilti Metal-HIT or UCAN Zamac pin bolt (light duty) for concrete and masonry
 - .3 Drilled, adhesive type:
 - .1 Hilti HVA or UCAN Adhesive Anchor consisting or anchor rod assembly with a capsule containing a two-component adhesive, resin and hardener.
 - .2 Hilti HY150- MAX-SD or RE500-SD consisting of anchor rod with a two part adhesive system.
 - .3 For use in concrete housekeeping bases (in vertical downward position) where distance to edge of concrete base could cause weakness if mechanical expansion type anchor were used.
 - .4 Rod assemblies shall extend minimum 2" (50 mm) into concrete slab below housekeeping bases.
- .3 Installation:
 - .1 Drilling for inserts shall be performed using appropriate tool specifically designed for insert. Diameter and depth of each drilled hole shall be exact dimensions as specified by insert Manufacturer.
 - .2 Refer to Manufacturer's recommendations for tightening torques to be applied to inserts.
 - .3 Where specifically called for, drills shall include a dust vacuum system, Hilti DRS Dust Vacuum System.

3.6 Service Penetrations in Rated Fire Separations

- .1 Refer to Section 23 05 05 Firestopping for firestop requirements.

3.7 Service Penetrations in Non-Rated Separations

- .1 Piping, tubing, ducts, wiring, conduits, etc. passing through non-rated fire separations and non-rated walls and floors shall be tightly fitted and sealed on both sides of separation with silicon sealant to prevent passage of smoke and/or transmission of sound.

3.8 Pipe Sleeves

- .1 Provide pipe sleeves for piping passing through rated walls and floors. Sleeves shall be concentric with pipe.
- .2 Pipes and ducts passing through fire rated separations that have no fire resistance (non-rated separations) do not require sleeve, but insulation at separation shall be wrapped with 24 ga (0.70 mm) thick galvanized sheet steel band for application of flexible caulking compound.
- .3 Pipe sleeves for floors and interior walls shall be minimum 24 ga (0.70 mm) thick galvanized sheet steel with lock seam joints.
- .4 Pipe sleeves for perimeter walls and foundation walls shall be cast-iron sleeve or Schedule 40 steel pipe with annular fin continuously welded at midpoint and protruding 6" (150 mm) beyond sleeve diameter. Annular fin shall be embedded into centre of wall.
- .5 Pipe sleeves for wet or wash down floor areas such as washrooms, janitors' rooms, laboratories and mechanical equipment rooms shall be Schedule 40 steel pipe.
- .6 Except as otherwise noted, pipe sleeves are not required for holes formed or cored in interior concrete walls or floors.
- .7 Pipe sleeves shall extend 2" (50 mm) above floors in unfinished areas and wet areas and ¼" (6.0 mm) above floors in finished areas.
- .8 Pipe sleeves shall extend 1" (25 mm) on each side of walls in unfinished areas and ¼" (6.0 mm) in finished areas.
- .9 Pipe sleeves shall extend 1" (25 mm) beyond exterior face of building. Caulk with flexible caulking compound.
- .10 Sleeve Size: ½" (12 mm) clearance all around, between sleeve and pipe or between sleeve and pipe insulation.
- .11 Paint exterior surfaces of ferrous sleeves with heavy application of rust inhibiting primer.
- .12 Packing of Sleeves:
 - .1 Where sleeves pass through foundation walls and perimeter walls, space between sleeve and pipe or between sleeve and pipe insulation shall be caulked with waterproof fire retardant non-hardening mastic.
 - .2 Pack future-use sleeves with mineral wool insulation and then seal with ULC approved fire stop sealant for rated fire separations.

3.9 Escutcheons and Plates

- .1 Provide on pipes passing through finished walls, partitions, floors and ceilings.

- .2 Plates shall be stamped steel, split type, chrome-plated or stainless steel concealed hinge, complete with springs, suitable for external dimensions of piping insulation. Secure to pipe or finished surface. For pipes passing through suspended ceilings and annulated piping passing through walls, outside diameter shall cover opening or sleeve.
- .3 Where pipe sleeve extends above finished floor, escutcheons or plates shall clear sleeve extension.

3.10 Equipment Supports

- .1 Provide stands and supports for equipment and materials supplied.
- .2 Lay out concrete bases and curbs required under Mechanical. Coordinate with Division 3. All concrete work is under Division 3.
- .3 Concrete bases shall be minimum 4" (100 mm) thick, or as noted and shall project at least 6" (150 mm) outside bedplate, unless otherwise directed. Bases and curbs shall be keyed to floor and incorporate reinforcing bars and/or steel mesh. Chamfer edges of bases.
- .4 Equipment with bedplates shall have metal wedges placed under edges of bedplates to raise them 1" (25 mm) above base after levelling. Wedges shall be left permanently in place. Fill space between bedplate and base with non-shrink grout - Embeco or In-Pakt.
- .5 Construct equipment supports of structural steel or steel pipe. Securely brace. Employ only welded construction. Bolt mounting plates to structure.
- .6 Support ceiling hung equipment with rod hangers and/or structural steel.

3.11 Equipment Installation

- .1 Provide unions and flanges to permit equipment maintenance and disassembly and to minimize disturbance to piping and duct systems and without interfering with building structure or other equipment.
- .2 Provide means of access for servicing equipment including permanently lubricated bearing.
- .3 Pipe equipment drains to floor drains
- .4 Line up equipment, rectangular cleanouts and similar items with building walls wherever possible.

3.12 Mechanical and Electrical Coordination of Responsibilities

- .1 All starters motor control centres, etc., along with input and output power wiring shall be by the Electrical Contractor. This is with the exception of packaged equipment.
- .2 Packaged equipment shall have integral starters and only power feeders will be provided. The packaged equipment starters shall be provided by the Mechanical Contractor.
- .3 Electrical Contractor shall provide all remote disconnect switches.
- .4 All control wiring (including BAS), except fire alarm, shall be provided by the Mechanical Contractor. This also includes Mechanical 120 volt control wiring, and interlock, and control wiring between controls transformers and low voltage terminal equipment, including infrared flushometers and transformers.
- .5 All motors for mechanical equipment shall be by the Mechanical Contractor.

- .6 Thermistor protection to be provided on motors 25 HP and larger using approved thermistors as part of the Mechanical Scope of Work.
- .7 Thermistors will be provided by Mechanical Contractor.
- .8 Electrical Contractor shall provide manual reset devices for motor starters for thermistor interface (only for starters that are provided by Electrical Contractor).
- .9 All fire alarm work shall be done by the Electrical Contractor. Electrical Contractor shall provide all relays for interface to control wiring for fan shutdown and fan start-up for air handling units and any other hard-wired mechanical components connected for fire alarm interlocks.
- .10 All end switches shall be provided by the Mechanical Contractor.
- .11 All relays required for Mechanical work shall be provided by the Mechanical Contractor.
- .12 All electric tracing shall be by the Mechanical Contractor with power connections by the Electrical Contractor. All electric tracing shall be 208 V unless specifically noted otherwise. All electric tracing shall be self-limiting type of cable. Mechanical Contractor shall provide loads for the circuits to the Electrical Contractor for connection requirements.
- .13 All electric heaters shall be supplied and installed by the Electrical Contractor.
- .14 Variable speed motor drive controllers and motors shall be installed by the Mechanical Contractor, and be complete with load and line side filters/reactors.
 - .1 The controller shall be specified with the following characteristics:
 - .1 Line side voltage distortion shall not exceed 3%.
 - .2 Line side current distortion shall not exceed 10%.
 - .3 Line and load sides shall be provided with chokes to prevent any transient or harmonic distortion being backfed into the main power supply. Provide a 5% reactor on the line side and the output shall be provided with an output filter consisting of a reactor and a capacitor.
 - .2 Power for the VSD control circuit shall be taken from the line side contactor, but after the line side choke for the drive fault relay.
 - .3 Drive BX cabling shall be provided between the VFD and VFD motor.
 - .4 Refer to VFD mounting details on drawings which reflects the responsibilities for supply of power and control wiring.
- .15 Mechanical Contractor shall provide Transient Voltage Surge Suppressor for all of their microprocessor based equipment, i.e. BAS, etc.
- .16 Mechanical Contractor and controls contractor shall provide the Electrical Contractor with locations where power circuits are required for mechanical control systems, i.e. Electronic Devices (trap primers, infrared plumbing trim, etc.) control transformers BAS panels, etc.
- .17 Should the Mechanical Contractor change or modify motor sizes or electrically powered mechanical equipment from what is reflected on the Bid Documents during any stage of this project, they shall be responsible to cover all associated electrical costs for the changes, such as revised motor starter and feeds etc.

3.13 Miscellaneous Metal/Metal Fabrications

- .1 Be responsible for miscellaneous steel work relative to Mechanical, including, but not limited to:
 - .1 Support of equipment.
 - .2 Hanging, support, anchoring, guiding and relative work as it applies to piping, ductwork, hot water storage tanks, expansion tanks, fans and mechanical equipment.
 - .3 Earthquake resistant devices - refer to Section 23 05 49.
 - .4 Access platforms, ladders and catwalks.
 - .5 Pipe anchor and/or support posts.
 - .6 Ceiling ring bolts - secure to structure or steel supports.
 - .7 Pipe protection at columns in vehicle and receiving areas.
- .2 All steel work shall be primed, and undercoat painted ready for finish under Division 9. Refer to drawings for details.
- .3 Coordinate with and comply with Section 05 50 00 Metal Fabrications as applicable.

3.14 Flashing

- .1 Flash and counterflash where mechanical equipment passes through weather or water proofed walls, floors and roofs.
- .2 Flash, vent/soil pipes penetrating roofs with aluminum 18" (450 mm) x 18" (450 mm) (base dimension) sheet. Flashing shall terminate flush with top of 12" (300 mm) high vent pipe. Gap between flashing and pipe shall be closed with separate aluminum cap 3" (75 mm) high. Main flashing shall not be turned over pipe. Vent installation to be compliant with RCABC Standard Construction Detail 10.3. For pipes through outside walls turn flange back into wall and caulk.
- .3 Flash floor drains over finished areas to floor waterproof membrane. Fasten floor membrane to drain clamp device.
- .4 Provide curbs for mechanical roof installations 8" (200 mm) minimum high above roof insulations. Flash and counterflash with galvanized steel or aluminum, made waterproof.
- .5 Provide continuous neoprene safes for built-up mop sinks, and shower stalls located above finished rooms. Solder at joints, flash into floor drains and turn up 6" (150 mm) into walls or to top of curbs and caulk into joints.

3.15 Di-Electric Couplings

- .1 Provide wherever pipes of dissimilar metals are joined.
- .2 Provide insulating unions for pipe sizes NPS 2 and under and flanges for pipe sizes over NPS 2.
- .3 Provide felt or rubber gaskets to prevent dissimilar metals contact.
- .4 Acceptable Products: Capital, Walter Villet, EPCO.

3.16 Lubrication of Equipment

- .1 Lubricate new equipment prior to operating, except sealed bearings, which shall be checked.
- .2 Use lubricant recommended by Manufacturer for service.

- .3 Extend lubricating connections and sight glasses to outside of housings, where lubricating positions are not readily accessible.
- .4 Submit check list, showing that operated equipment has been lubricated prior to and during any temporary heating period and demonstration and instruction period.

3.17 Painting

- .1 Finish painting of piping and ductwork, if required, shall be carried out by other trades. Refer to Division 9 - Finishes.
- .2 Provide factory finish on manufactured items. At completion, touch up damaged surfaces to match original. Do not paint over nameplates.

3.18 Equipment Protection and Clean-Up

- .1 Protect equipment and material in storage, on site and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping and duct systems.
- .2 Mechanical equipment stored on site shall be kept in dry, heated and ventilated storage area.
- .3 Thoroughly clean piping, ducts and equipment of dirt, cuttings and other foreign material.
- .4 Protect bearings and shafts during installation. Grease shafts and sheaves to prevent corrosion. Supply and install necessary extended nipples for lubrication purposes.
- .5 Provide, install and maintain 30% efficient temporary filters to return and exhaust air openings from ceiling spaces to prevent air born dust from entering ducts, plenums and coils. Install filters to return air grilles when fans are operated, and building is not clean.

3.19 Start-Up

- .1 Before starting equipment or systems, provide certificate stating plant is ready for start-up and the following conditions have been met.
 - .1 Safety controls installed and fully operational.
 - .2 Qualified personnel available to operate equipment.
 - .3 Permanent electrical connections made to equipment.
 - .4 Air filters installed.
 - .5 Mechanical equipment rooms, including plenums, vacuum cleaned.

3.20 Turnover Seminar for Operating Staff

- .1 At completion of project, Mechanical Contractor shall organize and conduct a one day seminar to instruct Owner and Representatives in operation and preventative maintenance of equipment and systems.
- .2 Provide services of qualified personnel, including Sub-Trades, major equipment suppliers and Consultant to attend seminar and instruct on his equipment or system(s). Seminar shall be chaired by Mechanical Contractor.
- .3 Mechanical Contractor shall submit agenda and list of Representatives to Consultant for approval 30 days before seminar. Confirm attendance by written notification to participants, followed by verbal confirmation before seminar date.

- .4 At seminar, submit final copies of Record Drawings and Operating and Maintenance Manuals to Owner.
- .5 Mechanical Contractor shall submit to Consultant, written follow-up of seminar complete with attendance list and signed acceptance from the operating staff representative indicating they have accepted the demonstrations and instructions. Coordinate with the commissioning agent for project deliverables.

1. GENERAL

1.1 Related Documents

- .1 Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

1.2 Definitions

- .1 Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.3 General Description of the Work of this Section

Only tested firestop systems shall be used in specific locations as follows:

- .1 Penetrations for the passage of duct, piping, and other mechanical equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

1.4 Related Work of Other Sections

- .1 Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
 - .1 Section 23 05 00 - Common Work Results for HVAC
 - .2 Section 23 07 13 - Duct Insulation
 - .3 Section 22 05 00 - Plumbing

1.5 References

- .1 Test Requirements: CAN/ULC-S115-11, "Standard Method of Fire Tests of Through Penetration Fire Stops".
- .2 Underwriters Laboratories of Canada (ULC) of Scarborough runs CAN/ULC-S115-11 under their designation of ULC-S115-11 and publishes the results in their "FIRE RESISTANCE RATINGS DIRECTORY" that is updated annually.

Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually. UL tests that meet the requirements of ULC-S115-M are given a cUL listing and are published by UL in their "Products Certified for Canada (cUL) Directory."

Omega Point Laboratories runs ASTM E-814 and publishes the results annually in their "Omega Point Laboratories Directory"
- .3 International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments
- .4 CAN/ULC-S102-M, Standard Test Method for Surface Burning Characteristics of Building Materials.

- .5 Test Requirements: ASTM G-21, "Standard Test for Determining Resistance of Synthetic Polymeric Materials to Fungi". Materials used under this section must carry a "Level 1" or lower test rating.
- .6 National Building Code of Canada.
- .7 NFPA 101 - Life Safety Code.

1.6 Quality Assurance

- .1 A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- .2 Firestop System installation must meet requirements of CAN4-S115-M or ULC S-115-M tested assemblies that provide a fire rating as shown in Section 2.03 Clauses J & K below.
- .3 Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.
- .4 Firestop Systems do not re-establish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural Consultant prior to penetrating any load bearing assembly.
- .5 For those firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's firestop custom detail derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Firestop custom detail drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).

1.7 Submittals

- .1 Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of ULC or cUL firestop systems to be used and manufacturer's installation instructions to comply with Section 1300.
- .2 Manufacturer's engineering judgment identification number and drawing details when no ULC or cUL system is available for an application. Consultant judgment must include both project name and contractor's name who will install firestop system as described in drawing.
- .3 Submit material safety data sheets provided with product delivered to job-site.
- .4 Submit signed letter from firestopping installation firm on company letterhead certifying penetrations of services through vertical & horizontal rated separations have been firestopped in accordance with ULC-S115.

1.8 Installer Qualifications

- .1 Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its firestopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- .2 The work is to be installed by a contractor with at least one of the following qualifications:

- .1 FM 4991 Approved Contractor
 - .2 UL Approved Contractor
 - .3 Hilti Accredited Fire Stop Specialty Contractor (HAFSC)
 - .3 Installer shall have minimum 3 years of experience with fire stop installation.
- 1.9 Delivery, Storage, and Handling
 - .1 Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and ULC or cUL label where applicable.
 - .2 Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
 - .3 Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
 - .4 Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
 - .5 Do not use damaged or expired materials.
- 1.10 Project Conditions
 - .1 Do not use materials that contain flammable solvents.
 - .2 Scheduling
 - .1 Schedule installation of CAST IN PLACE firestop devices **after** completion of floor formwork, metal form deck, or composite deck but **before** placement of concrete.
 - .2 Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
 - .3 Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
 - .4 Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.
 - .5 During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.
- 2. PRODUCTS**
- 2.1 Firestopping, General
 - .1 Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.
 - .2 Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

- .3 Firestopping Materials are either “cast-in-place” (integral with concrete placement) or “post installed.” Provide cast-in-place firestop devices prior to concrete placement.

2.2 Acceptable Manufacturers

- .1 Subject to compliance with through penetration firestop systems listed in U.L.C Fire Resistance Directory – Volume III or UL Products Certified for Canada (cUL) Directory, provide products of the following manufacturers as identified below:
 - .1 Hilti (Canada) Corporation, Mississauga, Ontario
1-800-363-4458/www.ca.hilti.com
 - .2 Nuco
 - .3 3M
 - .4 Tremco
 - .5 JV Firestop
- .2 Alternatives not listed in Part 2.2.1 will not be accepted.

2.3 Materials

- .1 Use only firestop products that have been ULC-S115 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 Pre-Installed firestop devices for use with non-combustible and combustible pipes (closed and open systems) penetrating concrete floors and/or gypsum walls, the following products are acceptable:
 - .1 Hilti Cast-In Place Firestop Device (CP 680-P)
 - .1 Add Aerator Adaptor when used in conjunction with aerator system.
 - .2 Hilti Tub Box Kit (CP 681) for use with tub installations.
 - .3 Hilti Cast-In Place Firestop Device (CP 680-M) for use with non-combustible penetrants.
 - .4 Hilti Speed Sleeve (CP 653) for use with cable penetrations.
 - .5 Hilti Firestop Drop-In Device (CFS-DID) for use with non-combustible and combustible penetrants.
 - .6 Hilti Firestop Block (CFS-BL)
 - .7 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.
- .3 Sealants or caulking materials for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - .2 Hilti Self Leveling Firestop Sealant (CFS-S SIL SL)
 - .3 Hilti Fire Foam (CP 620)
 - .4 Hilti Flexible Firestop Sealant (CP 606)
 - .5 Hilti Elastomeric Firestop Sealant (CFS-S SIL GG)
 - .6 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.

- .4 Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:
 - .1 Hilti Elastomeric Firestop Sealant (CFS-S SIL GG)
 - .2 Hilti Flexible Firestop Sealant (CP 606)
 - .3 Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - .4 Hilti Self Leveling Firestop Sealant (CFS-S SIL SL)
 - .5 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.
- .5 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, the following products are acceptable:
 - .1 Hilti Intumescent Firestop Sealant (FS-ONE MAX)
 - .2 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.
- .6 Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems) tested to 50 Pa. differential, the following products are acceptable:
 - .1 Hilti Firestop Collar (CP 643N)
 - .2 Hilti Firestop Collar (CP 644)
 - .3 Hilti Wrap Strips (CP 648E/648S)
 - .4 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.
- .7 Materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
 - .1 Hilti Firestop Mortar (CP 637)
 - .2 Hilti Firestop Block (CFS-BL)
 - .3 Hilti Fire Foam (CP 620)
 - .4 Hilti Firestop Board (CP 675T)
 - .5 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.
- .8 Non-curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
 - .1 Hilti Firestop Block (CFS-BL)
 - .2 Hilti Firestop Board (CP 675T)
 - .3 Acceptable Products: Nuco, 3M, Tremco, JV Firestop.
- .9 For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
 - .1 Hilti FS 657 Fire Block (for walls and floors)
 - .2 Hilti CP 658T Firestop Plug (for walls and floors)
 - .3 Hilti CP 680 Cast-In Place Firestop Device (for floors only)
- .10 For penetrations through a Fire Separation wall provide a firestop system with a "F" Rating as determined by ULC or cUL as indicated below:

Fire Resistance Rating of Separation	Required ULC or cUL "F" Rating of Firestopping Assembly
30 minutes	20 minutes
45 minutes	45 minutes
1 hour	45 minutes
1.5 hours	1 hour
2 hours	1.5 hours
3 hours	2 hours
4 hours	3 hours

For combustible pipe penetrations through a Fire Separation provide a firestop system with a "F" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.

- .11 For penetrations through a Fire Wall or horizontal Fire Separation provide a firestop system with a "FT" Rating as determined by ULC or cUL which is equal to the fire resistance rating of the construction being penetrated.

3. EXECUTION

3.1 Preparation

- .1 Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
- .1 Verify penetrations are properly sized and in suitable condition for application of materials.
 - .2 Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
 - .3 Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
 - .4 Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
 - .5 Do not proceed until unsatisfactory conditions have been corrected.

3.2 Coordination

- .1 Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.
- .2 Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

3.3 Installation

- .1 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) Directory.
- .2 Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.

- .1 Seal all holes or voids made by penetrations to ensure an air and water-resistant seal.
- .2 Consult with mechanical consultant, project manager, and damper manufacturer prior to installation of ULC or cUL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
- .3 Protect materials from damage on surfaces subjected to traffic.

3.4 Field Quality Control

- .1 Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
- .2 Keep areas of work accessible until inspection by applicable code authorities.
- .3 Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.
- .4 Install a warning card that is clearly visible adjacent to all large and medium openings that may be re-penetrated. This card should contain the following information:
 - .1 Warning that the opening has been fire stop protected
 - .2 Indicate the fire stop system used (ULC or cUL)
 - .3 F rating or FT rating
 - .4 Fire stop product(s) used
 - .5 Person to contact and phone number in case of modification or new penetration of fire stop system

3.5 Adjusting and Cleaning

- .1 Remove equipment, materials and debris, leaving area in undamaged, clean condition.
- .2 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION 23 05 05

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

- .1 Motors shall be UL listed and CSA certified.
- .2 Full Voltage Start Applications:
 - .1 All motors shall be in accordance with the National Electrical Manufacturers Association (NEMA) standards, and CSA C390. Motors also shall comply with applicable portions of Canadian Electrical Code.
- .3 Variable Frequency Drive and soft start applications:
 - .1 Motors shall be in accordance with NEMA standards (MG-1) Part 31 and inverter duty class. Motors also shall comply with applicable portions of Canadian Electrical Code.
 - .2 Motors connected to VFDs shall be wound using inverter spike resistant magnet wire capable of 1600V.
- .4 Electronic Commutation Motors (ECM) shall be provided in unitary equipment as specified in their respective sections (small fans, pumps, etc.).
- .5 Noise level of each motor shall comply with NEMA standards, less than 80 dBA at 39" (1 m).

1.3 Submittals

- .1 Submit data of test method used and motor efficiencies with shop drawings.

2. PRODUCTS

2.1 Electric Motors - General

- .1 Provide motors for mechanical equipment as specified.
- .2 Unless noted otherwise, provide open drip-proof, ball or roller bearing motors with grease fittings.
- .3 Motors shall have standard voltage ratings consistent with project distribution voltages. Confirm electric voltage, phase and starter requirements with electrical specification.
- .4 Motors shall be designed and manufactured to operate with $\pm 10\%$ voltage and $\pm 5\%$ frequency variations of the nameplate ratings.
- .5 Motors shall be rated for 1.15 service factor in 105°F (40°C) ambient environment.
- .6 Motors shall be standard 1750 RPM unless specifically scheduled otherwise.
- .7 Provide motors with terminal boxes, suitable for power connections.
- .8 Provide screw adjustable bases on belt-connected motors.

- .9 Motors shall be of capacitor start type when they may be manually cycled from starting switch, located in finished space.
- .10 Lubricate motors exposed to outdoor temperature with lubricants suitable for operation at the lowest temperature indicated by the Climatic Information contained in the National Building Code for the location in which they are installed.

2.2 Electric Motors - Premium Efficient

- .1 Motors shall be provided with premium efficiency inverter duty classification with non-wicking leads, class 'B' for ODP motors (pumps only) and class 'F' for TEFC motors insulation (minimum). Provide motor shaft grounding for variable frequency driven motors for all VFD applications.
- .1 Premium efficiency open drip-proof motors shall have the following typical full load efficiencies (nominal):

HP	Premium Efficient - Minimum Efficiency (%)		
	3500 RPM 2 Pole	1750 RPM 4 Pole	1150 RPM 6 Pole
1	80.0	85.5	82.5
1.5	84.0	86.5	86.5
2	85.5	86.5	87.5
3	86.5	89.5	88.5
5	91.0	89.5	90.2
7.5	88.5	91.0	92.4
10	90.2	91.7	92.4
15	91.0	93.0	92.4
20	92.5	93.0	92.4

- .2 Premium efficiency inverter duty totally enclosed fan cooled motors shall have the following typical load efficiencies (nominal).

HP	Premium Efficient - Minimum Efficiency (%)		
	3500 RPM 2 Pole	1750 RPM 4 Pole	1150 RPM 6 Pole
1	n/a	85.5	81.5
1.5	85.5	85.5	86.5
2	85.5	85.5	87.5
3	87.5	88.5	88.5
5	89.5	89.5	89.5
7.5	91.0	91.7	91.7
10	91.7	91.7	91.7
15	91.7	92.4	91.7
20	92.4	93.0	92.4

- .2 ECM Motors (Electronic Commutation Motors) shall be provided for unitary equipment as specified in their respective sections. ECM motors shall be permanently lubricated complete with heavy duty ball bearings to match the device (fan, pump, equipment type) and pre-wired to the specific voltage and phase. Internal motor circuitry shall convert the supplied AC power to the motor DC power to operate the motor. Motor shall be speed controllable down to 20% of rated full speed. Speed shall be controlled by either a Potentiometer dial mounted at the motor, or by a 0-10V signal from controls. Motor shall be a minimum of 85% efficient at all speeds.

2.3 Shaft Couplings

- .1 Shaft couplings shall be of the pin or jaw neoprene insert type, gear type, or flexing steel insert type and shall allow coupling inserts to be easily removed without disassembly of equipment.

2.4 Guards

- .1 Provide removable protective guards on exposed V-belt drives and shaft couplings in accordance with Worker's Compensation Board requirements.
- .2 Guards for drives shall have:
 - .1 18 ga (1.31 mm) expanded metal screen welded to 1" (25 mm) steel angle frame.
 - .2 16 ga (1.61 mm) thick galvanized sheet metal tops and bottom.
 - .3 Removable sides(s) for servicing.
 - .4 1-½" (38 mm) diameter holes on both shaft centres for insertion of tachometer.
 - .5 Sectionalize if necessary so one man can handle removal.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Fabricate and install belt guards for V-belt drives to permit movement of motors for adjusting belt tension and for belt slap.
- .5 Provide removable "U" shaped guards for flexible couplings with 12 ga (2.75 mm) thick galvanized frame and 16 ga (1.61 mm) thick expanded mesh face.
- .6 Provide guards on unprotected fan inlets and outlets. Guards to be provided by fan Manufacturer.
- .7 Prime coat guards and finish paint to match equipment.
- .8 Secure guards to equipment allowing for ease of removal.

3. **EXECUTION**

3.1 Electric Motors

- .1 Unless otherwise noted starters and protection devices will be included under Electrical Division.
- .2 Assist Electrical Division to ensure proper connection, correct thermal overload protection and correct motor controls.
- .3 Where starters included in this Division as integral part of packaged equipment, they shall contain thermal overload protection.

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END OF SECTION 23 05 13

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.
- .2 Refer to Section 23 05 49 for seismic restraint of piping.

1.2 General

- .1 Provide hangers and supports to secure equipment in place, prevent vibration, protect against damage from earthquake, maintain grade, provide for expansion and contraction and accommodate insulation.
- .2 Provide insulation protection saddles on insulated piping.
- .3 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP58.
- .4 Set inserts in position in advance of concrete work. Use grid system in equipment rooms.
- .5 Support from top of structural members. Where structural bearings do not exist or inserts are not in suitable locations, suspend hangers from steel channels or angles. Provide supplementary structural members, as necessary.
- .6 Do not suspend from metal deck.
- .7 Hangers for copper pipe shall be copper plated or plastic dipped unless pipe hangers bear on piping insulation (cold services).
- .8 All exterior roof mounted wire braces and supports/anchors/fittings shall be of aircraft grade stainless steel, with minimum cable size of 0.15" (4.0 mm) diameter.

2. PRODUCTS

2.1 Upper Attachments

- .1 Concrete:
 - .1 Inserts for cast-in-place concrete: galvanized steel wedge. ULC listed for pipe NPS ¾ through NPS 8 - Grinnell/Anvil Fig. 281.
 - .2 Carbon steel plate with clevis for surface mount: malleable iron socket with expansion case and bolt. Minimum two expansion cases and bolts for each hanger - Grinnell/Anvil, plate fig. 49, socket fig. 290 and Taylor plate fig. 166, socket fig. 64.
 - .3 Drilled concrete insert shall be Hilti Model HSL or HVA.
 - .1 Acceptable Products: Hubbard Enterprises Holdrite #121LD, #125, #205
 - .4 Inserts shall be ICBO approved.
 - .5 Power/powder actuated fastenings and drop-in anchors are not permitted to be used for tensile loading (i.e. suspension of mechanical equipment) or for seismic anchorage and/or restraint.
- .2 Steel Beam (Bottom Flange):

- .1 Cold piping NPS 2 and under: ductile iron C clamp - Grinnell/Anvil fig. 92 with fig. 89X retaining clip, Taylor fig. 406 with fig. 416 retaining clips.
 - .2 Cold piping NPS 2-½ and larger and hot piping: forged steel beam clamp - Grinnell/Anvil fig. 292, Holdrite #280, Holdrite #261, Taylor 450.
 - .3 Steel Beam (Top):
 - .1 Cold piping NPS 2 and under: ductile iron “top of beam” C clamp - Grinnell/Anvil fig. 92 with fig. 89X retaining clip, and Taylor fig. 406 with fig. 416 retaining clip.
 - .2 Cold piping NPS 2-½ and larger and hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227, Holdrite #261.
 - .4 Steel Joist (Top Chord):
 - .1 Cold piping NPS 2 and under: steel washer plate with double locking nuts - Grinnell/Anvil fig. 60, Taylor fig. 80.
 - .2 Cold piping NPS 2-½ and larger and hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket - Grinnell/Anvil: washer plate fig. 60, clevis fig. 66, socket fig. 290, Holdrite #261 or #115 with #271 Silencer, Taylor: washer plate fig. 80, clevis fig. 67, socket fig. 64.
 - .5 Steel Channel or Angle (Bottom):
 - .1 Cold piping NPS 2 and under: malleable iron C clamp - Grinnell/Anvil fig. 86, Taylor fig. 301.
 - .2 Cold piping NPS 2-½ and larger and hot piping: universal channel clamp - Grinnell/Anvil fig. 226.
 - .6 Steel Channel or Angle (Top):
 - .1 Cold piping NPS 2 and under: malleable iron “top of beam” C clamp - Grinnell/Anvil fig. 61.
 - .2 Cold piping NPS 2-½ and larger and hot piping: steel jaw, hook rod with nut, spring washer and plain washer - Grinnell/Anvil fig. 227.
- 2.2 Middle Attachments (Rod)
- .1 Carbon steel black (electro-galvanized/cadmium plated for mechanical rooms) continuous threaded rod - Grinnell/Anvil fig. 146, Myatt fig. 434, Taylor fig. 54.
- 2.3 Pipe Attachments
- .1 Cold piping, steel or cast-iron: hot piping steel, with less than 1” (25 mm) horizontal movement; hot piping, steel, with more than 12” (300 mm) middle attachment (rod) length: adjustable clevis - Grinnell/Anvil fig. 260, Taylor fig. 24.
 - .2 Cold copper piping: hot copper piping with less than 1” (25 mm) horizontal movement; hot copper piping with more than 12” (300 mm) middle attachment (rod) length: adjustable clevis copper plated - Grinnell/Anvil fig. CT-65, Taylor fig. 52.
 - .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 1” (25 mm); hot steel piping with middle attachment (rod) 12” (300 mm) or less pipe roller - Grinnell/Anvil fig. 174 or Grinnell/Anvil fig. 181, Taylor fig. 93, up to NPS 6 and Grinnell/Anvil fig. 171, Taylor fig. 95 NPS 8 and larger.

- .4 Bottom supported hot piping, steel and copper: pipe roller stand - Grinnell/Anvil fig. 271, Taylor 2795.
- .5 Spring hangers; where required to offset expansion on horizontal runs which follow long vertical risers - Grinnell/Anvil fig. 171, Taylor fig. 95, single pipe roll hanger with Grinnell/Anvil fig. 178, Taylor fig. 178.

2.4 Riser Clamps

- .1 Steel or cast-iron pipe: galvanized carbon steel - Grinnell Anvil fig. 261, Taylor fig. 82, or Myatt fig. 182.
- .2 Copper pipe: carbon steel copper finished - Grinnell/Anvil fig. CT-121, Taylor fig. 85.
- .3 Isolated Clamp – Holdrite #273 with 10 ga bearing plates and pads.

2.5 Saddles and Shields

- .1 Cold piping NPS 2 and under: protection shield with pipe insulation under shield with uninterrupted vapour barrier - Kingspan “K Block” - high density insulation.
- .2 Cold piping NPS 2-½ and over: protection shield with high density insulation under shield with uninterrupted vapour barrier - Kingspan “K Block” high density insulation.
- .3 Hot piping NPS 3 and under: insulation over pipe hanger, Holdrite #270 Isolation Hanger.
- .4 Hot piping NPS 4 and over: protective saddle with insulation under saddle - Grinnell/Anvil fig. 160 to 166, Holdrite #71 Isolation Hanger, Taylor fig. 70-77.

2.6 Wall Supports

- .1 Horizontal pipe adjacent to wall:
 - .1 Angle iron wall brackets with specific hangers.
 - .1 Acceptable Products: Holdrite #261, #280, #255 and #285.
- .2 Vertical pipe adjacent to wall:
 - .1 Exposed pipe wall support for lateral movement restraint - Grinnell/Anvil fig. 262 or 263, Taylor fig. 46.
 - .2 Channel type support - Burndy, Canadian Strut, Cantruss or Unistrut (arrangement to be acceptable to BC Boiler Inspection Department).

2.7 Floor Supports

- .1 Horizontal Pipe:
 - .1 Do not support piping from the floor unless specifically indicated.
- .2 Vertical Pipe:
 - .1 Mid-point of risers between floor slabs - adjustable fabricated steel supports. Refer to Section 23 05 49 Seismic Restraints.

3. EXECUTION

3.1 Hanger Spacing

- .1 Spacing and middle attachment (rod) diameter as specified in paragraphs below or as in table below, whichever is more stringent.
 - .1 Plumbing piping: most stringent requirements of the Plumbing Code or authority having jurisdiction.
 - .2 Fire protection: to applicable fire code; toggle hangers are unacceptable.
 - .3 For Gas Piping refer to Gas Code CAN/CGA-B149.1.
 - .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
 - .5 Within 12" (300 mm) of each horizontal elbow, tee, joints, etc.
 - .6 Provide oversize hangers for cold piping with vapour barrier to accommodate high density insulation and saddle.
- .2 Maximum hanger spacing table:

Pipe Size: NPS	Rod Diameter inches (mm)	Maximum Spacing Steel Pipe ft (m)	Maximum Spacing Copper Pipe ft (m)
½	⅜" (9.5 mm)	6'-0" (1.8 m)	5'-0" (1.5 m)
¾, 1	⅜" (9.5 mm)	8'-0" (2.4 m)	6'-0" (1.8 m)
1 ¼, 1 ½	⅜" (9.5 mm)	10'-0" (3.0 m)	6'-0" (1.8 m)
2	⅜" (9.5 mm)	10'-0" (3.0 m)	10'-0" (3.0 m)
2 ½, 3, 4	½" (12 mm)	10'-0" (3.0 m)	10'-0" (3.0 m)
5, 6, 8	⅝" (16 mm)	10'-0" (3.0 m)	
10, 12	⅞" (22 mm)	10'-0" (3.0 m)	

3.2 Hanger Installation

- .1 Offset hanger so that rod is vertical in operating position.
- .2 Adjust hangers to equalize load.
- .3 Install hanger to provide minimum ½" (12 mm) clear space between finished covering and adjacent work.
- .4 Support vertical piping at every other floor.
- .5 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .6 Where practical, support risers piping independently of connected horizontal piping.
- .7 Install plastic inserts between steel studs and piping.
- .8 For beam clamps, extend hanger rod tight to underside of beam with top bolt and washer.

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3.3 Inserts

- .1 User inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical.
- .2 Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying piping over 4" (100 mm) or ducts over 60" (1,525 mm) wide.
- .3 Where concrete slabs form finished ceiling, finish inserts, flush with slab surface.
- .4 Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square plate and nut above slab, in concealed locations.
- .5 Provide test mock up for review.
- .6 Provide inserts above pumps and sump pumps to permit equipment servicing. Provide an eyebolt.
- .7 Inserts shall be installed in accordance with Manufacturer's recommendations and in no case closer than 7'-0" (2.1 m) apart.

END OF SECTION 23 05 29

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.
- .2 Provide vibration isolation on motor driven equipment, piping and ductwork, such that noise transmitted to occupied space by any other path than airborne is less than airborne noise transmitted from mechanical space to occupied space. The following are considered minimum requirements to meet this criterion.

1.2 Regulatory Requirements

- .1 Supply isolators and seismic restraints meeting the structural requirements of the National Building Code and National Fire Code, including Part 4 requirements with respect to seismic snubbers or provide equivalent requirements where integral seismic restraint is provided in isolators/bolting.
- .2 Vibration isolator housings are considered a safety guard with respect to isolated equipment and any contained compressed springs. Include "Fail Safe" Seismic restraint in vibration isolation designed to hold mechanical equipment and springs in place.

1.3 Shop Drawings, Qualifications and Submittals

- .1 Anchorage of equipment shall be certified by registered professional Structural Consultant who specializes in seismic restraint of resiliently mounted systems. Seismic integral isolation mounts or snubbers shall be Office of Statewide Health and Planning Department - State of California (OSHDP) approved and the associated OSHDP number clearly indicated on seismic device. Where OSHDP certification is not available, results of tests consistent with OSHDP procedures and approvals shall be submitted and certified by registered professional Structural Consultant.
- .2 Obtain relevant equipment information and provide shop and placement drawings for vibration isolation elements and steel bases for review before materials are ordered.
- .3 Provide attachment to both equipment and structure meeting specified forces involved. Attachment details to structure to be reviewed by Structural Consultant for project.
- .4 Submit samples of materials required to complete work of this section for inspection and review, as requested.
- .5 Post disaster dynamic analysis shall consist of computer printout where equipment has been modeled as single 3-dimensional rigid body composed of several rigidly attached lumped masses. For purpose of analysis at each support, non-linear snubber/air or spring isolator combination may be replaced by single equivalent linear spring which is dependent upon displacement amplitude. System analysis must be conservative and consider six natural modes and associated frequencies. Resultant data shall be combination of modal responses presented in form of most probable value (RMS of six modes) and upper bound value sum of absolute values of six modes.

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1.4 General

- .1 This project is deemed a post disaster facility.
- .2 Provide vibration isolation on motor driven equipment with motors of ½ hp (0.37 KW) and greater (as indicated on the motor nameplate) and on piping and ductwork, as specified herein. For equipment less than ½ hp (0.37 KW), provide vibration isolation grommets at support points.
- .3 Provide seismic restraint for equipment including seismic restraint related hardware (bolts and anchors) from point of attachment to equipment to attachment to structure. Required anchors shall be indicated on shop drawings and clearly identified for correct location and to be readily identified after installation. Provide clear instructions for installation. Refer to Section 23 05 49, Seismic Restraints.
- .4 Place isolators under equipment so minimum distance between adjacent corner isolators is at least equal to height of centre of gravity of equipment. Include height of centre of gravity on shop drawings. Otherwise, design for increased forces on supports, and submit design calculations with shop drawings for approval.
- .5 Ensure isolation systems have a vertical natural frequency less than one third of lowest forcing frequency, unless otherwise unspecified. Use dynamic stiffness correction factors for elastomers and do not exceed 60 durometer.
- .6 Isolators and restraining devices, factory supplied with equipment, shall meet requirements of this section. Isolation supplier to check with pump supplier for number and location of isolators and if there is requirement for structural or inertia bases.
- .7 Provide concrete inertia bases or structural steel bases, where specified or required by equipment Manufacturer, located between vibrating equipment and vibration isolation elements, unless equipment Manufacturer certifies direct attachment capabilities. Coordinate with Division 3 for provision of concrete work.
- .8 Coordinate with Division 3 for provision of housekeeping pads at least 4" (100 mm) high under isolated equipment, or greater thickness where specified. Provide minimum 12" (300 mm) clearance between drilled inserts and edge of housekeeping pads. Housekeeping pads shall be tied to structure with reinforcement to meet Code seismic requirements.
- .9 For isolated equipment, design anchors, bolts, isolators and bases to meet Code requirements. For larger isolators, where Code requirement cannot be met by isolator housing, provide Type 6 seismic snubbers or Type 6P where post-disaster requirement is specified.
- .10 Use ductile materials in vibration and seismic restraint equipment.
- .11 Follow Structural Consultant's instructions for drilled inserts.
- .12 Coordinate with Section 23 33 00 "Air Duct Accessories" for ductwork connections to fans or plenums.
- .13 Provide flexible connectors between equipment and piping where required by Manufacturers to protect equipment from stress and reduce vibration in piping system. Meet connector Manufacturer's installation requirements as well as equipment Manufacturer's requirements.
- .14 Coordinate with Electrical for the provision of a minimum 180° hanging loop of flexible conduit for electrical connections to isolated equipment.
- .15 Supply isolators assembled and clearly labelled with instructions for installation by Contractor.

2. PRODUCTS

2.1 Isolators - General

- .1 Supply of vibration isolation equipment by one approved supplier with exception of isolators which are factory installed and are standard equipment with machinery. Confirm with Manufacturer that factory-installed isolators meet seismic requirements.
- .2 Select isolators at supplier's optimum recommended loading and do not load beyond limit specified in Manufacturer's literature.
- .3 Provide neoprene isolators and components using maximum 60 duro "Bridge bearing quality neoprene," as defined by CSA Standard CAN3-S6-M78. Ensure design of isolation and restraint elements allows adequate clearance to avoid binding.
- .4 Design springs "iso-stiff" ($k_x/k_y = 1.0$ to 1.5) with a working deflection between 0.3 and 0.6 of solid deflection.
- .5 Provide hot dipped galvanized housings and neoprene coated springs, or other acceptable weather protection, for isolation equipment located outdoors or in areas where moisture may cause corrosion.
- .6 Elastomeric components in Type 1 and Type 2 isolation products and Type 6 and 6P seismic snubbers shall be bridge bearing neoprene meeting CSA Standard CAN3-S6 and CAN/CSA-S6-88. Durometer shall be defined per ASTM D 675 and within +/- of stated durometer. Minimum tensile strength (2,000 psi (13,790 kPa) for 40 durometer and 2,500 psi (17,240 kPa) for 50 and 60 durometer) and minimum elongation at break point (40 duro = 450%, 50 duro = 400% and 60 duro = 350%) to be per ASTM D 412. Tests for aging shall be per ASTM D 573 where, when tested in a 212°F oven for 70 hours, increase in hardness is no greater than 15%, tensile strength change does not exceed 15% and elongation to break is not reduced by more than 40%. Effects of ozone on product shall be as prescribed by ASTM D 1149 and material will show no cracks when tested. Compression set will be determined by ASTM 395, Method B and 40 duro product shall not exceed 40% and 50 and 60 duro product shall not exceed 25%. Compounding of the neoprene shall be in strict accordance with the Raw Material Supplier's formulation, in order to meet the above noted test procedures.

2.2 Isolators - Type 1, Pads

- .1 Neoprene or neoprene/steel/neoprene pad isolators. Select Type 1 pads for minimum $\frac{3}{32}$ " (2.5 mm) static deflection or greater. Use hold down bolts selected for seismic loads. Isolate bolts from base of unit using neoprene hemi-grommets. Avoid over-compressing grommets (e.g. use Hilti HVA adhesive set bolts, or equal, with steel washers and lock nuts, adjusted finger tight to hemi-grommets). Size bolt and hemi-grommet for minimum lateral clearance. Use grommets only on light-weight equipment.
- .2 Where use to isolate equipment having to be anchored to meet post disaster requirements, provide dynamic analysis as per clause 1.3.5 of this section.
- .3 Acceptable Products:
 - .1 Mason WMW, Super W pads.
 - .2 Mason Industries Type HG Hemi-Grommets.
 - .3 EAR Grommets.

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.4 Kinetics Noise Control Inc. Type RSP.

2.3 Isolators - Type 2, Rubber Floor Mounts

- .1 Rubber/neoprene-in-shear isolators designed to meet specified seismic requirements. Select for 0.15" (4.0 mm) minimum static deflection and bolt to structure. Rubber isolators, provide protection in design of isolator to avoid contact of rubber element to oil in mechanical room.
- .2 Where use to isolate equipment having to be anchored to meet post disaster requirements, provide dynamic analysis as per clause 1.3.5 of this section.
- .3 Acceptable Products:
 - .1 Mason BR, maximum 50 durometer, Kinetics Noise Control Inc. Type RD, RQ.

2.4 Isolators - Type 3, Spring Floor Mounts

- .1 Spring mounts complete with levelling devices, selected to achieve 1" (25 mm) deflection under load. Spring to incorporate minimum ¼" (6.0 mm) thick neoprene sound pad or cup having 0.05" (1.3 mm) minimum deflection under load. Design isolator to meet specified seismic requirements.
- .2 Where use to isolate equipment having to be anchored to meet post disaster requirements, provide dynamic analysis as per clause 1.3.5 of this section.
- .3 Acceptable Products:
 - .1 Kinetics Noise Control Inc. FLS.

2.5 Isolators - Type 4, Hanger Mounts

- .1 Spring hangers, complete with ¼" (6.0 mm) thick neoprene cup/bushing sized for 0.05" (1.3 mm) minimum deflection, or neoprene hangers.
- .2 Acceptable Products:
 - .1 Mason HD, HS, Kinetics Noise Control Inc. SH.

2.6 Closed Cell Foam Gaskets/Neoprene Grommets - Type 7N

- .1 ¾" (19 mm) thick continuous perimeter closed cell foam gasket to isolate base of package equipment, AHUs, exhaust fans, etc. from concrete floors/roof curbs. Select width for nominal 3 psi loading under weight of equipment and allow for 25% compression ⅜" (4.8 mm). Increase width of curb using steel shim to accommodate gasket. For light equipment such as exhaust fans, deflection should be a minimum of 0.05" (1.3 mm). Contractor to check fire rating requirements specified for project.
- .2 Acceptable Products:
 - .1 American National Rubber-EPDM-SBR blend SCE 41 type neoprene.
 - .2 Mason Industries Type HG Hemi-Grommets.
 - .3 Kinetics Noise Control Inc. Neoprene/EPDM Grommets.

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3. EXECUTION

3.1 Installation

- .1 Execute work in accordance with specifications and in accordance with Manufacturer's instructions.
- .2 For equipment mounted on vibration isolators, provide minimum clearance of 2" (50 mm) to other structures, pipe equipment, etc.
- .3 Before bolting isolators to structure, start equipment and balance so isolators can be adjusted to correct operating position before installing (seismically rated) anchors and/or welding.
- .4 After installation and adjustment of isolators verify deflection under load to ensure loading within specified range and isolation is obtained.
- .5 Where hold down bolts for isolators or seismic restraint equipment penetrates roofing membranes provide "gum cups" and sealing compound to maintain waterproof integrity of roof. Ensure sealing compound is compatible with isolator components such as neoprene. Coordinate with Roofing Sub-Contractor.
- .6 Use Type 1 pads only where specified.
- .7 Provide Type 4 spring hangers for minimum static deflection of 1" (25 mm) for ceiling hung fans and air handling units, emergency generator exhaust piping and silencers, steam PRVs and any other vibrating sources.
- .8 Provide Type 4 resilient hangers on piping, tanks, etc. connected to vibrating source, if piping is over NPS 1-1/2". Provide hangers for distance of 20'-0" (6.1 m) for NPS 2 pipe and 40'-0" (12 m) for NPS 10 pipe. Isolate other pipe sizes for proportionate distance.
- .9 Isolate pumps and axial fans rotating at more than 1170 RPM on Type 2 isolators.
- .10 Use lowest RPM scheduled for two-speed equipment in determining isolator deflection.
- .11 Where ductwork or piping, etc. connected to, or serving noise generating or vibrating equipment, is routed through walls, floors pipe chases, etc., to avoid contact with structure, future framing, drywall and other finishes which may radiate noise. Use Type 2 mounts. Submit proposed details to meet this requirement.
- .12 Mount equipment designed for wall mounting on non-critical block work or concrete walls. Connect hangers to concrete structure only. Where structure is steel, connect to major structural beams only, or to structural angles with gussets attached to concrete shear walls. Do not attach to light framing members such as OWSJs. Do not connect to edge of beam flange (e.g. with clips). Weld nut or threaded sleeve to bottom flange at centre, directly below web, to accommodate threaded hanger rod.
- .13 Be responsible for ensuring that flexible duct connections (see Section 23 33 00) are installed with minimum 1-1/2" (38 mm) metal-to-metal gap. Use flanges to ensure that flexible connectors are clear of airstream.
- .14 Isolate variable frequency drive controller using isolators or soft grommets such that structure borne noise transmission to occupied space is less than airborne noise transmission. Controller supplier to provide isolation, including wiring connections, to control flanking noise transmission. Provide isolation meeting seismic requirements.

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- .15 Provide stabilizing springs limiting movement at flexible connections to 25% of fabric width under steady state conditions and 40% at start-up.
- .16 Floor or Pier Mounted Equipment: Isolate floor or pier mounted equipment on Type 3 isolators, unless otherwise specified.
- .17 Slab On Grade Mounted Equipment: For equipment mounted on slab on grade use on Type 2 isolators unless otherwise specified.

3.2 Inspections

- .1 Supplier shall provide assistance to Contractor as necessary during course of installation of isolation equipment.
- .2 Supplier shall inspect complete installation after system start-up and establish isolators for each piece of equipment are properly installed and adjusted. Supplier shall submit statutory declaration to Consultant stating complete vibration isolation installation is in accordance with his drawings and instruction and operates to his satisfaction.

END OF SECTION 23 05 48

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Regulatory Requirements

- .1 Restraints shall meet the requirements of the National Building Code and National Fire Code.

1.3 Seismic Restrain Design and Inspection

- .1 Arrange and pay for services of the registered professional Structural Consultant who specializes in restraint of building elements. This Structural Consultant (Seismic Consultant) shall provide required engineering services related to seismic restraints of non-vibration isolated equipment, ductwork and piping as indicated below.
- .2 Seismic Consultant shall provide assistance to Contractor as necessary during course of restraint of equipment, ductwork and piping.
- .3 Seismic Consultant shall inspect completed seismic installation and shall submit statutory declaration to Consultant stating that seismic installation is installed in accordance with their drawings and instructions and complies with regulatory requirements.

1.4 Submittals

- .1 Submit shop drawings of restraining devices including details of attachment to structure, either tested in independent testing laboratory or approved by the Registered Professional Engineer.
- .2 Proposed inserts or connections to structure to follow directions of project Structural Consultant.

1.5 Application

- .1 Provide cable restraints on isolated equipment and seismic restraint on other equipment, piping and ductwork; all in general accordance with SMACNA Guidelines (see Products).

1.6 Scope of Work

- .1 Provide restraint on piping, ductwork, equipment and machinery, which is part of building mechanical service systems to prevent injury or hazard to persons and equipment and retain equipment in normal position in event of earthquake. This specification covers equipment, which is not specifically covered in SMACNA Guidelines.
- .2 In addition to mechanical work reflected on drawings and within this specification, provide restraint for the following systems and equipment. Clearly include details anchorage and seismic restraint of these systems in shop drawing submittals. Explicitly reference these items as part of the scope of work on Letters of Assurance, and include as part of Seismic Consultant's professional field review.
 - .1 Backup generator and associated fuel systems.
 - .2 Clean-agent fire suppression systems.

- .3 Provide seismic restraint related hardware, (including bolts and anchors) from point of attachment to equipment through to and including attachment to structure.
- .4 When equipment is mounted on concrete housekeeping pads and/or concrete curbs, the anchor bolts shall extend through the pad into structure.
- .5 It is responsibility of equipment Manufacturers to design equipment so that strength and anchorage of internal components of equipment exceeds force level used to restrain and anchor unit itself to supporting structure.
- .6 Seismic restraints may only be omitted where permitted by SMACNA.

2. PRODUCTS

2.1 General

- .1 Mason Type Seismic Cable Brace (SCB) slack cable restraints.
- .2 Restraint systems as indicated in 1998 SMACNA "Seismic Restrain Manual Guidelines for Mechanical Systems" (second edition), Seismic Hazard Level (SHL) A. If lesser restraint is proposed to meet local Code seismic requirements, provide shop drawings of details certified by Seismic Consultant.

3. EXECUTION

3.1 General

- .1 It is responsibility of Contractor to ascertain that appropriate size device be selected for each individual piece of equipment.
- .2 The following are guidelines for some items not covered in SMACNA but certified shop drawings shall still be submitted. This list does not cover all equipment requiring restraints.

3.2 Air Terminals

- .1 Where air terminals are installed in mechanical grid ceilings, provide at least two 12 ASWG galvanized steel wire seismic security bridles per air terminal tied either to the building structure or to ceiling hanger wires.
- .2 Attach security bridles at opposite corners of each air terminal and such that the air terminal cannot fall.
- .3 Provide necessary brackets for attachment of security bridles to air terminals.

3.3 Mixing Boxes, Transfer Ducts, Return-Air Sound Traps, etc.

- .1 Provide seismic restraints in accordance with details in SMACNA Guidelines or, alternatively, slack cables may be used.

3.4 Non-Isolated Floor Mounted Equipment

- .1 Bolt non-isolated equipment and machinery (e.g. floor mounted tanks, etc.) to structure. Design anchors and bolts for seismic force applied horizontally through centre of gravity. For equipment, which may be subject to resonances, use nominal 2.0g seismic force.

3.5 Isolated Piping and Equipment

- .1 Install cables using appropriate grommets, shackles, and other hardware to ensure alignment of restraints and to avoid bending cables at connecting points.
- .2 Connect slack cable restraints to ceiling hung equipment such that axial projection of wires passes through centre of gravity of equipment.
- .3 Orient restraint wires on ceiling hung equipment at approximately 90° to each other (in plan), and tie back to ceiling slab at angle not exceeding 45° to slab.
- .4 On piping systems, provide transverse slack cable restraints at maximum spacing of 40'-0" (12 m) and longitudinal restraints at 80'-0" (24 m) maximum spacing, or as limited by anchor/slack cable performance. For pipes greater than NPS 10, reduce transverse restraint spacings 20'-0" (6.1 m). Small pipes may be rigidly tied to big pipes for restraint, but not the reverse.
- .5 Transverse bracing for one pipe section may also act as longitudinal bracing for pipe connected perpendicular, provided bracing is installed within 24" (600 mm) of elbow or T, and if connected pipe is same or smaller in size. Do not use branch lines to restrain main lines.
- .6 Provide flexibility in piping joints or sleeves where pipes pass through building seismic or expansion joints.
- .7 At vertical pipe risers, wherever possible, support weight of riser at point above centre of gravity of riser. Provide lateral guides at top and bottom of riser, and intermediate points not to exceed transverse spacings indicated above for horizontal pipes, with guide clearance not exceeding $\frac{1}{8}$ " (3.2 mm).
- .8 Vary adjacent spacing of restraints on piping run by 10% to 30% to avoid coincident resonances.
- .9 Install restraints at least 2" (50 mm) clear of other equipment and services.
- .10 Adjust restraint cables so they are not visibly slack, or so the flexibility is approximately 1- $\frac{1}{2}$ " (38 mm) under thumb pressure for 5'-0" (1.5 m) cable length (equivalent ratio for other cable lengths). Adjust clearance at cable strap/spacer piece to not exceed $\frac{1}{4}$ " (6 mm).
- .11 Provide transverse and axial restraints as close as possible to vertical bend.
- .12 At steel trusses, connect to top chords and follow truss Manufacturer's instruction.
- .13 For post disaster installations, provide vertical rod stiffeners when rod length is great than 50 rod diameters.
- .14 Maximum spacing between transverse and longitudinal restrains for piping and duct work shall be 25% less than specified in SMACNA for SHL A.

END OF SECTION 23 05 49

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of the Contract Documents and is to be read, interpreted and coordinated with all other parts.
- .2 References: American National Standards Institute (ANSI) – ASME A13.1 (Rev. 1985) Scheme for the Identification of Piping Systems.

1.2 Equipment Identification

.1 Manufacturer's Nameplates:

- .1 Each piece of manufactured equipment shall have metal nameplate, with raised or recessed letters. Mechanically fasten plate to equipment.
- .2 Manufacturer's nameplates shall indicate Manufacturer's name, equipment model, size, serial number and electrical characteristics and pertinent information for any other service connections.
- .3 Include Underwriters' Laboratories Canada (ULC) or Canadian Standards Association (CSA) registration logos and those of other agencies, as required by respective agencies.
- .4 Nameplates shall be located so they are easily read. Do not insulate or paint over name plates.

.2 System Nameplates:

- .1 Each piece of equipment shall be identified with its equipment schedule identification, e.g. supply fan SF-1, cooling coil CC-1, pump P-1.
- .2 Identification letters shall be 2" (50 mm) high black letters on white background, sized to suit label or provide laminated plastic plates with black face and white centre of minimum size 3-1/2" (90 mm) x 1-1/2" (38 mm) x 3/32" (2.5 mm) engraved with 1/4" (6.0 mm) high lettering. Use 1" (25 mm) high lettering for major equipment.
- .3 Apply nameplates securely in conspicuous places, on cool surfaces.
- .4 Identify systems, and areas or zones of building being serviced.

1.3 Piping Identification

.1 Piping Identification:

- .1 Each piping system shall be colour coded for identification and labelled with system identification code letters, including temperature and pressure, if applicable, and directional flow arrow in accordance with Pipe Identification Colour Schedule.
- .2 Identifying piping (pipe markers and direction arrows) at the following locations:
 - .1 Adjacent to major valves and where valves are in series at no more than 6'-6" (2.0 m) intervals.
 - .2 At least once in each room and 50'-0" (15 m) maximum spacing in open areas.
 - .3 Gas piping to be identified at 6'-6" (2.0 m) intervals in ceiling plenums.
 - .4 On both sides where piping passes through walls, partitions and floors.
 - .5 Adjacent to major changes in direction.

- .6 At point of entry and leaving each pipe chase and/or confined space and piping accessible at each access opening.
 - .7 At beginning and end points of each run and at each piece of equipment in each run.
 - .3 Identification labels may be stencilled. Identification arrows, labels and letters may be vinyl cloth (Brady B500) or vinyl film (Brady B946), with adhesive compatible with surface temperature.
 - .4 Identification colour bands for primary and secondary colours to indicate the type and degree of hazard shall be applied to overlap a minimum of 6" (150 mm). Ends to be stapled. Bands shall be Brady B550 vinyl cloth tape or Brady B946 vinyl tape, with adhesive compatible with surface temperature.
 - .5 Identification may consist of semi-rigid plastic vinyl labels with surface printing. On pipes larger than 6" (150 mm) diameter total O.D., these labels shall be saddle style, and shall ship complete with 33.5" (850 mm) long nylon cable ties for each label. Standard of acceptance: SMS Coil-Mark (<http://www.smilietd.ca/pdfDocs/Identification-Systems/Coil-Mark.pdf>)
- .2 Valve Tags:
- .1 Provide valve identification tags and secure them using non-ferrous chain, braided band or plastic band (suitable for temperature). Tags may be of brass, aluminum, metalphoto, lamicaid or fibreglass, stamped or engraved, of 1" (25 mm) minimum diameter. Tags may also be 1-1/4" (32 mm) square, two-ply plastic with engraved black characters on white background. Standard of acceptance: SMS valve tags (<http://www.smilietd.ca/pdfDocs/Identification-Systems/PHSVT.pdf>)
 - .2 Valves to be tagged include:
 - .1 Valves on main piping circuits.
 - .2 Valves on major branch lines.
 - .3 Valves on minor branch lines in horizontal service spaces, vertical service spaces and mechanical equipment rooms.
 - .4 DO NOT TAG valves on control valve stations, steam trap stations, fixture stops, or system drain valves.
 - .5 Drain valves and hose bibbs on systems containing glycol.
 - .6 Control valves
 - .3 Schedule valve numbers using sequential numbering system indicating location, service and the normal position (open or closed). Numbers shall be prefixed by letter "P" or letter "H" indicating valve is on plumbing or heating service.
- 1.4 Ductwork Identification
- .1 Identify plenum access doors with accessed items, e.g. Filter F-1, Supply Fan SF-1, Cooling Coil CC-1.
 - .2 Stencil on plenum doors, downstream from air filter bank, "Do not open when fan operating."
 - .3 Identify ductwork in mechanical equipment rooms to denote system and/or zone served and air flow direction arrow.
 - .4 Identify automatic control dampers concealed in ductwork. Identify "open" and "closed" position of operator arm on outside of duct or duct insulation.

- .5 Identification letters shall be 2" (50 mm) high black letters on white background. Flow arrows shall be 2" (50 mm) wide by 6" (150 mm) long black arrows on white background. Stencil over final finish only.

1.5 Ceiling Access Identification

- .1 Secure ¼" (6.0 mm) self-adhesive coloured dots (Brady Quik Dots or Avery Data Dots) to ceiling to identify location of access to equipment concealed above ceiling, according to the following schedule:

	Colour
Concealed equipment and cleaning access	Yellow
Control Equipment, including control valves, dampers and sensors	Black
Fire and smoke dampers	Red
Fire protection, including sprinkler equipment and drains	Red
Heating/Chilled water, DCW, DHW isolation valves	Green
Pipe mounted equipment, other than fire, smoke and sprinkler equipment	Green

- .2 When T-bar ceilings are installed, adhere coloured dots to T-bar framing, adjacent to panel to be removed.

1.6 Duct Access Identification

- .1 Secure 2" (50 mm) high, Gothic style self-adhesive stick-on letters, (Letrasign or Brady Quick Align) on duct access panels to identify their usage, according to the following schedule:

	Colour	Letters
Cleaning and service access	black	C.A.
Controls, including sensors	black	C
Dampers (backdraft, balance and control)	black	D
Fire dampers	red	F.D.
Smoke dampers and detectors	red	S.D.

1.7 Tagging Identification

- .1 Secure engraved laminated plastic identification tags (black face and white centre) on the following items:
- .1 Temperature control instruments, gauges and panels, coordinated with control diagrams identification.
 - .2 Electrical switchgear supplied under the Mechanical.
 - .3 Refer also to Controls Sections.

1.8 Identification Schedules

- .1 Submit schedules of the following for review prior to framing:
- .1 Pipe Identification Colours.
 - .2 Valves.
 - .3 Ceiling Access Identification Colours.

- .4 Duct Access Identification Colours.
 - .2 Schedules will be required in each major mechanical room and at least one schedule will be required on each floor having minor mechanical room. Frame schedules under glass in matching frames and hang where directed.
 - .1 Include one copy of schedules in each operating maintenance manual.
- 1.9 Pipe Identification Banding Colours
- .1 Letters:
 - .1 ½" (12 mm) high - 1-¼ NPS pipe and smaller.
 - .2 1" (25 mm) high - 1-½ NPS up to 2-½ NPS pipe.
 - .3 2" (50 mm) high - 3 NPS and larger pipe.
 - .2 Bands:
 - .1 1-½" (38 mm) wide, except arrow bands 2" (50 mm) wide.
 - .3 Colours:
 - .1 Horizontally hatched - primary colour.
 - .2 Vertically hatched - secondary colour.
 - .3 Black letters and arrows on yellow primary colour.
 - .4 Background, white letters and arrows or red, blue or green backgrounds.
- 1.10 Buried Piping Identification/Markers
- .1 Metallic Pipe: Provide continuously printed 4" (100 mm) wide x 4 mil thick "Blaze Orange" plastic tape with printing indicating type of service of buried pipe. Place tape at ±12" (300 mm) above buried pipe in backfill.
 - .2 Non-Metallic Piping: Provide detectable multi-ply tape consisting of aluminum foil core between two (2) layers of 4" (100 mm) x 4 mil thick "Blaze Orange" plastic tape with printing indicating type of service of buried pipe. Place tape at ±12" (300 mm) above buried pipe in backfill lifts.
 - .3 Where multiple small pipes are buried in a common trench and do not exceed an overall width of 18" (450 mm), install a single tape line marker.

END OF SECTION 23 05 53

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Work Included

- .1 Adjust and balance domestic cold water systems and plumbing mixing valves.
- .2 Adjust and balance air systems.
- .3 Perform acoustic measurements.

1.3 Intent

- .1 Perform work as an integral part of contract.

1.4 Quality Assurance

- .1 Acceptable TAB Contractors are: MDT Systems, KD Engineering, Western Mechanical Services, and Flotech Mechanical.
- .2 Acceptable TAB firms shall be credentialed by international organizations such as AABC (Associated Air Balance Council) and the NEBB (National Environmental Balancing Bureau). Exceptions to credentialed TAB firms would require submittal to the Consultant for review and approval.
- .3 Procedures shall be in accordance with current edition of AABC's National Standards for Field Measurement and Instrumentation, Total System Balance or NEBB's Procedural Standards for TAB Environmental Systems.
- .4 Each Balancing TAB Sub-Trade (other than those with proper acceptance) intending to bid for work shall submit the following information not less than seven days before close of Sub-Trade tenders. **ANY FIRM THAT DOES NOT COMPLY WILL NOT BE ACCEPTED BY CONSULTANT.**
 - .1 List previous projects of similar scope with dates projects were executed.
 - .2 Outline depth of firm including principals, years of operation, address and phone number.
 - .3 List instruments and procedures that will be used on project.
 - .4 List name of job site supervisor and provide resume of his/her specific work experience.
 - .5 Provide sample of balance report on project of similar scope.

1.5 Submittals

- .1 Submit name of proposed TAB firm for approval within seven (7) days of contract award.
- .2 Include qualifications, including name and qualification of individual certifying reports. Failure to submit name of TAB firm within required time period shall be cause for Consultant to select an alternative firm to carry out work at no change in contract price.
- .3 Within 14 days of request, TAB schedules and agenda shall be submitted for approval. TAB work shall not commence until approved.

1.6 Procedures

- .1 General: Before starting TAB work, review with Consultant methods and instruments to be used. Include descriptive data, procedure data and sample forms.
- .2 Descriptive Data: Review design concepts and general function of each system including associated equipment and operation cycles including BAS Systems sequence of operations. Confirm listing of flow and terminal measurements to be performed and selection points for proposed sound measurements.
- .3 Procedure Data: Outline procedures for taking test measurements to establish compliance with requirements. Specify type of instrument to be used, method of instrument application (by sketch) and correction factors.
- .4 Data sheets required as a minimum are as follows:
 - .1 Air System Schematic Diagram
 - .2 Air Moving Equipment Test Sheet.
 - .3 Exhaust Fan Test Sheet.
 - .4 Covering comments sheet detailing systems balanced setpoints.

Note: All test sheets shall include a Column detailing achieved results as a % of design.

1.7 Cooperation

- .1 TAB firm shall check and report defects or deficiencies that may affect balancing.
- .2 Mechanical Contractor shall cooperate with balancing firm to:
 - .1 Provide sufficient time before final completion date so that TAB can be accomplished.
 - .2 Provide labour and tools to make corrections without delay.
 - .3 Place heating ventilating and air conditioning systems and equipment into full operation and continue operation.
 - .4 Advise TAB firm of changes made to system during construction.
 - .5 Install required test holes complete with removable and replaceable plugs.
 - .6 Make necessary revisions to controls, dampers, fan and pump drives and consult with equipment Manufacturers as required to achieve specified systems performance.
 - .7 Supply and install dampers as shown and where required to obtain final system balance.
 - .8 Provide ladders scaffolds, tools and labour to assist work of balancing firm, including removing ceiling tiles and guards and adjusting pulleys and belts, replace when finished.
 - .9 Control and/or equipment Manufacturer shall work with balancing firm when setting damper linkages and minimum outside air dampers. They shall be available for readjusting of dampers of controls improperly calibrated.
 - .10 Set pressure regulating valves to operating and code conditions.
 - .11 Check and set relief and safety valves to code requirements.
 - .12 Clean strainers. Provide clean air filter immediately before air balancing.
 - .13 Open fire dampers.
 - .14 Change variable pitch pulley supplied on 15 hp (11 KW) motors and larger to fixed pulleys after air balance. Provide pulleys.

.15 Provide drive changes required to suit final balance.

1.8 Tests

- .1 Give written 24 hour notice of date for tests.
- .2 Do not externally insulate or conceal work until tested and approved. Follow construction schedule and arrange for tests.
- .3 Conduct tests in presence of Consultant. Arrange for Owner's Representative to be present.
- .4 Bear costs including retesting and making good.
- .5 Refer to Piping Sections for specific test requirements.
- .6 Prior to tests, isolate equipment or other parts which are not designed to withstand test pressures.

2. PRODUCTS

2.1 Instruments

- .1 Instruments for TAB of air and hydronic systems shall have been calibrated within six months and verified for accuracy before start of work.
- .2 Submit list of equipment to be used for balancing and calibration certificates for each instrument listed.

3. EXECUTION

3.1 General Procedures

- .1 TAB to maximum flow deviation from specified values of 10% at terminal devices and -0% +5% at equipment or mean sound level deviation of 20 db. Provide air balancing volumes and settings for all air supply, exhaust and return air ducts and terminals regardless of whether a special air volume tag has been noted on the drawing.
- .2 Permanently mark setting on valves, splitters, dampers and other adjustment devices.
- .3 Take measurements to verify system TAB has not been disrupted or such disruption has been rectified.
- .4 At final field review, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- .5 At completion, allow minimum two days for Consultant to witness test procedures and conduct tests for each system.
- .6 When building is occupied before completion, continue execution of work outside occupied hours.

3.2 Site Visits

- .1 Schedule minimum of two (2) site visits to correspond with site meetings held by Contractor. After each visit, submit written report to Contractor and Consultant. Site visits shall commence after start of air distribution work and be spread over remaining construction period to start of balancing.

- .2 Review of installation shall be made at scheduled visit and any additional dampers or valves required for proper balance shall be reviewed with Consultant and Contractors.
- .3 Allow for one (1) visit to site to adjust systems for seasonal changes during warranty.

3.3 Acceptance

- .1 Mechanical systems shall not be considered ready for final field review until TAB results are acceptable to Consultant.
- .2 If found that specified flows cannot be achieved on portions of system, actual conditions shall be reported to Consultant for consideration of correctable action before continuing TAB procedure.
- .3 If measured flow at final field review shows deviation of 10% at terminal devices, 5% at equipment or more or mean sound level deviation of 10 db or more from certified report listing, by more than 10% of selected areas, report shall be rejected.
- .4 If report rejected, systems shall be re-balanced and certified report submitted at no extra cost.

3.4 TAB Report

- .1 Submit draft copies of reports before final acceptance of project. Provide [] copies of final report for inclusion in Operating and Maintenance Manuals.
- .2 Submit with report, fan and pump curves with operating conditions plotted.
- .3 Report shall be indexed as follows:

Section 1	Instrumentation and Measurement Procedures.
Section 2	System Data (Designed, Installed and Recorded), test sheet to be systems sequential.

Each system should include the following test sheets:

- .1 System Schematics for both air and hydronic systems.
- .2 Maintain equipment test sheets.
- .3 System distribution (inlet / outlets / valves) test sheets.
- .4 Profile pressure test sheets.
- .5 Comments sheet noting system setpoints.

Section 3	Drawing.
Section 4	Discussion of Results.
Section 5	Warranty and Certification

3.5 Air System Procedures

- .1 Adjust duct and terminal balance dampers and adjust or change drive sheaves to balance supply, return and exhaust air systems to provide design air qualities (within $\pm 10\%$) at each outlet and inlet and maintain design relationship between outdoor and exhaust air system quantities.
- .2 Adjust air terminals to obtain optimum air distribution pattern.
- .3 Permanently mark final balance position on balance dampers and adjustable air turning devices by means of permanent custom adhesive stickers across balancing dampers to seal them in position.

- .4 Submit report to the Consultant indicating final fan rpm, motor operating amperages, system static pressure and final air quantities obtained.
- .5 Air systems shall be balanced with clean filters in place, at total 105 % to 110% of specified total airflow rates.

3.6 TAB Data

- .1 TAB and equipment data shall be listed in imperial (SI Metric) Units.
- .2 Air Handling Equipment Installation Data:
Arrangement, discharge and class.
Motor type, hp (KW), rpm (r/min), voltage, phase cycles and full load amps.
Location and local identification.
- .3 Air Handling Equipment Design Data:
Airflow rate (cfm (L/s)).
Static pressure (" w.g. (Pa)).
Motor hp (KW), rpm (r/min) and amps.
Outside airflow rate (cfm (L/s)).
Fan rpm (r/min).
Fan hp (KW).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).
- .4 Air Handling Equipment Recorded Data
Airflow rate (cfm (L/s)).
Static pressure (" w.g. (Pa)).
Fan rpm (r/min).
Motor operating amps.
Entering and leaving air dry and wet bulb temperatures (°F (°C)).
- .5 Duct Air Quantities - Mains, Branches, Outside Air and Exhausts (Minimum and Maximum)
Duct sizes (at traverse normally) (inches (mm)).
Number of pressure readings.
Sum of velocity measurements.
Average velocity (ft/m (m/s)).
Duct recorded airflow rate (cfm (L/s)).
Duct design airflow rate (cfm (L/s)).
- .6 Air Inlets and Outlets:
Outlet identification, location and designation.
Application factors.
Design and recorded airflow rates (cfm (L/s)).
- .7 Building Pressurization Data
Outside air temperatures (°F (°C)).
Outside wind velocity (ft/m (m/s)).
Building pressure relative to ambient (in. w.c. (Pa))
Supply air, return air and exhaust airflow rates (cfm (L/s)).
Locations of pressure measuring points, inside and outside building.

.8 Backup Generator Equipment Design Data

Element type and identification (location and designation).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).
Entering and leaving water temperatures (°F (°C)).
Water pressure drop across coil (ft of head (kPa)).
Water pressure drop across bypass valve (ft of head (kPa)).
Air static pressure drop (" w.g. (Pa)).
Water flow rate (USgpm" (L/s)).
Airflow rate (cfm (L/s)).
Adjusted temperature rise or drop (°F (°C)).

.9 Air Heating and Cooling Equipment Recorded Data

Element type and identification (location and designation).
Entering and leaving air dry and wet bulb temperatures (°F (°C)).
Entering and leaving water temperatures (°F (°C)).
Water pressure drop across coil (ft of head (kPa)).
Water pressure drop across bypass valve (ft of head (kPa)).
Air static pressure drop (" w.g. (Pa)).
Water flow rate (USgpm" (L/s)).
Airflow rate (cfm (L/s)).
Adjusted temperature rise or drop (°F (°C)).

.10 Sound Level Data

Diagram or description of relationship of sound source to measuring instrument.
Overall DB (A) level.
Reading at each octave band frequency from 31.5 Hz to 16 kHz.
NC curves plotted and compared to those recommended by ASHRAE or AABC publications.

END OF SECTION 23 05 93

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 General

- .1 Provide external thermal insulation for plenums and ductwork where specified.
- .2 Provide internal acoustical insulation for plenums and ductwork where specified.
- .3 Journeyman insulation applicators shall supervise the insulation work.
- .4 Be responsible for ensuring sufficient space is provided for proper installation of insulation materials.

1.3 Regulatory Requirements

- .1 Flame spread ratings and smoke developed classifications shall be as required by applicable code, CAN/ULC-102-10 and NFPA 90A. Flame spread rating throughout material shall not exceed 25 and smoke developed shall not exceed 50. Materials shall not flame, smoulder, smoke, or glow at temperatures they are exposed to in service.
- .2 Minimum insulation thickness and insulating values shall be in accordance with NECB latest edition or ASHRAE Std 90.1 latest edition or as per the schedule in this specification, whichever is more stringent.
- .3 Fibreglass duct wrap shall comply with:
 - .1 CAN 4-S102.
 - .2 CAN/CGSB-51.5M; Type II (FSK Facing).
 - .3 CAN/CBSB-51.11-92.
 - .4 CCG Low FS Laminate Cert. #GI-141.
 - .5 ULC Listed and classified.
 - .6 ASTM C 553; Type I, II III
 - .7 ASTM C 795.
 - .8 ASTM C 1136; Type II (FSK and PSK facings only)
 - .9 ASTM C 1290; Specification for flexible fibrous glass blanket/HVAC ducts.
 - .10 ASTM E-84 Surface Burning Characteristics, 25/50 Flame/Smoke.
 - .11 CAN/ULC – S102-10 “Test for Surface Burning Characteristics of Building Materials”.
- .4 Duct liner (internal lining) shall comply with:
 - .1 CAN 4-S102.
 - .2 CAN/CGSB 51.11-92.
 - .3 ULC listed.
 - .4 ASTM C 1071; Type I.

- .5 NFPA 90A and 90B.
- .6 Microbial Growth; ASTM C 1338, G21, G22.
- .5 All insulation products shall be formaldehyde-free.
- 1.4 Qualifications and Samples
 - .1 Submit Manufacturer documentation (and samples when requested) for materials, applications and finishing methods to establish they satisfy specification and meet applicable code requirements, before commencing work.
- 1.5 Definitions
 - .1 “Concealed” means insulated mechanical services in furred spaces, shafts and hung ceilings.
 - .2 “Exposed” will mean not concealed.
- 2. **PRODUCTS**
- 2.1 Insulation products shall contain none of the following, Asbestos, Lead, Mercury, Formaldehyde or any related compounds. Insulation products shall be certified UL green guard gold or ‘indoor advantage gold’. Insulation products shall contain 50% or more recycled content and provide verification.
- 2.2 External Flexible Insulation
 - .1 External flexible glass fibre insulation with integral vapour barrier:
 - .1 Minimum density – 1.0 lb/ft³ (16kg/m³)
 - .2 Thermal conductivity at 75°F - 0.024 BTU/hr/ft/°F (24°C - 0.042 W/m/°C).
 - .3 Acceptable Manufacturers:
 - .1 Certainteed STD Ductwrap #75 FSK, Manson Alley-Wrap FSK, Owens Corning Soft.R.FSK Ductwrap, Knauf FSK Ductwrap with ECOSE technology, Johns-Manville Micro Lite FSK.
- 2.3 Duct Liner
 - .1 Flexible Duct Liner:
 - .1 Yellow or naturally coloured internal flexible glass fibre acoustical insulation with one face faced with non-woven fibreglass mat.
 - .2 Minimum sound absorption (NRC) of 0.60 as tested per ASTM C423 using Type “A” mounting.
 - .3 Thermal conductivity at 75°F - 0.023 BTU/hr/ft/°F (24°C - 0.040 W/m/°C).
 - .4 Acceptable Manufacturers:
 - .1 Certainteed Toughgard Duct Liner 150# or Type 150, Manson Akousti-Liner, Knauf Duct Liner with ECOSE technology, Owens Corning Quiet-R Rotary Duct Liner.
- 2.4 Accessories
 - .1 Insulation Adhesive:

- .1 Bakelite 230-39, Childers CP-82, CP-56W, Design Polymerics DP2502, Foster 85-20, Polymer Glasstack #25, Robson Ticki-Tuff.
- .2 Vapour Barrier Tape (FSK):
 - .1 Finishing tape to meet flame spread rating and smoke developed classification requirements of applicable code and compatible with facing material, CAN/ULC-S102.
 - .2 Foil, scrim and kraft paper FSK foil faced retarder tape complying with ASTM 1136 self-adhesive tape.
- .3 Vapour Barrier Adhesive:
 - .1 Bakor 230-21, Childers CP-82, Design Polymerics DP2502, Foster 85-20, 3M 4230.
- .4 Insulation Coating Water Based for Indoor Use:
 - .1 Foster 30-33/30-65; Childers CP 33/35.
- .5 Weather/Abuse Coating – for Outdoor Use:
 - .1 Aluminum: 0.5mm thick with longitudinal slip joints and 2” (50mm) end laps, 0.4mm thick die shaped fitting covers with factory attached protective liner on interior surface.
- .6 Reinforcing Membrane:
 - .1 Glass reinforcing membrane as commercially available.
- .7 Seal Coating, Fabric Adhesive and Fabric Coating:
 - .1 Bakor 120-09, Childers CP-50 AMV1, Design Polymerics DP3050, Foster 30-36/81-42.

2.5 Duct Insulation Schedule and Thickness

- .1 External Flexible Insulation with vapour barrier. (Exposed within room which is being served by exposed ducts, do not require external insulation).

Service	Thickness
Outdoor air ductwork.	2” (50 mm)
All exhaust air ductwork between HRV/Fan and discharge to outdoors.	1-½” (38 mm)

Refer to Section 22 07 19 for Emergency Generator Exhaust.

- .2 Internal Flexible Duct Liner

Service	Thickness
All ductwork where indicated by single hatching.	1” (25 mm)

3. EXECUTION

3.1 Application

- .1 Apply external insulation to ductwork only after pressure tests have been made and systems accepted.

- .2 Apply insulation and insulation finish so finished product is uniform, smooth in finish, with longitudinal seams concealed from view. Apply ductwork insulation materials, accessories and finishes in accordance with Manufacturer's recommendations. Fix and supply duct insulation by staples, washer pins or wire wraps at minimum 24" (600 mm) centres. Use weld-pin washers where duct dimension is larger than 26" (650 mm) high or wide.
- .3 Insulation and vapour barrier shall be continuous through non-rated separations.
- .4 Insulation and vapour barrier shall be continuous through non-rated separations. Where vapour barrier is indicated, seal joints, seams and penetrations in insulation at hangers, supports, anchors and other projections with vapour-barrier mastic.
 - .1 Install insulation continuously through hangers and around anchor attachments.
 - .2 For insulation application where vapour barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachments to structure with vapour-barrier mastic.
 - .3 Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- .5 Install insulation with non-self-sealing factory-applied jackets as follows:
 - .1 Draw jacket tight and smooth.
 - .2 Cover circumferential joints with 3" (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4" (100 mm) o.c.
 - .3 Overlap jacket longitudinal seams at least 1-½" (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at **[2" (50 mm)] [4" (100 mm)]** o.c.
 - .1 For below ambient services, apply vapour-barrier mastic over staples.
 - .2 Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - .3 Where vapor barriers are indicated, apply vapour-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

3.2 Insulation Termination

- .1 Terminate insulation short of control, smoke and fire dampers so as not to interfere with operation, seal all edges to maintain continuous vapour barrier.
- .2 Terminate insulation 24" (600 mm) short of duct mounted electric heating coils.

3.3 External Flexible Insulation with Vapour Barrier

- .1 On rectangular duct work and plenums, over 24" (600 mm) in width, spotweld pins ¼" (6 mm) longer than insulation thickness, one per square foot of duct minimum. If pins are installed in field, capacitor gun shall be used. Impale insulation over pins, and hold in place using metal or nylon clips (washers). Alternatively, use assembly consisting of welded pin with integral head washer welded in place over insulation (Clinched pins not acceptable).

- .2 Adhere foil faced vapour barrier tape over butt joints, raw edges, holding washers and other points of penetration of vapour barrier jacket on exposed hot and cold ducts and concealed cold ducts. Provide 16 ga (1.61 mm) wire wrap on 18" (450 mm) centers as additional exterior insulation reinforcing, to snug-tight so insulation is not crushed/compressed.

3.4 Internal Flexible Duct Liner Application

- .1 Adhere insulation with insulation adhesive applied to whole of metal surface, with the coating side of insulation exposed to airstream.
- .2 Ducts 24" (600 mm) in width and less require no further adhesion.
- .3 Duct sides and plenum panels greater than 24" (600 mm) in width shall have metal clips or nylon pins adhered to metal surface at 12" (300 mm) centres to supplement adhesive. (Welding pins may be used provided capacitor type gun is used.) Impale insulation or pins or clips with coated side of insulation exposed to airstream and secured with holding washers. Cover holding washers with reinforcing membrane and insulation coating/sealer.
- .4 Seal transverse joints, raw edges, and other points of penetration of coating with reinforcing membrane and insulation coating/sealer.
- .5 Seal longitudinal and butt joints with insulation coating sealer.
- .6 No raw edges of internal insulation material shall be exposed to moving airstream. Provide 26 ga (0.55 mm) sheet metal nosing at all leading edges of exposed lining to overlap insulation by at least 1" (25 mm) downstream.
- .7 Duct size indicated is inside dimension of the insulation. Metal duct sizes shall be increased to allow for internal acoustic insulation thickness.

3.5 Ductwork Insulation Finished

- .1 "Concealed" ductwork insulation, in horizontal and vertical service spaces, will require no further finish.
- .2 "Exposed" duct insulation in warehouse/service type spaces shall be painted with one sealer coat of insulation coating.

END OF SECTION 23 07 13

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

- .1 Commissioning shall be executed in accordance with intent of ASHRAE Guideline 1.1 – 2007 “HVAC and R Technical Requirements for the Commissioning Process”.
- .2 Acceptable Commissioning Agents: MDT Systems, KD Engineering, Airmec, MMM Group – Commissioning Division, Norm Nicholson Technical Services, and Flotech Mechanical.

1.3 General

- .1 Be responsible for the performance and commissioning of equipment supplied in Mechanical. Commissioning is process of advancing installation static completion to full working order in accordance with contract documents and design intent. It is activation of completed installation.
- .2 In consultation with General Contractor, ensure sufficient time is allowed and fully identified on construction schedule for proper commissioning of mechanical systems.

2. PRODUCTS: NOT USED

3. EXECUTION

3.1 Commissioning and Demonstration

- .1 Submit schedule for commissioning phase of work. Schedule shall show:
 - .1 Equipment start-up schedule.
 - .2 Submission dates for documents required prior to substantial completion.
 - .3 Timing of various phases of commissioning, testing, balancing and demonstration process.
- .2 Commissioning is concluded when air and water systems have been balanced and installation is in working order and acceptable for use. Work will include the following:
 - .1 Balancing of air systems as specified in Section 23 05 93.
 - .2 Adjust vibration isolators and earthquake restraints for optimum performance.
 - .3 Verification and certifications of sealing of HVAC penetrations through fire separations (rated and non-rated) and sound separations.
 - .4 Verification of water tightness of roof and exterior wall penetrations.
 - .5 Verification that coil drain pans operate.
 - .6 Set up automatic control valves/dampers and automatic temperature control devices.
 - .7 Testing and debugging of controls.
 - .8 Set up and test alarm and protective devices.
 - .9 Power failure test with emergency generator start-up.
 - .10 Calibration and adjustment of interlocks with life safety systems.

- .3 At conclusion of commissioning, demonstrate operation of systems to Consultant and to Owner's Operating Staff.
- .4 The verification process shall include the demonstration of the following:
 - .1 Ease of access provided for servicing coils, motors, drives, fusible link fire dampers, smoke dampers, control dampers and damper operators.
 - .2 Location of and opening and closing of access panels.
 - .3 Operation of automatic controls dampers and automatic temperature control devices.
 - .4 Operation of alarm and protective devices.
 - .5 Operability of randomly selected fire dampers.
 - .6 Noise level from HVAC equipment in maximum operating conditions.
 - .7 Operation of equipment and systems under each mode of operating, and failure, including:
 - .1 Automatic controls.
 - .2 Packaged air conditioners.
 - .3 Heat recovery systems.
 - .4 Fans.
 - .5 Tanks - domestic hot water.
- .5 At completion of the commissioning, testing, balancing and demonstration, submit the following to Consultant:
 - .1 Letter certifying that work specified is complete, clean and operating in accordance with specification and drawings.
 - .2 Completed copies of commissioning check sheets, copies of start-up reports from specialty Contractors and Vendors and functional performance test sheets.
 - .3 Record drawings as specified.
 - .4 List of alarm and protective devices tested, with the final operating settings.

END OF SECTION 23 08 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Document and is to be read, interpreted and coordinated with other parts.
- .2 Refer to Section 23 05 49 for required seismic restraint of ductwork.

1.2 Reference Standards

- .1 The construction and installation of ductwork and plenums shall be in accordance with the latest edition of the following referenced SMACNA manuals and ASHRAE handbooks.
 - .1 SMACNA - HVAC Duct Construction Standards.
 - .2 SMACNA - HVAC Air Duct Leakage Test Manual.
 - .3 ASHRAE - Handbook - Equipment Volume.

1.3 General

- .1 Duct sizes on drawings indicate clear inside dimensions. For acoustically lined or internally insulated ducts, maintain inside duct dimensions.
- .2 Where duct sizes are shown in nominal metric sizes, round and oval duct sizes may be supplied in nearest available sizes in equivalent imperial units.
- .3 Provide for openings in correct locations through slabs and walls. Openings shall be planned to include installation of fire dampers at rated fire separations.
- .4 Where ducts penetrate roofs, provide roof curbs with flashing and counter flashing.
- .5 Arrange for 4" (100 mm) high by 4" (100 mm) wide concrete curbs around duct penetrations through floor slabs outside of duct shafts.
- .6 Project drawings are diagrammatic and efforts have been made to provide information regarding number of offsets and transitions, but all are not necessarily shown. Changes may be required in duct routings, elevation and duct shape to eliminate interference with structure and other services. Required adjustments shall be established when coordinating and field measuring work prior to fabrication and must be provided as part of contract and association costs must be considered and included.
- .7 Ductwork shall be clean and free from scale, corrosion and deposits. Ductwork shall be degreased and wiped clean of oil and other surface films with appropriate solvents prior to installation.
- .8 Ductwork shall be delivered clean to site and maintained in clean condition. Dirty ductwork shall be removed from site.
- .9 Where welding ductwork, welding shall be continuous with Everdur welding. Tack welding is unacceptable, except as specifically noted. Paint damaged areas with zinc coating after welding.
- .10 Provide seismic restraints for ductwork in accordance with SMACNA "Guidelines for seismic restraints of mechanical systems and plumbing piping systems."

- .11 Where a combustible structure and/or there is a combustible ceiling plenum, that plenum shall not be used as an open plenum and all transfer air/return air shall be fully ducted, unless otherwise noted.

2. PRODUCTS

2.1 Galvanized Steel

- .1 Galvanized steel shall have 1-¼ oz/ft² (380 g/m²) galvanizing coat both sides to ASTM A525 G90.

2.2 Ductwork and Plenum Pressures

- .1 Provide ductwork and plenums of galvanized steel for static pressure categories listed below.
 - .1 6" w.g. (1,500 Pa) static pressure:
 - .1 Standby generator radiator exhaust.
 - .2 2" w.g. (500 Pa) static pressure:
 - .1 Supply ductwork.
 - .2 Return air ductwork.
 - .3 Exhaust and relief air ductwork and plenums, except where otherwise specified.
 - .4 Outdoor air ductwork.

2.3 Ductwork – Under 2" w.g. (500 Pa) Static Pressure

- .1 Provide galvanized steel duct work for system operating pressures 2" w.g. (500 Pa) and less. Ductwork shall be constructed, reinforced, sealed and installed to withstand 1-½ times working static pressure.
- .2 Construct rectangular ductwork in accordance with SMACNA Duct Construction Standards Third Edition - 2005.
- .3 Nomasco "Ductmate System, Lockformer TDC" or Exanno "Nexus System" may be used for rectangular duct joints.
- .4 At least two opposite faces of rectangular ductwork shall be joined together using joint which cannot pull apart.
- .5 Construct rectangular duct fittings in accordance with Section 2 and 4, including Figures 4-1 to 4-9 of SMACNA Duct Construction Standards Third Edition - 2005, but excluding beaded crimp joints and snaplock seams.
- .6 Construct round ductwork in accordance with Section III, including Tables 3-1 to 3-15 and Figures 3-1 to 3-11, of SMACNA Duct Construction Standards Third Edition - 2005, but excluding beaded crimp joints and snaplock seams.
- .7 Construct flat oval ductwork in accordance with Section 3.3 of SMACNA Duct Construction Standards Third Edition - 2005. Joints and seams shall be similar to those indicated for round ducts. Flat oval duct to be used for positive pressure application only.

- .8 Construct round and flat oval duct fittings in accordance with Section III of SMACNA Duct Construction Standards Third Edition - 2005. Round elbows shall have centreline radius of 1.0 times duct diameter. Sheet metal gauge of fittings and elbows shall have centreline radius of 1.0 times duct diameter. Sheet metal gauge of fittings and elbows shall not be less than thickness specified for longitudinal seam straight duct. Adjustable elbows are not permitted.

2.4 Wire Mesh Screens

- .1 Provide wire mesh screens in air intake openings.
- .2 Screens shall be constructed from aluminum wire 16 ga (1.29 mm) diameter.
- .3 Screen mesh shall be ½" (12 mm).
- .4 Mount screens in 20 ga (0.81 mm) thick folded aluminum frames.

3. EXECUTION

3.1 Ductwork and Plenum Installation

- .1 Where duct contains a fire or smoke damper, construct duct so free area is maintained through damper.
- .2 Where duct is internally insulated, enlarge duct to not reduce free area.
- .3 Make taper of diverging transitions less than 20° and taper of converging transitions less than 30° in accordance with SMACNA Duct Construction Standards Third Edition - 2005. Maximum divergence upstream of equipment to be 30° and 45° convergence downstream.
- .4 Make inside radius of rectangular duct elbow at least equal to duct width, measured in direction of radius. If space conditions do not permit full radius elbow, use square elbows with multi-blade turning vanes.
- .5 Turning vanes shall be single wall type. Vanes in galvanized sheet metal ducts shall be constructed from galvanized steel, minimum thickness 22 ga (0.85 mm). Vanes shall be spaced at 1-½" (38 mm) centres and shall turn through 90° with radius of 2" (50 mm). Vanes shall not include straight trailing edge. Vanes and runners in aluminum ducts shall be constructed from aluminum. Aluminum vanes shall be 18 ga (1.02 mm).
- .6 For under 2" w.g. (500 Pa) pressure systems, install tie rods to limit maximum unsupported vane length to 36" (914 mm). Refer to Figure 2-4 of the SMACNA Duct Construction Standards Third Edition – 2005.
- .7 For 2" w.g. (500 Pa) and greater pressure systems, install tie rods to limit maximum unsupported vane length to 18" (450 mm). Refer to Figure 2-4 of SMACNA Duct Construction Standards Third Edition - 2005
- .8 Install duct necks before grilles, registers and diffusers and cushion heads after diffuser take-offs to suit site conditions.
- .9 Where indicated, install adjustable air turning devices, where full radius take-off fittings cannot be installed, in accordance with SMACNA Duct Construction Standards Third Edition - 2005. Adjustment shall be accessible outside duct with lockable quadrant operator or through grille or register with key-operated worm gear mechanism.
- .10 Cross-break or bead metal duct panels unless otherwise noted.
- .11 Do not cross-break duct panels on 2" w.g. (500 Pa) and greater static pressure systems.

- .12 Do not cross-break bottom duct panels when ductwork is handling moisture.
- .13 Roof mounted ducts shall have standing seams and shall be sealed weather tight.
- .14 Grade ductwork handling moist/humid air, minimum of 1" (25 mm) in 10'-0" (3.0m) back to source. At low points in ductwork, provide 6" (150 mm) deep drain sump and 1-1/4" (32 mm) diameter drain connection with deep seal trap and pipe to drain.
- .15 Construct ductwork handling moisture with three-sided bottom sections and separate top panel. Install three-sided bottom sections and internally seal transverse joints with CGE Silicone Sealant "Silpruf". Then install top panels and seal top panel seams and joints.
- .16 Provide moisture collection sections inside louvres for outside air and exhaust air.
- .17 Support ductwork using galvanized steel straps, cadmium plated threaded rods, flat bar or angle hangers. Attachments to structure shall be compatible with structure and selected for load of ductwork. Install ductwork hangers in accordance with Chapter 5 of SMACNA Duct Construction Standards Third Edition - 2005.
- .18 Support duct risers at base and each floor and not greater than 12'-0" (3.6 m) intervals.
- .19 Prior to fabrication of ductwork, coordinate and field measure to ensure complete installation respecting other services. Provide necessary fittings, offsets, and alternate construction methods to facilitate installation.
- .20 Arrange ductwork and plenums so duct and plenum mounted equipment can be removed.
- .21 Arrange access doors to open against airflow and static pressure.
- .22 Provide necessary baffling in manufactured or built-up mixed air plenums to ensure good mixed air temperature with variations of not more than $\pm 9^{\circ}\text{F}$ (5.5°C) under operating conditions.
- .23 Ducts passing through non-rated fire separations, sound insulated walls and through non-rated walls and floors shall be tightly fitted and sealed on both sides of separation with silicon sealant to prevent passage of smoke and/or transmission of sound (ULC approved fire stop sealant is not required). Where ducts are insulated, provide 24 ga (0.70 mm) thick galvanized steel band tightly fitted around insulation and caulk to band.
- .24 During construction, protect openings in ductwork from dust infiltration by covering with polyethylene and protect floor outlet duct openings with metal caps.
- .25 Where ductwork passes through open web steel joists, coordinate with joist fabricator before fabricating ductwork.
- .26 Where ducts penetrate roofs, install sleeves and roof curb complete with flashing and counter flashing. Pack sleeves in roof with fibreglass insulation.
- .27 Provide drip pans under piping and shields for protection of electrical panels and equipment.

3.2 Ductwork and Plenum Cleaning

- .1 All ductwork and equipment installed shall be free of scale, debris and dirt.
- .2 Maintain duct and equipment openings covered with poly or equivalent to prevent entry of dirt.
- .3 Clean plenums and buried supply ductwork with industrial vacuum cleaner on completion of duct and plenum installation.
- .4 Install air filters for specified performance.

- .5 Blow out supply ductwork, (by means of supply fan) at completion of duct and plenum installation and prior to installation of air terminals.
- .6 Ductwork shall be considered clean when foreign material visible to naked eye has been removed. Random sampling review by Consultant will be conducted to check for cleanliness.

END OF SECTION 23 31 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

- .1 Catalogued or published ratings shall be obtained from tests carried out by Manufacturer or from independent testing agency signifying adherence to codes and standards.
- .2 Flame and smoke spread ratings less than 25/50 and tested in accordance with CAN/ULC-S012-07 "Tested for Surface Burning Characteristics of Building Materials".

2. PRODUCTS

2.1 Backdraft Dampers - Medium Duty

- .1 Minimum Requirements:
 - .1 16 ga (1.61 mm) galvanized steel or 16 ga (1.61 mm) aluminum channel frame.
 - .2 14 ga (1.63 mm) aluminum blades, complete with stiffening ribs/bends.
 - .3 Full blade length shafts, brass ball or nylon bearings.
 - .4 Felt or neoprene anti-chatter blade strips.
 - .5 Blade connecting linkage with eyelet and pin bearings.
 - .6 Maximum blade length of 30" (762 mm), use multiples for larger dimensions.
 - .7 Manufacturer's label.
 - .8 Where balanced backdraft damper (BBD) is indicated, damper shall incorporate adjustable counter balance weight and lever.
 - .9 Maximum pressure drop across damper at 800 ft/m (4.06 m/s) shall be 0.18" w.g. (45 Pa).
- .2 Standard of Acceptance:
 - .1 Airolite 625, Penn CBD-6.

2.2 Balancing Dampers

- .1 Construction in accordance with SMACNA Duct Standards. PIN type balancing dampers are not permitted.
- .2 Minimum Requirements:
 - .1 Rectangular ducts:
 - .1 Up to 12" (300 mm) deep - single blade (butterfly type).
 - .2 13" (325 mm) to 16" (400 mm) deep - two opposed blades, mechanically interlocked with pivots at quarter points.
 - .3 17" (430 mm) deep and over - multiple opposed blades, mechanically interlocked with blades not greater than 8" (200 mm) deep and pivots equally spaced.
 - .2 Round Ducts:

- .1 Single Blade (butterfly type).
 - .3 Material:
 - .1 Minimum 16 ga (1.61 mm) thick galvanized steel blades on butterfly dampers.
 - .2 Minimum 16 ga (1.61 mm) thick galvanized steel blades on multi-blade dampers with rigidly constructed galvanized steel frame (no frame required on single blade dampers).
 - .3 Minimum 18 ga (1.27 mm) thick stainless steel blades for fume exhaust ducts.
 - .4 Bearings:
 - .1 End bearings on low pressure single blade dampers above 12" (300 mm) diameter.
 - .2 Bearings on multiple blade dampers shall be bronze iolite type.
 - .5 Operating Mechanism:
 - .1 Lockable quadrant type with end bearing on accessible rectangular ducts up to 16" (400 mm) deep and on accessible round ducts.
 - .2 Wide pitch screw mechanism type with crank operator on accessible rectangular ducts 17" (430 mm) and over in depth and on inaccessible rectangular and round ducts.
 - .3 Override limiting stops.
 - .4 No blade movement in set position.
 - .6 Concealed Regulators:
 - .1 For drywall ceilings with no access panels, provide concealed balancing damper regulators embedded in finished ceiling, mounted behind grilles, on or inside plenum slot diffusers and various other types of diffusers. Concealed damper regulator to be connected to balancing damper by means of flexible Bowden cable and installed flush with ceiling. Cover plate held in place with 2 screws and easily removed for damper adjustment. Concealed damper regulator similar to Young Regulator Co. Model No. 270-301. Provide necessary hardware, including Young Regulator balance damper model 5020-CC, Bowden cable and Young Regulator Model 030-12 wrench.
 - .2 Drawing designation: D (CR).
- 2.3 Duct and Plenum Access
- .1 Dimensions:
 - .1 Doors:
 - .1 20" (500 mm) wide x 54" (1,350 mm) high.
 - .2 Head of door 70" (1,780 mm) above floor.
 - .2 Panels:
 - .1 15" (380 mm) x 20" (500 mm).
 - .2 Where far corners of the duct are closer than 20" (500 mm) and equipment within duct is closer than 12" (300 mm) size may be reduced to 16" (400 mm) x 12" (300 mm) or 18" (450 mm) x 10" (250 mm) elliptical.
 - .3 Where space will not permit above dimensions they should be matched as closely as possible and additional access provided as required.
 - .2 Products:
 - .1 Doors - construct in accordance with SMACNA Duct Standards Figure 6-12 except for latch type. 1-1/2" (38 mm) thick insulation.

- .2 Panels - Nailor Hart, Ventlok, 1" (25 mm) thick insulation.
 - .3 Gaskets - neoprene or foam rubber.
 - .3 Hardware:
 - .1 Panels up to 16" (400 mm) x 12" (300 mm) - 2 sash locks.
 - .2 Panels – 15" (380 mm) x 20" (500 mm) - 4 sash locks.
 - .3 Doors - piano hinge and Ventlok 310 latches complete with front and inside handles and front door pull.
- 2.4 Duct Connectors - Vibration Isolation
- .1 Provide flexible duct connections to provide vibration isolation at duct and plenum connections to fan and air handling units. See Figure 2-19 SMACNA Duct Standards.
 - .2 Minimum Requirements:
 - .1 Pre-assembled 3" (75 mm) minimum long flexible connection with 3" (75 mm) long 24 ga (0.70 mm) galvanized steel duct connectors on each side of flexible connection. Flexible connector - fibre glass fabric with elastomer coating.
 - .3 Centrifugal fans with 36" (914 mm) diameter and larger fan wheels, use 6" (150 mm) long flexible connection.
 - .4 Do not install connectors on perchloric acid fume exhaust systems.
 - .5 Standard of Acceptance:
 - .1 Duro Dyne "Durolon," Dynair "Hypalon," Ventfabrics "Ventlon".
- 2.5 Ductwork and Plenum Sealers
- .1 Provide water-based duct sealing compounds for use in fabrication of ductwork and plenum joints.
 - .2 Low Pressure Systems - SMACNA Seal Classification B. Medium and High Pressure Systems - SMACNA Seal Classification A.
 - .3 Standard of Acceptance:
 - .1 Foster 32-19, Hardcast Versa Grip, Hardcast Foil Grip 1402, Robson's Duct Seal-WB, United Duct Sealer, Trans Continental Multi-Purpose.
 - .4 Where accessible, apply sealer to inside of joints on ducts and plenums under positive pressure - e.g. discharge side of fans.
 - .5 Apply sealer to outside of joints on ducts and plenums under negative pressure - e.g. suction side of fans.
- 2.6 Fire Dampers
- .1 Minimum Requirements:
 - .1 Fire dampers shall be ULC or Warnock Hersey tested and shall bear testing agency's label.
 - .2 Fire dampers shall meet requirements of National Building Code and authorities having jurisdiction.

- .3 Fire dampers shall be “dynamic,” rated to close under airflow, where the air system runs during a fire alarm condition.
- .4 Fire dampers may be static type in applications where there is no airflow/air system is off in a fire alarm condition.
- .5 Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire separation.
- .6 Fusible link actuated, weighted to close and lock in closed position when released or having negator-spring-closing operator for multi-leaf type in horizontal position with vertical airflow.
- .7 Fire dampers in low-pressure ductwork may be multi blade or curtain type.
- .8 Fire dampers in medium and high-pressure ductwork shall be curtain type.
- .9 Curtain fire dampers shall be blades retained in recess so free area of connecting ductwork is not reduced.
- .10 Fusible Links: ULC approved with melting point of 165°F (74°C) on supply, return and exhaust air systems. Use fusible links with melting point of 286°F (141°C) on return and exhaust air systems if used for smoke venting.
- .11 Standard of Acceptance
 - .1 Static Type – Price FD, Type A, B, or C as required, Nailor, Controlled Air.
 - .2 Dynamic Type – Price FDD, Type A, B, or C as required, Nailor, Controlled Air.Note: Type A dampers only acceptable at wall-mounted grille terminations.
- .12 Fire damper access panel/door in rigid ductwork shall be equal to Nailor 0800 type, with acoustic insulation of duct is lined, without insulation if duct is unlined.

3. EXECUTION

3.1 Balancing Dampers

- .1 Provide balancing dampers at points on low pressure supply, return and exhaust systems where branches are taken from larger duct as required for proper air balancing complete with 1” (25 mm) high stand-off bridges for operators to allow full, continuous duct insulation.
- .2 Provide balancing dampers at each run out to grille or diffuser.
- .3 Identify airflow direction and blade rotation and open and closed position
- .4 On round ductwork larger than 12” (300 mm) diameter and externally insulated rectangular ductwork, provide sheet metal bridge to raise quadrant type operator above insulation thickness (coordinate with Section 23 07 13). Provide open end bearing where bridges are used. Bridges on uninsulated round ducts shall be at least 1” (25 mm) high.
- .5 Where quadrant type operators are used, lever shall be arranged parallel with damper blade complete with 1” (25 mm) high stand-off bridge for operators to allow continuous duct insulation to be applied on the duct.

3.2 Backdraft Dampers

- .1 Install backdraft dampers on exhaust and relief openings through building walls and roof on exhaust fans where control dampers are not called for or indicated.

3.3 Control Dampers - Automatic

- .1 Packaged equipment specified to be complete with control dampers, shall include control dampers as normally supplied by equipment Manufacturer unless otherwise noted.
- .2 Other automatic control dampers are specified in Controls Sections.
- .3 Under this section be responsible for receipt, handling, storage and installation of control dampers supplied under Control or other Sections.
- .4 Indicated size of control dampers is dimension outside frame. Oversize ductwork to include depth of damper frame if pressure drop across damper exceeds 0.1" w.g. (25 Pa).
- .5 Control damper frames shall be fitted tightly into ductwork and sealed airtight.
- .6 Check that dampers are installed square and true. Ensure damper end linkages are easily accessible. Provide saw-cuts with black paint in the exposed ends of all damper shafts, aligned with damper blade for visual indication of damper blade position.
- .7 Do not install control dampers in thickness of wall unless otherwise indicated.

3.4 Duct and Plenum Access

- .1 Locations: Provide access doors and panels as follows:
 - .1 Doors: Where indicated on drawings.
 - .2 Panels:
 - .1 Every 40'-0" (12 m) on ductwork.
 - .2 Base of each duct riser.
 - .3 Both side of equipment blocking duct e.g.
 - .1 Air flow measuring stations.
 - .2 Coils.
 - .4 At or to one side of other equipment in duct, e.g.
 - .1 Backdraft dampers (counter weight side).
 - .2 Balance dampers serving multiple outlets/inlets.
 - .3 Bearings (fans/motors).
 - .4 Control dampers.
 - .5 Control sensors.
 - .6 Fire dampers (rectangular ducts and round ducts 13" (325 mm) diameter and larger - latch side).
 - .7 Heat detectors (upstream from device)
 - .8 Smoke dampers (operator side).
 - .9 Smoke detectors (upstream from device).
 - .5 Panels need not be provided where access is available through door or register mounted to side of duct.
 - .6 Kitchen exhaust access requirement specified under "Ductwork - Kitchen - Exhaust."
- .3 Patches:
 - .1 Where required for cleaning and where access panels are not specified e.g. on both sides of turning vanes.

- .4 Flexible duct - on round duct and round fire dampers up to 12" (300 mm) diameter.
 - .2 Seal frames airtight.
 - .3 Install to not interfere with airflow.
 - .4 Install to provide access for service and cleaning.
 - .5 Do not use sheet metal screws for attaching access panels to ductwork.
 - .6 Round ducts 13" (325 mm) diameter and larger shall include a short collar for installation of access panels.
 - .7 Small rectangular ducts shall be transitioned to minimum dimension across duct of 13" (325 mm) for installation of access panels.
- 3.5 Duct Connectors - Vibration Isolation
- .1 Ensure flexible duct connectors do not reduce duct free area on suction side of fans.
- 3.6 Fire Dampers
- .1 Install in accordance with the SMACNA Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems - Fourth Edition 1992. Demonstrate fire damper drop test for all of the fire dampers installed in this project.
 - .2 Fire damper sleeves must not extend more than 3" (75 mm) from wall on each side.
 - .3 Fire dampers shall be installed within wall thickness of fire separation.
 - .4 Wall openings sized to allow sleeve/damper expansion.
 - .5 Arrange dampers so linkages and locking catches are accessible from access side of fire damper. Provide an access panel at all fire dampers, complete with red stencilled "F.D" label.
 - .6 Install to close in direction of normal airflow.
 - .7 Size so free area of duct is maintained through assembly. All fire dampers shall be Type B – Blades of airstream, unless specifically noted otherwise or as required for specific installation.
 - .8 Install in galvanized steel sleeve, retained in place with retaining angles on four sides at each face of wall.
 - .9 Connect ductwork to damper sleeves using break-away duct joints on faces.

END OF SECTION 23 33 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

- .1 Catalogued or published ratings shall be from tests carried out by Manufacturer or from independent testing agency signifying adherence to codes and standards.

1.3 Submittals

- .1 Fan shop drawings shall include sound rating data and fan curves showing operating point plotted on curves.
- .2 Fan shop drawings shall include motor efficiencies. Refer to Section 23 05 13 for minimum motor efficiencies.

1.4 General

- .1 Provide ECM DC motors complete with manual speed dial and 0-10V DC controls signal terminal for variable speed control. See Section 23 05 13 for ECM motor requirements.

2. PRODUCTS

2.1 Fans – General

- .1 Provide fans selected for maximum efficiency and generating noise levels on site not exceeding levels indicated. If fans are not specified at maximum efficiency, advise mechanical Consultant before tendering and submit alternate price for maximum efficiency fans. If approval to supply noisier fans is not obtained prior to tendering, provide equipment meeting ASHRAE levels on site without loss in efficiency.
- .2 Submit fan sound power levels with shop drawings measured to applicable AMCA standards, or other data acceptable to Consultant. Provide test data, if requested. Indicate on shop drawings test configuration, including ductwork, and end reflection corrections applied to data and/or if such corrections have been omitted.
- .3 Fans: statically and dynamically balanced, constructed in conformity with AMCA-99-83. Dynamically balance fans to 1.5 mm/s vibration amplitude, maximum measured on bearing housings. Provide fan shafts with critical speed at least 1.5 times operational speed.
- .4 Ratings: based on tests performed in accordance with AMCA 210, and ASHRAE 51-85. Unit shall bear AMCA certified rating seal.
- .5 Refer to drawings for motor position, rotation and discharge arrangements.
- .6 For motors less than 10 hp (7.5 KW) provide standard adjustable pitch drive sheaves +/- 10% range. Use mid-position of range for specified rpm (r/min).
- .7 For motors 10 hp (7.5 KW) and larger, provide fixed pitch drive sheaves with split tapered bushing and keyway. Provide final drive sheaves of size to suit final balancing.
- .8 Match drive and driven sheaves.

- .9 V-belts shall conform with American Belt Manufacturers standards. Multiple belts shall be matched sets.
- .10 Minimum drive rating shall be 150% of nameplate rating of motor.
- .11 Not less than 2-belt configuration required for motors $\frac{3}{4}$ hp (0.56 KW) and larger.
- .12 Provide osha style belt guard with tachometer ports for belt drive fans.
- .13 Where fans are used for smoke exhaust, motor, bearings, operators, etc. shall be capable of three hours of operation at 482°F (250°C).
- .14 Bearings shall have minimum L-10 life of 100,000 hours based on maximum safe speed of fan class.
- .15 Where required, fans shall be treated to suit airstream in which they are used.
- .16 Provide secure attachment points for seismic restraints. Mounting brackets shall be suitable for seismic loading.

2.2 Fans – Ceiling Exhaust

- .1 Centrifugal blower, motor vibration isolated.
- .2 Built-in backdraft damper.
- .3 White plastic exhaust grille.
- .4 Adjustable hanger bracket.
- .5 Pre-wired outlet box, plug-in receptacle.
- .6 Solid state speed control – where scheduled.
- .7 Acceptable Products: Broan, Delta Breez, Nutone, Reversomatic, Penn/Barry, Panasonic, Air King, Lexton.

2.3 Fans-In-Line Centrifugal

- .1 In-line centrifugal fan with axial flow construction.
- .2 Square housing, steel with galvanized finish.
- .3 Access panel to provide cleaning and service access.
- .4 Backward inclined, non-overloading wheel.
- .5 Drip-proof motor.
- .6 Permanently lubricated pillow block ball bearings.
- .7 Rust preventative coating on shafts.
- .8 Belt or direct driven as scheduled.
- .9 Belt guard, motor cover, where externally belt driven.
- .10 Plug-in electrical disconnect switch, mounted on the outside of the fan housing.
- .11 Insulated housing lining.
- .12 Solid state speed controller where scheduled.
- .13 Acceptable Products: Greenheck, Loren-Cook, Delhi, Lau.

2.4 Fans – Propeller

- .1 Formed steel or aluminum propeller blades.
- .2 Spun steel venture.
- .3 Grease lubricated ball bearings suitable for operating in any position.
- .4 Belt driven with adjustable drive sheave and belt guard or direct driven as scheduled.
- .5 Motor mounting brackets.
- .6 Totally enclosed motor.
- .7 Fan guard as scheduled.
- .8 Automatic backdraft dampers with gasketed edges as scheduled.
- .9 Acceptable Products: Greenheck, Loren-Cook.

3. EXECUTION

3.1 Fans

- .1 Install fans as indicated, complete with vibration isolators and seismic restraints as specified in Sections 23 05 48 and 23 05 49.
- .2 Install fans with flexible connections on inlet ductwork and on discharge ductwork. Ensure metal bands of connectors are parallel with minimum 1" (25 mm) flex between ductwork and fan during running.
- .3 Install connectors to be clear of air stream. Provide flange extensions as necessary. Ensure accurate alignment of duct of fan.
- .4 Provide safety screens where fan inlet or outlet is exposed.
- .5 Provide belt guards on belt driven fans.
- .6 Provide and install sheaves and belts required for final air balance.
- .7 Assist Balancing Agency in altering blade pitch angles as required for final air balance. Provide access to fan wheel for blade adjustment.

END OF SECTION 23 34 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

- .1 Catalogued or published ratings shall be those obtained from tests carried out by Manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

2. PRODUCTS

2.1 Air Terminals

.1 General:

- .1 Grilles, registers and diffusers shall be product of one Manufacturer.
- .2 Refer to drawings for sizes and air quantities.
- .3 Refer to schedules on drawings for details.
- .4 Base air outlet application on space noise level of NC 30 maximum.
- .5 Air terminals shall be checked for compatibility with ceiling types. Refer to Architectural reflected ceiling plans.
- .6 Manufacturer (other than design listed) shall match performance data and indicate specific comparison for each item, with shop drawing submission.
- .7 Ceiling mounted air terminals shall be provided with means for attachment of two seismic security wires at opposite corners on each air terminal.
- .8 Provide concealed baffles, where necessary, to direct air away from walls, columns or other obstructions within radius of air terminal operation.
- .9 Provide auxiliary frames for diffusers located in drywall ceilings and grilles mounted in gypsum walls in public areas. In other areas grilles should be attached to ductwork, or flanged to outside of the opening.
- .10 Standard of Acceptance for General Grilles, Registers and Diffusers: EH Price, Nailor, Titus, Krueger, Tuttle & Bailey.

2.2 Louvres - Stationary

.1 General:

- .1 Extruded aluminum frames and blades.
- .2 Welded construction with exposed joints ground flush and smooth or mechanically fastened with stainless steel fasteners.
- .3 Lower assembly sealed and water tight.
- .4 Removable 16 ga (1.29 mm) diameter aluminum wire bird screen with ½" (12 mm) mesh. Bird screen mounted in 20 ga (0.81 mm) thick aluminum folded frame. Frame to be installed inside louvre.

- .5 Anodized permanodic hard colour finish.

3. EXECUTION

3.1 Air Outlets and Inlets

- .1 Provide grilles, registers, diffusers as schedule and as noted on the plans. Provide specific mounting type coordination with wall, floor and ceiling types as noted.
- .2 Install with cadmium plated screws in counter sunk holes where fastenings are visible.
- .3 Install ductwork as high as practical, using offsets where required to obtain maximum duct neck lengths for diffusers.
- .4 Paint ductwork behind grilles with matte black paint where duct or insulation surfaces are visible.
- .5 Attach registers and grilles to branch ducts with duct necks having minimum length to prevent grille or register damper from protruding into branch duct.
- .6 Where air terminals are installed in mechanical grid ceiling, provide minimum two 12 ga (2.75 mm) galvanized steel wire seismic security bridles at opposite corners of each air terminal and such that air terminal cannot fall.
- .7 Hand over door grilles to General Contractor for installation.

3.2 Louvres

- .1 Provide necessary flashing and counterflashing for louvres installed in walls.
- .2 Caulk louvre and flashing and counterflashing to make installation water tight.
- .3 Blank-off panels shall be constructed to SMACNA standards, minimum 20 ga (1.00 mm) sandwich panel with 1" (25 mm) thick fibreglass insulation.
- .4 Blank-off panels shall have painted flat black enamel finish.

END OF SECTION 23 37 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

- .1 Catalogued or published ratings shall be those obtained from tests carried out by Manufacturer or by independent testing agency signifying adherence to codes and standards.

1.3 References

- .1 AHRI 1060 latest edition.

2. PRODUCTS

2.1 Heat Recovery Ventilators – Flat Plate Type

.1 General:

- .1 Factory packaged, self-contained and pre-wired unit, CSA certified.
- .2 Packaged heat recovery ventilator consisting of flat plate heat exchanger, ventilation air fan, exhaust air fan, dampers, temperature sensors and controls, suitable for operation with low outdoor air temperatures (-22°F (-30°C)).
- .3 Unit shall be constructed in accordance with CSA C22.2 and UL 1812 and shall carry the ETL and (C)ETL label of approval.
- .4 Insulation shall comply with NFPA 90A requirements for flame spread and smoke generation.
- .5 Tested and rated in accordance to AMCA 210, AHRI 1060 and ASHRAE 84, test procedures for airflow and thermal effectiveness.
- .6 Single point power connection only, voltage as identified in the schedules.
- .7 Units shall be run tested prior to shipment.
- .8 Unit shall be capable of providing constant volume at specified external static pressure at all fan operating speeds.

.2 Unit Cabinet:

- .1 Unit shall include baked on, polyester pre-painted 20 ga (1.00 mm) galvanized steel finish. Warranty cabinet finish for 10 years against cracking, chipping, peeling, brazing or spotting.
- .2 Cabinet shall be insulated throughout with minimum 1" (25 mm) foil faced fire retardant material.
- .3 Painted galvanized metal cabinet, internally lined and insulated – suitable for outdoor installation where unit is exposed to outdoor environment.
- .4 Main access panel shall be hinged and provide access to components requiring servicing.

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- .5 Outdoor and exhaust side filters with service access. Filter efficiency according to equipment schedules on drawings.
- .3 Fans:
 - .1 Supply air and exhaust air fans with multiple-speed motors.
 - .2 Fan ratings based on tests in accordance with AMCA Standard 210.
 - .3 Fans selected to operate on stable, efficient part of fan curve when delivering air quantities scheduled against static pressure of system.
 - .4 Fan blades shall be statically and dynamically balanced and tested prior to shipment.
 - .5 Fan shall be provided with internal vibration isolation mounts.
 - .6 Motors shall be continuous duty, permanently lubricated and matched to fan loads. Motor selection shall include 15% service factor.
- .4 Flat Plate Heat Exchanger:
 - .1 Rugged aluminum or polypropylene flat plate heat exchanger designed for general purpose or corrosive applications and shall meet UL 94 HB flame spread test, and be removable from unit.
 - .2 Cross leakage of less than 1%.
 - .3 Fifteen-year warranty on flat plate heat exchanger.
- .5 Controls:
 - .1 Unit shall be provided with factory mounted and factory wired microprocessor control, requiring only field connection to wall-mounted controllers.
 - .2 Service connectors shall be quick disconnect type.
 - .3 Unit circuitry shall allow dry contacts for occupancy control, remote fan interlock on call for ventilation, selection of low or high speeds, remote sensor contacts, interlock with building DDC system. Dry contacts for control functions to be building DDC system compatible (future provision).
 - .4 Automatic defrost cycle.
- .6 Accessories:
 - .1 Frost Control Options:
 - .1 Recirculation Defrost Cycle: Unit shall be equipped with recirculation defrost to prevent frost from forming on flat plate heat exchanger and to prevent negative pressure from occurring in building.
 - .2 Corrosion resistant external finish, suitable for outdoor installation.
 - .3 Two speed fan.
 - .7 Standard of Acceptance: Aldes, Nu-Air, Venmar CES Inc, Munters/Deschamps, Innovent.

3. EXECUTION

3.1 Heat Recovery Ventilators Installation

- .1 Install in accordance with Manufacturer's recommendations.

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- .2 Start-up Heat Recovery Ventilators in accordance with Manufacturer's start-up instructions.
Provide start-up report to Consultant, and include in O & M manual.

END OF SECTION 23 72 00

1. GENERAL

1.1 Related Work

- .1 This Specification Section forms part of Contract Documents and is to be read, interpreted and coordinated with other parts.

1.2 Quality Assurance

- .1 Products shall meet all requirements of Canada Standards Association (CAN/CSA-2.3/CAN/CSA C22.2 #236) for construction of packaged air conditions, ANSI Z21.47/UL1995 for construction of packaged air conditioners, CGA, Provincial and Municipal Codes and be CSA listed.
- .2 Units shall be products of Manufacturers who provide local service personnel from factory Representative, franchised dealer or certified maintenance service shop.
- .3 Provide start-up service and report.

1.3 References

- .1 Products shall be manufactured to, tested to, installed to, or listed in compliance with the following standards as applicable.
 - .1 NFPA 90 A & B – Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems.
 - .2 ANSI/ASHRAE 15 – Safety Code for Mechanical Refrigeration.
 - .3 ANSI/ASHRAE/IESNA 90.1-Latest Edition – Energy Standard for New Buildings Except Low-Rise Residential Buildings.
 - .4 ANSI/NFPA 70-1995 – National Electric Code.

1.4 Warranty

- .1 Provide five-year parts warranty on compressor unit.
- .2 Provide one-year parts warranty on all other components.

2. PRODUCTS

2.1 Packaged Outdoor Wall-Mounted Air Conditioner

- .1 General:
 - .1 Wall-mounted self-contained packaged single-zone high-efficiency DX cooling unit with auxiliary electric resistance heat, bearing CSA and ULC labels.
 - .2 The wall mount unit shall be completely factory assembled and tested, and shall include compressor, indoor and outdoor coils, fans and motors as required, prewired controls, interconnecting refrigerant tubing, wiring, disconnects, and other necessary components mounted in a corrosion resistant cabinet, ready for field connections. Unit shall be shipped from the factory with a full operating refrigerant and oil charge. Manufacturer shall test operate unit at factory before shipment.
 - .3 Standard of Acceptance: Marvair, Bard.

.2 Cabinet:

- .1 The external cabinet (except for the condenser fan's venturi ring) and all internal partitions shall be constructed of type 316L stainless steel. The cabinet shall include a sloped top and built-in mounting flanges. The conditioned air section shall be insulated with 1/2 inch, 2 pound dual density fiberglass. The electrical control box shall be accessible from the front of the air conditioner. Integrated but optional supply and return grilles to suit installation.

.3 Economizer:

- .1 Factory installed within the cabinet of the air conditioner. Slip-in or field installed economizers are not acceptable. The economizer shall be designed to assure easy access to the air conditioning electrical controls. The economizer shall maintain a fixed supply air temperature of 55°F (13°C) during the "free" cooling operation by providing full range modulation for the outside return/air damper. The air conditioning unit shall include a method of pressure (exhaust) relief. The economizer shall be capable of introducing outside air and exhausting indoor air at a rate equal to the rated airflow of the air conditioner. The package shall be complete with necessary damper, linkage, and spring-return modulating damper motor. The economizer controls shall include an enthalpy sensor capable of controlling the damper by measuring the total heat content of the outside air

.4 Compressor:

- .1 Hermetic scroll type. The refrigeration circuit shall contain a liquid filter dryer, suction and liquid access valves. The refrigeration circuit shall include a high-pressure switch and a low-pressure switch with a lockout relay. The compressor motor shall be protected by an internal line break thermostat. Electrical wiring connections at the compressor shall be protected by receptacle housing. The refrigerant metering device shall be thermal expansion valve

.5 Refrigerant:

- .1 R-410A.

.6 Outdoor Section:

- .1 The condenser coil shall be constructed of aluminum plate fins mechanically bonded to seamless copper tubes. Outdoor fan shall be direct driven, slow speed propeller type for quiet operation. The outdoor motor shall be equipped with a thermal protector.

.7 Indoor Section:

- .1 The evaporator coil shall be constructed of aluminum plate fins mechanically bonded to seamless copper tubes. Two direct drive indoor blowers shall be of centrifugal type, forward curved. The indoor motor shall be equipped with a thermal protector.

.8 Filters:

- .1 50mm (2") disposable MERV 8, mounted internally. Provide 4 sets of spare filters.

.9 Integrated Controls:

- .1 Operates compressor, indoor fan motor, and electrical heaters. Incorporates refrigeration safeties, low-ambient outdoor fan control (capable of cooling down to -7°C or 20°F), and short-cycle protection.

.10 Indoor Controller:

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- .1 Packaged controller equal to Marvair CommStat 3 with built-in temperature sensor, capable of alternating lead/lag operation of two units in fully redundant air conditioning system, with LED indicators for status and function, digital display of temperature, and alarm relays.
- .11 Corrosion Protective Coating:
 - .1 All components, including all exposed internal and external sheet metal, the condenser coil, the condenser fan blade, the evaporator coil, the evaporator blower, and all refrigerant tubing in the air conditioner shall have an anti-corrosion coating specifically designed for the protection of HVAC coils and components. The coating shall have a negligible effect on pressure drop and heat transfer and shall be UV and impact resistant. External fasteners shall be corrosion resistant. The fan motor shall be sealed or partially sealed.

3. EXECUTION

3.1 Packaged Equipment Installation

- .1 Install as per Manufacturers' instructions.
- .2 Maintain proper clearance around equipment to permit performance of service maintenance.
- .3 Connect units to ductwork with flexible connections.
- .4 Pipe from condensate drains to grade complete with 'P' trap.

END OF SECTION 23 74 00

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.46-M1988, Electric Air-Heaters.
- .2 Underwriters' Laboratories (UL) Inc.
 - .1 UL 1042-1994, Electric Baseboard Heating Equipment.

1.2 PRODUCT DATA

- .1 Submit product data sheets for baseboard convectors. Include:
 - .1 Product characteristics.
 - .2 Performance criteria.
 - .3 Mounting methods.
 - .4 Physical size.
 - .5 kW rating, voltage, phase.
 - .6 Cabinet material thicknesses.
 - .7 Limitations.
 - .8 Colour and finish.
- .2 Manufacturer's Instructions: Provide to indicate special handling, installation and maintenance procedures.

1.3 CLOSEOUT SUBMITTALS

- .1 Submit operation and maintenance data for baseboard convectors in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 BASEBOARD CONVECTORS

- .1 Heaters: to CSA C22.2 No.46 standard wattage density as indicated with connection box one end.
 - .1 Element through-type fitted with aluminum convector vanes and resistor wire enclosed in mineral insulation in copper sheath.
- .2 Element: locked to cabinet and supported at additional points throughout length to allow for linear expansion with non metallic supports.

- .3 Cabinet: to CSA C22.2 No.46, pre-drilled back for securing to wall. Integral air diffusion reflector with wireway at bottom and built-in clamps.
 - .1 Bottom inlet/top outlet.
 - .2 Bottom inlet/front outlet.
 - .3 Front inlet/front outlet.
 - .4 Sloping inlet/sloping front outlet.
 - .5 Panel: steel, metal thickness, bottom 0.8 mm, front 1.2 mm thick.
 - .6 Finish: phosphatized and finished with baked enamel; white colour.

2.2 CONTROLS

- .1 Wall mounted thermostats: type line voltage, 2 pole complete with tamper proof cover.
- .2 Integral thermostats: type line voltage, 2 pole.

Part 3 Execution

3.1 INSTALLATION

- .1 Install baseboard convactor heaters, blank sections and controls.
- .2 Install grounding wire to maintain ground integrity between heating, blank, and auxiliary sections.
- .3 Install thermostats in locations indicated.
- .4 Make power and control connections.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Ensure heaters and controls operate correctly.

END OF SECTION

1. GENERAL

1.1 Sequencing

- .1 This section defines the sequence of operation for the mechanical systems that are to be executed by solid-state or standalone packaged equipment controls.
- .2 The control sequences provided in this section contain a general description of the intent of the operation of the systems to be controlled.
- .3 The control sequences shall be interpreted in conjunction with the respective system configuration schematics, layout and details shown on the drawings.
- .4 The Contractor shall review individual systems to ensure equipment and life safety interlocks are not overridden.
- .5 Review with the Consultant during the shop drawing stage to finalize control sequences for each system.

2. BUILDING SPECIFIC SEQUENCE OF OPERATIONS

2.1 Emergency Generator

- .1 Motorized dampers MD-01 and MD-02 serving emergency generator room shall spring fail open and power closed by normal power (i.e. spring open when normal power fails).
- .2 Provide interlock with clean agent fire suppression system controller, and power closed when system is activated.
- .3 Provide manual test switch to disconnect normal power to dampers for regular maintenance testing of generator.

2.2 Heat Recovery Ventilator HRV-1

- .1 HRV-1 shall be provided with a relay enabled by either of two conditions:
 - .1 Line-voltage timelock set to operate 1 hour every 4 hours (manually adjustable)
 - .2 Interlock with lights in Entry/Mud Room
 - .3 Interlock with lights in Gear Storage Room

2.3 Communications Room Air Conditioning Units AC-1 and AC-2

- .1 Operate automatically in lead-lag/duty-standby configuration to maintain room setpoint using standalone packaged controller; refer to section 23 74 00.

2.4 Vehicle Garage Exhaust Fan EF-1

- .1 Line-voltage timelock set to operate 1 hour every 4 hours (manually adjustable).
- .2 Motorized dampers MD-04, and MD-05 are interlocked to open with operation of EF-1.

2.5 Generator Room Exhaust Fan EF-2

- .1 Line-voltage reverse acting thermostat set to operate to maintain maximum indoor temperature of 25°C (manually adjustable).

.2 Motorized damper MD-03 are interlocked to open with operation of EF-2.

2.6 Electric Resistance Heat

.1 Heaters and line-voltage controls are provided under electrical scope of work.

.2 Operate to maintain minimum indoor temperature of 18°C (manually adjustable).

2.7 Other Systems

.1 Fire Suppression Systems, Fuel Oil system, standby generator, uninterruptable power supply (UPS) and other systems are not part of the mechanical scope of work.

2.8 EXECUTION

N/A

END OF SECTION 25 90 01

Part 1 General

1.1 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.1 Canadian Electrical Code, Part 1 (2015), Safety Standard for Electrical Installations.
 - .2 CAN3-C235-83, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
 - .3 CSA B651-12 Accessible Design for the Built Environment.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 2Y-1-1958, Light Gray Colour for Indoor Switch Gear.
- .3 National Electrical Manufacturers Association (NEMA)

1.2 DEFINITIONS

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these specifications, and on drawings, are those defined by IEEE SP1122.

1.3 DESIGN REQUIREMENTS

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
- .3 Language operating requirements: provide identification nameplates for control items in English.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit WHMIS MSDS in accordance with Section 02 81 01 - Hazardous Materials.
- .3 Submit for review single line electrical diagrams in glazed frames and locate:
 - .1 Electrical distribution system in main electrical room for each building in scope of work.
 - .2 Electrical power generation and distribution systems in power plant rooms.
- .4 Submit for review fire alarm riser diagram, plan and zoning of building in glazed frames at fire alarm control panel and annunciator.

- .5 Shop drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of BC, Canada.
 - .2 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.
 - .3 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
 - .4 Indicate on drawings clearances for operation, maintenance, and replacement of operating equipment devices.
 - .5 Submit one copy of drawings and product data in PDF digital format to authority having jurisdiction.
 - .6 If changes are required, notify Departmental Representative of these changes before they are made.
 - .7 Submit .dwg files for all approved switchgear shop drawings.
 - .8 Switchboard, control, SCADA, etc. drawings are diagrammatic only. Contractor shall submit a fully coordinated drawing package indicating all devices, terminals, wiring, cable schedules and interface with existing systems or equipment from other sources.
- .6 Quality Control: in accordance with Section 01 45 00 - Quality Control.
 - .1 Provide only 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 General Conditions of contract.
 - .5 Submit, upon completion of Work, load balance report as described in PART 3 - LOAD BALANCE.
 - .6 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to Departmental Representative.
 - .7 Manufacturer's Field Reports: submit to Departmental Representative manufacturer's written report, within 3 days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in PART 3 - FIELD QUALITY CONTROL.

- .8 Submit one copy of all manufacturer specific software packages, including license certifications/quantities required for adjusting the settings and configuration of electrical and communication systems components. Software shall include all required licencing, specialty port adapters and communication protocols. List all manufacturer specific software packages provided.

1.5 QUALITY ASSURANCE

- .1 Quality Assurance: in accordance with Section 01 45 00 - Quality Control.
- .2 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with authorities having jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
 - .1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
 - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.
- .3 Site Meetings:
 - .1 In accordance with Section 01 32 16.06 - Construction Progress Schedule - Critical Path Method (CPM), Section 01 32 16.07 - Construction Progress Schedule - Bar (GANTT) Charts.
 - .2 Site Meetings: as part of Manufacturer's Field Services described in Section 01 91 13 - General Commissioning (CX) Requirements, schedule site visits, to review Work, at stages listed.
 - .1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of Work, after cleaning is carried out.
- .4 Health and Safety Requirements: do construction occupational health and safety in accordance with Section 01 35 29.06 - Health and Safety Requirements.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Material Delivery Schedule: provide Departmental Representative with schedule within 2 weeks after award of Contract.
- .2 Construction/Demolition Waste Management and Disposal: separate waste materials for recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

1.7 SYSTEM STARTUP

- .1 Instruct Departmental Representative and operating personnel in operation, care and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of manufacturer's factory service engineer to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.

- .3 Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with aspects of its care and operation.

1.8 OPERATING INSTRUCTIONS

- .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .2 Operating instructions to include following:
 - .1 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - .3 Safety precautions.
 - .4 Procedures to be followed in event of equipment failure.
 - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .3 Print or engrave operating instructions and frame under glass or in approved laminated plastic.
- .4 Post instructions where directed.
- .5 For operating instructions exposed to weather, provide weather-resistant materials or weatherproof enclosures.
- .6 Ensure operating instructions will not fade when exposed to sunlight and are secured to prevent easy removal or peeling.

Part 2 Products

2.1 SUSTAINABLE REQUIREMENTS

- .1 Materials and products in accordance with Section 01 47 15 - Sustainable Requirements: Construction.
- .2 Do verification requirements in accordance with Section 01 47 17 - Sustainable Requirements: Contractor's Verification.

2.2 MATERIALS AND EQUIPMENT

- .1 Provide material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified material and equipment are not available, obtain special approval from authority having jurisdiction before delivery to site and submit such approval as described in PART 1 - SUBMITTALS.
- .3 Factory assemble control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

- .1 Verify installation and co-ordination responsibilities related to motors, equipment and controls, as indicated.

2.4 WARNING SIGNS

- .1 Baked enamel signs, minimum size 175 x 250 mm.

2.5 WIRING TERMINATIONS

- .1 Ensure lugs, terminals, screws used for termination of wiring are suitable for either copper or aluminum conductors.

2.6 EQUIPMENT IDENTIFICATION

- .1 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 Wording on nameplates to be approved by Departmental Representative prior to manufacture.
- .3 Allow for minimum of twenty-five (25) letters per nameplate.
- .4 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.
- .5 Disconnects, starters and contactors: indicate equipment being controlled and voltage.
- .6 Terminal cabinets and pull boxes: indicate system and voltage.
- .7 Transformers: indicate capacity, primary and secondary voltages.

2.7 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, numbered and coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour coding: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

2.8 CONDUIT IDENTIFICATION

- .1 Colour code conduits, boxes and metallic sheathed cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.
- .3 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

Conduit Prime Auxiliary

0 to 250 V Yellow

251 to 600 V Yellow Green

Telephone Green

Other Communication Systems Green Blue

Fire Alarm Red

Emergency Voice Red Blue

Other Security Systems Red Yellow

2.9 CABLING AND WIRING IDENTIFICATION

- .1 Identify all feeders with coloured tags having 4 slotted tie holes and secured with 2 plastic tag ties as follows:
 - .1 Minimum of 1 tag for each feeder in each manhole, pull box, or building.
 - .2 Minimum of one tag on each side of every connector, splice assembly, or junction box.
 - .3 Size 150 mm x 50 mm.
 - .4 Material: 3-ply lamicoid, minimum 5 mm thick.
- .2 Identify all other cables with plastic tie-tags. Markings to be indelible and shall identify cable end destinations and service description.

- .3 Identify the phasing by colour coding and phase designation letter ("A," "B," "C") at each and every set of 600 V and 240 V conductors at each termination (both Line and Load ends) and at both sides of each intermediate connector and splice point, with adhesive cable markers. Maintain phase sequence and colour coding throughout.
- .4 Identify concrete duct banks, service ducts and conduits for communication and power and other spare raceways where they enter or leave buildings, with engraved stainless steel marker plates indicating the type of raceway and buried depth. Install marker plates on the exterior wall immediately above point of entry. Obtain prior approval of the Departmental Representative for method of attachment to the building surface.
- .5 Colour code: to CSA C22.1.
- .6 Paint all exposed steel conduits and steel pull boxes carrying HV cables inside buildings with 100 mm wide yellow and 50 mm wide purple bands and stencil "DANGER 12.5 kV" (or 25 kV) in red characters.

2.10 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 Y1-1.
 - .2 Paint indoor switchgear and distribution enclosures light gray to EEMAC 2Y-1.

Part 3 EXECUTION

3.1 INSTALLATION

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CSA C22.3 No.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

- .1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

- .1 Install conduit and sleeves prior to pouring of concrete.
 - .1 Sleeves through concrete: plastic, sized for free passage of conduit, and protruding 50 mm.
- .2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.

3.4 LOCATION OF OUTLETS

- .1 Locate outlets in accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings.
- .2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.
- .3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3000 mm, and information is given before installation.
- .4 Locate light switches on latch side of doors.

3.5 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
 - .1 Local switches: In accordance with CSA B651-12 Accessible design for built environment.
 - .2 Wall receptacles: In accordance with CSA B651-12 Accessible design for built environment.
 - .3 Panelboards: as required by Code or as indicated.
 - .4 Telephone and interphone outlets: In accordance with CSA B651-12 Accessible design for built environment.
 - .5 Wall mounted telephone and interphone outlets: In accordance with CSA B651-12 Accessible design for built environment.
 - .6 Fire alarm stations: In accordance with CSA B651-12 Accessible design for built environment.
 - .7 Fire alarm bells: 2100 mm.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

- .1 Ensure circuit protective devices such as overcurrent trips, relays and fuses are installed and tested/verified to required values and settings.

3.7 FIELD QUALITY CONTROL

- .1 Load Balance:
 - .1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

- .2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.
- .3 Provide upon completion of work, load balance report as directed in PART 1 - SUBMITTALS: phase and neutral currents on panelboards, dry-core transformers and motor control centres, operating under normal load, as well as hour and date on which each load was measured, and voltage at time of test.
- .2 Conduct following tests in accordance with Section 01 45 00 - Quality Control.
 - .1 Power distribution system including phasing, voltage, grounding and load balancing.
 - .2 Circuits originating from branch distribution panels.
 - .3 Lighting and its control.
 - .4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.
 - .5 Systems: fire alarm system 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 Megger 600-2.4 kV circuits, feeders and equipment with a 5000 V instrument.
 - .4 High voltage cable 2.4kV and higher megger and VLF Hipot to cable manufacturer's recommended testing procedures.
 - .5 Check resistance to ground before energizing.
- .3 Carry out tests in presence of Departmental Representative.
- .4 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .5 Manufacturer's Field Services:
 - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product and submit Manufacturer's Field Reports as described in PART 1 - SUBMITTALS.
 - .2 Provide manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
 - .3 Schedule site visits, to review Work, as directed in PART 1 - QUALITY ASSURANCE.
- .6 Provide fault study, arc flash study, and protection & coordination study for both the 12.5 kV and 25 kV operating voltages. Studies shall include all high and low voltage equipment. Studies to be signed and sealed by Professional Engineer registered in British Columbia. Decals are to be installed by this contractor after approval of arc flash study.

3.8 CLEANING

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the materials and installation for wire and box connectors, rated to 1000V.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-C22.2No.18 latest edition, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware.
 - .2 CSA C22.2No.65 latest edition, Wire Connectors.
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
 - .1 EEMAC 1Y-2, latest edition, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 National Electrical Manufacturers Association (NEMA)

Part 2 Products

2.1 MATERIALS

- .1 Pressure type wire connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CSA C22.2No.65, with current carrying parts of copper alloy sized to fit copper conductors 10 AWG or less.
- .3 Clamps or connectors for armoured cable, flexible conduit, as required to: CAN/CSA-C22.2No.18.

Part 3 Execution

3.1 INSTALLATION

- .1 Remove insulation carefully from ends of conductors and:
 - .1 Apply coat of zinc joint compound on aluminum conductors prior to installation of connectors.
 - .2 Install mechanical pressure type connectors and tighten screws. Installation shall meet secureness tests in accordance with CSA C22.2 No.65.
 - .3 Install fixture type connectors and tighten. Replace insulating cap.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies copper conductors rated 0-1000 Volts and the most common electrical insulation and covering materials.
- .2 This section does not include fire rated building wire to ULC S139 and CSA C83, marine, hazardous, mining, instrumentation, communication and fire alarm wiring.

1.2 REFERENCES

- .1 CSA C22.2 No .0.3 latest edition, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 131 latest edition, Type TECK 90 Cable.

1.3 GENERAL REQUIREMENTS

- .1 Typically use insulated 98% conductivity copper conductor wiring enclosed in EMT (steel) conduit for the general wiring systems unless otherwise indicated.
- .2 Teck cable may only be used where specifically indicated on the drawings or in the specifications. Where permitted, Teck wiring up to 750 system volts to be PVC jacketed armoured cable, multi-copper conductor type Teck90 1000 volt having a PVC jacket with FT-4 flame spread rating.
- .3 Flexible AC90 armoured cabling (BX) shall not be used for the general wiring system other than final drops to recessed light fixtures in concealed locations.
- .4 Provide all control wiring except HVAC controls as specified in Mechanical Divisions.
- .5 Refer to Equipment Schedule(s) for detailed responsibilities.

Part 2 Products

2.1 WIRE AND CABLE GENERAL

- .1 Conductors: stranded for 10 AWG and larger. Minimum size #12 AWG.
- .2 Insulation to be 600 volt RW90XLPE (X link) for the general building wiring in conduit.
- .3 Use RW90XLPE for underground installations.
- .4 Site services sub-circuits, including site lighting, to be minimum #10 AWG for power and #12 for controls. Increase wiring size for lengthy and/or loaded circuits so that system will not exceed the maximum voltage drop as recommended by the Canadian Electrical Code CSA 22.1, latest edition.
- .5 Main feeders to be conduit and copper insulated wiring unless otherwise noted on drawings. Provide ground wiring for all conduits in or below slabs. Increase conduit size as required.

- .6 Armoured AC90 (BX) cable may only be utilized for recessed tee bar luminaire drops from ceiling mounted outlet boxes. Use anti-short connectors. Cable from luminaire to luminaire is discouraged. Allow nominally 900mm extra cable looped and supported in the ceiling space to permit fixture relocations of one tile space.
- .7 TBS90 #14 AWG stranded shall be used in all switchgear assemblies. Current transformer secondary wiring shall be #12 AWG stranded. Current transformer leads shall incorporate ring type tongues for termination purposes.
- .8 Conductors to be colour-coded. Conductors No.10 gauge and smaller shall have colour impregnated into insulation at time of manufacture. Conductors size No.8 gauge and larger may be colour-coded with adhesive colour coding tape, but only black insulated conductors shall be employed in this case, except for neutrals which shall be white wherever possible. Where colour-coding tape is utilized, it shall be applied for a minimum of 50 mm at terminations, junctions and pullboxes and conduit fittings. Conductors not to be painted.

2.2 TECK CABLE

- .1 Cable: to CAN/CSA-C22.2 No. 131 latest edition.
- .2 Conductors:
 - .1 Grounding conductor: copper.
 - .2 Circuit conductors: copper, size as indicated.
- .3 Insulation:
 - .1 Type: ethylene propylene rubber.
 - .2 Chemically cross-linked thermosetting polyethylene rated type RW90, 600 V.
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: thermoplastic polyvinyl chloride material.
- .7 Fastenings:
 - .1 One hole steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
 - .2 Channel type supports for two or more cables at 1000 mm centers.
 - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Connectors:
 - .1 Watertight approved for TECK cable.

2.3 ARMoured CABLES

- .1 Conductors: insulated, copper, size as indicated.
- .2 Type: AC90.
- .3 Armour: interlocking type fabricated from aluminum strip.

2.4 ARMoured FIRE ALARM CABLE

- .1 Use flexible armoured fire alarm cable from junction box to ceiling mounted fire alarm device.
- .2 Type: armoured FAS cable, fire rated to CSA FT4 requirements.
- .3 Armour: interlocked aluminum tape armour. Cable armour shall be colour coded "red".

2.5 CONTROL CABLES

- .1 Type LVT: 2 soft annealed copper conductors, sized as indicated, with thermoplastic insulation, outer covering of thermoplastic jacket.
- .2 Low energy 300 V control cable: solid annealed copper conductors sized as indicated, with TWH over each conductor and overall covering of PVC jacket.
- .3 600 V type: stranded copper conductors, sizes as indicated with R90 (x-link) ethylene-propylene rubber insulation type over each conductor and overall covering of PVC jacket.

Part 3 EXECUTION

3.1 INSTALLATION OF BUILDING WIRES

- .1 Install wiring as follows:
 - .1 In conduit systems in accordance with Section 26 05 34.
 - .2 In cable trays for electrical systems in accordance with Section 26 05 36.
 - .3 In underground ducts in accordance with Section 26 05 34.
 - .4 In wireways and auxiliary gutters in accordance with Section 26 05 37.
 - .5 All wires are to be pulled in together in a common raceway, using liberal amounts of lubricant.
 - .6 No combining of circuits onto common neutral will be permitted. Use 2 pole or 3 pole breakers for combined circuits, no connector clips will be allowed.
 - .7 Ensure that all single phase loadings are reasonably closely balanced over the main feeders.

3.2 INSTALLATION OF TECK CABLE 0 -1000 V

- .1 Install cables.
 - .1 Group cables wherever possible on channels or in cable trays.
- .2 Lay cable in cable trays for electrical systems in accordance with Section 26 05 36.
- .3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

3.3 INSTALLATION OF ARMOURED CABLES

- .1 Group cables wherever possible.
- .2 Lay cable in cable trays for electrical systems in accordance with Section 26 05 36.
- .3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - 0 - 1000 V.

3.4 INSTALLATION OF CONTROL CABLES

- .1 Control cable and conduit will be supplied and installed by Mechanical Contractor. Controls wiring must be installed in conformance with Electrical Specifications. Install control cables in conduit.
- .2 Ground control cable shield.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 Motorola R56, 2005 - STANDARDS AND GUIDELINES FOR COMMUNICATION SITES

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 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 grounding equipment from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 EQUIPMENT

- .1 Grounding conductors: bare stranded copper, soft annealed, size as indicated.
- .2 Insulated grounding conductors: green, copper conductors, size as indicated.
- .3 Ground bus: copper, size as indicated, complete with insulated supports, fastenings, connectors.

- .4 Non-corroding accessories necessary for grounding system, type, size, material as indicated, including but not necessarily limited to:
 - .1 Grounding and bonding bushings.
 - .2 Protective type clamps.
 - .3 Bolted type conductor connectors.
 - .4 Bonding jumpers, straps.
 - .5 Pressure wire connectors.
- .5 Grounding Plates
 - .1 Ground plates shall be ULC or CSA listed.
 - .2 Ground plates shall be constructed of copper or copper-clad steel.
 - .3 Ground plates shall expose not less than 0.37 m² of surface to exterior soil
 - .4 Ground plates shall have a minimum thickness of 1.5 mm
 - .5 Ground plates shall be free of paint or other nonconductive coatings
 - .6 Ground plates shall be buried not less than 762 mm below the surface of the earth.
 - .1 If soil conditions do not allow the ground plate to be buried at this depth the ground plate is to be encased in 152mm of conductive concrete, surrounding the ground plate from all sides.
 - .7 Ground plates shall be installed below frost depth.
 - .8 Ground plates shall be installed vertically to allow for minimum excavation and better contact with the soil when backfilling. If this is not possible due to bedrock depth, plates may be installed horizontally and with the same constraints as the shallow burial requirements listed above.
 - .9 Ground wires shall be connected to the ground plate via exothermic weld connection.

Part 3 Execution

3.1 EXAMINATION

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

3.2 INSTALLATION GENERAL

- .1 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run ground wire in conduit.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Make buried connections, and connections to conductive water main, electrodes, using copper welding by thermite process or permanent mechanical connectors or inspectable wrought copper compression connectors to ANSI/IEEE 837.
- .5 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .6 Soldered joints not permitted.
- .7 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .8 Connect building structural steel and metal siding to ground by welding copper to steel.
- .9 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.
- .10 Include costs for a ground impedance test to confirm final system meets Motorola and Coast Guard requirements for system impedance. Include a per unit cost for any additional ground impedance tests.
- .11 Include Per Unit rates for trenching, grounding bonds, ground rods, and labour to be used for Change Order quotation if additional ground work is required to meet impedances.

3.3 SYSTEM AND CIRCUIT GROUNDING

- .1 Install system and circuit grounding connections to neutral.

3.4 EQUIPMENT GROUNDING

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to following list. Service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, cable trays.

3.5 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to site conditions and to approval of Departmental Representative and local authority having jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

3.6 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 in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 This section specifies U shape support channels either surface mounted. Suspended or set in poured concrete walls or ceilings.

1.2 PRODUCTS

- .1 Support Channels
 - .1 U shape, size 41 x 41mm, 2.5mm thick, surface mounted, suspended, or set in poured concrete walls and ceilings.

Part 2 Execution**2.1 INSTALLATION**

- .1 Secure equipment to surfaces with lead anchors or nylon shields as required.
- .2 Secure equipment to poured concrete with expandable inserts.
- .3 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Ensure that T bars are adequately supported to carry weight of equipment specified before installation.
- .5 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .6 Fasten exposed conduit or cables to building construction or support system using straps.
 - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
 - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
 - .3 Beam clamps to secure conduit to exposed steel work.
- .7 Suspended support systems.
 - .1 Support individual cable or conduit runs with 6 mm dia threaded rods and spring clips.
 - .2 Support 2 or more cables or conduits on channels supported by 6 mm dia threaded rod hangers where direct fastening to building construction is impractical.
- .8 For surface mounting of two or more conduits use channels at 1.5m on centre spacing.
- .9 Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.

- .10 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .11 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .12 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of Departmental Representative.
- .13 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.

END OF SECTION

Part 1 GENERAL

1.1 RELATED SECTIONS

- .1 Section 26 05 00 Common Work Results – Electrical

1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 Provide certified professionally sealed shop and placement drawings for all electrical equipment and equipment assemblies including runs of cable trays and conduit/cable racks showing the methods of attachment to the particular structure for each piece of equipment and assembly ***and provide anchorage/attachment details approved and sealed by a BC Professional Engineer for review by the Departmental Representative.***
- .2 If requested by the Departmental Representative, calculations ***sealed by a Professional Engineer registered in BC*** shall be provided for the seismic restraint design shown on the shop drawings. Shop drawings shall show the equipment type, manufacturer's name, model number, and weight of the equipment to be restrained

1.3 SUBMITTALS

- .1 Submit samples of materials required to complete the seismic restraint work for review if and when requested.

Part 2 Products

2.1 MATERIALS

- .1 Earthquake snubbers for resiliently mounted major equipment.
- .2 Expansion-deflection fittings for metal conduits crossing building expansion or seismic joints.
- .3 Security bridles: Minimum #16 ASWG stranded stainless steel aircraft cable.
- .4 All equipment shall be tested in an independent testing laboratory or shall be certified by a ***Registered Professional Engineer*** to demonstrate that the equipment meets the requirements of all Codes and Bylaws in terms of "withstanding" the lateral forces in any direction to be expected in the project seismic zone. ***Withstanding*** shall generally mean remaining in one piece and not breaking away from moorings.

Part 3 EXECUTION

3.1 INSTALLATION

- .1 Provide seismic restraint and anchorage for all equipment and services in accordance with the BC Building Code and all applicable Building Bylaws.

- .2 Arrange and pay for the **Professional Engineer** who designed all anchorage/attachments to inspect same on site (note that multiple inspections will be required as the work progresses) and to provide typewritten Inspection Reports to the Departmental Representative throughout construction and to provide as required by the authorities having jurisdiction all required **Letters of Assurance and Conformance** with the specified Codes, Standards and Bylaws.
- .3 Free-standing equipment shall be fastened to the basic structure using anchorage/attachments to overcome seismic overturning forces as designed by a Professional Engineer as noted in this Section.
- .4 Resiliently-mounted major equipment such as standby generators and the core and coil of large power and distribution transformers shall be restrained by earthquake snubbers, selected for the weight of each piece of equipment to be protected. Securely bolt snubbers through floor or concrete base/housekeeping pad to basic structure and to the frame of equipment using anchorage/attachments, all as designed by a Professional Engineer as noted in this Section.
- .5 All transformer core and coils shall be seismically restrained without short circuiting the sound isolation resilient mounting. All transformer enclosures shall be separately restrained against seismic forces.
- .6 Provide seismic restraint for all cables, raceways, cable trays and bus ducts exceeding 50mm in any cross-sectional dimension and which are supported more than 300mm vertically from the basic structure.
- .7 Provide slack cable restraint systems as designed by a Professional Engineer as described previously, but generally as follows
 - .1 Connect slack cable restraints to suspended equipment in such a way that the axial projection of the wires passes through the centre of gravity of the equipment.
 - .2 Orient restraint wires on suspended equipment at approximately 90° to each other (in plan), and tie back to the structure at an angle not exceeding 45° to the horizontal.
 - .3 Select each anchor in the structure for a load equal to twice the weight of the equipment with a safety factor of 4.
 - .4 Install cable using appropriate grommets, shackles, thimbles, U-bolts, and other hardware to ensure alignment of the restraints and to avoid bending the cables at connection points.
 - .5 Restraints shall be installed at least 50mm clear of all other equipment and services.
 - .6 Adjust restraint cables such that they are not visibly slack, but such that the flexibility is approximately 35mm under thumb pressure for a 1500mm cable length (equivalent ratio for other cable lengths).
- .8 Provide transverse and axial restraints within 4m of a vertical bend.
- .9 Trapeze hangers for cables, cable trays, raceways and bus ducts shall be restrained utilizing minimum 10mm diameter slack cable restraints which shall be provided at a maximum transverse spacing of 12.5m and longitudinal restraints at 25m maximum spacing, or as otherwise limited by anchor/slack cable performance. Adjacent spacing of restraints on a run shall vary by 10% to 30% to avoid coincident resonances.
- .10 Transverse bracing for one raceway section may also act as longitudinal bracing for the raceway connected perpendicular to it, provided the bracing is installed within 610mm of the elbow or junction box. Branch runs shall not be used to restrain main runs.

- .11 Install a 300mm length of flexible conduit and a braided bonding jumper in each surface-mounted conduit where it crosses a building expansion or seismic joint.
- .12 Install expansion-deflection fittings in each conduit embedded in concrete where it crosses a building expansion or seismic joint. The fitting shall include an integral bonding strap where the conduit is metallic.
- .13 Provide custom fabricated flexible sections allowing horizontal and vertical movement of cable trays at building expansion or seismic joint.
- .14 Rigid support systems shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. (Examples: wall and a roof; solid concrete wall and a metal deck with lightweight concrete fill.) Provide loops in cables and flexible connections in raceways where such services leave a suspended trapeze rack or other support and extend down to floor braced equipment or wall-mounted equipment. Freedom of movement shall be up to 300mm in all directions.
- .15 All recessed lighting fixtures in mechanical grid ceilings (e.g. T-bar) shall be restrained using at least two (2) security bridles per fixture tied to the basic building structure. Attach security bridles at ends of each fixture using a further attachment to each corner of the fixture and in such a manner that the fixture cannot fall lower than 300mm beneath ceiling.
- .16 Surface-mounted lighting fixtures mounted on mechanical grid ceilings shall be attached to the ceiling system with positive clamping devices that completely surround the supporting members. Security bridles shall be attached between the clamping devices and the adjacent ceiling hanger or to the structure above in the same manner as described for recessed fixture supports.
- .17 Pendant-hung lighting fixtures supported from their outlet boxes shall be provided with a security bridle from the outlet box to an adjacent ceiling hanger or to the structure above in the same manner as described for recessed fixture supports.
- .18 Electrical outlet boxes flush-mounted in mechanical grid ceilings shall be anchored to the ceiling grid.

END OF SECTION

Part 1 General**1.1 SECTION INCLUDES**

- .1 This section specifies materials and installation for splitters, junction boxes, pull boxes and cabinets.

1.2 PRODUCT DATA

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings for custom manufactured items showing materials, finish, dimensions, accessories, layout, and installation details.

Part 2 Products**2.1 SPLITTERS**

- .1 Sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position.
- .2 Main and branch lugs to match required size and number of incoming and outgoing conductors as indicated.
- .3 At least three spare terminals on each set of lugs in splitters less than 400 A.

2.2 JUNCTION AND PULL BOXES

- .1 Welded steel construction with screw-on flat covers for surface mounting.
- .2 Covers with 25 mm minimum extension all around, for flush-mounted pull and junction boxes.

2.3 CABINETS

- .1 Sheet steel cabinet, with full length hinged door, latch, lock, 2 keys, containing 19 mm G1S fir plywood backboard (if required) for surface or flush mounting as required.
- .2 Include filtered vents and/or fan-cooling when enclosed equipment is heat producing.

Part 3 Execution**3.1 SPLITTER INSTALLATION**

- .1 Install splitters and mount plumb, true and square to the building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

3.2 JUNCTION, PULL BOXES AND CABINETS INSTALLATION

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor.
- .3 Install terminal blocks as required.
- .4 Only main junction and pull boxes are indicated. Install pull boxes so as not to exceed 30 m of conduit run between pull boxes.

3.3 IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.
- .2 Install size 2 identification labels indicating system name, voltage and phase, as appropriate to clearly indicate the enclosure use.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies rigid and flexible fasteners, fittings and installation.

1.2 PRODUCTS

1.3 OUTLET AND CONDUIT BOXES – GENERAL

- .1 Size boxes in accordance with CSA C22.1.
- .2 102 mm square or larger outlet boxes as required for special devices.
- .3 Gang boxes where wiring devices are grouped. Do not use sectional boxes.
- .4 Blank cover plates for boxes without wiring devices.
- .5 Combination boxes with barriers where outlets for more than one system are grouped.

1.4 SHEET STEEL OUTLET BOXES

- .1 Electro-galvanized steel single and multi gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. Larger 102 mm square x 54mm deep outlet boxes (No. 52151 or 52171) to be used when more than one conduit enters one side. Provide extension and plaster rings as required.
- .2 For larger boxes use GSB solid type as required.
- .3 Boxes for surface mounted switches, receptacles, communications, telephone to be 100mm square No. 52151 or 52171 with Taylor 8300 series covers.
- .4 Lighting fixture outlets: 102 mm square outlet boxes (No 52151, 52171 or 72171) or octagonal outlet boxes (No 54151 or 54171).
- .5 102 mm square outlet boxes with extension and plaster rings for flush mounting devices in finished plaster and/or tile walls.

1.5 MASONRY BOXES

- .1 Electro-galvanized steel masonry single and multi gang type MDB boxes for devices flush mounted in exposed block walls.

1.6 CONCRETE BOXES

- .1 Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

1.7 SURFACE CONDUIT BOXES

- .1 Cast FS or FD aluminum boxes with factory-threaded hubs and mounting feet for surface wiring of switches and receptacles.

1.8 FITTINGS – GENERAL

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of foreign materials.
- .3 Conduit outlet bodies for conduit up to 35 mm. Use pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

Part 2 EXECUTION

2.1 INSTALLATION

- .1 Typical outlet box mounting heights are indicated in Section 26 05 00 or refer to wiring device and communication specification sections and to architectural layouts for particular mounting heights of outlet boxes where indicated.
- .2 Support boxes independently of connecting conduits.
- .3 Ceiling outlet boxes to be provided for each surface mounted fixture or row of fixtures installed in other than T bar ceilings with removable tiles.
- .4 Fill open boxes with paper, sponges, foam or similar approved material to prevent entry of construction material. Remove upon completion of work.
- .5 For flush installations mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .6 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not to be used.
- .7 All outlet boxes to be flush mounted in all areas, excluding mechanical rooms, electrical rooms, and above removable ceilings.
- .8 Adjust position of outlets in finished masonry walls to suit masonry course lines. Coordinate cutting of masonry walls to achieve neat openings for all boxes. All cutting of masonry work for installation of electrical fittings to be done using rotary cutting equipment.
- .9 No sectional or handy boxes to be installed.
- .10 Provide vapour barrier wrap or boots behind outlets mounted in exterior walls. Maintain integrity of the vapour barrier and insulation to prevent condensation through boxes.
- .11 Coordinate location and mounting heights of outlets above counters, benches, splash-backs and with respect to heating units and plumbing fixtures. Coordinate with architectural details.

- .12 Outlets installed back to back in party stud walls to be off-set by one stud space.
- .13 Back-boxes for all communications systems equipment to be provided in accordance with specific manufacturer's recommendations and as specified in the communications sections of these specifications.
- .14 Separate outlets located immediately alongside one another to be mounted at exactly the same height above finished floor. Similarly, outlets mounted on a wall in the same general location at varying heights to be on the same vertical centre-line unless otherwise noted.
- .15 Where outlet boxes penetrate through a fire separation, ensure that the boxes are externally tightly fitted with an approved non-combustible material to prevent passage of smoke or flame in the event of a fire.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies rigid and flexible conduits, fasteners, fittings and installation.

1.2 REFERENCES

- .1 Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware: to CSA C22.2 No. 18.
- .2 Rigid metal conduit (RMC): to CSA C22.2 No. 45.
- .3 Electrical metallic tubing (EMT): to CSA C22.2 No. 83.
- .4 Rigid PVC conduit: to CSA C22.2 No. 211.2.
- .5 Flexible metal conduit (FMC): to CSA C22.2 No. 56.
- .6 Flexible PVC conduit: to CAN/CSA-C22.2 No. 227.3.

1.3 BASIC WIRING METHODS

- .1 Underground or in concrete exterior to building:
 - .1 All wiring shall be in Schedule 40 RPVC conduit.
- .2 Concrete walls and slabs interior to building:
 - .1 All wiring shall be in Schedule 40 RPVC conduit.
- .3 Partition walls and ceilings:
 - .1 All wiring to be run in EMT conduit for:
 - .1 Branch circuits.
 - .2 Fire alarm.
 - .3 Low voltage systems.
 - .4 Distribution feeders and sub-feeders.
 - .5 Surface wiring in electrical and mechanical rooms.
- .4 T-bar ceilings:
 - .1 EMT to junction box with flexible armoured cable drops for individual luminaires. No feed through wiring to luminaires allowed, except for where luminaires butted together. Allow adequate cable to relocate luminaire one T-bar space in any direction.

- .5 Motors, transformers and all vibrating equipment:
 - .1 Short (600mm to 1200mm) PVC jacketed flexible conduit with liquid tight connectors shall be used. Allow sufficient slack to avoid strain on connectors at extreme extension of equipment movement.
- .6 Surface raceways - interior:
 - .1 All surface raceways shall be EMT, except if located without protection in areas susceptible to damage, which shall be rigid steel conduit.
- .7 Surface raceways - exterior:
 - .1 All surface raceways shall be UV compensated Schedule 40 RPVC conduit, protected from damage and excessive heating to the Departmental Representative's satisfaction.

1.4 LOCATION

- .1 Electrical drawings are diagrammatic and do not show all conduits, wire, cable, etc. Electrical contractor to provide conduit, wire cable, etc., for a complete operating job to meet in all respects the intent of the drawings and specifications.
- .2 Outlet positions shown on architectural drawings (plans and elevations) to take precedence over locations and mounting heights indicated on electrical plans or in specifications.
- .3 Locate electrical devices on walls with regard given for convenience of operation and conservation of wall space. Switches, receptacles, fire alarm pull stations, etc. generally to be vertically lined up where items are in the same general location. Adjacent common devices to be installed in common outlet box.
- .4 Review the exact location criteria of each electrical outlet and device with the Departmental Representative prior to rough-in. Relocate any item installed without architectural confirmation as required by the Departmental Representative at no cost as long as the relocation is within 3m of the location originally shown on the electrical drawings.
- .5 Locate light switches on latch side of doors. Locate disconnect devices in mechanical rooms on latch side of door.
- .6 All outlets located on exterior walls to be complete with moulded plastic vapour barriers to maintain integrity of wall vapour barrier system.
- .7 All raceways and wiring shall be installed concealed in building fabric, except for mechanical and electrical rooms where they shall be installed on the surface.
- .8 All outlet boxes, junction boxes, and cabinets to hold electrical devices shall be mounted so the equipment can be flush mounted unless indicated otherwise.
- .9 All junction boxes and other raceway access devices shall be mounted to avoid being visible from public areas. Obtain approval from Departmental Representative for any and all junction boxes that, due to the building design, cannot be concealed.

- .10 All junction boxes mounted, out of necessity, on surface of solid walls shall be painted to match adjacent surface, with junction boxes painted to match designated systems.

Part 2 Products

2.1 RIGID PVC RACEWAY SYSTEM

- .1 Rigid PVC fittings shall be of the same manufacturer as the conduit.
- .2 All fittings with removable covers shall be complete with VC gaskets and brass securing screws and inserts. All metal components shall be brass or stainless steel.

2.2 RIGID METAL CONDUIT RACEWAY SYSTEM

- .1 Rigid threaded metal conduits shall be installed as noted in drawings.
- .2 All couplings and connection to enclosures shall use threaded fastening or locknuts; use of set screw type connections will not be accepted.
- .3 Galvanized coating with easy pull internal treatment.
- .4 All threads shall be tapered; Running threads will not be accepted.
- .5 Factory formed threads shall be used where possible. When field threading is required, provide application of cold galvanizing paint or coating,

2.3 EMT RACEWAY

- .1 Electrical Metallic Tubing (EMT) shall be galvanized steel of sufficient quality and thickness to allow smooth field formed bends.
- .2 EMT couplings, connectors and fittings shall be steel. Cast type units shall not be used on this installation.

2.4 PVC JACKETED FLEXIBLE CONDUIT

- .1 PVC jacketed flexible conduit (liquid tight) shall be interlocking spiral aluminum conduit with continuous extruded PVC jacket.
- .2 Conduit fittings shall be steel liquid tight type that fit over PVC jacket and seal uniformly all round.

2.5 FLEXIBLE ELECTRIC NON-METALLIC (ENT) TUBING

- .1 Flexible electrical non-metallic tubing (ENT) **shall not** be used on this project.

2.6 OUTLET BOXES AND JUNCTION BOXES

- .1 Except as noted for rigid PVC raceways, all outlet boxes and junction boxes shall be one piece formed or welded.
- .2 Outlet boxes to be galvanized steel.

- .3 Junction boxes to be galvanized steel or aluminum.

2.7 CONDUIT FASTENINGS

- .1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1500mm oc.
- .4 Threaded rods, 6 mm dia., to support suspended channels.

2.8 CONDUIT FITTINGS

- .1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.
- .2 Factory "ells" where 90° bends are required for 25 mm and larger conduits.
- .3 Watertight connectors and couplings for EMT. Set-screws are not acceptable.

2.9 EXPANSION FITTINGS FOR CONDUIT

- .1 Threaded Concrete Encased Conduit Joints
 - .1 Weatherproof expansion fittings suitable for pass seismic joints in concrete, allowing for the following degrees of movement:
 - .1 Axial expansion or contraction of 19mm
 - .2 Angular misalignment of the axes of the conduits in any direction by 30 degrees.
 - .3 Parallel misalignment of the axes of the conduit in any direction up to 19mm.
 - .2 Inner sleeve maintaining constant conduit inner diameter and a smooth insulated wireway.
 - .3 Watertight flexible neoprene outer jacket that is corrosion resistant and protects the grounding straps and connection points.
 - .4 Copper braided bonded straps.
 - .5 Stainless steel jacket clamps
 - .6 Standard tapered conduit threads for rigid threaded electrical conduits.
 - .7 Rigid threaded conduit hubs are iron alloy.
- .2 RPVC Above Ground Joints
 - .1 Rigid PVC expansion joints allowing for contraction and expansion of conduits where secured to a wall (or similar) and emerging from below grade.

- .2 Solvent weld joints.
- .3 Sleeves in Concrete at PHS - Pumphouse Connection
 - .1 Flexible rubber tubing complete with stainless steel crimped compression band connection providing a water tight seal while enabling 19mm of movement in three dimensions.
 - .2 Assembly shall be embedded in a resilient foam material to allow for movement between concrete assemblies.
 - .3 Tubing shall be black synthetic rubber, Class A oil resistant with spiral-ply synthetic fabric wire helix reinforcement. Inner diameter to match outer diameter of all conduits/pathways noted in drawings to ensure tight, water resistant seal without bunching upon compression/connection.

2.10 FISH CORD

- .1 Polypropylene.

Part 3 Execution

3.1 INSTALLATION

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 Conceal conduits except in mechanical and electrical service rooms and in unfinished areas.
- .3 Use electrical metallic tubing (EMT) except in cast concrete and above 2.4 m not subject to mechanical injury.
- .4 Use rigid PVC conduit underground, in corrosive areas, and surface mounted in wet areas not subject to damage.
- .5 Use flexible metal conduit for connection to motors in dry areas, connection to recessed incandescent fixtures without a prewired outlet box, connection to surface or recessed fluorescent fixtures and work in movable metal partitions.
- .6 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet or corrosive locations.
- .7 Minimum conduit size for lighting and power circuits: 19mm.
- .8 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.
- .9 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .10 Install fish cord in empty conduits.
- .11 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

- .12 Dry conduits out before installing wire.
- .13 Conduits shall be installed mechanically continuous from outlet to outlet and without pockets. All the necessary standard bushings, elbows and bends shall be provided. All conduit bends shall have a radius of not less than six (6) times the internal diameter of the conduit and in no case shall the equivalent of more than four quarter bends from outlet to outlet be made. For all conduit sizes to be used for low voltage raceway, the conduits shall have a minimum bending radius of 230mm.
- .14 Conduit bends shall be made with no more than 10% flattening of the conduit. Bends shall be smooth throughout deformations.
- .15 On surface wall runs, all conduit shall be installed in true vertical or horizontal direction and on ceilings in true 90 degree angles or parallel to the walls. Crossings of conduits shall also be made at 90 degree angles. Parallel running conduit shall be kept on equal spacing on the entire length of run including bends.
- .16 All conduits shall be fastened to structure with steel straps (no cast type straps allowed).
- .17 Where more than three conduits are run parallel in ceiling cavity, they shall be installed on cantruss type channel, complete with all Manufacturer's fittings to secure channel to structure and to conduit.
- .18 Raceways extending out concrete slabs shall be securely protected using rebar stubs or similar material. All duct stubs are to be kept sealed during construction

3.2 SURFACE CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on suspended or surface channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

3.3 CONCEALED CONDUITS

- .1 Run parallel or perpendicular to building lines.
- .2 Do not install horizontal runs in masonry walls.
- .3 Do not install conduits in terrazzo or concrete toppings.

3.4 CONDUITS IN CAST-IN-PLACE CONCRETE

- .1 Locate to suit reinforcing steel. Install in centre one third of slab.
- .2 Protect conduits from damage where they stub out of concrete.
- .3 Install sleeves where conduits pass through slab or wall.
- .4 Provide oversized sleeve for conduits passing through waterproof membrane, before membrane is installed. Use cold mastic between sleeve and conduit.
- .5 Do not place conduits in slabs in which slab thickness is less than 4 times conduit diameter.
- .6 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .7 Organize conduits in slab to minimize cross-overs.
- .8 Do not install conduits in slabs/concrete floors in lab areas.

3.5 CONDUITS IN CAST-IN-PLACE SLABS ON GRADE

- .1 Run conduits 25 mm and larger below slab and encased in 75 mm concrete envelope. Provide 50 mm of sand over concrete envelope below floor slab.
- .2 Do not install conduits in slabs/concrete floors in lab areas.

3.6 CONDUITS UNDERGROUND

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

3.7 FIRE STOPPING

- .1 Apply ULC approved fire stopping assembly to all conduit penetrations passing through fire rated walls and floors.
- .2 Provide shop drawings showing details for each type of application on the project. Shop drawings shall include catalogue data and installation details.

3.8 EXPANSION COUPLINGS

- .1 Provide expansion couplings in concrete ductbanks where noted in drawings. Coordinate with structural details for location of seismic joints and orientation. Conduit shall maintain full diameter throughout joint and shall not be reduced or increased.
- .2 Install RPVC expansion joints where RPVC conduit emerges from ground and is secured to a building, wall or similar immovable object to ensure the RPVC conduits do not shear or break due to settlement.
- .3 Install RPVC expansion joints where RPVC is surface mounted and subject to excessive expansion or contraction as determined by Canadian Electrical Code.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section specifies materials and installation for metal and fiberglass cabletroughs and fittings.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CAN/CSA C22.1 No.126.1, Metal Cable Tray Systems.
- .2 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA FG 1, Fibreglass and Cable Tray Systems.
 - .2 NEMA VE 1, Metal Cable Tray Systems.
 - .3 NEMA VE 2, Cable Tray Installation Guidelines.

1.3 PRODUCT DATA

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .4 Identify types of cable trays used.

Part 2 Products

2.1 CABLE TRAY (COMMUNICATION ROOM)

- .1 A aluminum ladder type cable tray shall be provided above equipment racks as shown on the building floor plan.
- .2 The tray shall be mounted @ 2.7M AFF unless otherwise noted.
- .3 Wall mounted tray brackets shall be bolted through any plywood backboards to the wall.
- .4 Cable tray to have rounded edges where in possible contact with cables.

2.2 CABLE TRAY (ALL OTHER AREAS)

- .1 All ventilated tray to be aluminum, complete with angles, offsets, corners, saddles, tees, etc. as indicated and required to suit the installation. Radii on fittings shall be 300mm minimum.
- .2 Provide solid bottom cable tray with solid bolt on cover where noted in drawings.

- .3 All tray shall have 45 degree corners at all vertical and horizontal corners, tees and width change locations.
- .4 Cable tray to have a minimum cable loading depth of 114mm. Cable tray width to be a minimum of 457mm wide for communications, or as indicated on drawings.
- .5 Suspended tray supports to be trapeze style hangers of minimum 40mm square "Unistrut" supported from 9.5mm threaded rod hangers from preset or afterset concrete inserts or direct steel support.
- .6 Barriers required where different systems are in same cable tray. Barriers to be continuous metal dividers for entire length of the tray.
- .7 Observe cable spacing requirements for power cables to ensure correct deration factors as noted in drawings.

2.3 SUPPORTS

- .1 Provide splices and supports for a continuously grounded system as required.

Part 3 Execution

3.1 GENERAL INSTALLATION – POWER & COMMUNICATIONS

- .1 Provide cable tray in location and general routing as shown on drawings.
- .2 Provide dropouts when cables exiting all horizontal cable trays.
- .3 Support suspended cable tray from trapeze style hangers with hangers spaced as recommended by the manufacturer based on a maximum load capacity for the tray. Support trays at all corners, offsets and tee fittings
- .4 Where shown and appropriate, support cable tray from wall using a cantilever support arrangement. Cable trays may be supported using wall mounted support on masonry walls or from the building steel only.
- .5 Cable tray location and mounting heights to be coordinated on site with other trades to provide minimum headroom and serviceability. Verify drawing details to allow for all services run in ceiling spaces. Provide vertical and horizontal offsets as required to suit job site conditions.
- .6 Cable tray sections shall be joined by approved connector plates and rust-resistant (plated) hardware. Torque all hardware as per manufacturer's recommendations.
- .7 Unless otherwise indicated, bond all cable tray with a minimum #6 AWG copper bonding conductor installed continuously within the full length of all cable trays. Securely connect the bond wire to the tray at each end and at a minimum of 15m intervals. Connect bonding conductor to the building ground system at one or both ends.
- .8 Where cable tray passes through fire separations install fire pillows as required to maintain proper fire rating.

- .9 Cable tray may require installation of risers, bend, etc. to adjust tray up or down as well as sideways for the tray routing to fit within limits of space available, and to clear other services, ducts, pipes etc. along the route. Routing may be adjusted somewhat as necessary to enable installation of services under other trades.
- .10 Where tray runs change elevation, trays shall overlay each other when manufactured waterfall assemblies can not be used. To prevent cables stress install drop-outs on the top tray when overlap method is to be used. Further, tray sections shall be coupled together to provide some rigidity. This coupling maybe made by using a short length of tray and adjustable elbows or may be coupled by means of common support rods at the tray overlap.
- .11 Sharp metal edges in cable trays which could cut the cable shall be smoothed and the cable dressed away from these edges. Manufacturer surface imperfections shall be touched up with a cold galvanizing coating before installing cable.
- .12 There shall be no wiring joints or splices within the cable tray.

3.2 INSTALLATION – COMMUNICATIONS

- .1 Use ventilated cable tray for Voice/Data service cable down drops in the Communication Rooms.
- .2 Cables shall be secured in place in tray with tie wraps where in horizontal runs and with cable clamps in vertical runs. Low tension cabling shall be secured to tray by use of Velcro style straps.
- .3 The “communications” cable tray system is for extra-low voltage cabling only. There shall be no cables within the tray that has a voltage exceeding 36V.
- .4 Power distribution conduits shall not be located within 200mm of the cable tray.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the installation of direct buried cables and cables in ducts including protection, markers and testing.

1.2 REFERENCES

- .1 Canadian Standards Association,
- .2 Insulated Cable Engineers Association, Inc.

Part 2 Products

2.1 CABLE PROTECTION

- .1 38 x 140 mm planks pressure treated with clear, or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative.

2.2 MARKERS

- .1 Concrete type cable markers: 600 x 600 x 100 mm with words: cable, joint or conduit impressed in top surface, with arrows to indicate change in direction of cable and duct runs.
- .2 Cedar post type markers: 89 x 89 mm, 1.5 m long, pressure treated with clear, or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing cable or conduit to indicate depth and direction of duct and cable runs.
 - .1 Nameplate: aluminum anodized 89 x 125 mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words Cable, Joint or Conduit with arrows to indicate change in direction.

Part 3 Execution

3.1 DIRECT BURIAL OF CABLES

- .1 After sand bed is in place, lay cables maintaining 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.
- .3 Make termination and splice only as indicated leaving 0.6 m of surplus cable in each direction.
 - .1 Make splices and terminations in accordance with manufacturer's instructions using approved splicing kits.
- .4 Underground cable splices not acceptable.

- .5 Minimum permitted radius at cable bends for rubber, plastic or lead covered cables, 8 times diameter of cable; for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.
- .6 Cable separation:
 - .1 Maintain 75 mm minimum separation between cables of different circuits.
 - .2 Maintain 300 mm horizontal separation between low and high voltage cables.
 - .3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.
 - .4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.
 - .5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.
 - .6 Install treated planks on lower cables 0.6 m in each direction at crossings.
- .7 After sand protective cover is in place, install continuous row of overlapping 38 x 140 mm pressure treated planks as indicated to cover length of run.

3.2 CABLE INSTALLATION IN DUCTS

- .1 Install cables as indicated in ducts.
 - .1 Do not pull spliced cables inside ducts.
- .2 Install multiple cables in duct simultaneously.
- .3 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .4 To facilitate matching of colour coded multiconductor control cables reel off in same direction during installation.
- .5 Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .6 After installation of cables, seal duct ends with duct sealing compound.

3.3 MARKERS

- .1 Mark cable every 150 m along cable and duct runs and changes in direction.
- .2 Mark underground splices.
- .3 Where markers are removed to permit installation of additional cables, reinstall existing markers.
- .4 Install concrete cable markers within 180 m from each side of runway centreline; 45 m from each side of taxi way centreline; 50 m from edge of taxi ramps or aprons.
- .5 Install cedar post type markers.
- .6 Lay concrete markers flat and centred over cable with top flush with finish grade.

3.4 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Ensure resistance to ground of circuits is not less than 50 megohms.
- .5 Pre-acceptance tests.
 - .1 After installing cable but before splicing and terminating, perform insulation resistance test with 1000 V megger on each phase conductor.
 - .2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.
- .6 Acceptance Tests
 - .1 Ensure that terminations and accessory equipment are disconnected.
 - .2 Ground shields, ground wires, metallic armour and conductors not under test.
 - .3 High Potential (Hipot) Testing.
 - .1 Conduct hipot testing at 90% of original factory test voltage in accordance with manufacturer's recommendations.

- .4 Leakage Current Testing.
 - .1 Raise voltage in steps from zero to maximum values as specified by manufacturer for type of cable being tested.
 - .2 Hold maximum voltage for specified time period by manufacturer.
 - .3 Record leakage current at each step.
- .7 Provide Consultant with list of test results showing location at which each test was made, circuit tested and result of each test.
- .8 Remove and replace entire length of cable if cable fails to meet any of test criteria.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies photoelectric lighting control equipment for exterior use only.

1.2 PRODUCE DATA

- .1 Submit product data in accordance with Section 01 33 00 – Submittal Procedures

Part 2 PRODUCTS

2.1 PHOTOELECTRIC LIGHTING CONTROL

- .1 Wall and luminaire mounting.
- .2 Capable of switching 1000 W of lighting at 120V.
- .3 Voltage variation: plus or minus 10%.
- .4 Temperature range: minus 40°C to plus 40°C.
- .5 Switching on lights at 70 lux.
- .6 Switching off lights at 105 lux.
- .7 Rated for a minimum of 5000 operations.
- .8 Options:
 - .1 Lightning arrester.
 - .2 Fail-safe circuit completed when relay de-energized.
 - .3 Twist-lock type receptacle.
 - .4 Terminal strip.
 - .5 Sensitivity adjustment.
- .9 Switching time delay of 0 to 30 s.
- .10 Wall mounting bracket.
- .11 Colour coded leads: size 10 AWG, 500mm long.

2.2 CONTACTOR

- .1 Cabinet mounting.
- .2 Capable of switching multiple lamp circuits with total lighting load of 6000 W.
- .3 Waterproof enclosure.
- .4 Manual override.

Part 3 EXECUTION

3.1 INSTALLATION

- .1 Install photoelectric controls in accordance with manufacturer's instructions.
- .2 Install on the building exterior as indicated on plans.
- .3 Install contactors and manual override switch in a wall cabinet inside the main electrical room.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section specifies standard and custom panelboards and their installation.

1.2 SCOPE OF WORK

- .1 Provide and install panelboards as indicated on the drawings, single line diagram, panel schedules and these specifications.
- .2 Types of panelboards in this section include the following:
 - .1 Lighting and power panelboards

1.3 PRODUCT INFORMATION

- .1 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Shop drawings to include electrical detail of panel, branch breaker type, quantity, ampacity and enclosure dimension.
- .3 Shop drawings to include matching tub and trim details for factory installed low voltage relay cabinets where specified.

1.4 PLANT ASSEMBLY

- .1 Install circuit breakers in panelboards before shipment from plant.
- .2 In addition to CSA requirements, manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.
- .3 All panelboards to be of a common manufacturer.

1.5 FINISH

- .1 Apply finishes in accordance with Section 26 05 00 – Common Work Results - Electrical.
- .2 Panel finish in electrical and equipment rooms and closets to be standard ASA Grey baked enamel. Confirm with Departmental Representative prior to shop finishing panels.

Part 2 Products

2.1 PANELBOARDS, DOORS AND TRIMS

- .1 Panelboards: to CSA C22.2 No. 29 and product of one manufacturer.

- .2 Bus and breakers unless otherwise indicated on the drawings and in the specifications, shall be rated for:
 - .1 Minimum 10 kA at 208Y/120V.
- .3 Tin plated copper bus with full size neutral.
- .4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number.
- .5 Mains capacity, number of circuits and number and size of branch circuit breakers as indicated.
- .6 Provide all necessary connectors and mounting hardware in every space to facilitate installation of future breakers. Provide blank fillers for all spaces.
- .7 Concealed hinges and concealed trim mounting screws, hinged locking door with flush catch.
- .8 Panelboards to have flush doors.
- .9 Provide two keys for each panelboard and key similar voltage and system panelboards alike.
- .10 Panel tubs to be typically 600mm wide.
- .11 All surface mounted enclosures to be complete with sprinkler drip cover.
- .12 Provide door within door trims where indicated to facilitate ease of service maintenance Each tub trim cover to be hinged and self supporting and to swing out to expose breaker cable terminations and wireways. Hinged trim shall be secured with cover screws on opening side by concealed machine screws. Hinged breaker cover shall be recessed into the hinged overall tub cover. Breaker cover shall have latch type closures. Submit details on shop drawings prior to manufacturing.

2.2 BREAKERS

- .1 All breakers to be:
 - .1 Bolt on type molded case, non-adjustable and non-interchangeable trip, single, two and three pole, 120/208V with trip free position separate from "On" or "Off" positions.
- .2 Two and three pole breakers to have common simultaneous trip and able to be located in any circuit position within the panelboard.
- .3 Main breaker (where required) to be separately mounted at top or bottom of panel to suit cable entry. When mounted vertically, down position should open breaker.
- .4 Provide circuit breakers with indicated trip ratings as shown in the panelboard schedules or the Single Line Diagram.
- .5 Provide spare circuit breakers as indicated on panel schedules or single line diagram as applicable.
- .6 Provide Lock-on devices as indicated and for Fire Alarm circuits, Security Equipment circuits, Exit sign circuits and Emergency Battery Equipment circuits.

2.3 PANELBOARD IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 – Common Work Results - Electrical.
- .2 Nameplate for each panelboard size 5 (2 line) engraved as indicated and include panel designation and voltage/phase.
- .3 Complete updated circuit directory with typewritten card(s) located in slide-in plastic pocket(s) fixed to the back of the related door. Directory card to indicate the panel designation, mains size, voltage/phase and the location and load controlled of each circuit. Include a “letter sized” paper copy of each directory in the project maintenance manual.
- .4 Provide a plasticized typewritten information card fixed to the back of the each panel door. Information card to indicate the panel designation and location, feeder type and size and locations of any controlling contactors and feeder pullboxes. Include a “letter sized” paper copy of each information card in the project maintenance manual.

Part 3 Execution

3.1 INSTALLATION

- .1 Locate panelboards as indicated and mount securely, plumb true and square, to adjoining surfaces.
- .2 Panelboards located in service rooms, mechanical rooms, and electrical rooms to be mounted on unistrut supports.
- .3 Mount panelboards to height given in Section 26 05 00 or as indicated.
- .4 Connect loads to circuits as indicated.
- .5 Connect neutral conductors to common neutral bus with respective neutral identified.
- .6 Provide spare breakers as indicated on panelboard schedules and on single line diagram.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section specifies switches, receptacles, wiring devices, cover plates and their installation.

1.2 PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
 - .2 CSA-C22.2 No.42.1, Cover Plates for Flush Mounted Wiring Devices.
 - .3 CSA-C22.2 No.55, Special Use Switches.
 - .4 CSA-C22.2 No.111, General Use Snap Switches.

Part 2 Products

2.1 COLOUR

- .1 All devices to be Decora style white.

2.2 SWITCHES

- .1 Heavy duty specification grade.
- .2 20 A, 120 V, single pole, double pole, three-way, four-way switches as indicated.
- .3 Manually-operated general purpose ac switches as indicated and with following features:
 - .1 Terminal holes approved for No.10 AWG wire.
 - .2 Silver alloy contacts.
 - .3 Urea or melamine molding for parts subject to carbon tracking.
 - .4 Suitable for back and side wiring.
 - .5 White toggle (red toggle for emergency power circuits).
- .4 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rating capacity of motor loads.
- .5 Switches of one manufacturer throughout project.

2.3 RECEPTACLES – GENERAL

- .1 Heavy duty specification grade.
- .2 Duplex receptacles, CSA type L5-15 R, 125 V, 15 A, U ground, with following features:
 - .1 White nylon molded housing (red for emergency power circuits)
 - .2 Suitable for No.10 AWG for back and side wiring.
 - .3 Break-off links for use as split receptacles.
 - .4 Eight back wired entrances, four side wiring screws.
 - .5 Triple wipe contacts and non riveted grounding contacts.
- .3 Receptacles of one manufacturer throughout project.

2.4 RECEPTACLES – PARTICULAR APPLICATION

- .1 Surge Suppression TVSS 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, blue face, parallel blade, U ground, impact resistant nylon face audible and LED alarm.
- .2 Ground Fault Interrupter type to be 15 Amp, 125 volt duplex receptacles to be 2 pole, 3 wire hospital grade, white face, parallel blade, U ground, impact resistant nylon face, complete with breaker and reset button.
- .3 20 Amp Receptacles (Housekeeping) Duplex receptacles – T-slot type CSA type L5-20R 125V. 20 Amp u ground with features matching 15 Amp rated Receptacles.
- .4 All other single outlet and special purpose receptacles to be similar to the grade and series indicated above. Confirm ampacity, voltage and pin configuration prior to installation.

2.5 COVER PLATES

- .1 Stainless steel: Type 302 or 304, No. 4 finish, 1mm thick, accurately die cut, protective cover for shipping. Outlets in labs or as indicated in the drawings or specifications.
- .2 Steel: sheet steel hot dip galvanized with rolled edges for surface mounted utility boxes.
- .3 Wall plates to be flush mounting with "positive bow" feature to ensure that all edges of plate are flush with wall or surface box when installed.
- .4 All plates to be beveled type with smooth rolled outer edge and smooth face. Exposed sharp edges are not acceptable.
- .5 Cast metal: die cast profile, ribbed for strength, flash removed, primed with grey enamel finish and complete with four mounting screws to box for special purpose wiring devices.
- .6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for wiring devices as indicated. Double doors for standard duplex receptacles. Cover plates to fasten to box by four screws.

- .7 Gaskets: resilient rubber or close cell foam urethane.
- .8 Cover plates for all wiring devices to be from one manufacturer throughout project.

Part 3 Execution

3.1 INSTALLATION GENERAL

- .1 Mount wiring devices to height specified in Section 26 05 00 or as indicated.
- .2 Upper edge of plates located on separate outlets immediately alongside one another to be at exactly the same height above finished floor.
- .3 All plates to be installed parallel or perpendicular to building lines.

3.2 INSTALLATION PARTICULAR

- .1 Switches:
 - .1 Install single throw switches with handle in "UP" position when switch closed.
 - .2 Install switches in gang type outlet box when more than one switch is required in one location.
- .2 Receptacles:
 - .1 Install all receptacles in the vertical plane unless otherwise noted.
 - .2 Generally install the L5-15/20R U ground pin down unless otherwise noted. Neutral up when receptacle in mounted horizontal.
 - .3 Install receptacles vertically in gang type outlet box when more than one receptacle is required in one location.
 - .4 Surge suppression duplex receptacles to be provided for all communication and computer terminal equipment backboards and cabinets including fire alarm, telephone, public address, door security, nurse call, central dictation, RF television, security television, etc. Provide dedicated neutral conductors for each surge suppression receptacle.
 - .5 Ground fault interrupter duplex receptacles to be used, adjacent sinks or water sources.
- .3 Cover plates:
 - .1 Protect 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 meant for flush outlet boxes on surface-mounted boxes.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Materials for moulded-case circuit breakers, circuit breakers, and ground-fault circuit-interrupters.

1.2 RELATED SECTIONS

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 74 19 - Construction/Demolition Waste Management and Disposal.
- .3 Section 26 23 00 - Low Voltage Switchgear.
- .4 Section 26 28 20 - Ground Fault Circuit Interrupters - Class 'A'.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 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 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include time-current characteristic curves for breakers with ampacity of 100A and over.

1.5 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Separate for recycling all waste in accordance with Waste Management Plan.

Part 2 Products

2.1 BREAKERS GENERAL

- .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 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
 - .1 Trip settings on breakers with adjustable trips as noted.
- .5 Circuit breakers with interchangeable trips as indicated.
- .6 Circuit breakers to have minimum 10kA symmetrical rms interrupting capacity rating or as noted in drawings or panel schedules.

2.2 THERMAL MAGNETIC BREAKERS

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

2.3 SOLID STATE TRIP BREAKERS

- .1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and/or ground fault short circuit protection.
- .2 Overcurrent device shall provide power, current and power quality metering and remove open/close and status functions. Device shall communicate to the Power System SCADA system via Ethernet.

2.4 OPTIONAL FEATURES

- .1 Refer to drawings, single lines and panel schedules for features to be included on moulded case breakers.
- .2 Required features for all circuit breakers larger than 150 amps.
 - .1 On-off locking device.
 - .2 Handle mechanism.

Part 3 Execution

3.1 INSTALLATION

- .1 Install circuit breakers in switchboard or panel board assemblies as noted in drawings.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for fused and non-fused disconnect switches.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International).
 - .1 CAN/CSA C22.2 No.4-latest edition, Enclosed Switches.
 - .2 CSA C22.2 No.39-latest edition, Fuseholder Assemblies.

1.3 SUBMITTALS

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 DISCONNECT SWITCHES

- .1 Fusible, non-fusible, horsepower rated disconnect switch in CSA Enclosure type 2 or as indicated.
- .2 Provision for padlocking in off switch position by three locks.
- .3 Mechanically interlocked door to prevent opening when handle in ON position.
- .4 Fuses: size as indicated.
- .5 Fuseholders: suitable without adaptors, for type and size of fuse indicated.
- .6 Quick-make, quick-break action.
- .7 ON-OFF switch position indication on switch enclosure cover.
- .8 Provide auxiliary Form-C contacts on switch operating mechanism where noted in drawings.
- .9 Provide mechanical key interlocking scheme where noted in drawings.
- .10 Exterior mounted disconnect switches shall be NEMA 4X rated.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

- .1 Install disconnect switches complete with fuses if applicable.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This Section specifies contactors for system voltages up to 600 V and normally used to control heating, motor or lighting loads.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.14-latest edition, Industrial Control Equipment.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

Part 2 Products

2.1 CONTACTORS

- .1 Electrically held controlled by pilot devices as indicated and rated for type of load controlled. Half size contactors not accepted.
- .2 Breaker or Fused switch combination contactor as indicated.
- .3 Complete with 2 normally open and 2 normally closed auxiliary contacts unless indicated otherwise.
- .4 Mount in CSA Enclosure type 2 unless otherwise indicated.
- .5 Include following options in cover:
 - .1 Red indicating lamp.
 - .2 Stop-Start pushbutton.
 - .3 Hand-Off-Auto selector switch.
 - .4 On-Off selector switch.
- .6 Control transformer: in accordance with Section 26 29 03 - Control Devices, in contactor enclosure.

2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.

Part 3 Execution

3.1 INSTALLATION

- .1 Install contactors and connect auxiliary control devices.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 26 29 23.02 Power System SCADA.

1.2 REFERENCES

- .1 National Electrical Manufacturers Association (NEMA)
 - .1 NEMA ICS 1-2000(R2008), Industrial Control and Systems: General 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 and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Include schematic, wiring, interconnection diagrams.
 - .2 Include all propose programming, modifications or software packages.
 - .3 Provide Riser Diagrams showing interface of all new and existing equipment as well as intermediate wiring, wiring devices, signal conditioners and measuring devices.

1.4 QUALITY ASSURANCE

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

1.5 CLOSEOUT SUBMITTALS

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

1.6 DELIVERY, STORAGE AND HANDLING

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

- .3 Storage and Handling Requirements:
 - .1 Store materials indoors and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect control devices from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 AC CONTROL RELAYS

- .1 Control Relays: to CSA C22.2 No.14 and NEMA ICS 1.
- .2 Fixed contact plug-in type: heavy duty 2,3 or 4 poles. Coil rating: 120 VAC or 120VDC as noted. Contact rating: 120V, 3A.
- .3 Relays to include indicator LED and tab for manually actuating the relay.

2.2 RELAY ACCESSORIES

- .1 Plug in relay bases with vibration clips.

2.3 PUSHBUTTONS

- .1 Illuminated and/or Heavy duty. Operator extend type, as indicated, color as noted with 1-NO and 1-NC contacts rated at 120 V, 10 A, AC labels as indicated. Stop pushbuttons coloured red, provision for padlocking in depressed position labelled "emergency stop".

2.4 SELECTOR SWITCHES

- .1 Maintained or Spring return to center, positions as indicated heavy duty operators knob contact arrangement as indicated, rated 120 V, 10A, AC.

2.5 INDICATING LIGHTS

- .1 Heavy duty full voltage, LED type, push-to-test, lens colour: indicated], supply voltage: 120V AC/DC, lamp voltage: 120V AC/DC, labels as indicated.

2.6 CONTROL AND RELAY PANELS

- .1 CSA Type 1 sheet steel enclosure with hinged padlockable access door, accommodating relays timers, labels, as indicated, factory installed and wired to identified terminals.

2.7 CONTROL CIRCUIT TRANSFORMERS

- .1 Single phase, dry type.
- .2 Primary: as noted, 60 Hz ac.
- .3 Secondary: 120 V, AC.
- .4 Rating: 250VA.
- .5 Secondary fuse: amps as required.

Part 3 Execution

3.1 INSTALLATION

- .1 Confirm correct and reliable transmission of all data values via ModBUS to PSS and ensure that full scale readings are possible and correct.
- .2 Confirm that all design performance values for the PSS have been met for inputs provided through the RID.
- .3 Relocate existing control devices and equipment as noted in drawings. At completion of project, all redundant cabling and wiring shall be removed. Contractor shall demolish and remove all conduits made redundant during this project, unless specifically noted to remain by Departmental Representative.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time and check out operation of section.
- .3 Upon completion of sectional test, undertake group testing.
- .4 Check out complete system for operational sequencing.
- .5 Coordinate all commissioning and demonstration operations with Departmental Representative.

3.3 CLEANING

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

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for fire detection and fire alarm systems.

1.2 REFERENCES

- .1 NBC-latest edition, National Building Code of Canada.
- .2 Government of Canada
 - .1 TB OSH Chapter 3-03, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-03, Standard for Fire protection Electronic Data Processing Equipment.
 - .2 TB OSH Chapter 3-04, latest edition, Treasury Board of Canada, Occupational Safety and Health, Chapter 3-04, Standard for Fire Alarm Systems.
- .3 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S524-latest edition, Installation of Fire Alarm Systems.
 - .2 ULC-S525- latest edition, Audible Signal Appliances.
 - .3 CAN/ULC-S526- latest edition, Visual Signal Appliances, Fire Alarm.
 - .4 CAN/ULC-S527- latest edition, Control Units.
 - .5 CAN/ULC-S528- latest edition, Manual Pull Stations.
 - .6 CAN/ULC-S529- latest edition, Smoke Detectors.
 - .7 CAN/ULC-S530- latest edition, Heat Actuated Fire Detectors.
 - .8 CAN/ULC-S531- latest edition, Smoke Alarms.
 - .9 CAN/ULC-S536- latest edition, Inspection and Testing of Fire Alarm Systems. .10 CAN/ULC-S537- latest edition, Verification of Fire Alarm Systems.

1.3 DESCRIPTION OF SYSTEM

- .1 Provide new two stage addressable fire alarm system.
- .2 System shall be fully supervised, microprocessor-based, fire alarm system, utilizing digital techniques for data control and digital and multiplexing techniques for data transmission.
- .3 System to carry out fire alarm and protection functions; including receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; initiating trouble signals and signalling to fire department.
- .4 The system shall be fully addressable, zoned, non-coded single stage.

- .5 System to be modular in design to allow for future expansion.
- .6 Operation of system shall not require personnel with special computer skills.

1.4 SCOPE OF WORK

- .1 Supply and install new fire alarm panel and associated wiring.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

- .1 System:
 - .1 To TB OSH Chapter 3-04.
 - .2 Subject to Fire Commissioner of Canada (FC) approval.
 - .3 Subject to FC inspection for final acceptance.

1.6 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include:
 - .1 Layout of equipment.
 - .2 Zoning.
 - .3 Complete wiring diagram, including schematics of modules.

1.7 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance data for Fire Alarm System for incorporation into manual.
- .2 Include:
 - .1 Operation and maintenance instructions for complete fire alarm system to permit effective operation and maintenance.
 - .2 Technical data - illustrated parts lists with parts catalogue numbers.
 - .3 Copy of approved shop drawings.
 - .4 List of recommended spare parts for system.

1.8 EXTRA MATERIALS

- .1 Include four (4) spare glass rods for manual pull box stations if applicable.
- .2 Provide one spare device of each type used on site as part of this project.

1.9 MAINTENANCE

- .1 Provide one year's free maintenance with two inspections by manufacturer during warranty period. Inspection tests to conform to CAN/ULC-S536. Submit inspection report to Departmental Representative.

Part 2 Products

2.1 MATERIALS

- .1 Equipment and devices: ULC listed and labelled and supplied by single manufacturer.
- .2 In accordance with applicable CAN/ULC standards.

2.2 SYSTEM OPERATION

- .1 Single stage operation. Operation of any alarm initiating device to:
 - .1 Cause audible signal devices to sound throughout building.
 - .2 Transmit signal to fire department via fire alarm transmitter.
 - .3 Cause zone of alarm device to be indicated on control panel and remote annunciator.
 - .4 Cause air conditioning and ventilating fans to shut down or to function so as to provide required control of smoke movement.
- .2 Capability to program smoke detector status change confirmation on any or all zones in accordance with CAN/ULC-S527, Appendix C.

2.3 CONTROL PANEL

2.4 BELL CIRCUIT POWER SUPPLY/BOOSTER

- .1 120V, ac, 60Hz input, 24Vdc output from rectifier to operate alarm circuits, with standby power of gell cell batteries minimum expected life of 4 years, sized in accordance with BC Building Code.

2.5 MANUAL ALARM STATIONS

- .1 Manual alarm stations: pull lever, glass rod, wall mounted surface type, non-coded single pole normally open contact for single stage English signage.
- .2 Provide steel protective guards for pull stations installed where noted.
- .3 Acceptable Products: Edwards – “SIGA-270”

2.6 AUTOMATIC ALARM INITIATING DEVICES

- .1 Acceptable Products: Heat detectors, fixed temperature, non-restorable, rated 57°C. Edwards – “SIGA-HFS”

- .2 Acceptable Products: Thermal detectors, addressable, Rate of Rise 8°C/min. Edwards – “SIGA-HRS”.

2.7 AUDIBLE SIGNAL DEVICES

- .1 Signal chimes: heavy duty, single stroke, 24Vdc, with solid striking plunger and resonating chamber, 95dB.
- .2 Bells: vibrating type, gongs of special alloy steel, 24Vdc, 150mm, 95dB.
- .3 Horns: 95dB, weatherproof mounting, 24Vdc.
- .4 Mini-horns: 95dB, surface mounting, red colour, 24Vdc.
- .5 All audible devices must be programmed to a temporal pattern 3, as required by the BC Building Code.

2.8 END-OF-LINE DEVICES

- .1 End-of-line devices to control supervisory current in alarm circuits and signalling circuits, sized to ensure correct supervisory current for each circuit. Open, short or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at main control panel and remotely as indicated.

2.9 GRAPHIC DISPLAY

- .1 Provide graphic display with LED indicators as part of fire alarm panel.

2.10 VISUAL ALARM SIGNAL DEVICES

- .1 Strobe type: flashing red, 24Vdc.
- .2 Designed for surface mounting on ceiling or walls as indicated.

2.11 ISOLATION MODULES

- .1 Addressable zone isolation modules.
- .2 Acceptable Products: Edwards – “SIGA-IM”

2.12 RELAY MODULES

- .1 Addressable relay modules.
- .2 Acceptable Products: Edwards – “SIGA-CR”

2.13 WIRE AND CABLE

- .1 Conductor Insulation: Minimum rating 300 volts. Single conductor RW90XLPE (X-link).
- .2 Multi-conductor cables 105°C with outer PVC jacket, colour coded, FAS rated.

- .3 Conductor sizes as follows:
 - .1 To initiating circuits: #18 AWG minimum, and in accordance with manufacturer's requirements.
 - .2 To signal circuits: #16 AWG minimum, and in accordance with manufacturer's requirements.
 - .3 To control circuits: #12 AWG minimum, and in accordance with manufacturer's requirements.
 - .4 Size all fire alarm wiring for maximum 3% voltage drop at maximum load at last device in run.
- .4 All wiring to be copper.
- .5 All wiring to be tag identified at the points of connection.
- .6 Provide a ground conductor with all system wiring and bond all metal parts including device boxes.
- .7 All fire alarm system wiring to be in conduit except short drops from ceiling junction box to detectors mounted in T-Bar ceiling may be rated fire alarm system cable.

Part 3 Execution

3.1 INSTALLATION

- .1 Install systems in accordance with CAN/ULC-S524 and TB OSH Chapter 3-04.
- .2 Locate and install manual alarm stations and connect to alarm circuit wiring.
- .3 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 600 mm radius clear space on ceiling, below and around detectors.
- .4 Connect alarm circuits to main control panel.
- .5 Locate and install signal devices, bells, chimes, horns and visual signal devices and connect to signalling circuits.
- .6 Connect signalling circuits to main control panel.
- .7 Install end-of-line devices at end of alarm and signalling circuits.
- .8 Install remote annunciator panels and connect to annunciator circuit wiring.
- .9 Sprinkler system: wire alarm and supervisory switches and connect to control panel.
- .10 Provide "SIGA-IM" isolation module at point where fire alarm cabling enters buildings.
- .11 All initiating device wiring shall be Class 'A'.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests as described herein and in accordance CAN/ULC-S537.
- .2 Fire alarm system:
 - .1 Test each device and alarm circuit to ensure manual stations, thermal and smoke detectors, and sprinkler system transmit alarm to control panel and actuate general alarm ancillary devices.
 - .2 Check annunciator panels to ensure zones are shown correctly.
 - .3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper operation of system.
 - .4 Manufacturer's technician to verify all new devices and reconnected existing fire alarm system equipment and components in accordance with ULC Standard S537.
 - .5 Provide a Certification of Verification.
 - .6 After verification, demonstrate and spot test system as required by Departmental Representative and Fire Commissioner.
 - .7 Class A circuits.
 - .1 Test each conductor on all circuits for capability of providing alarm signal on each side of single open-circuit fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.
 - .2 Test each conductor on all circuits for capability of providing alarm signal during ground-fault condition imposed near midmost point of circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

3.3 TRAINING

- .1 Arrange and pay for on-site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This specification describes the operation and functionality of a continuous duty, single-phase, solid-state, static Uninterruptible Power Supply (UPS) hereafter referred to as the UPS.

1.2 REFERENCES

- .1 American National Standards Institute (ANSI)
 - .1 ANSI S1.13-1995 (R1999) Measurement of Sound Pressure Levels in Air.
 - .2 ANSI S1.4-1983 (R2001) with Amd. S1.4A-1995, Specification for Sound Level Meters.
- .2 Canadian Standards Association (CSA International)
 - .1 CSA C813.1-01, Performance Test Method for Uninterruptible Power Supplies.
- .3 International Organization for Standardization (ISO):
 - .1 ISO 9001, "Quality Management Systems - Requirements."
 - .2 ISO 14001, "Environmental Management Systems - Requirements with Guidance for Use."
- .4 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - .1 ANSI/IEEE 519, "Guide for Harmonic Control and Reactive Compensation of Static Power Converters" (copyrighted by IEEE, ANSI-approved).

1.3 SYSTEM DESCRIPTION

- .1 Included Features of the UPS:
 - .1 The UPS utilizes double conversion online topology.
 - .2 The UPS features internal bypass and input power factor correction.
 - .3 The primary sections of the UPS are: input disconnect and filter stage, input PFC power stage, energy storage stage (DC bus capacitor bank), output power stage (inverter), bypass and a battery charger. The control of power module and fault detection logic is microcontroller-based.
 - .1 The input disconnect and filter stage contains an input back-feed relay (in models with an input wire plug), input filter, transient suppression, and battery select switches (mechanical relay or solid-state).
 - .2 The input PFC power stage contains non-isolated power factor correcting AC/DC converters. This converter is capable of full power operation over a very wide input voltage range or from a nominal DC battery voltage.

- .3 The energy storage stage is a split DC bus capacitor handling seamless transitions from battery to line and vice versa, as well as the low and high frequency power stages ripple.
- .4 The output power (inverter) stage operates directly from the DC bus and produces a configurable AC output voltage of 120 V/240 V output. The output of the UPS is connected either to the inverter or through a bypass relay, contactor, or static switch to the filtered input line.
- .4 The UPS contains a battery charger, which operates from the DC bus.
- .5 The system also includes the following features.
 - .1 Field-replaceable battery modules
 - .2 Removable input/output wiring trays
 - .3 Battery disconnects
 - .4 Emergency Power Off (EPO)
 - .5 An integrated UPS Network Management Card 2 with Environmental Monitoring (AP9631).
- .2 **Performance, Design, and Configurations:** The UPS and associated equipment operates in conjunction with a primary power supply and an output distribution system to provide quality uninterrupted power for electronic equipment load.
 - .1 This specification describes the performance, functionality, and design of the UPS, the external Battery Systems, and connectivity solutions.
 - .2 All programming and miscellaneous components for a fully operational system as described in this section are available as part of the UPS.

1.4 SYSTEM DESCRIPTION

- .1 Mechanical Design
 - .1 The UPS and battery cabinets are rack-mount configurations.
 - .2 The cabinet dimensions including terminations are listed below for tower, stack or rack-mount configurations. The side rack-mounting brackets increase the overall width to 482 mm.
- .2 System Characteristics
 - .1 System Capacity:
 - .1 10 kVA or 3000 W 120/240V single phase output, whichever limit is reached first.

- .2 **Efficiency:** The UPS efficiency stated here is at full load and without degradation of output regulation and shall meet or exceed 92%.
- .3 Input:
 - .1 AC Input Nominal Voltage:
 - .1 120/240 VAC, 1-phase, hardwired.
 - .2 AC Input Voltage Window:
 - .1 160 – 280 VAC (L1-L2) at full load.
 - .2 100 – 280 VAC (L1-L2) at 50% load.
 - .3 **Input Frequency Range:** 45-65 Hz, auto-selecting.
 - .4 **Input Power Factor:** >0.95 @ 100% load
 - .5 Input Current Distortion:
 - .1 Maximum 6% at 100% load at nominal voltage.
- .4 UPS Output:
 - .1 AC Output Nominal Voltage:
 - .2 120/240 V single phase with step down transformer.
 - .3 Output Connectors:
 - .1 Hardwire: 3-wire (2Ph + G)
 - .4 AC output voltage distortion:
 - .1 Maximum 2% @ 100% linear load; Maximum 5% @ 100% non-linear load
 - .5 AC output static voltage regulation:
 - .6 +/-1%.
 - .7 AC output dynamic voltage regulation:
 - .1 +/-5%, for 10 to 90% load step at <50 ms recovery time:

- .8 Output Voltage Harmonic Distortion:
 - .1 <2% THD maximum for a 100% linear load
 - .2 <5% THD maximum for a 100% non-linear load
- .9 Overload Rating:
 - .1 Normal Operation (Online):
 - .1 150% for 30 seconds
 - .2 125% for 1 minute
 - .3 105% continuous
 - .2 **Bypass Operation:** Overload is limited by the external input circuit breaker feeding the UPS:
 - .1 A supplementary 30/32 A circuit breaker is fitted at the input.
- .10 Output Power Factor Rating:
 - .1 0.5 lagging to 0.5 leading.
- .11 Output Frequency:
 - .1 50/60 +/- 3Hz (Tracking) or 50/60 +/- 0.1 Hz (free-running) or 50/60 +/- 1 Hz (free-running), user-selectable.
- .12 Crest Factor: 3:1

1.5 MODES OF OPERATION

- .1 **Normal:** The UPS output power stage (inverter) constantly recreates the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT switches. In both online operation and battery operation, the output power stage (inverter) creates an output voltage waveform independent of the mains input voltage waveform. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages do not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter). The input Power Factor Correction (PFC) power stage and the output power stage (inverter) operate in an on-line manner to continuously regulate power to the critical load. The input PFC stage is capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within the range of the UPS specifications.
- .1 **Overload Capability:** The output power stage (inverter) is capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for an indefinite length of time.

- .2 **Output Contactor:** The output power stage (inverter) is equipped with an output mechanical relay to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter will be removed from the critical bus.
- .3 **Battery Protection:** The inverter is provided with monitoring and control circuits to limit the level of discharge on the battery system.
- .2 **Battery:** Upon failure of the AC input source, the critical load continues being supplied by the output inverter, which derives its power from the battery system. There is no interruption in power to the critical load during both transfers to battery operation and retransfers from battery to normal operation. The UPS battery system consists of user-replaceable, hot-swappable cartridges.
 - .1 A minimum of two battery cartridges must be installed, providing 192 VDC nominal for the DC bus rail.
 - .2 The batteries of the UPS models in this specification are maintenance-free, leak-proof, valve-regulated lead-acid (VRLA) batteries with suspended electrolyte.
 - .3 The UPS shall incorporate a battery monitor system to continuously monitor the health of each removable battery module as well as external battery modules installed in extended run battery cabinets. This system shall notify the user in the event that a failed or weak battery module is found.
 - .4 UPS shall be expandable for additional runtime with additional battery packs. These packs and the modules within them are hot-pluggable, allowing for easy and quick installation or replacement without the need for electrical wiring, electrician services or powering down of the UPS.
 - .5 Each UPS Battery Module has a means of DC disconnect for transportation and to disconnect the battery module completely from the internal bus while the battery is installed in the UPS system.
- .3 **Charging:** Upon restoration of the AC input source, the UPS simultaneously recharges the battery and provides regulated power to the critical load.
 - .1 The intelligent battery management system contains a temperature monitoring circuit and compensation algorithm that regulates the battery charging voltage and current so as to optimize battery life. The UPS shall monitor the temperature of all battery packs and use the highest one as a reference to adjust the battery float voltage.
 - .2 The battery charging circuit remains active when in bypass or online states.
- .4 **Bypass:** During bypass operation the utility power is connected to the load, bypassing the internal converters. The system automatic bypass provides a transfer of the critical load from the Inverter output to the automatic bypass input source during times when the inverter cannot support the load. The UPS constantly monitors the output current, as well as the bypass source voltage, and inhibits potentially unsuccessful transfers to automatic bypass from taking place. The design of the automatic bypass switch power path consists of a heavy-duty electromechanical bypass relay or contactor.

- .1 **Automatic Transfers:** An automatic transfer of load to bypass takes place if the load on the critical bus exceeds the overload rating of the UPS, if both normal and battery operation modes are unavailable, if the UPS has an internal fault, or if for any reason the UPS cannot support the critical bus. Automatic transfers of the critical load from bypass back to normal operation takes place when the overload condition is removed from the critical bus output of the system or when other causes are corrected. If the bypass mode becomes unavailable the UPS will automatically switch to mains power. In the event that mains power is unavailable the system will switch to battery power.
- .2 **Manual Transfers:** Manually initiated transfers to and from bypass may be initiated through the UPS computer interface (via serial or USB communications) or by engaging the bypass switch on the rear panel of the unit.

1.6 INPUT PFC POWER STAGE

- .1 **General:** The input Power Factor Correction (PFC) power stage of the UPS constantly rectifies the power imported from the mains input of the system, converting input mains AC power to DC power for precise regulation of the DC bus voltage, battery charging, and output power stage (inverter) regulated output power
- .2 **Input Current Total Harmonic Distortion:** The input current THD_I at full system load will be held to the following percentages while providing conditioned power to the critical load bus, and charging the batteries under steady-state operating conditions. This is true while supporting loads of both a linear or nonlinear type. This will be accomplished with no additional filters, magnetic devices, or other components.
 - .1 Input THD current shall be 6% or less
- .3 Input Current Limit:
 - .1 The input converter shall control and limit the input current drawn from the utility supply to 150% of the UPS output.
 - .2 During conditions where input current limit is active, the UPS shall be able to support 100% load, charge batteries at 10% of the UPS output rating, and provide voltage regulation with mains deviation of up to +/-20% of the nominal input voltage.
 - .3 In cases where the source voltage to the UPS is nominal and the applied UPS load is equal to or less than 100% of UPS capacity, input current shall not exceed 130% of UPS output current, while providing full battery recharge power and importing necessary power for system losses.
- .4 Charging:
 - .1 The battery charging circuit contains a temperature monitoring circuit, which regulates the battery charging current to optimize battery life.
 - .2 The battery charging circuit remains active when the UPS is in automatic bypass and in normal operation.

- .3 The battery charging system adjusts the charging current according to the number of battery modules and by monitoring the individual battery current.

1.7 OUTPUT POWER STAGE (INVERTER)

- .1 **General:** The UPS output power stage (inverter) constantly recreates the UPS output voltage waveform by converting the DC bus voltage to AC voltage through a set of IGBT-driven power converters. In both normal operation and battery operation, the output power stage (inverter) creates an output voltage independent of the mains input voltage. Input voltage anomalies such as brown-outs, spikes, surges, sags, and outages, shall not affect the amplitude or sinusoidal nature of the recreated output voltage sine wave of the output power stage (inverter).
- .2 **Overload Capability:** The output power stage (inverter) is capable of withstanding 150% overload for 30 seconds or 125% overload for 1 minute or 105% overload for indefinite length of time.
- .3 **Output Contactor:** The output power stage (inverter) is equipped with an output mechanical contactor to provide physical isolation of the inverter from the critical bus. With this feature a failed inverter will be removed from the critical bus.
- .4 **Battery Protection:** The inverter is provided with monitoring and control circuits to limit the level of discharge on the battery system.

1.8 DISPLAY AND CONTROLS

- .1 **Control Logic:** The UPS is controlled by an embedded microcontroller which performs the following functions:
 - .1 Monitoring the quality of the output voltage
 - .2 Monitoring vital parameters of the UPS
 - .3 Executing the state machine
 - .4 Intelligent battery management
 - .5 Controlling the input and output power stage
 - .6 Remaining runtime calculation
 - .7 Self-diagnostics, self-test, and proactive fault detection
 - .8 Communication to the host server via a serial port
 - .9 Communication to the Network Management Card or another SmartSlot accessory card, if the UPS is equipped with such a card

- .2 **Display/Control Unit:** Located on the front of the UPS is a display/control unit.
 - .1 **Control Functions for All Models:** The following controls functions can be accomplished by use of the pushbutton switches or LCD display:
 - .1 Turn the UPS on
 - .2 Turn the UPS off
 - .3 Initiate a self-test to test the battery condition
 - .4 Silence an audible alarm
 - .5 Cold-start the UPS
 - .6 Display the input RMS voltage
- .3 **Display Data:** The following indicators are available on the Display/Control Unit:
 - .1 The UPS load LED bar
 - .2 The UPS is online
 - .3 The UPS is on battery
 - .4 The UPS is in bypass
 - .5 The UPS is overloaded
 - .6 The UPS is in fault state
 - .7 The battery needs to be replaced
 - .8 The battery capacity/utility voltage LED bar
- .4 **Communication Interface:** The following are contained within the UPS for remote communications with a network via web browser or SNMP.
 - .1 An RJ-45 serial interface port.
 - .2 A pre-installed Network Management Card 2 with Environmental Monitoring (AP9631).
- .5 **Bypass switch:** On the rear panel of the UPS there shall be a switch that when engaged forces the UPS into bypass state provided the input voltage and frequency are within acceptable limits.
- .6 **EPO switch:** UPS shall be equipped with an Emergency Power Off (EPO) terminal that can be wired so as to provide the means to instantaneously de-energize the UPS and its load from a remote location in case of emergency.

.7 **Audible Alarms:** Using audio signal, the UPS will notify the user about important events. The following is the list of distinct audio alarms:

- .1 The UPS is on battery
- .2 The UPS is on battery and the remaining battery capacity is low
- .3 The UPS has shut down due to low battery capacity
- .4 The battery needs to be replaced
- .5 The UPS is overloaded
- .6 The UPS is in fault state

.8 **Potential Free (Dry) Contacts:** The following dry alarm contacts shall be available on the UPS:

- .1 The UPS is on battery
- .2 The UPS is on battery and the remaining battery capacity is low
- .3 The UPS is off
- .4 The battery needs to be replaced
- .5 The UPS is in bypass
- .6 The UPS is overloaded;
- .7 The UPS is in fault state.

1.9 BATTERY

- .1 The UPS battery is of modular construction made up of owner-replaceable, hot-swappable, fused, battery modules. Each battery module is monitored to determine the highest battery unit temperature for use by the UPS battery diagnostic, and temperature compensated charger circuitry.
- .2 The batteries are of the valve regulated lead acid (VRLA) type.

Part 2 Accessories

2.1 Software and Connectivity:

- .1 **Network Management Card:** The Network Management Card allows one or more network management systems (NMSs) to monitor and manage the UPS in TCP/IP network environments, are equipped with a Network Management Card with Environmental Monitoring (AP9631) pre-installed.

- .2 **Unattended Shutdown:** The UPS, in conjunction with a network interface card, is capable of gracefully shutting down one or more operating systems during the time when the UPS is on battery mode. The UPS is also capable of using an RS-232 port to communicate.
- .2 **Remote UPS Monitoring:** The following methods of remote UPS monitoring shall be available:
 - .1 **Web Monitoring:** Remote monitoring is available via a web browser such as Internet Explorer.
 - .2 **Dry Contact Monitoring and Control:** The UPS must be equipped dry contact monitoring.

2.2 SHOP DRAWINGS

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Include:
 - .1 Outline sketch showing arrangement of meters, controls, recommended aisle spaces, battery rack, battery arrangement and dimensions.
 - .2 Shipping weight
 - .3 Schematic diagram showing interconnection of rectifier, inverter, battery, bypass switch, meters, controls and indicating lamps.
 - .4 Description of system operation, referenced to schematic diagram, for:
 - .1 Manual control during initial start-up and load transfer to bypass and back to inverter output;
 - .2 Inverter;
 - .5 System performance and reliability:
 - .1 Consider any deviation from the required output power waveform as failure in UPS and include estimate, with supporting calculations, of the Mean Time Between Failures (MTBF) expressed in hours.
 - .2 Provide estimate with supporting data for Mean Time to Repair factor (MTTR).
 - .6 Full load kVA output at unity power factor.
 - .7 Efficiency of system at 25%, 50%, 75% and 100% rated load.
 - .8 Type of ventilation: natural or forced.

- .9 Battery:
 - .1 Number of cells;
 - .2 Maximum and minimum voltages;
 - .3 Type of battery;
 - .4 Type of plates;
 - .5 Catalogue data with cell trade name and type;
 - .6 Size and weight of each cell;
 - .7 Cell charge and discharge curves of voltage, current, time and capacity;
 - .8 Derating factor for specified temperature range;
 - .9 Nominal ampere hour capacity of each cell;
 - .10 Maximum short circuit current;
 - .11 Maximum charging current expected for fully discharged condition;
 - .12 Recommended low voltage limit for fully discharged condition;
 - .13 Expected life.
- .10 Heat losses at no load, 25%, 50%, 75% and 100% of rated output, in kW.
- .11 Cooling air required in m³/s.
- .12 List of recommended spare parts, tools and instruments with catalogue numbers and current prices.
- .13 Typical operation and maintenance manual.
- .14 Description of factory test facilities.
- .15 Manufacturer's maintenance capabilities including:
 - .1 Willingness to undertake maintenance contract;
 - .2 Number of trained personnel available;
 - .3 Location of trained personnel and repair facilities.

2.3 QUALITY ASSURANCE

- .1 Submit for approval to Departmental Representative, indicating and recording instruments calibration certificates, including meters installed as part of system, in accordance with Section 01 33 00 - Submittal Procedures.

2.4 CLOSEOUT SUBMITTALS

- .1 Provide data for incorporation into operation and maintenance manual specified in Section 26 05 00 – Common Work Results - Electrical.
- .2 Submit interim, draft final, and final Operation and Maintenance (OM) Manual. Final manual approved by Departmental Representative. Submit interim copies to Departmental Representative prior to notification of factory test date.
- .3 Operation and Maintenance Manual to include:
 - .1 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operations maintenance and repair.
 - .2 Technical data:
 - .1 Approved shop drawings;
 - .2 Characteristic curves for automatic circuit breakers and protective devices;
 - .3 Project data;
 - .4 Technical description of components;
 - .5 Parts lists with names and addresses of suppliers.

2.5 DELIVERY, STORAGE AND HANDLING

- .1 Crating:
 - .1 Adequately enclosed and protected from weather and shipping damage by use of minimum 12 mm plywood with vapour barrier inside.
 - .2 For tractor train or sea shipment use double layer of vapour barrier and 19 mm plywood covering.
 - .3 Subassemblies may be packed separately.
 - .4 Label crates:
 - .1 Shipping address.
 - .2 Weight and dimensions
 - .3 Serial number of unit and brief description of contents.
 - .4 Stencilled with durable paint on at least two sides of each crate.
 - .5 List of contents:

- .1 In weatherproof envelope stapled on outside of each crate;
- .2 Copy placed inside each crate.

2.6 SYSTEM START-UP

- .1 Provide for:
 - .1 For factory service engineer to supervise start-up of system, checking, adjusting and testing on site;
 - .2 For instruction of Departmental personnel on theory, construction, installation, operation and maintenance of system:
 - .1 After installation and during site testing;
- .2 Advise on:
 - .1 Expected failure rate of equipment;
 - .2 Type of expected failures;
 - .3 Estimated time between major overhauls based on 20 year equipment life;
 - .4 Estimated cost of major overhaul based on current costs and excluding travelling expenses;
 - .5 Type and cost of test equipment needed for fault isolating and performing preventive maintenance.

Part 3 Products

3.1 UNINTERRUPTIBLE POWER SYSTEM

- .1 Input power:
 - .1 240 V, single phase, 3 wire or, grounded neutral as applicable, 60 Hz.
 - .2 Normal supply from ac mains.
 - .3 Emergency supply from standby automatic diesel-electric unit.
- .2 Output power:
 - .1 120/240 V, single phase, 3 wire, grounded neutral, 60 Hz.
 - .2 Full load output at 1.0, Unity power factor.
 - .3 Overload capability: 125% of rated full load current at 1.0 power factor and rated voltage for 10 min.

- .4 Frequency - nominal 60 Hz:
 - .1 Adjustable from 58.5 to 61.5 Hz.
 - .2 Maximum variation from set value under load changes, including transients, not to exceed 0.3 Hz.
 - .3 Drift from set value - after two months normal operation within ambient temperature range of 0 degrees to 40 degrees C, not to exceed 0.6 Hz.
- .5 Duration of full load output after mains failure not less than 15 min.
- .6 Output voltage control:
 - .1 Continuously adjustable on load at least 5% from rated value.
 - .2 Voltage regulation: voltage not to change by more than 2% as load increases gradually from zero to 100%, or for specified duration of full load after mains failure.
 - .3 Transient voltage change not to exceed +/-10% of rated voltage upon 50% sudden load change, loss or return of ac input voltage to system when fully loaded or transfer of full load from inverter to bypass and vice versa, and return to normal within 3 Hz.
 - .4 Harmonics over entire load range:
 - .1 Total rms value not to exceed 3% rms value of total output voltage.
 - .2 Single harmonic not to exceed 1.9% of total output voltage.
 - .5 Proper angular phase relation maintained within 2 electrical degrees at up to 80% load unbalance.
- .7 Efficiency: Overall system efficiency at rated 100% load with battery fully charged not less than 95%. Overall system efficiency at rated 25% load with battery fully charged not less than 94%.
- .8 Interference suppression:
 - .1 If UPS equipment generates electromagnetic rf interference at levels which adversely affects other equipment in vicinity, install suppression circuits or shielding as required to eliminate such interference.
 - .2 If harmonics reflected back to mains from rectifier adversely affect other loads connected to same bus, install suppression circuits to prevent that condition.
- .3 Single Phase rack mounted UPS systems shall be 5kVA total output power each with battery extender modules to provide a full 60 minutes of runtime at full load. Input voltage shall be 240V single phase; output shall be 120/240V single phase, grounded neutral.

3.2 ELECTRICAL REQUIREMENTS

- .1 In accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 No battery, other than main battery incorporated in design.
- .3 Wires number tagged or colour coded with same designation on drawings. Tags: non deteriorating type.
- .4 Variable resistors: fine adjustment, rheostat type.
- .5 Indicator lamps: long life LED, rated for continuous duty, with sockets having adequate heat dissipation of lamps and dropping resistor if used.
- .6 Solid state circuits used where more reliable than mechanical timers or control relays.
- .7 Standard components available from commercial sources used throughout, with 10 years minimum shelf life.
- .8 Arrangement to permit easy removal of defective components to facilitate servicing, by replacing with stock spares.
- .9 Small components, related to specific function, removable plug-in modular sub- assembly or printed circuit card.
- .10 Heavy sub-assemblies easily accessible, or slide on runners of anti-friction material, and have flexible leads and bolted connections.
- .11 Components and sub-assemblies accurately made for interchangeability.

3.3 ENCLOSURE

- .1 Dead front free rack mounting minimum 2.5 mm thick, CSA Enclosure 1.
- .2 Service Access from **front** only.
- .3 Meters, indicating lamps and controls group mounted in panel front.
- .4 Panel front enclosed by hinged doors to prevent tampering and to protect instruments and controls during shipping. Doors formed wrap-around type, rigid, to open and close smoothly, locking type handle with 2 keys. Hinges to permit doors to be lifted off cubicle.
- .5 Module sizes not to exceed number of rack units indicated in drawings for main module and battery modules.
- .6 External cable connections at top or side of cubicle through bolted plate for drilling at site to suit.
- .7 Ambient temperature range during operation -20 degrees C to +40 degrees C. Natural or forced ventilation as required. For forced ventilation power from inverter output and fan directly driven by

motor mounted on vibration isolators. Each enclosure to have redundant fans, with fan failures alarmed. Air inlet and outlet openings protected with screens and metal guards.

- .8 Disposable air filters on fan cooled enclosures. Method of attachment and opening locations to make removal convenient and safe.
- .9 Maximum operating sound level not to exceed 73 dbA as measured on sound level meter with A weighting and slow response, at distance of 1 meter.
- .10 Enclosure frames interconnected by ground bus with ground lug for connection to ground.

3.4 RECTIFIER

- .1 Input power supply from:
 - .1 Ac mains;
 - .2 Automatic diesel engine driven generating unit.
- .2 Input disconnect: bolt-on moulded case three pole air circuit breaker, quick make, quick break type for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.
- .3 Input transformer: connected between ac input and rectifier input
- .4 Surge suppressor: to protect equipment from supply voltage switching transients.
- .5 Rectifier:
 - .1 Solid-state Pulse Width Modulation (PWM) rectifier utilizing Insulated Gate Bipolar Transister (IGBT)
- .6 Filter: for rectifier dc output.
- .7 Fuse: to protect dc output.
- .8 Adjustments and controls:
 - .1 Line voltage adjusting taps to allow for +/-10% variation from nominal.
 - .2 Manual adjustment of float voltage with range of +/-5%.
 - .3 Manual adjustment of equalizing voltage.
 - .4 Automatic current limiting on rectifier adjustable between 80 and 120% of normal rating.
 - .5 Provision to disconnect rectifier from inverter and battery if rectifier dc output exceeds safe voltage limits of battery.

.9 Performance of rectifier:

- .1 Automatically maintain battery in fully charged state while mains power available, and maintain dc float voltage within +/-1% of setting, no load to full load, during mains voltage variations up to +15% to -20%.
- .2 Battery charging rate such that after battery has provided full load power output for specified duration, charger returns battery to 95% of fully charged state in 4 hours.
- .3 Programmable Automatic equalize charging circuit to initiate equalize charging of battery.
- .4 Manually initiated equalize charging feature with automatic timer adjustable from 0 to 24 hours to return unit to float charge.

3.5 INVERTER

- .1 Input power supply from:
 - .1 Rectifier dc output;
 - .2 Battery dc output.
- .2 Input disconnect: bolt-on moulded case, single pole, circuit breaker, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.
- .3 Input filter: with separately fused computer grade capacitor banks and indicator lights, to eliminate inverter source noise and restrictions on input cable length.
- .4 Power stage: High efficiency Solid-state Pulse Width Modulation (PWM) rectifier utilizing Insulated Gate Bipolar Transistor (IGBT). Components, solid state devices capable of satisfactory operation under ambient conditions of -20 degrees C to +40 degrees C.
- .5 Output filter: output of high frequency switching stage contains elements of carrier frequency which are filtered to low harmonic sine wave.
- .6 Output disconnect: bolt-on, moulded case, three pole circuit breaker or magnetic contactor, quick make, quick break type, for manual or automatic operation, temperature compensated for 40 degrees C ambient, magnetic instantaneous trip element.

3.6 BATTERY

- .1 Battery to be sealed type.
 - .1 Discharge current to supply inverter at full load output, for 15 min.
 - .2 Battery modules and trays are replaceable without shutting down UPS or going into bypass.

3.7 STATIC BYPASS SWITCH

- .1 Two solid state closed circuit automatic transfer switches.
- .2 Logic unit with three normal source voltage sensors, which monitor overvoltage undervoltage and loss of voltage.
- .3 High speed automatic transfer from normal voltage to alternate source when:
 - .1 Normal source voltage lost: transfer time and sensing 1/4 cycle;
 - .2 Normal source: undervoltage at 80% of nominal value; adjustable.
 - .3 Normal source: over voltage at 115% of nominal value.
 - .4 Loss of normal source static switch continuity.
 - .5 Short circuit on normal source trips normal source breaker.
- .4 Return to normal source:
 - .1 When normal source remains within return voltage limits of 95% to 110% of nominal value (adjustable) for approximately 1 s timing interval, circuit checks voltage balance and phase synchronization, then initiates return with zero switching time.
- .5 Switch position lights and contacts.
- .6 Synchronizing verification light.
- .7 Manual reset pushbutton.
- .8 Transfer test switch.
- .9 Alternate power source monitor light.
- .10 Accessories:
 - .1 Manual bypass switch for maintenance and testing without load disturbance.
 - .2 Continuity monitor: automatic transfer to alternate source in event of static switch discontinuity.
 - .3 Alternate power source loss alarm contacts.

3.8 OPERATING DEVICES

- .1 Operating accessories:
 - .1 Counter for number of failures of normal mains ac power: non-reset type, zero to 99,999 operations.

- .2 Elapsed time meter indicating accumulated time of battery discharge in minutes non-reset type, zero to 99,999.9 minutes.
- .3 Elapsed time meter indicating accumulated time of inverter operation in hours, non-reset type, zero to 99,999.9 hours.
- .2 Mode lights mounted on front panel to indicate:
 - .1 Ac output on inverter - green;
 - .2 Ac input available - green;
 - .3 Inverter and ac input synchronized - green;
 - .4 Inverter and ac input not synchronized - amber;
 - .5 Static bypass switch in bypass position - red;
 - .6 Overtemperature alarms:
 - .1 Rectifier - red;
 - .2 Inverter - red;
 - .3 Bypass switch - red;
 - .7 Cooling fan fuse open - red;
 - .8 Inverter output over voltage - red;
 - .9 Inverter output under voltage - red;
 - .10 Battery over voltage - red;
 - .11 Battery under voltage - red;
 - .12 Inverter fuse/breaker open - red;
 - .13 Rectifier fuse/breaker open - red;
 - .14 Static bypass switch fuse/breaker open - red;
 - .15 UPS on battery operation - red;
 - .16 Rectifier in equalize mode - amber;
 - .17 Battery discharging indicator - red, to change from steady to flashing during final 5 to 10 min of battery duration.
- .3 Alarms: audible alarm when any mode light shows red. Silence pushbutton not to extinguish trouble light.

3.9 FABRICATION

- .1 Shop assemble:
 - .1 Rectifier unit;
 - .2 Inverter unit;
 - .3 Bypass switch unit;
- .2 Interconnect units, and add remote mode lights, alarms and controls to produce complete uninterruptible power system before requesting Departmental Representative to witness factory tests.

3.10 FINISHES

- .1 Apply finishes in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Cubicles:
 - .1 Inside finish: White or Beige;
 - .2 Exterior finish: manufacturers standard colour;
 - .3 Exterior hardware and trim: corrosion resistant and not requiring painting such as stainless steel or aluminum.

3.11 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 For major components such as ac input breaker, inverter breakers, bypass switch: size 5 nameplates.
- .3 For mode lights, alarms, meters: size 3 nameplates.

3.12 SOURCE QUALITY CONTROL

- .1 Complete system including rectifier, inverter, bypass switch, remote annunciator panel, controls and battery factory tested in presence of Departmental Representative.
- .2 Notify Departmental Representative:
 - .1 One week in advance of date of factory test;
 - .2 That system has had preliminary testing and has met design requirements satisfactorily.
 - .3 Test procedures:
 - .4 Prepare blank forms and check sheet with spaces for recording data.

- .5 Mark check sheet and record test data on forms in duplicate as test proceeds. Attach meter recordings.
- .6 Provide Departmental Representative's signature on form to indicate concurrence in results reported.
- .7 Duplicate given to Departmental Representative at end of test.
- .8 Information from original presented as part of O&M Manual.
- .3 Test equipment:
 - .1 Instruments used during test, including indicating meters installed as part of system to have recent calibration certificate.
 - .2 Dummy load for testing, adjustable to 150% of system rated output at 0.8 power factor lagging. Load on each phase adjustable from zero to 100 % so that unbalanced output maybe tested for 3 phase systems.
- .4 Tests:
 - .1 Visual inspection to determine:
 - .1 Materials, workmanship, and assembly conform with design requirements;
 - .2 Parts are new and free of defects;
 - .3 Battery and components are not damaged;
 - .4 Battery cells are of identical construction;
 - .5 Electrolyte in each cell is at manufacturer's recommended full level;
 - .6 Each battery cell polarity and polarity of connections to inverter are correct;
 - .7 Proper size fuses are installed;
 - .8 Metres have suitable range;
 - .9 Accessories are present;
 - .10 Portable metres for acceptance tests are suitable and instrument transformers connected correctly.
 - .2 Demonstrate:
 - .1 System start-up and shut down;
 - .2 Operation during mains power failure, recording output during failure and return of mains power, using oscilloscope and camera attachment. Repeat several times;

- .3 Adjustable settings;
- .4 Record values measured at test points using oscilloscope, digital multimeter, and camera attachment;
- .5 Protective devices and indications function as designed. Record actual settings, and note operation of remote indications and transfer to bypass. Tests to include:
 - .1 Annunciator lights correct indication;
 - .2 Overcurrent on inverter output;
 - .3 Over voltage and under voltage of inverter output;
 - .4 Dc input voltage to inverter too low. Gradually reduce dc input voltage to inverter while delivering full load output and load to transfer automatically to bypass and inverter shut down. Record input and output values.
 - .5 Simulate over temperature by applying heat to sensor with hot air blower.
- .6 Simulate fuse blowing to test indication response.
- .7 Simulate fan failure.
- .8 Bypass switch automatic operations. Record with camera/oscilloscope absence of load disturbance during automatic bypass switching.
- .9 Over voltage of rectifier dc output.
- .3 Harmonic test:
 - .1 With system fully loaded, one-half loaded, and at no load, determine total harmonic content with harmonic distortion meter at output terminals.
 - .2 Determine each harmonic magnitude with harmonic wave analyzer.
 - .3 Measure phase to neutral at 0.8 lagging power factor.
- .4 Transients:
 - .1 With normal power input, apply full load to system.
 - .2 Remove one half load from each phase.
 - .3 Reapply one half load instantly.
 - .4 Record voltages and currents using oscilloscopes.

.5 Steady load:

- .1 Switch system onto ac mains, start inverter and connect dummy 1.0, Unity power factor load.
- .2 Operate system at full rated load for 24 hours and at 125% load for 10 min in ambient temperature of 40 degrees C.
- .3 Record data at start of test and at half hour intervals thereafter; including:
 - .1 Input frequency;
 - .2 Input voltage;
 - .3 Input current;
 - .4 Input kW;
 - .5 Output voltage phase to phase, phase to neutral;
 - .6 Output current each phase;
 - .7 Output kW;
 - .8 Temperature of ventilating air-in;
 - .9 Temperature of ventilating air-out;
 - .10 Temperature at critical zones;

.6 Varying loads:

- .1 Take one set of readings as above of no load, 25% load, 50% load, 75% load and 125% load.
- .2 Calculate efficiencies of rectifier, inverter, and complete system.

.7 Unbalanced loads:

- .1 Adjust loads on inverter to full load on two phases, 80% load on third phase.
- .2 Adjust loads on inverter to zero load on two phases, 20% load on third phase.
- .3 For both cases, record phase and line voltages and currents with phase angles to prove that phase relation remains unchanged with unbalanced loads.

.8 Battery:

- .1 Charge battery to ensure cells fully charged. When voltage reaches steady value at end of charge, record:
 - .1 Ambient temperature;
 - .2 Voltage of battery;
 - .3 Charging current;
- .2 Discharge battery by operating uninterruptible power system with ac mains open, at full rated output for duration quoted in design requirements. Record, at 5 min intervals:
 - .1 Voltage of battery;
 - .2 Current;
 - .3 Ambient temperature;
 - .4 Battery temperature;
- .3 Recharge battery automatically by closing ac mains supply to system for 4 hours period, with dummy load connected. Record at 15 min intervals.
 - .1 Battery voltage;
 - .2 Charging current.
- .4 Repeat discharge test and readings to prove battery was at least 95% recharged in 4 hours charge period.
- .5 Recharge battery.

.9 Operating sound level:

- .1 Measure sound level according to ANSI S1.13 using sound level meter with A weighting and slow response, conforming to ANSI S1.4.
- .2 Operator to take reading by placing meter in front of him with microphone pointed at right angles to path of travel of generated sound, positioned at height of 1.5 m and distance of 1 m from equipment to be tested.
- .3 Measure sound level during low ambient sound level.

Part 4 Execution

4.1 INSTALLATION

- .1 Locate UPS cubicles modules and battery modules as indicated.
- .2 Assemble and interconnect components to provide complete UPS as specified.
- .3 Connect ac mains to main input terminal.
- .4 Connect UPS output to load.
- .5 Start-up UPS and make preliminary tests to ensure satisfactory performance.

4.2 TESTING

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical and CSA-C813.1.
- .2 Provide:
 - .1 Competent field personnel to perform test, adjustments and instruction on UPS equipment.
 - .2 Dummy load adjustable to 150% of system rated output.
- .3 Notify Departmental Representative 10 working days in advance of test date.
- .4 Tests:
 - .1 Inspection of cubicles, battery rack and battery.
 - .2 Inspection of electrical connections.
 - .3 Inspection of installation of remote mode lights and alarms.
 - .4 Demonstration of system start-up and shut-down.
 - .5 Run UPS for minimum period of 4 hours at full rated load to demonstrate proper operation with ac mains input, emergency generator input, no ac input.
 - .6 Discharge battery by operating UPS with ac mains open for specified duration of full load. Record readings of temperature of each cell.
 - .7 Recharge battery automatically with full rated load on UPS for 4 hours and record readings of voltage of each cell.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section specifies the materials and installation for luminaires for the entire project including exterior lighting fixtures.
- .2 Refer to the Luminaire Schedule on the electrical drawings.

1.2 REFERENCES

- .1 CAN/CSA C22.1-09, Canadian Electrical Code, Part I.
- .2 CAN/CSA C22.2 No.9.0, General Requirements for Luminaires.

1.3 PRODUCT DATA

- .1 Submit shop drawings and product data in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit complete photometric and heat dissipation data prepared by independent testing laboratory for proposed luminaires.

1.4 INTENT

- .1 Provide lighting fixtures and accessories for all outlets as listed in the Luminaire Schedule and as shown on drawings.
- .2 Lighting fixtures shall be structurally well designed and constructed, using new parts and materials of the highest commercial grade available.
- .3 Ground all lighting equipment to grounding system.
- .4 Verify all ceiling types and finishes before ordering fixtures and provide fixtures suitable for mounting in or on ceilings being installed in each area, as specified. Where fixture types specified are not suitable for ceiling being installed, obtain written instructions from the Departmental Representative before ordering fixtures.
- .5 Fixtures of the same or similar type shall be supplied by the same manufacturer.

Part 2 PRODUCTS

2.1 SOLID STATE LIGHTING

- .1 Solid state lighting rated correlated colour temperature (CCT) shall be with four (4) MacAdam ellipses of the specified CCT in the luminaire schedule. Colour consistency between lamps in the same fixture type shall be within three (3) MacAdam ellipses of the rated CCT.
- .2 Solid state lighting shall have a CRI greater or equal to the value listed in the luminaire schedule. In addition the lamps shall have an R9 value greater than 50 measured under the same conditions as the CRI.

- .3 Solid state lighting systems (including required drivers) shall have a power factor greater than 90 at full rated output.
- .4 Solid state lighting lumen maintenance data shall be provided for L70 testing.

2.2 FIXTURES

- .1 Accessories and components shall comply with relevant CSA Standards.
- .2 Except where otherwise noted in the Luminaire Schedule, depth of recessed fixtures shall not exceed 150 mm, including mounting yokes, or bridges. Design of reflector and lamp position shall be to provide high efficiency, even brightness and lack of lamp lines.
- .3 All metal parts shall be thoroughly cleaned and finished in high reflectance baked enamel over corrosion-resistant primer. Finish as indicated in luminaire schedule.
- .4 All internal fixture diffusers, lens panels, lens frames, etc., shall be securely and adequately supported and shall be removable without the use of tools for cleaning.
- .5 Fixtures shall incorporate adequate gasketing, stops and barriers to form light traps and prevent light leaks.
- .6 Fixtures shall be designed for adequate dissipation of ballast and lamp heat to avoid short ballast life, nuisance thermal tripping and decreased lamp output. Heat test reports by independent laboratories shall be provided where required by the Departmental Representative.
- .7 Construction of all fixtures shall be such as to provide a rigid well aligned fixture. Formed or ribbed backplates, end plates, reinforcing channel, heavy gauge sockets, straps, etc., shall be used where required to accomplish this.
- .8 The construction and performance of all fluorescent fixtures shall be subject to the acceptance of the Departmental Representative.

Part 3 EXECUTION

3.1 INSTALLATION AND SUPPORTS

- .1 Provide complete and proper support for all fixtures, fixture hangers, etc., including headers in ceiling space, where required, for proper support of outlet boxes and fixture hanger assemblies.
- .2 Support fixtures as shown on the drawings, level, plumb and true with the structure and other equipment in a horizontal or vertical position as intended. Wall or side bracket mounted fixture housings shall be rigidly installed and adjusted to give a neat flush fit to the surface on which it is mounted.
- .3 All hangers, supports, fastenings or accessory fittings shall be protected against corrosion. Care shall be taken during the installation to assure that insulation and corrosion protection is not damaged.

- .4 The suspension length of all ceiling mounted suspended types of lighting fixtures as listed in the Fixture Schedule shall be the overall length from the ceiling to the lowest point of the fixture body, reflector or glassware in its hanging position.
- .5 Metal inserts, expansion bolts or toggle bolts in concrete slabs for stems which do not carry wiring must be accurately located in relation to the outlet boxes, to allow perfect alignment and spacing of suspension stems.
- .6 Where fixtures are surface mounted on the underside of an inverted tee bar ceiling, the fixture shall be supported either directly from the building structure by means of rod hangers and inserts or by means of metal angle headers, supported from the tee bar framing structure above the tile. Fixtures shall be supported from the quarter points.
- .7 Wiring from outlet boxes to fluorescent fixtures and wiring through fluorescent fixture channels shall be rated for 90 degrees C.
- .8 Install fixture lenses as late as possible to protect from dirt and dust. Remove and clean or replace lenses to the satisfaction of the Departmental Representative.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for emergency lighting systems.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA C22.2 No.141-M1985(R1999), Unit Equipment for Emergency Lighting.

1.3 PRODUCT DATA

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Data to indicate system components, mounting method, source of power and special attachments.

Part 2 Products

2.1 EQUIPMENT

- .1 Emergency lighting equipment: to CSA C22.2 No.141.
- .2 Supply voltage: 120VAC.
- .3 Output voltage: 24 V dc.
- .4 Operating time: **120** min.
- .5 Battery: sealed, maintenance free.
- .6 Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10% input variations.
- .7 Solid state transfer circuit.
- .8 Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .9 Signal lights: solid state, for 'AC Power ON' and 'High Charge'.
- .10 Lamp heads: integral on unit remote, 345 degrees horizontal and 180 degrees vertical adjustment.
Lamp type: LED 5 W.
- .11 Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.
- .12 Finish: white.

- .13 Auxiliary equipment:
 - .1 Test switch.
 - .2 Battery disconnect device.
 - .3 AC input and DC output terminal blocks inside cabinet.
 - .4 Bracket.
 - .5 Hardwire connection for AC.
 - .6 RFI suppressors.

Part 3 Execution

3.1 INSTALLATION

- .1 Install unit equipment.
- .2 Direct heads.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for exit signs complete with directional arrows.

1.2 PRODUCT DATA

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets indicating dimensions, materials, and finishes, including classifications and certifications.

Part 2 Products

2.1 EXIT SIGN TYPES

- .1 All exit signs shall comply with CAN/CSA C860 (latest edition), CSA 22.2 #141 and National Building Code, 2010.
- .2 Exit signs shall be complete with 10 year warranty.
- .3 Exit signs shall be LED and have a complaint green “Running Man” pictogram complete with directional arrows as noted on drawings.

2.2 MOUNTING TYPE

- .1 Exit signs to be suitable for universal mounting. Allow for exit signs to be mounted as to best suit ceiling/wall type and architectural features:
 - .1 Surface wall mounted
 - .2 End wall mounted double face
 - .3 Ceiling mounted single face
 - .4 Ceiling mounted double face
- .2 Exit signs to have direction arrows where indicated.

Part 3 Execution

3.1 INSTALLATION

- .1 Install exit signs as shown on plans complete with double face units where indicated.
- .2 Connect to dedicated circuit as indicated on the plans.
- .3 Exit signs must be clear of all visual obstruction.
- .4 Contractor to confirm locations before final installation.

3.2 LOCATION

- .1 Review locations of exit signs with engineer and Departmental Representative to ensure effectiveness and compatibility with decor before rough in. Failure to do so may result in relocation at no extra charge to the project.

3.3 MOUNTING HEIGHT

- .1 Wall mounted signs shall be clear above doors and, if space allows, 2.4 metres to centre, but with 25mm clearance of ceiling.
- .2 Ceiling mounted signs shall be mounted directly on ceiling, unless it is obstructed from view. Stem mount using two fixture rods (9.5mm white smooth type).

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 This section specifies the materials and installation for communication cables inside buildings including shielded and unshielded twisted pair (STP and UTP) copper cables as well as supporting infrastructure.

1.2 SCOPE

- .1 Supply and installation of a data/communication cabling system, complete with complete with provision of cables, and connectors as indicated on the drawings and as required for a complete and fully functioning system.
- .2 Fibre Optic System to be in accordance with Section 27 05 15.
- .3 The data/communications system installation is to be in accordance with EIA/TIA-568 Standards.
- .4 All cables made redundant by new installation or as noted in drawings for demolition, are to be removed. All existing abandoned cables are also to be removed back to the source.

1.3 REFERENCES

- .1 Canadian Standards Association, (CSA International)
 - .1 CSA-T529-latest edition, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/EIA TIA 568a with modifications).
 - .2 CSA-C22.2 No. 214-latest edition, Communications Cables (Bi-national Standard, with UL 444).
 - .3 CAN/CSA-C22.2 No. 182.4-latest edition, Plugs, Receptacles, and Connectors for Communication Systems.
- .2 Telecommunications Industry Association (TIA)
 - .1 TIA/EIA-568-latest edition, Commercial Building Telecommunications Cabling Standards Set.

1.4 SYSTEM DESCRIPTION

- .1 Structured system of telecommunications cables (copper) installed within buildings for distributing voice and data, including video signals.
- .2 Installed in physical star configuration with separate horizontal and backbone sub-systems.

Part 2 Products

2.1 CABLE AND CONNECTORS

- .1 Each UTP and STP cable shall meet the requirements of will consist of four unshielded twisted pairs of 24 AWG (0.5mm) 100-ohm nominal characteristic impedance, solid round annealed copper conductors insulated with flame retardant polymer.
- .2 All cables will be certified/approved by CSA Standard PCC FT4 flammability test and UL CMR.
- .3 UTP cables will meet or exceed the requirements in the proposed National Electrical Manufacturers Association (NEMA) Standard for Low-Loss Extended Frequency Premises Telecommunication Cable. The cable will meet the performance requirements of Category cable of the Underwriters Laboratories Inc. specifications and cable surface markings shall indicate this classification.
- .4 STP and UTP cabling indicated for data communications shall be Cat 6 rated. To be CCG Standard CMP-00423TE-6A-06S, or an approved alternate.
- .5 UTP cabling indicated for telephone only shall be Cat 5e.

2.2 COMMUNICATION OUTLETS AND TERMINAL CONNECTIONS

- .1 Data/communications outlets are to consist of 100 x 100 box c/w single gang plaster ring and flush mounted into walls unless indicated otherwise. Outlets to be complete with quantity of modular RJ45 jacks as indicated on plans.
- .2 Cable runs will have 300mm length of cable left coiled up inside outlet box for termination of RJ45 jacks.
- .3 All cables shall have all pares connected using the EIA.TIA standard pin configuration 568A. When combined, telephone jacks are to mount in the top position of outlets, and data jacks in the lower position.

2.3 COVERPLATES

- .1 Coverplates are to be brushed stainless steel in accordance with Section 26 27 26 complete with provision for data/communication jacks as indicated on plans.
- .2 Cover plates to have 2, 4 or 6 cutouts for jacks.
- .3 Provide blank filler plugs for all unused ports.
- .4 The wall plates shall be clearly and permanently marked with icon identification for both service types as well as with clear identification of cable/termination numbers.

2.4 PATCH PANELS AND PATCH CORDS

- .1 Patch panels and final connection by CCG forces

2.5 IDC MOUNTING BLOCKS

- .1 Voice horizontal cables shall be terminated onto Category 5e "BIX: style mounting blocks complete with BIX distribution connectors in telecommunications room.

- .2 Provide BIX mounting blocks complete with BIX distribution connectors for termination of telephone inter-building cable, each end, for cross-connect to telephone horizontal field equipment.
- .3 Label BIX connectors, indicating room locations of all outlets.
- .4 Label riser cables.

2.6 GROUND BAR

- .1 Label bus bar connections.
- .2 All patch panels, racks, and cable trays must be bonded to ground with #6 Cu. green insulated ground wire.
- .3 Ground bar shall be a factory assembled unit complete with mounting feet, lugs and predrilled holes, not fabricated on site.

2.7 LABELLING

- .1 Labels on wall plates and patch panels computer printed, black lettering on white tape. Labelling identification numbering to be as directed by Departmental Representative.
- .2 All raceways shall be clearly and permanently marked at both ends to indicate destination and function. The markings shall be clearly visible after construction is completed.
- .3 All empty raceways shall be clearly and permanently marked at both ends to indicate destination and function. The markings shall be clearly visible after construction is completed.
- .4 Each cable shall be clearly marked with a permanent sequential identifier at each end of the cable. All horizontal cable terminations will be labelled at patch panels and at data/comm. outlets. Label of wiring to be the same identifier as the label at the termination point.

2.8 PERFORMANCE REQUIREMENTS

- .1 The complete end-to-end installation, including jacks, cables, patch panels, and patch cords shall meet the industry standard performance parameters for enhanced Category 6 as recommended by CAN/CSA-T529, latest revision. Test parameters shall include: Attenuation, Return Loss, NEXT, Power Sum NEXT, ELNEXT, Power Sum NEXT, ELFEXT, ACR, Power Sum ACR, Propagation Delay, and Delay Skew.

Part 3 Execution

3.1 INSTALLATION OF HORIZONTAL DISTRIBUTION CABLES

- .1 Communications raceway shall be minimum 27mm (1”) EMT conduit stubbed into accessible ceiling space. All cables shall be installed in conduit or cable tray and as indicated on the drawings.
- .2 Wires and cable shall be as short as practical except that sufficient slack shall be provided to:
- .3 Prevent undue stress on cable forms, wires, and connections.
- .4 Enable network components to be removed and replaced during servicing without disconnecting other parts.
- .5 Facilitate movement of equipment for maintenance purposes.
- .6 Wires and cables shall be placed and protected to avoid contact with rough surfaces or sharp edges. Where wires or cables run through holes in metal, they shall be protected by suitable grommets or bushings.
- .7 Clearance between cables and heat emitting or interference generating devices shall be such as to avoid deterioration of these wires and cables due to heat dissipation from these devices, and to comply with industry standards. In particular cables shall have a minimum separation of 150mm from unshielded power lines and 600mm from fluorescent lighting.
- .8 The horizontal wiring shall be continuous with no splice points. Bridged taps are not permitted and there will be no cross-connects between the outlet and the patch panel.
- .9 The maximum cable length for each run is 90 metres and will allow for 3 extra metres at the work station end and 7 extra metres for the patch cord/cross-connect end.
- .10 Each cable shall be clearly marked with a permanent sequential identifier at each end of the cable. All horizontal cable terminations will be labelled at cross-connects and at telecommunications outlets. Labelling will include room number or patch panel as per labelling requirements reference.
- .11 Horizontal conduit fill must comply with the Canadian Electrical Code requirements.

3.2 INSTALLATION OF BACKBONE CABLES

- .1 Install wiring and devices as indicated on plans
- .2 Provide 20mm G.I.S. painted plywood for equipment mounting.
- .3 The cabling components installed in the structured cabling system shall be warranted for a minimum of 25 years from the date of installation against defects in materials and workmanship.
- .4 Leave a pullstring in each data/communications outlet conduit.
- .5 Provide bushings on all conduit ends.

3.3 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Test intra-building telephone cable for continuity.
- .3 All data/communications cables shall be tested using testing equipment approved for Category 5e installations.
- .4 Testing shall be conducted by authorized representative of cable and hardware manufacturer.
- .5 Tests shall be performed from termination block to wall outlet jack on horizontal cables.
- .6 Testing set-up shall be for a channel test, maximum length of 95m.
- .7 Testing shall include verification of labelling integrity.
- .8 Test results shall be documented and shall include the following information in addition to the cable parameters:
 - .1 Cable ID
 - .2 Transmit and Receive locations
 - .3 Test Equipment used to complete the test
 - .4 Contractor's name
 - .5 Technician's name and signature
 - .6 Date test was performed
 - .7 Relevant additional comments
- .9 The complete end-to-end installation, including jacks, cables and patch panels shall meet or exceed industry standard performance requirements for Category 6. Cable test parameters are to include: Attenuation, Return Loss, NEXT, Power Sum NEXT, ELFEXT, Power Sum ELFEXT, ACR, Power Sum ACR, Propagation Delay, and Delay Skew. Permanent Link Test is required.
- .10 Provide verification of the pin outs to CSA T529, ISDN (T568A) configuration.
- .11 Test results must include the Telecommunication Room number from which the cables terminate and indicate the following information:
 - .1 Telecommunication Room
 - .2 Room number of outlet box location
 - .3 Communication jack number.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section specifies materials and installation for fibre optic cable systems

1.2 SCOPE

- .1 Installation of a complete fiber optic cabling system, complete with provision of cables, connectors, and patch panels as indicated on plans.

1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
 - .1 CSA-T529-latest edition, Telecommunications Cabling Systems in Commercial Buildings (Adopted ANSI/EIA TIA 568a with modifications).
 - .2 CAN/CSA-C22.2 No. 182.4-latest edition, Plugs, Receptacles, and Connectors for Communication Systems.
- .2 Telecommunications Industry Association (TIA)
 - .1 TIA/EIA-568-latest edition, Commercial Building Telecommunications Cabling Standards Set.

1.4 DESCRIPTION OF SYSTEM

- .1 Install a complete fiber optic data cabling system as defined on the drawings and in these specifications.
- .2 The contract includes the supply and installation of cabling for a complete system, including but not limited to:
 - .1 Raceways and wireway systems as indicated on plans.
 - .2 Installation of connectors and terminations for all fibers.
 - .3 Testing of all fibers.
 - .4 Final connection and supply of patch panels by CCG forces

1.5 WARRANTY

- .1 There shall be a minimum one year vendor warranty on all cables, components and equipment including installation. The one year warranty period begins upon substantial performance or when the system is fully functional, whichever is later.

1.6 PRODUCT DATA AND SHOP DRAWINGS

- .1 Submit product data and shop drawings in accordance with Section 01 33 00 – Submittal Procedures. This includes any test results provided by the cable manufacturer, and cable test results as specified herein.
- .2 Shop drawings to include dimensions and performance characteristics of equipment and cable routing diagrams.

1.7 MAINTENANCE AND OPERATIONAL DATA

- .1 Provide maintenance data for all fiber optic cables and equipment for insertion into the project Operations and Maintenance Manual.
- .2 Contractor shall supply the Departmental Representative with a complete, up-dated, and accurate set of “As-built” drawings at job completion. These drawings will form part of the project Operations and Maintenance Manual.

Part 2 PRODUCTS

2.1 CONNECTORS

- .1 All fiber connectivity components are to be included in contract.
- .2 All fibers will be terminated using LC style epoxy connectors for multimode, and SC style 8° angle polished pigtails fusion spliced for single mode fibers.

2.2 FIBER OPTIC CABLES

- .1 Fiber optic cables will be provided and installed by the electrical contractor.
- .2 Fibre optic cables shall be:
 - .1 Multimode: (strands as noted in drawings) multimode 50µm/125µm indoor/outdoor distribution fibre.
- .3 Provide WHMIS sheets for fiber cable supplied, showing characteristics of cable construction, etc.

2.3 PATCH PANELS

- .1 All fibers will be terminated onto patch panels by CCG forces.
- .2 Electrical contractor is responsible for the supply of all required equipment and components including but not limited to the following:
 - .1 Adapters, connectors, and pigtails
 - .2 Cable guides as part of an integrated cable management system
 - .3 Heat shrink sleeves

Part 3 EXECUTION

3.1 FIBER OPTIC CABLING – OTDR TESTING

- .1 Test all fibers prior to and after installation to ensure fiber integrity.
- .2 Arrange to obtain all required fiber optic cabling. This contractor is to terminate as necessary, and to perform optical time-domain reflectometer (OTDR) tests on cables intended for use on this project, prior to proceeding with, and after completion of installation, to ensure that the fiber optic cables are free from faults. Submit all test results to Departmental Representative.
- .3 Transmission testing performance parameters:

Wavelength (nm)	Maximum Attenuation (dB/km)	Min. Information Transmission Capacity (MHz-km)
Multimode 850	3.2	1500
Multimode 1300	1.5	500
Single Mode 1310	1.0	N/A
Single Mode 1550	1.0	N/A

3.2 FIBER OPTIC CABLING – INSTALLATION

- .1 Install all runs, terminations and patch panels in strict accordance with industry standards, grouped together by type and in sequence; top down and/or left to right.
- .2 All fiber optic cables are to be installed in conduit or cable trays, for protection of cables.
- .3 Do not apply excessive tension to the cable. Pulling tension shall be less than the cable manufacturer's recommendation.
- .4 The cable shall be installed such that it will not be crushed or damaged during or after installation.
- .5 Any damaged cable, or cable installed with excessive force will be replaced by the electrical contractor at no cost to the project.
- .6 Do not exceed the minimum bend radius of 20 times cable outer diameter for installation, and 10 times cable outer diameter upon completion of the installation.
- .7 Vertical run cables will be supported using intermediate tension relief as recommended by the manufacturer. Use a split wire mesh grip and install the cable from the top down. Vertical cables should be installed using a pulling grip to ensure the stress is placed on the cable itself and not the fiber.
- .8 Cabling shall not be installed in 90° elbows or junction boxes unless the minimum bend radius requirements for the cable are met.
- .9 If lubricant is used, ensure it meets the manufacturer's recommendations.

- .10 Bushings and grommets shall be used on all metal ends, edges, and openings where cables pass through to ensure the cable is not damaged.
- .11 Leave a minimum of 1.5m service loop each end of each cable at each point of termination.
- .12 Cables will be continuous with no splice points.
- .13 Label all individual cables.
- .14 Install all fibre runs in separate conduits for other systems cables. Do not install fibre optic cables in conduits with copper cables.

3.3 INSTALLATION INSPECTION

- .1 The completed installation will be inspected visually by the Departmental Representative prior to the commencement of functional and electrical performance testing. The installation will be inspected for compliance with the industry standards referenced above, and particular attention will be given to the following criteria:
 - .1 Neatness, clamping and harnessing of cables and wiring.
 - .2 Wire and cable management, identification, and labeling.
 - .3 Overall system completeness.
 - .4 Nameplates, identification plates and markings.
 - .5 Construction and finishes.
 - .6 System grounding
 - .7 Mechanical installation including compliance with seismic restraint requirements.

END OF SECTION

Part 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section specifies empty telecommunications raceway systems with either overhead, cabletrough or cellular distribution system.

1.2 SYSTEM DESCRIPTION

- .1 Empty telecommunications raceways system consists of outlet boxes, cover plates, conduits, cabletrays, pull boxes, sleeves and caps, fish wires, concrete encased ducts.

Part 2 Products

2.1 MATERIAL

- .1 Conduits: in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .2 Underground cable ducts: in accordance with Section 33 65 73 - Concrete Encased Ductbanks and Manholes.
- .3 Cabletrays: in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .4 Junction boxes and cabinets: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
- .5 Outlet boxes, conduit boxes, and fittings: in accordance with Section 26 05 31 - Splitters, Junction, Pull Boxes and Cabinets.
- .6 Fish wire: polypropylene type.

Part 3 EXECUTION

3.1 INSTALLATION

- .1 Install empty raceway system, including distribution system, fish wire, terminal cabinets, outlet boxes, floor boxes, pull boxes, cover plates, conduit, sleeves and caps, cabletroughs, service poles, miscellaneous and positioning material to constitute complete system.
- .2 All conduits left as empty or space must be marked at each end with the termination location.

END OF SECTION

Part 1 General

1.1 OVERVIEW

- .1 Supply and install an intrusion alarm system as described in specifications and drawings. Locate the alarm control panel in equipment room.
- .2 The intrusion alarm system shall be integrated seamlessly with the card access system. Provide all required hardware and software for the integration with the card access system. Provide programming to utilize the card access system mapping.
- .3 The contractor shall coordinate with owner's departmental representative regarding final keypad labelling of partitions, areas, doors, zones, etc.
- .4 Supply and install keypads as shown on drawings.
- .5 The contractor shall provide all required components to supply a fully functional intrusion alarm system as described in the contract documents. The contractor shall provide all required components that are not listed in the specification but are required to supply a fully functional intrusion alarm system as described in the contract documents.
- .6 Provide all required wiring for connection to telephone line monitoring. Coordinate alarm monitoring with owner's departmental representative.
- .7 The contractor shall provide mobile applications software for smart phones and smart tablets to enable authorized mobile control of the intrusion alarm system.
- .8 The contractor shall provide battery backup for all intrusion alarm panels, cabinets, etc.
- .9 The contractor shall install motion detectors as shown on drawings. The contractor shall install either long range, or short range, motion detectors to assure that the area required to be protected by the motion detectors is fully covered.

1.2 SECTION INCLUDES

- .1 This Section specifies the intrusion detection system consisting of a control panel, detection accessories, and communications.

1.3 REFERENCE STANDARDS

- .1 Underwriters Laboratories of Canada (ULC)
 - .1 CAN/ULC-S303-latest edition, Local Burglar Alarm Units and Systems
 - .2 CAN/ULC-S304-latest edition, Intrusion Detection
 - .3 CAN/ULC-S306-latest edition, Intrusion Detection Units
 - .4 ULC-S318-latest edition, Power Supplies for Burglar Alarm Systems.
 - .5 ORD-C634-latest edition, Connectors and Switches for Use with Burglar Alarm Systems

1.4 DESIGN PERFORMANCE REQUIREMENTS

- .1 Design intrusion detection system using only ULC/UL Listed products.
- .2 Design intrusion detection system using ULC/UL Listed Alarm Service Company, company specializing in intrusion detection systems.
- .10 Design intrusion detection system as a ULC/UL Certified Alarm System.
- .11 Design system as a modular intrusion alarm, alarm monitoring system expandable, and easily modified for inputs, outputs and remote-control stations.
 - .1 Design components in accordance with CAN/ULC-S306 and be capable of the following:
 - .1 Annunciating undesirable, abnormal or dangerous condition
 - .2 Prioritizing alarms by alarm type, and to include panic/duress alarm, intrusion alarm and tamper alarm
 - .3 Determining zone where alarm occurred
 - .4 Annunciating power failure and power restoration
 - .5 Annunciating low battery condition
 - .6 Operate continuously for minimum period of 4 hours in the event of a power failure.
- .12 Equipment control panels with continuous tamper detection on door and wall.
 - .1 Tamper detection to trigger alarm.
- .13 Design system with the following:
 - .1 Alarm masking
 - .2 Remote maintenance or diagnostics with password activation
 - .3 Unique identifier for each authorized person
 - .4 Arming and disarming capabilities: manual and automatic by time of day, day of week, or by operator command
 - .5 Support both manual and automatic responses to alarms entering system.
 - .6 Each alarm capable of initiating different functions of camera, homing, and activation of remote devices, audio switching, door control and card or pin validation
 - .7 Zone or alarm location annunciated at monitoring station
- .14 Communications link: security level as appropriate for type of facility as described in CAN/ULC-S304.
- .15 Signal link: Security level as appropriate for type of facility as described in CAN/ULC-S304.
- .16 Junction boxes: tamper proof.
- .17 Design system power supplies rated to provide cumulative load of all systems components plus safety factor of 50% or greater.

1.5 CONTRACTOR QUALIFICATIONS

- .1 The Intrusion Alarm System shall be installed by a qualified Security Systems Contractor, certified by the respective equipment manufacturer, and having a minimum of five (5) years installation and service experience with similar installations. The contractor business, employees, managers and owners must be licensed in the Province of British Columbia under the Private Investigators and Security Agencies Act. The business must be licensed and bonded as an Alarm Service and each employee who is installing and servicing security alarm devices and equipment, must be licensed and bonded as an employee of the company and not as a sub-contractor. The equipment installers must hold a valid Trade Qualification Certificate issued by the Province of British Columbia. Proof of the Company and Installers Certification shall be requested and reviewed prior to contract award.

1.6 PRODUCT DATA

- .1 Product Data: Submit manufacturer's printed product literature, specifications and datasheet for engineer and client review.
 - .1 Submit two copies of WHMIS MSDS - Material Safety Data Sheets for engineer and client review.
 - .2 Submit manufacture's literature for each control panel, detection accessory device.
 - .3 Submit:
 - .1 Functional description of equipment
 - .2 Technical data for all devices
 - .3 Device location plans and cable lists
 - .4 Devices mounting location detail drawings
 - .5 Typical devices connection detail drawings
- .2 Shop Drawings: Submit for engineer and client review.
 - .1 Submit shop drawings to indicate project layout, mounting heights and locations, wiring diagrams, detection device coverage patterns, contact operating gaps.
 - .2 Submit zone layout drawing indicating number and location of zones and areas covered.
- .3 Quality Assurance Submittals: Submit the following in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Test Reports: Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
 - .2 Certificates: Submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
 - .1 Submit UL Product Safety Certificates.
 - .2 Submit verification Certificate that service company is ULC/UL Listed alarm service company.
 - .3 Submit verification Certificate that intrusion alarm system is Certified Alarm System.

- .3 Instructions: Submit manufacturer's installation instructions.
- .4 Manufacturer's Field Services: Submit copies of manufacturer's field reports.
- .4 Maintenance Data: Submit maintenance data for incorporation into manual specified in Closeout Submittals.
 - .1 Include:
 - .1 System configuration and equipment physical layout
 - .2 Functional description of equipment
 - .3 Instructions of operation of equipment
 - .4 Illustrations and diagrams to supplement procedures
 - .5 Operation instructions provided by manufacturer
 - .6 Cleaning instructions

1.7 WARRANTY

- .1 For all materials, the 12-month warranty for parts and labour.
- .2 Provide a separate maintenance and service agreements options for the following:
- .3 Extending warranty by 12-months
- .4 Extending warranty by 24-months
- .5 Extending warranty by 36-months
- .6 Additional maintenance and service agreements, with parts to be considered as extra.
- .7 Manufacturer's Warranty: Submit, for Consultant's acceptance, manufacturer's standard warranty document executed by authorized company official.

1.8 SUPPORT SERVICES

- .1 Provide manufacturer/dealer advice, information and support services for 1 year.

Part 2 Products

2.1 MATERIALS

- .1 Control Panel: ULC approved, expandable and designed for multiplexed expansion.
 - .1 Zones (protection inputs): 246
 - .2 Fixed Zones: 8
 - .3 Expandable: 238 zones
 - .4 Number of user codes required: 1000
 - .5 Number of Areas/Partitions required: 32
 - .6 Keypads: 32 unsupervised, 16 supervised
 - .7 Alarm: Monitored
 - .8 System: Wired
 - .9 Integrated with sub systems: access control, building entry

- .10 Programmable outputs required: 131
 - .11 System supervision: telephone
 - .12 Siren output: 12VDC, 2A
 - .13 Number of devices per zone: One (1) Double doors are wired as one zone
 - .14 Battery backup: 2 x 7AH batteries
- .2 Ethernet Communications Module:
- .1 LAN/WAN: RJ-45 modular Ethernet port
 - .2 Communications: 10/100Base-T, IPv6, IPv4 networks
 - .3 Operating Voltage: 12VDC
 - .4 Reporting: full 2-way event
 - .5 Remote Control: full 2-way control and programming
 - .6 Encryption: 128-bit to 256-bit
 - .7 Browser support: Internet Explorer 6 or higher
- .3 Battery backup:
- .1 Amp/hours: 7
 - .2 Voltage: 12VDC
- .4 Enclosures:
- .1 Material: Steel
 - .2 Colour: Grey
 - .3 Dimensions: 410mmL x 410mmH x 90mmD
- .5 Motion Detectors:
- .1 Technology: five sensors, Data Fusion
 - .2 Anti-masking: Yes, MANTIS Technology
 - .3 Active white light suppression: Yes
 - .4 Long range coverage: 18m x 25m, 60ft x 80ft
 - .5 Short range coverage: 8m x 10m, 25ft x 33ft
 - .6 Mounting Height: 2m to 3m
 - .7 Operating Voltage: 9-15VDC
 - .8 Current Consumption: 26mA
 - .9 Tamper contact: NC
 - .10 Trouble contact: NC
 - .11 Alarm relay: NC
 - .12 Colour: White
 - .13 Dimensions: 127mmH x 69mmW x 58mmD
- .6 Long Range Motion Detectors:
- .1 Technology: Passive Infrared, Microwave
 - .2 Anti-masking: Yes,

.3	Long range coverage:	120ft x 25ft, 300ft x 15ft
.4	Broad range coverage:	90ft x 70ft
.5	Mounting:	Wall or Ceiling
.6	Mounting Height:	4.6m maximum
.7	Operating Voltage:	9-15VDC
.8	Current Consumption:	32mA
.9	Tamper contact:	NC
.10	Trouble contact:	NC
.11	Alarm relay:	Form C
.12	Colour:	White
.13	Dimensions:	208mmH x 195mmW x 130mmD

.7 Recess Door Contacts: ULC approved

.1	Mounting:	1" round concealed
.2	Gap:	1"
.3	Mounting:	Steel
.4	Contact:	Normally Closed
.5	Type:	Magnetic

.8 Track Mounted Overhead Door Contacts: ULC approved

.1	Mounting:	Track
.2	Cable Length:	460mm armored cable
.3	Gap:	175" (44.45mm)

.9 Communications: To alarm monitoring station, coordinate with owner.

.10 Connectors and switches: To ORD-C634

.11 Power supplies: Hardwired only to ULC-S318 or UL 603

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 datasheet.

3.2 INSTALLATION

.2 Install panels, intrusion detection system and components in accordance with manufacturer's written installation instructions to locations, heights and surfaces shown on reviewed shop drawings.

.3 Interface intrusion alarm control panel with the card access system. Provide all required programming.

.4 Install panels, intrusion detection system and components secure to walls, ceilings or other substrates.

.5 Install required boxes in inconspicuous accessible locations.

- .6 Label all components of the intrusion alarm systems. Use laser printed labels designed for wrapping around wires. Use laser printed permanent labels for all other devices. Label all of the following:
 - .1 Zone wiring
 - .2 Keypad wiring
 - .3 Motion Detectors – on the detector
 - .4 Door Contacts – on the door frame
 - .5 Keypads
 - .6 Batteries with installation and replacement dates
 - .7 Communications lines and incoming demarcations
 - .8 Power supplies
- .7 Install keypads so that persons standing outside the entrance cannot observe the sequence of the input arm/disarm code.
- .8 Install two (2) door contacts on double doors.
- .9 All security end devices must be “home-run”.
- .10 Provide two (2) lines for monitoring the alarm system off-site. Install communications line in accordance with Section 27 15 00 Communications Cabling Inside Buildings.
- .11 All wiring to be enclosed in appropriately sized, thin wall, electrical tubing (EMT) or conduit.
- .12 Conceal conduit and wiring.
- .13 Provide appropriate signage advertising the fact that a monitored security intrusion alarm system is present. Install at all access points to the building and at periodic intervals around the perimeter of the facility. Submit draft of signage to consultant for approval prior to installation.

3.3 PROGRAMMING

- .1 Provide all required programming for the intrusion alarm system to be completely operable as indicated in specifications and drawings.
- .2 Program all user codes. Coordinate with owner.
- .3 Program all zones with an easy to understand name such as “Main Lobby Entry Doors”.
- .4 Coordinate with owner in regards to entry/exit delay times.
- .5 Provide all required programming to integrate the intrusion alarm system with the card access system.
- .6 Provide all required programming for the intrusion alarm system to communication to an off-site alarm monitoring company. Coordinate with owner in regards to which monitoring company they will be using.
- .7 Provide all required programming for intrusion alarm keypads.
- .8 Program the keypad at the reception to be silent during duress alarms from the reception area.

3.4 TRAINING

- .1 The contractor as part of their tendered price shall provide a minimum three (3) sessions of two (2) hours each additional time allotted, as needed, to perform thorough instruction on the proper operational features of the security systems.
- .2 The contractor as part of their tendered price shall provide a two (2) hour instruction session 30 days after completion of initial training sessions.
- .3 Coordinate training schedules with the owner's departmental representative.

3.5 FIELD QUALITY CONTROL

- .1 Schedule site visits, to review Work, at stages listed:
 - .1 After delivery and storage of products, and when preparatory Work, or other Work, on which the Work of this Section depends, is complete but before installation begins.
 - .2 Twice during progress of Work at 25% and 60% complete.
 - .3 Upon completion of the Work, after cleaning is carried out.
- .2 Obtain reports, within 3 days of review, and submit, immediately, to Consultant.

3.6 VERIFICATION

- .1 Perform verification inspections and test in the presence of Consultant.
 - .1 Provide all necessary tools, ladders and equipment.
 - .2 Ensure appropriate subcontractors and manufacturer's representatives are present for verification.
- .2 Test each zone for the following:
 - .1 Zone identification
 - .2 Zone detection
 - .3 Zone tampering
 - .4 All zone type reporting to monitoring station
 - .5 Zone delay times
 - .6 Zone operations including accessories such as keypads, sirens, and horns.
- .3 Test all programming functions, keypad functions, intrusion alarm functions and all integration functions to card access functions. Provide a written test report showing all the tests that have been completed and the results of the tests. Submit to consultant for approval. Submit copies of approved test results in shop drawing submittal.
- .4 Visual verification: Objective is to assess quality of installation and assembly and overall appearance to ensure compliance with Contract Documents. Visual inspection to include:
 - .1 Sturdiness of equipment fastening
 - .2 Non-existence of installation related damages
 - .3 Compliance of device locations with reviewed shop drawings
 - .4 Compatibility of equipment installation with physical environment
 - .5 Inclusion of all accessories

- .6 Device and cabling identification
- .7 Application and location of ULC approval decals
- .5 Technical verification: The purpose is to ensure that all systems and devices are properly installed, and free of defects and damage. Technical verification includes:
 - .1 Measurements of coverage patterns
 - .2 Connecting joints and equipment fastening
 - .3 Compliance with manufacturer's specification, product literature and installation instructions
- .6 Operational verification: Purpose to ensure that devices and systems' performance meet or exceed established functional requirements. Operational verification includes:
 - .1 Operation of each device individually and within its environment
 - .2 Operation of each device in relation with programmable schedule and or/specific functions.

3.7 CLEANING AND ADJUSTING

- .1 Remove protective coverings from control panels, detection accessories and components.
- .2 Adjust all components for correct function.

Clean housings and system components, free from marks, packing tape, and finger prints, in accordance with manufacturer's written cleaning recommendations.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM D4791 (latest edition), Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 – Shop Drawings, Product Data and Sample.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for aggregate materials and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
 - .1 Submit gradation curves of aggregate material as outlined in Section 31 23 33.01 to Departmental Representative for review.
 - .2 Allow continual sampling by Departmental Representative during production if requested.
 - .3 Provide Departmental Representative with access to source and processed material for sampling.
 - .4 Supply new or clean sample bags or containers according appropriate to aggregate materials.
 - .5 Pay cost of sampling and testing of aggregates which fail to meet specified requirements.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Transportation and Handling: handle and transport aggregates to avoid segregation, contamination and degradation.
- .3 Storage: store washed materials or materials excavated from underwater 24 hours minimum to allow free water to drain and for materials to attain uniform water content.

Part 2 Products

2.1 MATERIALS

- .1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material, clay lumps or minerals, free from adherent coatings and injurious amounts of disintegrated pieces or other deleterious substances.
- .2 Granular Sub-base and Granular Base material: properties in accordance with the following requirements:
 - .1 Crushed or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation	% Passing		
	Granular Sub-Base (75mm crushed gravel)	Granular Base (19mm crushed gravel)	Sand
75 mm	100	-	-
50 mm	-	-	-
37.5 mm	60-100	-	-
25 mm	-	-	-
19 mm	35-80	100	-
12.5 mm	-	75-100	100
9.5 mm	26-60	60-90	-
4.75 mm	20-40	40-70	45-100
2.36 mm	15-30-	27-55	30-90
2.00 mm	-	-	-
1.18 mm	10-20	16-42	-
0.600 mm	5-15	8-30	10-50
0.425 mm	-	-	-
0.300 mm	3-10	5-20	3-20
0.180 mm	-	-	-
0.150 mm	-	-	-
0.075 mm	0-5	2-8	0-8

- .3 Unshrinkable fill: proportioned and mixed to provide:
 - .1 Maximum compressive strength of 0.4 MPa at 28 days.
 - .2 Maximum cement content of 25 kg/m; to CSA-A3001, Type GU.
 - .3 Minimum strength of 0.07MPa at 24 h.
 - .4 Concrete aggregates: to CSA-A23.1/A23.2.
 - .5 Cement: Type GU.
 - .6 Slump: 160 to 200 mm.
- .4 Flat and elongated particles of coarse aggregate: to ASTM D4791.
 - .1 Greatest dimension to exceed 5 times least dimension.

- .5 Fine aggregates satisfying requirements of applicable section to be one, or blend of following:
 - .1 Screenings produced in crushing of quarried rock, boulders, gravel or slag.
 - .2 Reclaimed asphalt pavement.
 - .3 Reclaimed concrete material.
- .6 Coarse aggregates satisfying requirements of applicable section to be one of or blend of following:
 - .1 Crushed rock.
 - .2 Gravel and crushed gravel composed of naturally formed particles of stone.
 - .3 Light weight aggregate, including slag and expanded shale.
 - .4 Reclaimed asphalt pavement.
 - .5 Reclaimed concrete material.

2.2 SOURCE QUALITY CONTROL

- .1 Inform Department Representative of proposed source of aggregates and provide access for sampling 4 weeks minimum before starting production.
- .2 If materials from proposed source do not meet, or cannot reasonably be processed to meet, specified requirements, locate alternative source.
- .3 Advise Department Representative 4 weeks minimum in advance of proposed change of material source.
- .4 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions are acceptable for topsoil stripping.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Department Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with topsoil stripping only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Topsoil stripping:
 - .1 Do not handle topsoil while in wet or frozen condition or in any manner in which soil structure is adversely affected.
 - .2 Begin topsoil stripping of areas as directed by Departmental Representative after area has been cleared of brush, weeds, grasses and removed from site.
 - .3 Strip topsoil to depths as directed by Departmental Representative. Avoid mixing topsoil with subsoil.
 - .4 Stockpile in locations as directed by Departmental Representative. Stockpile height not to exceed 2 m.
 - .5 Dispose of topsoil as directed by Departmental Representative.
- .2 Aggregate source preparation:
 - .1 Prior to excavating materials for aggregate production, clear and grub area to be worked, and strip unsuitable surface materials. Dispose of cleared, grubbed and unsuitable materials as approved by authority having jurisdiction.
 - .2 Where clearing is required, leave screen of trees between cleared area and roadways as directed.
 - .3 Clear, grub and strip area ahead of quarrying or excavating operation sufficient to prevent contamination of aggregate by deleterious materials.
 - .4 When excavation is completed dress sides of excavation to nominal 1.5:1 slope, and provide drains or ditches as required to prevent surface standing water.
 - .5 Trim off and dress slopes of waste material piles and leave site in neat condition.
 - .6 Provide silt fence or other means to prevent contamination of existing watercourse or natural wetland features.
- .3 Processing:
 - .1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.
 - .2 Blend aggregates, as required, including reclaimed materials that meet physical requirements of specification is permitted in order to satisfy gradation requirements for material and, percentage of crushed particles, or particle shapes specified.
 - .1 Use methods and equipment approved in writing by Departmental Representative.

- .4 When operating in stratified deposits use excavation equipment and methods that produce uniform, homogeneous aggregate gradation.
- .5 Where necessary, screen, crush, wash, classify and process aggregates with suitable equipment to meet requirements.
 - .1 Use only equipment approved in writing by Departmental Representative.
- .6 Stockpiling:
 - .1 Stockpile aggregates on site in locations as indicated unless directed otherwise by Departmental Representative. Do not stockpile on completed pavement surfaces.
 - .2 Stockpile aggregates in sufficient quantities to meet project schedules.
 - .3 Stockpiling sites to be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.
 - .4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of aggregate. Stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into Work.
 - .5 Separate different aggregates by strong, full depth bulkheads, or stockpile far enough apart to prevent intermixing.
 - .6 Do not use intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Department Representative within 48 hours of rejection.
 - .7 Stockpile materials in uniform layers of thickness as follows:
 - .1 Maximum 1.5 m for coarse aggregate and base course materials.
 - .2 Maximum 1.5 m for fine aggregate and sub-base materials.
 - .3 Maximum 1.5 m for other materials.
 - .8 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
 - .9 Do not cone piles or spill material over edges of piles.
 - .10 Do not use conveying stackers.
 - .11 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.3 CLEANING

- .1 Progress Cleaning:
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Leave aggregate stockpile site in tidy, well drained condition, free of standing surface water.
- .4 Leave any unused aggregates in neat compact stockpiles as directed by Departmental Representative.
- .5 Waste Management: separate waste materials for reuse or recycling.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
- .6 Restrict public access to temporary or permanently abandoned stockpiles by means acceptable to Departmental Representative.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 31 23 16.26 - Excavating, Trenching and Backfill
- .2 Section 01 14 00 – Work Restrictions

1.2 REFERENCES

- .1 Definitions:
 - .1 Rock is defined as all solid rock in form of bedrock, masses, ledges, seams or layers and includes igneous rock of any sort, conglomerate, sandstone or shale, that requires breaking by continuous drilling and blasting before excavation and removal. Rock also includes rocks having individual volumes in excess of 1.0m³, removed by blasting or other means.
 - .2 Dense tills, hardpan, partially cemented materials, clay or frozen materials which do not require breaking by continuous drilling and blasting before excavation and removal are not classified as rock.

Part 2 Products

2.1 NOT USED

Part 3 EXECUTION

3.1 ROCK REMOVAL

- .1 Co-ordinate this Section with Section 01 35 33 - Health and Safety Requirements.
- .2 Strip Rock of all earth.
- .3 Notify Departmental Representative when rock is exposed to coordinate review by Departmental Representative's Geotechnical Engineer. Departmental Representative requires minimum (4) calendar days' notice in advance of review to permit coordination of field review.
- .4 Rock blasting is not permitted due to proximity to sensitive electronic communications equipment located at site.
- .5 Remove rock to alignments, profiles, and cross sections required for installation of building footings and underground services.
- .6 Use rock removal procedures to produce uniform and stable excavation surfaces. Minimize overbreak, and to avoid damage to adjacent structures.
- .7 Excavate rock to horizontal surfaces with slope not to exceed Geotechnical Consultant's recommendations.
- .8 Prepare rock surfaces which are to bond to concrete, by scaling, pressure washing and broom cleaning surfaces.
- .9 Excavate trenches to lines and grades to minimum of 150 mm below pipe invert or duct bank as indicated. Provide recesses for bell and spigot pipe to ensure bearing will occur uniformly along barrel of pipe.

- .10 Cut trenches to widths as indicated.

Part 4 CLEANING

- .1 Clean in accordance with Section 01 74 11 - Cleaning.
- .2 Rock Disposal:
 - .1 Submit to Departmental Representative for review, location for offsite disposal of surplus rock.
 - .2 Dispose of surplus removed rock at approved location offsite.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 01 33 00 Submittal Procedures
- .2 Section 01 51 00 Temporary Facilities
- .3 Section 31 05 16 Aggregate Materials
- .4 Section 32 11 23 Aggregate Base Courses

1.2 REFERENCES

- .1 Master Municipal Contract Documents (MMCD), Platinum Edition Volume II - 2009, British Columbia.
- .2 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C117-04, Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C136-05, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D422-632002, Standard Test Method for Particle-Size Analysis of Soils.
 - .4 ASTM D698-00ae1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN- m/m³).
 - .5 ASTM D1557-02e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN- m/m³).
 - .6 ASTM D4318-05, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .4 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000-03, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .1 CSA-A3001-03, Cementitious Materials for Use in Concrete.
 - .2 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.3 DEFINITIONS

- .1 Disposal Facility:
 - .1 An existing facility located in Canada where soil or other material is placed in or on land and that is designed, constructed, and operated to prevent any pollution from being caused by the facility outside the area of the facility.

- .2 The facility must hold a valid and subsisting permit, certificate, approval, or any other form of authorization issued by a province or territory for the disposal of soil characterized with:
 - .1 Concentrations: RL- Metals and Hydrocarbons.
 - .2 Concentrations: IL+ Metals with RL+ Hydrocarbons.
 - .3 Concentrations: IL+ Metals with RL– Hydrocarbons.
- .3 The facility must comply with federal, provincial, municipal, local, or other legislation, regulations, codes, by-laws, zoning, or other requirements.
- .2 Excavation classes: two classes of excavation will be recognized; rock excavation common excavation and.
 - .1 Rock: solid material in excess of 1.00m³, and which cannot be removed by means of heavy duty mechanical excavating equipment available on site. Frozen material not classified as rock
 - .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .3 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .4 Topsoil:
 - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
 - .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .5 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .6 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of Work.
- .7 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .8 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Frost susceptible materials:
 - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136 : Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.

.2 Table:

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 – 80
0.005 mm	0 - 45

- .3 Coarse grained soils containing more than 20 % by mass passing 0.075 mm sieve.
- .9 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

1.4 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Preconstruction Submittals:
 - .1 Within (14) calendar days of Award of Contract, Contractor to submit to Departmental Representative for review and approval, location of proposed soil disposal facility prior to disposal of any material.
 - .2 Contractor to submit records of underground utility pre-locates of existing utilities for review by Departmental Representative within (2) calendar days of completion of locate work.
 - .3 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
 - .1 All tracked equipment to have rubber track pads when working on paved surfaces on site.
 - .4 Within (21) calendar days of Award of Contract, Submit certificates for proposed granular materials to confirm compliance with the Canadian Council of Ministers of the Environment (CCME) Residential/Parkland (RL/PL) Land Usage Soil Quality Guidelines.
- .3 Quality Control: in accordance with Section 01 45 00 - Quality Control:
 - .1 Submit name of testing laboratory retained by Contractor for materials testing for review and approval by Departmental Representative.
 - .2 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
 - .3 Submit to Departmental Representative written notice when bottom of excavation is reached.
 - .4 Submit to Departmental Representative testing inspection results report as described in PART 3 of this Section.
- .4 Samples:
 - .1 Inform Departmental Representative at least 4 weeks prior to beginning Work, of proposed source of fill materials and provide documentation that proposed fill meets CCME guidelines.

1.5 CONTAMINATED SOIL

- .1 CCG's consultant has completed soil characterization testing within the building excavation area. A copy of the report detailing the findings of the characterization is included in the specification APPENDIX for Contractor review and use.
- .2 Payment for disposal (including loading and hauling costs) of characterized material will be paid as a negotiated change order to the contract. Contractor must provide PSPC with

all disposal records including weigh bills, disposal receipts and truck manifest documentation.

- .3 The area for building excavation is known to contain soil contamination. Based on soil characterization test results, excavated materials found within the area of the Work include contamination that contains:
 - .1 Concentrations: RL- Metals and Hydrocarbons.
 - .2 Concentrations: IL+ Metals with RL+ Hydrocarbons.
 - .3 Concentrations: IL+ Metals with RL- Hydrocarbons.
- .4 All material from areas identified as containing concentrations listed above is to be “hot loaded” into dump trucks and transported directly to approved disposal facility. No stockpiling of materials listed in Item 1.5.3 above will be permitted.

1.6 QUALITY ASSURANCE

- .1 Notify Departmental Representative (48) hours in advance of completing foundation excavation to allow for coordination of Owner’s geotechnical engineer to conduct field review prior to placement of engineered fill, footing formwork or concrete.
- .2 Qualification Statement: submit proof of insurance coverage for professional liability for professionals retained by Contractor.
- .3 Submit design and supporting data for excavations at least 2 weeks prior to beginning Work. Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in Province of British Columbia, Canada.
- .4 Keep design and supporting data on site.
- .5 Do not use soil material until written report of soil test results are reviewed and approved by Departmental Representative.
- .6 Health and Safety Requirements:
 - .1 Do construction occupational health and safety in accordance with Section 01 35 33 - Health and Safety Requirements.

1.7 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
- .2 Divert materials from landfill to local facility for reuse.

1.8 EXISTING CONDITIONS

- .1 Examine soil report prepared by Geotechnical Engineer in specification APPENDIX.
- .2 Examine contaminated soils characterization report by CCG’s consultant in specification APPENDIX.
- .3 Buried services:
 - .1 Before commencing work verify location of buried services on and adjacent to work area.

- .2 Conduct utility locates in all areas of excavation to identify location and approximate depth of services.
- .3 Retain and pay for hydroexcavation company to conduct a “Hydro-Vac” excavation of utilities identified on Contract documents.
- .4 Arrange with appropriate authority for relocation of buried services that interfere with execution of work.
- .5 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
- .6 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
- .7 Prior to beginning excavation Work, notify applicable Departmental Representative establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during Work.
- .8 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
- .9 Where utility lines or structures exist in area of excavation, obtain direction of Departmental Representative before removing or re-routing.
- .10 Record location of maintained, re-routed and abandoned underground lines on project record drawings.
- .11 Confirm locations of recent excavations adjacent to area of excavation.
- .4 Existing buildings and surface features:
 - .1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative.
 - .3 Where required for excavation, cut roots or branches as directed by Departmental Representative.

Part 2 - Products

2.1 MATERIALS

- .1 Granular Sub-base and Granular Base material: in accordance with Section 31 05 16 – Aggregate Materials

Part 3 - Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control drawings, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.

- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 SITE PREPARATION

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
- .2 Cut pavement or sidewalk neatly along limits of proposed excavation in order that surface may break evenly and cleanly.

3.3 PREPARATION/PROTECTION

- .1 Protect existing features in accordance with applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Departmental Representative.
- .4 Protect natural and man-made features required to remain undisturbed. Unless otherwise indicated or located in an area to be occupied by new construction, protect existing trees from damage.
 - .1 Protect buried services that are required to remain undisturbed.

3.4 STRIPPING OF TOPSOIL

- .1 Begin topsoil stripping from work area after has been cleared of brush, weeds, grasses and removed from site.
- .2 Strip topsoil to depths required.
 - .1 Do not mix topsoil with subsoil.
- .3 Stockpile in locations as directed by Departmental Representative.
 - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .4 Dispose of unused topsoil as directed by Departmental Representative.

3.5 STOCKPILING

- .1 Stockpile fill materials in areas designated in temporary facilities plan.
 - .1 Stockpile granular materials in manner to prevent segregation.
 - .2 Protect fill materials from contamination.
 - .3 Implement sufficient erosion and sediment control measures to prevent sediment release off construction boundaries and into water bodies.

3.6 DEWATERING AND HEAVE PREVENTION

- .1 Keep excavations free of water while Work is in progress.
- .2 Protect open excavations against flooding and damage due to surface run-off.

- .3 Dispose of water in accordance with Section 01 35 43 - Environmental Procedures to approved runoff areas or containment facilities and in manner not detrimental to public and private property, or portion of Work completed or under construction.
 - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.
- .4 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to watercourses or drainage areas.

3.7 EXCAVATION

- .1 Advise Departmental Representative at least 7 days in advance of excavation operations. Excavate to lines, grades, elevations and dimensions as indicated.
- .2 Remove concrete, masonry, paving, walks, demolished foundations and rubble and other obstructions encountered during excavation offsite.
- .3 Excavation must not interfere with bearing capacity of adjacent foundations and slabs. Contractor to notify Departmental Representative immediately where undermining of slabs of foundations occurs. Contractor responsible for devising and executing a remediation plan for filling all voids associated with undermining of slabs and foundations.
- .4 Do not disturb soil within branch spread of trees or shrubs that are to remain.
 - .1 If excavating through roots, excavate by hand and cut roots with sharp axe or saw, as directed by the project Arborist.
 - .2 Provide 24 hours' notice to Departmental Representative of need for Arborist on site.
- .5 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30 m of trench in advance of installation operations. No more than 5 m of trench may be exposed at end of day's operation and must be securely covered. Road plates are to be used to cover exposed excavations in areas of vehicular travel.
- .6 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
- .7 Restrict vehicle operations directly adjacent to open trenches.
- .8 Dispose of surplus and unsuitable excavated material at approved receiving facilities. Contractor must provide PSPC with all disposal records including weigh bills, disposal receipts and chain of custody documentation.
- .9 Do not obstruct flow of surface drainage or natural watercourses.
- .10 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .11 Notify Departmental Representative when bottom of excavation is reached.
- .12 Obtain Departmental Representative approval of completed excavation.
- .13 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.

- .14 Correct unauthorized over-excavation as follows:
 - .1 Fill with granular base material to not less than 95% Modified Proctor Density.
- .15 Hand trim, make firm and remove loose material and debris from excavations.
 - .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
 - .2 Clean out rock seams and fill with concrete mortar or grout to approval of Departmental Representative.

3.8 BEDDING AND SURROUND OF UNDERGROUND SERVICES

- .1 Place and compact granular material for bedding and surround of underground services as indicated.
- .2 Place bedding and surround material in unfrozen condition.

3.9 BACKFILLING

- .1 Do not proceed with backfilling operations until completion of following:
 - .1 Departmental Representative has inspected and approved installations.
 - .2 Departmental Representative has inspected and approved of construction below finish grade.
 - .3 Inspection, testing, approval, and recording location of underground utilities.
 - .4 Removal of concrete formwork.
 - .5 Removal of shoring and bracing; backfilling of voids with satisfactory soil material.
- .2 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .3 Do not use backfill material which is frozen or contains ice, snow or debris.
- .4 Place backfill material in uniform layers not exceeding 300 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Backfilling around installations:
 - .1 Do not backfill around or over cast-in-place concrete within 24 hours after placing of concrete.
 - .2 Place layers simultaneously on both sides of installed Work to equalize loading. Difference not to exceed 0.150 m.
 - .3 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
 - .1 Permit concrete to cure for minimum 14 days or until it has sufficient strength to withstand earth and compaction pressure and approval obtained from Departmental Representative.
- .6 Place unshrinkable fill in areas as indicated.
- .7 Consolidate and level unshrinkable fill with internal vibrators.
- .8 Install drainage system in backfill as indicated.

3.10 GRADING

- .1 Grade so that water will drain away from buildings, walls and paved areas, to catch basins and other disposal areas approved by Departmental Representative.
- .1 Grade to be gradual between finished spot elevations shown on drawings.

3.11 RESTORATION

- .1 Upon completion of Work, remove waste materials and debris in accordance to Section 01 74 21 - Construction/Demolition Waste Management and Disposal, trim slopes, and correct defects as directed by Departmental Representative.
- .2 Replace topsoil as indicated.
- .3 Reinstate lawns to elevation which existed before excavation.
- .4 Reinstate pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .5 Clean and reinstate areas affected by Work as directed by Departmental Representative.
- .6 Use temporary plating to support traffic loads over unshrinkable fill for initial 24 hours.
- .7 Protect newly graded areas from traffic and erosion and maintain free of trash or debris.

END OF SECTION

Part 1 – GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 01 61 00 Common Product Requirements.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C117-04, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C131-06, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .3 ASTM C136-06, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .4 ASTM D698-07e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft³) (600kN-m/m³).
 - .5 ASTM D1557-09, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³) (2,700kN-m/m³).
 - .6 ASTM D1883-07e2, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
 - .7 ASTM D4318-10, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 U.S. Environmental Protection Agency (EPA) / Office of Water
 - .1 EPA 832/R-92-005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.
- .4 Master Municipal Contract Documents (MMCD), Platinum Edition Volume II - 2009, British Columbia – Section 31 05 17.

1.3 ACTION AND INFORMATION SUBMITTALS

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit certificates for proposed granular materials to confirm compliance with the Canadian Council of Ministers of the Environment (CCME) Residential/Parkland (RL/PL) Land Usage Soil Quality Guidelines.

1.4 DELIVERY, STORAGE AND HANDLING

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

Part 2 - Products

2.1 MATERIALS

- .1 Granular Base and Granular Sub-Base material: properties in accordance with the following requirements:
 - .1 Crushed or screened stone, gravel or sand.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation	% Passing		
	Granular Sub-Base (75mm crushed gravel)	Granular Base (19mm crushed gravel)	Sand
75 mm	100	-	-
50 mm	-	-	-
37.5 mm	60-100	-	-
25 mm	-	-	-
19 mm	35-80	100	-
12.5 mm	-	75-100	100
9.5 mm	26-60	60-90	-
4.75 mm	20-40	40-70	45-100
2.36 mm	15-30-	27-55	30-90
2.00 mm	-	-	-
1.18 mm	10-20	16-42	-
0.600 mm	5-15	8-30	10-50
0.425 mm	-	-	-
0.300 mm	3-10	5-20	3-20
0.180 mm	-	-	-
0.150 mm	-	-	-
0.075 mm	0-5	2-8	0-8

Part 3 - Execution

3.1 PREPARATION

- .1 Temporary Erosion and Sedimentation Control:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.

- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 PLACEMENT AND INSTALLATION

- .1 Place granular base after sub-base and subgrade surface is inspected and approved in writing by 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 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
 - .1 Departmental Representative may authorize thicker lifts (layers) if specified compaction can be achieved.
 - .7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
 - .8 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 Compaction Equipment:
 - .1 Ensure compaction equipment is capable of obtaining required material densities.
- .4 Compacting:
 - .1 Compact to density not less than 95% Modified Proctor Density to ASTM D1557.
 - .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 in writing by Departmental Representative.
 - .5 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.
- .5 Proof rolling:
 - .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm.
 - .2 Obtain written approval from Departmental Representative to use non-standard proof rolling equipment.
 - .3 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

- .4 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 common material and compact.
 - .3 Replace sub-base material and compact.
 - .4 Replace base material and compact in accordance with this Section.
- .5 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 this section at no extra cost.

3.3 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.

3.4 PROTECTION

- .1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Departmental Representative.

3.5 CLEANING

- .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 - GENERAL

1.1 RELATED SECTIONS

- .1 Section 01 33 00 – Submittal Procedures.
- .2 Section 01 74 21 – Construction/Demolition Waste Management And Disposal.
- .3 Section 32 11 23 – Aggregate Base Courses

1.2 REFERENCES

- .1 American Society for Testing and Materials International, (ASTM).
 - .1 ASTM D1557-12e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (2,700 kN-m/m³)).
 - .2 ASTM C88-13, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
 - .3 ASTM C117-13, Standard Test Method for Material Finer Than 0.075 (No. 200) mm Sieve in Mineral Aggregates by Washing.
 - .4 ASTM C123-14, Standard Test Method for Lightweight Particles in Aggregate.
 - .5 ASTM C127-15, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
 - .6 ASTM C128-15, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
 - .7 ASTM C131-14, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .8 ASTM C136-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .9 ASTM D698-12E2, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³).
 - .10 ASTM D995-95b (2002), Standard Specification for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
 - .11 ASTM D1557-12E1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³).
 - .12 ASTM D1559-89, Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
 - .13 ASTM D2419-14, Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - .14 ASTM D3203-11, Standard Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures.
 - .15 ASTM D4318-10E1, Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 - .16 ASTM D4791-10, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

- .2 Asphalt Institute (AI)
 - .1 AI MS-2-94, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-1.5 – M91 (March 1999), Low Flash Petroleum Spirits Thinner.
 - .2 CAN/CSGB-1.74 – 2001, Alkyd Traffic Paint.
 - .3 CAN/CGSB-8.1-88, Sieves Testing, Woven Wire, Inch Series.
 - .4 CAN/CGSB-8.2-M88 Sieves Testing, Woven Wire, Metric.
- .4 British Columbia Ministry of Transportation and Infrastructure, 2016 Standard Specification for Highway Construction

1.3 SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit asphalt concrete mix design to Departmental Representative at least 2 weeks prior to commencing work.

1.4 SAMPLES

- .1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit to Department Representative, samples of material for sieve analysis at least 2 weeks before beginning Work.

1.5 QUALITY ASSURANCE

- .1 Testing to be completed by accredited testing laboratory.

1.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate and recycle waste materials in accordance with Section 01 74 21 – Construction/Demolition Waste Management and Disposal.
- .2 Remove from site and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal paper, plastic, polystyrene, corrugated cardboard, packaging material in appropriate on-site bins for recycling in accordance with Waste Management Plan.
- .4 Place materials defined as hazardous or toxic in designated containers.
- .5 Divert unused aggregate materials from landfill to facility for reuse as approved by Department Representative.
- .6 Dispose of unused paint and paint thinner materials at official hazardous material collections site as approved by Department Representative.
- .7 Fold up metal banding, flatten and place in designated area for recycling.
- .8 Do not dispose of unused paint thinner material into sewer system, into streams, lakes, onto ground or in other location where it will pose health environmental hazard.
- .9 Divert unused asphalt from landfill to facility capable of recycling materials.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect aggregate from damage.
 - .3 Replace defective or damaged materials with new.

Part 2 - Products

2.1 MATERIALS

- .1 Aggregates: in accordance with Section 31 05 16 – Aggregate Materials
- .2 Asphalt concrete aggregates:
 - .1 Coarse aggregate is aggregate retained on 4.75 mm sieve and fine aggregate is aggregate passing 4.75 mm sieve when tested to ASTM C136.
 - .2 When dryer drum plant or plant without hot screening is used, process fine aggregate through 4.75 mm sieve and stockpile separately from coarse aggregate.
 - .3 Separate stock piles for coarse and fine aggregate are not required for sheet asphalt.
 - .4 Do not use aggregates having known polishing characteristics in mixes for surface courses.
 - .5 Aggregate: material to the following requirements:
 - .1 Crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material and other deleterious materials.
 - .2 Gradations to be within limits specified when tested to ASTM C136 and ASTM C117. Sieve sizes to CAN/CGSB-8.2.
 - .3 Table:

Sieve Designation	Percent Passing			
	*Lower Course #1	*Lower Course #2	*Upper Course #1	*Upper Course #2
25.0 mm	100	--	--	--
19.0 mm	--	100	100	--
12.5 mm	70 - 85	84 - 99	84 - 99	100
9.5 mm	--	73 - 88	73 - 88	--
4.75 mm	40 - 65	50 - 68	50 - 68	55 - 75
2.36 mm	32 - 53	35 - 55	35 - 55	38 - 58
1.18 mm	26 - 44	27 - 46	27 - 46	28 - 47
0.600 mm	18 - 36	18 - 36	18 - 36	20 - 36
0.300 mm	10 - 26	10 - 26	10 - 26	10 - 26
0.150 mm	4 - 17	4 - 17	4 - 17	4 - 17
0.075 mm	3 - 8	3 - 8	3 - 8	3 - 8

*** Footnote to asphalt mix-type selection:**

Lower Course #1: Arterial and collector, lower course only.

Lower Course #2: Local, lower course only.

Upper Course #1: Arterial and collector, upper course only.

Upper Course #2: Local, surface course only.

- .4 Sand equivalent: to ASTM D2419, Minimum 40.
- .5 Magnesium Sulphate soundness: to ASTM C88. Max % loss by mass after five cycles:
 - .1 Coarse aggregate 15,
 - .2 Fine aggregate 18.
- .6 Los Angeles abrasion: Grading B, to ASTM C131. Max % loss by mass:
 - .1 Coarse aggregate, upper course: 25,
 - .2 Coarse aggregate, lower course: 35.
- .7 Absorption: to ASTM C127. Max % by mass:
 - .1 Coarse aggregate, upper course: 1.75,
 - .2 Coarse aggregate, lower course: 2.00.
- .8 Loss by washing: to ASTM C117. Max % passing 0.075mm sieve:
 - .1 Coarse aggregate, upper course: 1.5,
 - .2 Coarse aggregate, lower course: 2.0.
- .9 Flat and elongated particles: to ASTM D4791, (with length to thickness ratio greater than 3): Max % by mass:
 - .1 Coarse aggregate, upper coarse: 10
 - .2 Coarse aggregate, lower coarse: 10
- .10 Crushed fragments: at least 60% of particles by mass within each of the following sieve designation ranges, to have at least 2 freshly fractured faces. Material to be testing according to ASTM C136 and ASTM C117.
- .11 Determination of the amount of fractured material will be in accordance with British Columbia Ministry of Transportation and Infrastructure, 2016 Standard Specification for Highway Construction, Appendix 1, Fracture Count for Coarse Aggregate, Method "B", which determines fractured faces by mass.

Passing		Retained on
25mm	to	12.5mm
12.5mm	to	4.75mm

- .12 Regardless of compliance with specified physical requirements, fine aggregates may be accepted or rejected on basis of past field performance.
- .3 Mineral filler for asphalt concrete:
 - .1 Finely ground particles of limestone, hydrated lime, Portland cement or other approved non-plastic mineral matter, thoroughly dry and free from lumps.
 - .2 Add mineral filler when necessary to meet job mix aggregate gradation or as directed by Departmental Representative to improve mix properties.
 - .3 Mineral filler to be dry and free flowing when added to aggregate.
- .4 Asphalt cement: to CGSB-16.3-M90, Grade 80-100.
- .5 Asphalt prime: to CAN/CGSB-16.1 grade RM-20.

- .6 Sand blotter: clean granular material passing 4.75 mm sieve and free from organic matter or other deleterious materials.
- .7 Asphalt tack coat: to CAN/CGSB-16.2, grade SS-1.

2.2 MIX DESIGN

- .1 Mix design to AI MS-2.
- .2 Job mix formula to be approved by Departmental Representative.
- .3 Design of mix: by Marshall Method to requirements below:
 - .1 Compaction blows on each face of test specimens: 75.
 - .2 Mix physical requirements:

Property	Pavement Course
Marshall Stability at 60 degrees C, kN minimum.	6.4 lower course 5.5 upper course 5.5 fine
Flow Value, mm.	2-4
Air Voids in Mixture, %	3-6 lower course 3-5 upper course 3-5 fine
Voids in Mineral Aggregate, % minimum	13 lower course 1 14 lower course 2 14 upper course 1 15 upper course 2 15 fine
Index of Retained Stability, % minimum	75

- .3 Measure physical requirements as follows:
 - .1 Marshall load and flow value: to ASTM D1559.
 - .2 SPEC NOTE: Use one of the following two paragraphs.
 - .3 Air voids: to ASTM D3203.
 - .4 Index of Retained Stability: measure in accordance with Section Marshall Immersion Test (ASTM D1559).
- .4 Do not change job-mix without prior approval of Departmental Representative. When change in material source proposed, new job-mix formula to be submitted to Departmental Representative for review and approval.

2.3 FOUNDATIONS

- .1 Foundations for roadways and parking lots comprise:
 - .1 250mm compacted thickness of granular subbase.
 - .2 100mm compacted thickness of granular base.

2.4 PAVEMENT THICKNESS

- .1 Pavements for roadways and parking lots.
 - .1 Base course: 40mm, Upper Course #1
 - .2 Wear course: 40mm, Upper Course #1.

Part 3 - Execution

3.1 PLANT AND MIXING REQUIREMENTS

- .1 Batch and continuous mixing plants:
 - .1 To ASTM D995.
 - .2 Heat asphalt cement and aggregate to mixing temperature. Do not heat asphalt cement above 160°C.
 - .3 Before mixing, dry aggregates to a moisture content not greater than 0.5% by mass or to a lesser moisture content if required to meet mix design requirements.
 - .4 Contractor's testing agency will monitor temperature of completed mix at plant and at paver after considering hauling and placing conditions.
 - .5 Feed aggregates from individual stockpiles through separate bins to cold elevator feeders.
 - .6 Feed cold aggregates to plant in proportions that will ensure continuous operations.
 - .7 Immediately after drying, screen aggregates into hot storage bins in sizes to permit recombining into gradation meeting job-mix requirements.
 - .8 Store hot screened aggregates in a manner to minimize segregation and temperature loss.
 - .9 Maintain temperature of materials within plus or minus 5°C of specified mix temperature during mixing.
 - .10 Mixing time:
 - .1 In batch plants, dry mix for not less than 10s. Continue wet mixing as long as necessary to obtain a thoroughly blended mix but not less than 30 s or more than 75 s.
 - .2 In continuous mixing plants, mixing time as required but not less than 45 s.
- .2 Dryer drum mixing plant:
 - .1 Feed aggregates to burner end of dryer drum by means of a multi-bin cold feed unit and blend to meet job-mix requirements by adjustments of variable speed feed belts and gates on each bin.
 - .2 Meter total flow of aggregate by electronic weigh belt system with an indicator that can be monitored by plant operator and which is interlocked with asphalt pump so that proportions of aggregate and asphalt entering mixer remain constant.
 - .3 Provide for easy calibration of weighing systems for aggregates without having material enter mixer.

- .4 Make provision for conveniently sampling full flow of materials from the cold feed.
- .5 Provide screens or other suitable devices to reject oversized particles or lumps of aggregate from cold feed prior to entering drum.
- .6 Provide a system interlock which will stop all feed components if either asphalt or aggregate from any bin stops flowing.
- .7 Accomplish heating and mixing of asphalt mix in a drum dryer-mixer. Control heating to prevent fracture of aggregate or excessive oxidation of asphalt. Equip system with automatic burner controls and provide for continuous temperature sensing of asphalt mixture at discharge, with a printing recorder that can be monitored by plant operator. Submit printed record of mix temperatures at end of each week, if required.
- .8 Mixing period and temperature to produce a uniform mixture in which particles are thoroughly coated, and moisture content of material as it leaves mixer to be less than 0.5%.
- .3 Temporary storage of hot mix:
 - .1 Provide mix storage of sufficient capacity to permit continuous operation, maintained at specified temperatures and designed to prevent segregation.
 - .2 Do not store asphalt mix in storage bins in excess of 12 h.
- .4 Mixing tolerances:
 - .1 Permissible variation in aggregate gradation from job mix (percent of total mass):

.1	4.75 mm sieve and larger	5.5
.2	2.36 mm sieve	4.5
.3	0.600 mm sieve	3.5
.4	0.150 mm sieve	2.5
.5	0.075 mm	1.5
 - .2 Permissible variation of asphalt cement from job mix, 0.3%.
 - .3 Permissible variation of mix temperature at discharge from plant, 5°C.

3.2 EQUIPMENT

- .1 Pavers: mechanical grade-controlled self-powered pavers capable of spreading mix within specified tolerances, true to line, grade and crown as shown on Contract Drawings.
- .2 Rollers: sufficient number of rollers of type and weight to obtain specified density of compacted mix.
- .3 Vibratory rollers:
 - .1 Minimum drum diameter: 1200 mm.
 - .2 Maximum amplitude of vibration (machine settling): 0.5 mm for lifts less than 40 mm thick.
- .4 Haul trucks: of adequate size, speed and condition to ensure orderly and continuous operation and as follows:
 - .1 Boxes with tight metal bottoms.

- .2 Covers of sufficient size and weight to completely cover and protect asphalt mix when truck fully loaded.
- .3 In cool weather or for long hauls, insulate entire contact area of each truck box.
- .4 Trucks which cannot be weighed in a single operation on scales supplied will not be accepted.
- .5 Hand tools:
 - .1 Lutes or rakes with covered teeth for spreading and finishing operations.
 - .2 Tamping irons having mass not less than 12 kg and a bearing area not exceeding 310cm² for compacting material along curbs, gutters and other structures inaccessible to roller. Mechanical compaction equipment, when approved by Departmental Representative, may be used instead of tamping irons.
 - .3 Straight edges, 3.0 m in length, to test finished surface.

3.3 EXAMINATION

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

3.4 SUBGRADE PREPARATION AND INSPECTION

- .1 Verify grades of subgrade drains and other items set in paving area for conformity with elevations and sections before placing granular base material.
- .2 Obtain written approval of subgrade by Departmental Representative before placing granular sub-base and base.

3.5 GRANULAR SUB-BASE AND GRANULAR BASE

- .1 Place granular sub-base and base material on clean unfrozen surface, free from snow and ice.
- .2 Place granular sub-base and base to compacted thicknesses as indicated. Do not place frozen material.
- .3 Place in layers not exceeding 150 mm compacted thickness. Compact to density not less than 95 % corrected maximum dry density in accordance with ASTM D1557.
- .4 Finished base surface to be graded in accordance with design drawings.

3.6 ASPHALT PRIME

- .1 Cutback asphalt:
 - .1 Heat asphalt prime for pumping and spraying in accordance with manufacturer's instructions.

- .2 Apply cutback asphalt prime to granular base at rate as required but do not exceed 2.0 L/m².
- .3 Apply on damp surface, unless otherwise directed by Departmental Representative.
- .2 Emulsified asphalt:
 - .1 Dilute asphalt emulsion with clean water at 1:1 ratio for application. Mix thoroughly by pumping or other method approved in writing by Departmental Representative.
 - .2 Apply diluted asphalt emulsion but do not exceed 5 L/m².
 - .3 Apply on damp surface unless directed by Departmental Representative.
- .3 Do not apply primer when air temperature is below 5 degrees C or when rain is forecast within 2 hours.
- .4 If asphalt prime fails to penetrate within 24 hours, spread sand blotter material in amounts required to absorb excess material. Sweep and remove excess blotter material.

3.7 ASPHALT TACK COAT

- .1 Obtain Departmental Representative approval of surface before applying asphalt tack coat.
- .2 Dilute asphalt emulsion with water at 1:1 ratio for application. Mix thoroughly by pumping or other method as required.
- .3 Apply cutback asphalt tack coat to pavement surface at rate as required but do not exceed 0.7 L/m² when diluted with water at 1:1 ratio.
- .4 Apply only on clean dry surface.
- .5 Paint contact surfaces of curbs, gutters, manholes and like structures with thin, uniform coat of asphalt tack coat material.
- .6 Do not apply primer when air temperature is below 5 degrees C or when rain is forecast within 2 hours.
- .7 Apply tack coat only to surfaces that are expected to be overlaid on same day.
- .8 Evenly distribute excessive deposits of tack coat by brooming.
- .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 tack coat has cured.
- .11 Re-tack contaminated or disturbed areas.
- .12 Permit tack coat to cure before placing asphalt paving.

3.8 TRANSPORTATION OF MIX

- .1 Transport mix to job site in vehicles cleaned of foreign material.
- .2 Paint or spray truck beds with light oil, limewater, soap or detergent solution, at least once a day or as required. Elevate truck bed and thoroughly drain. No excess solution will be permitted.

- .3 Schedule delivery of material for placing in daylight, unless Departmental Representative approves artificial light.
- .4 Deliver material to paver at a uniform rate and in an amount within capacity of paving and compacting equipment.
- .5 Deliver loads continuously in covered vehicles and immediately spread and compact. Deliver and place mixes at temperature within specified range. Temperature of mix upon placement shall not be less than 125°C.

3.9 PLACING

- .1 Obtain Departmental Representative's approval of base, existing surface, tack coat, or prime coat prior to placing asphalt.
- .2 Place asphalt concrete to thicknesses, grades and lines as shown on Contract Drawings.
- .3 Placing conditions:
 - .1 Place asphalt mixtures only when air temperature is above 5°C. Place overlay pavement only when air temperature is above 10°C.
 - .2 When temperature of surface on which material is to be placed falls below 10°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 shown on Contract Documents:
 - .1 Levelling course(s) to thicknesses required but not exceeding 100 mm each.
 - .2 Lower course in layers not to exceed 100 mm each.
 - .3 Surface course in layers of maximum 60 mm each.
- .5 Where possible do tapering and levelling where required in lower lifts. Overlap joints by not less than 300 mm.
- .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 When using pavers in echelon, have first paver follow marks or lines, and second paver follow edge of material placed by first paver. Work pavers as close together as possible and in no case permit them to be more than 30 m apart.
 - .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 Approved wood or steel forms, rigidly supported to assure correct grade and cross section, may be used. Use measuring blocks and intermediate strips to aid in obtaining required cross-section.
- .2 Distribute material uniformly. Do not broadcast material.
- .3 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.
- .4 After placing and before rolling, check surface with templates and straightedges and correct irregularities.
- .5 Provide heating equipment to keep hand tools free from asphalt. Avoid high temperatures which may burn material. Do not use tools at a higher temperature than temperature of mix being placed.

3.10 COMPACTION

- .1 Roll asphalt continuously to average density not less than 97% of 75 blow Marshall density in accordance with ASTM D1559 with no individual test less than 95%.
- .2 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 to be pneumatic tired type.
 - .2 Start rolling operations as soon as placed mix can bear weight of roller without undue displacement of material or cracking of surface.
 - .3 Operate roller slowly initially to avoid displacement of material. For subsequent rolling do not exceed 5 km/h for static steel-wheeled rollers and 8 km/h for pneumatic-tired rollers.
 - .4 For lifts 50 mm thick and greater, adjust speed and vibration frequency of vibratory rollers to produce minimum of 20 impacts per metre of travel. For lifts less than 50 mm thick, impact spacing should not exceed compacted lift thickness.
 - .5 Overlap successive passes of roller by at least one half width of roller and vary pass lengths.
 - .6 Keep wheels of roller slightly moistened with water to prevent pick-up of material but do not over-water.
 - .7 Do not stop vibratory rollers on pavement that is being compacted with vibratory mechanism operating.
 - .8 Do not permit heavy equipment or rollers to stand on finished surface before it has been compacted and has thoroughly cooled.
 - .9 After traverse and longitudinal joints and outside edge have been compacted, start rolling longitudinally at low side and progress to high side.
 - .10 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.
 - .11 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.
- .3 Breakdown rolling:

- .1 Commence 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. Exceptions may be made when working on steep slopes or super-elevated sections.
- .4 Use only experienced roller operators for this work.
- .4 Second rolling:
 - .1 Use pneumatic-tired, steel wheel or vibratory roller 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.
- .5 Finish rolling:
 - .1 Accomplish finish rolling with steel wheel rollers while material is still warm enough for removal of roller marks.
 - .2 Conduct rolling operations in close sequence.

3.11 JOINTS

- .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.
- .3 For cold joints, cut back to full depth vertical face and tack face with hot asphalt.
- .4 Transverse joints:
 - .1 Offset joint in succeeding lifts by at least 600 mm.
 - .2 Cut back full depth vertical face and tack face with thin coat of asphalt prior to continuing paving.
 - .3 Compact transverse joints to provide a smooth riding surface.
- .5 Longitudinal joints:
 - .1 Offset longitudinal joints in succeeding lifts by at least 150 mm.
 - .2 Overlap previously laid strip with spreader by 100 mm.

3.12 PAVEMENT PATCHING

- .1 Ensure temporary and permanent pavement patching done by handwork conforms to all standards specified for machine placed asphaltic concrete.
- .2 Subbase and base preparation as specified in Section 32 11 23 – Aggregate Base Courses unless shown otherwise on Contract Drawings.

3.13 SIDEWALKS, DRIVEWAYS AND CURBS

- .1 Hot-mix asphalt concrete sidewalks, driveways and curbs as shown on Contract Drawings.
- .2 Machine place where practical.
- .3 Ensure placement by handwork conforms to all standards specified for machine placed asphaltic concrete.
- .4 Other than requirements relating specifically to Portland cement concrete, ensure hot-mix asphalt concrete sidewalks and curbs comply with all requirements of Section 32 16 15 – Concrete Walks, Curbs and Gutters.

3.14 FINISHED TOLERANCES

- .1 Ensure finished asphalt surface within 6 mm of design elevation but not uniformly high or low.
- .2 Ensure finished asphalt surface does not have irregularities exceeding 6 mm when checked with a 3 m straight edge placed in any direction.
- .3 Water ponding not permitted.
- .4 Against concrete gutter, finished asphalt surface to be higher than the gutter by not more than 6mm.

3.15 DEFECTIVE WORK

- .1 Correct irregularities which develop before completion of rolling by loosening upper mix and removing or adding material as required.
- .2 If irregularities or defects remain after final compaction, remove upper course promptly and lay new material to form a true and even surface and compact immediately to specified density.

3.16 TRAFFIC MARKINGS

- .1 Paint parking space divisions and other pavement markings in accordance with manufacturer's recommendations and as indicated.
- .2 Use paint thinner in accordance with manufacturer's requirements.

3.17 TESTING

- .1 Inspection and testing of asphalt pavement will be carried out by designated testing laboratory in accordance with Section 01 45 00 - Quality Control.
- .2 Costs of tests will be paid by contractor.

3.18 CLEANING

- .1 Remove lids or covers from all castings and clean any prime, tack coat or hot-mix asphaltic concrete from frames, lids and covers of all castings.
- .2 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.

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

3.19 PROTECTION

- .1 Keep vehicular traffic off newly paved areas until paving surface temperature has cooled below 38 degrees C.
 - .1 Do not permit stationary loads on pavement until 24 hours after placement.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

- .1 Section 03 20 00 Concrete Reinforcing
- .2 Section 03 30 00 Cast-In-Place Concrete
- .3 Section 31 05 00 Common Works Results – Earthworks, Exterior Improvements, and Utilities
- .4 Section 31 23 33.01 Excavating, Trenching and Backfilling.
- .5 Section 32 11 23 Aggregate Base Courses.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C117, Standard Test Method for Materials Finer than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D260-86, Standard Specification for Boiled Linseed Oil.
 - .4 ASTM D1557-12e1, Modified Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³(2,700 kN- m/m³)).
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-3.3-99, Kerosene, Amend. No. 1, National Standard of Canada.
 - .2 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .3 CAN/CGSB-19.24-M90, Multicomponent, Chemical-Curing Sealing Compound
- .3 Canadian Standards Association (CSA International)
 - .1 CSA-A23.1-04/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
 - .2 CSA-G30.5-M1983 (R1998), Welded Steel Wire Fabric for Concrete Reinforcement
- .4 Master Municipal Contract Documents (MMCD), Platinum Edition Volume II - 2009, British Columbia. Contractor to maintain a copy on-site at all times.

1.3 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit concrete mix designs 2 weeks prior to construction.

1.4 DELIVERY, STORAGE AND HANDLING

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

Part 2 PRODUCTS

2.1 MATERIALS

- .1 Concrete mixes and materials: in accordance with Section 03 30 00 - Cast-in- Place Concrete and:
 - .1 Hand-formed and hand-placed concrete:
 - .1 Slump: 80mm
 - .2 Air entrainment: 5-8%
 - .3 Max. aggregate size: 20mm
 - .4 Min. cement content: 335 kg/m³
 - .5 Min. 28 day strength: 32 MPa
 - .2 Extruded concrete:
 - .1 Slump: 0-25mm
 - .2 Air entrainment: 6-9%
 - .3 Max. aggregate size: 10mm
 - .4 Fineness modulus: 2.1 to 2.4
 - .5 Min. cement content: 335 kg/m³
 - .6 Min. 28 day strength: 32 MPa
- .2 Reinforcing steel: in accordance with Section 03 20 00 - Concrete Reinforcing.
 - .1 Welded steel wire fabric to CSA CSA-G30.5-M1983 (R1998)
- .3 Joint filler and Curing Compound: in accordance with Section 03 30 00 - Cast- in-Place Concrete.
- .4 Joint sealer to CAN/CGSB-19.24-M90, Type 1, Class B
- .5 Granular base:
 - .1 In accordance with Section 32 11 23 Aggregate Base Courses.
- .6 Non-staining mineral type form release agent: chemically active release agents containing compounds that react with free lime to provide water-soluble soap.
- .7 Fill material:
 - .1 Granular material as specified on contract drawings
- .8 Curing compound: to be spray applied, liquid type conforming to ASTM C309 containing a fugitive dye, applied in accordance with manufacturer's recommendations, or other during methods such as sheet material and burlap mats, subject to Departmental Representative approval.

Part 3 EXECUTION

3.1 GRADE PREPARATION

- .1 Do grade preparation work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

- .2 Construct embankments using excavated material free from organic matter or other objectionable materials.
 - .1 Dispose of surplus and unsuitable excavated material in approved location off site.
- .3 Place fill in maximum 300 mm layers and compact to at least 95% Modified Proctor Density in compliance with ASTM D1557.

3.2 GRANULAR BASE

- .1 Obtain Departmental Representative's approval of subgrade before placing granular base.
- .2 Place granular base material to lines, widths, and depths as indicated.
- .3 Compact granular base in maximum 300 mm layers to at least 95% Modified Proctor Density in compliance with ASTM D1557.

3.3 FORMWORK

- .1 Use flexible forms for all curves less than 60m radius
- .2 Set forms to line and grade as shown on Contract Drawings free from waves or irregularities in line or grade
- .3 Adequately brace forms to maintain specified tolerances after concrete is placed.
- .4 Treat forms lightly with approved form release agent and remove surplus agent.

3.4 CONCRETE

- .1 Obtain Departmental Representative approval of granular base prior to placing concrete.
- .2 Do not place concrete when air temperature appears likely to fall below 5 degrees Celsius within 24 hours unless specified precautions are taken and approved.
- .3 Do concrete work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .4 Immediately after floating, give sidewalk surface uniform broom finish to produce regular corrugations not exceeding 2 mm deep, by drawing broom in direction normal to center line.
- .5 Provide edging as indicated with 10 mm radius edging tool.

3.5 TOLERANCES

- .1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

3.6 EXPANSION AND CONTRACTION JOINTS

- .1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals of 3 m.
- .2 Install expansion joints at intervals of 9 m.
- .3 When sidewalk is adjacent to curb, make joints of curb, gutters and sidewalk coincide.

3.7 ISOLATION JOINTS

- .1 Install isolation joints around manholes and catch basins and along length adjacent to concrete curbs, catch basins, buildings, or permanent structure.
- .2 Use 13mm pre-molded hardboard joint material to form isolation joints joint filler in isolation joints.
- .3 Seal isolation joints with sealant noted on drawings.

3.8 CURING

- .1 Cure concrete by adding moisture continuously in accordance with CSA- A23.1/A23.2 to exposed finished surfaces for at least 1 day after placing, or sealing moisture in by curing compound as directed by Departmental Representative.
- .2 Where burlap is used for moist curing, place two pre-wetted layers on concrete surface and keep continuously wet during curing period of at least 7 days.
- .3 Apply curing compound evenly to form continuous film, in accordance with manufacturer's requirements.

3.9 BACKFILL

- .1 Allow concrete to cure for 7 days prior to backfilling.
- .2 Backfill to designated elevations with material as directed by Departmental Representative.
 - .1 Compact and shape to required contours as indicated.

3.10 TESTING

- .1 Refer to Section 01 45 00 – Quality Control for geotechnical testing requirements.

3.11 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 American Society for Testing and Materials (ASTM).
 - .1 ASTM D570 – 98 (2018) - Standard Test Method for Water Absorption of Plastics.
 - .2 ASTM D4061 – 13 – Standard Test Method for Retroreflectance of Horizontal Coatings.
 - .3 ASTM D6628 – 16 - Standard Specification for Color of Pavement Marking Materials.
 - .4 ASTM D7585 / D7585M – 10 - Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments.
 - .5 ASTM D562 - 10 - Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer.
 - .6 ASTM D 711 - Standard Test Method for No-Pick-Up Time of Traffic Paint.
 - .7 ASTM D868 – 10 - Standard Practice for Determination of Degree of Bleeding of Traffic Paint.

1.2 SUBMITTALS

- .1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.
 - .1 Submit list of all painting materials to the Departmental Representative for review prior to ordering materials.

1.3 QUALITY CONTROL

Part 2 PRODUCTS

2.1 MATERIALS

- .1 Paint:
 - .1 Alkyd traffic paint to CGSB 1-GP-74M.
 - .2 Alkyd reflectorized traffic paint to CGSB 1-GP-149M.
 - .3 Colour to CGSB 1-GP-12C:
 - .1 White 513-301
 - .2 Yellow 505-308
 - .4 Consistency: 85 ± 5 Krebs units in accordance with test method ASTM D 562.
 - .5 Drying Time: Maximum 30 minutes at 21°C at 50-60% relative humidity in accordance with test method ASTM D 711.
 - .6 Bleeding: The Paint shall have a degree of resistance to bleeding of seven or greater in accordance with test method ASTM D 868 or ASTM D 969.
 - .7 Retroreflectivity: Paint shall meet retroreflectivity as per ASTM D 7585/D 7585M. Retroreflectivity shall be measured in accordance to ASTM E 1710.
- .2 Thinner:

- .1 to CGSB-1.5
- .3 Glass Beads: Glass reflectorized beads shall be added during the spraying of Paint in accordance with the glass beads manufacturer's recommended application requirements.
 - .1 Glass beads for pavement marking shall:
 - .1 Be colourless;
 - .2 Be at least 75% by weight as true spherical shape as determined with a Roundness Tester by ASTM D 1155 with exception of the 80um size;
 - .3 Have smooth, lustrous, and free of air inclusions, dark specs, milkiness, incipient fractures, surface films or other imperfect finishing characteristics;
 - .4 Have spheres exhibit an index of refraction of not less than 150 when tested by the liquid immersion method at 25° C;
 - .5 Meet requirements of AASHTO M 247; and
 - .6 Have a silica (SiO₂) content greater than 60%.

Part 3 EXECUTION

3.1 EQUIPMENT REQUIREMENTS

- .1 Paint applicator to be pressure type mobile distributor capable of applying paint in single, double and dashed lines. Applicator to have positive shut-off and to be capable of applying marking components uniformly, at rates specified, and to dimensions shown on Contract Drawings.
- .2 Distributor to be capable of applying reflective glass beads as an overlay on freshly applied paint.

3.2 CONDITION OF SURFACES

- .1 Ensure pavement and concrete surface free from surface water, frost, ice, dust, oil, grease and other foreign materials.
- .2 Testing for Moisture:
 - .1 Pavement markings shall be applied to dry pavement only. The Contractor shall test the pavement surface for moisture before beginning work after each period of rainfall, fog, high humidity, or cleaning, or when the ambient temperature has fallen below the dew point.
 - .2 Do not commence marking until the pavement is sufficiently dry and the pavement condition has been approved by the Departmental Representative. Employ the "plastic wrap method" to test the pavement for moisture as follows: Cover the pavement with a 300 mm by 300 mm (12inch by 12 inch) section of clear plastic wrap and seal the edges with tape. After 15minutes, examine the plastic wrap for any visible moisture accumulation inside the plastic. Do not begin marking operations until the test can be performed with no visible moisture accumulation inside the plastic wrap.

3.3 APPLICATION

- .1 Painted Markings:
 - .1 Lay out pavement markings.
 - .2 Unless otherwise approved by Departmental Representative, apply paint only when air temperature is above 10° C and no rain is forecast.
 - .3 Apply traffic paint evenly at rate of 3 m²/L.
 - .4 Do not thin paint unless approved by Departmental Representative.
 - .5 Symbols and letters to conform to dimensions shown on Contract Drawings.
 - .6 Ensure paint lines of uniform colour and density with sharp edges.
 - .7 Thoroughly clean distributor tank before refilling with paint of different colour.
 - .8 Apply glass beads at uniform application rate as required by the glass bean manufacture.

3.4 FIELD QUALITY CONTROL

- .1 Placement of Markings.
 - .1 The Contractor shall ensure that all markings are installed properly and placed in strict compliance with this specification and the contract drawings. The longitudinal edges of markings shall not vary from a straight line by more than 25 millimeters per 5 meters. The overall dimensions of the markings shall not vary from the drawings by within plus or minus 10 millimeters of specified dimensions.
 - .2 Any markings that are improperly placed or fail to meet the requirements of this specification will be removed and reinstalled at the Contractor's expense.
 - .3 Materials used for repairs shall be from the same lot and batch as those approved for the performance of the contract or shall be subjected to the same requirements and approved by the Departmental Representative prior to beginning repairs.
- .2 Paint Colour: Testing for conformance shall be made by visual comparison to a standard colour card provided by the Paint manufacturer that certifies colour compliance with this specification.
- .3 Retroreflectivity: Retroreflectivity will be measured as per ASTM D 7585/D 7585M and ASTM E 1710 as follows:
 - .1 All measurements for nighttime retroreflectivity will be made using a Mirolux MX-30, Stripemaster or Stripemaster 2 retroreflectometer or equivalent, as approved in writing by the Departmental Representative.
 - .2 Measurements will be made by the Contractor using the retroreflectometer manufacturer's instructions for operation and procedures and will be made only by competent staff. Sampling will be made using a sample size of 10 test point measurements at 1 m intervals on a single line, tabulated as an average with standard deviation and percent relative standard deviation, and minimum/maximum values.
 - .3 All measurements and related data will be retained by the Contractor in an electronic format approved by the Departmental Representative and will be submitted to the Departmental Representative on request.

3.5 CLEAN-UP

- .1 Removal of all paint where spilled, splashed, splattered or sprayed as work progresses using means and materials that are not detrimental to affected surfaces.
- .2 Keep work area free from an unnecessary accumulation of tools, equipment, surplus materials and debris.
- .3 Remove combustible rubbish material and empty paint cans each day and safely dispose of same in accordance with requirements of authorities having jurisdiction.
- .4 Clean equipment and dispose of wash water / solvents as well as all other cleaning and protective materials, paints, thinners, paint removers/strippers, in accordance with the safety requirements of authorities having jurisdiction.
- .5 Protect area where paint has been applied and avoid scuffing newly applied paint.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

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

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - .2 ASTM A90/A90M, Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
 - .3 ASTM A121-07, Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.
 - .4 A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - .5 ASTM C618-08a, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
 - .6 ASTM F1664-08, Standard Specification for Poly(Vinyl Chloride) (PVC)-Coated Steel Tension Wire Used with Chain-Link Fence.
 - .7 ASTM A123/A123M, Standard Specification for Zinc (Hot Dip Galvanized) coatings on Iron and Steel Products.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-138.1, Fabric for Chain Link Fence.
 - .2 CAN/CGSB-138.2, Steel Framework for Chain Link Fence.
 - .3 CAN/CGSB-138.3, Installation of Chain Link Fence.
 - .4 CAN/CGSB-138.4, Gates for Chain Link Fence.
 - .5 CAN/CGSB-1.181, Ready-Mixed Organic Zinc-Rich Coating.
 - .6 CAN/CSA-G164-M92, Hot Dip Galvanizing of Irregularly Shaped Articles
 - .7 CAN/CSA-G40.20-13/G40.21-13, General requirements for rolled or welded structural quality steel / Structural quality steel
 - .8 CAN/CSA-W59 - Welded steel construction (metal arc welding)
- .3 CSA International
 - .1 CSA A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
 - .2 CAN/CSA-A3000, Cementitious Materials Compendium.
- .4 Master Painters Institute (MPI)
 - .1 Architectural Painting Specification Manual - current edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

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

- .1 Submit manufacturer's instructions, printed product literature and data sheets for concrete mixes, fences, posts and gates and include product characteristics, performance criteria, physical size, finish and limitations.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .2 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect fence and gate materials from damage.
 - .3 Replace defective or damaged materials with new.
- .3 Packaging Waste Management: remove for reuse of pallets, crates, padding, packaging materials as specified in Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 MATERIALS

- .1 Concrete mixes and materials: in accordance with CSA A23.1 and Section 03 30 00 - Cast-in-Place Concrete.
 - .1 Nominal coarse aggregate size: 20-5.
 - .2 Compressive strength: 20 MPa minimum at 28 days.
 - .3 Additives: fly ash to CSA A3000 ASTM C618.
- .2 Chain-link fence fabric: to CAN/CGSB-138.1.
 - .1 Type 1, Class A, medium style, Grade 2.
 - .2 Height of fabric: as indicated.
- .3 Posts, braces and rails: to CAN/CGSB-138.2, galvanized steel pipe. Dimensions as indicated.
- .4 Top, bottom tension wire: to CAN/CGSB-138.2, single strand, galvanized steel wire.
- .5 Tie wire fasteners: aluminum wire.
- .6 Tension bar: to ASTM A653/A653M, 5 x 20 mm minimum galvanized steel.
- .7 Gates: to CAN/CGSB-138.4.
- .8 Gate frames: to ASTM A53/A53M, galvanized steel pipe, standard weight 45 mm outside diameter pipe for outside frame, 35 mm outside diameter pipe for interior bracing.
 - .1 Fabricate gates as indicated with electrically welded joints, and hot-dip galvanized after welding.
 - .2 Fasten fence fabric to gate with twisted selvage at top.
 - .3 Furnish gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate.

- .4 Furnish double gates with chain hook to hold gates open and centre rest with drop bolt for closed position.
- .9 Fittings and hardware: to CAN/CGSB-138.2, galvanized steel.
 - .1 Tension bar bands: 3 x 20 mm minimum galvanized steel or 5 x 20 mm minimum aluminum.
 - .2 Post caps to provide waterproof fit, to fasten securely over posts and to carry top rail.
 - .3 Overhang tops to provide waterproof fit, to hold top rails and an outward inward projection to hold barbed wire overhang.
 - .4 Include projection with clips or recesses to hold 3 strands of barbed wire spaced 100 mm apart.
 - .5 Projection of approximately 300 mm long to project from fence at 45 degrees above horizontal.
 - .6 Turnbuckles to be drop forged.
 - .7 Organic zinc rich coating: to CAN/CGSB-1.181 MPI #18.
- .10 Grounding rod per Canadian Electrical Code.

2.2 FINISHES

- .1 Galvanizing:
 - .1 For chain link fabric: to CAN/CGSB-138.1 Grade 2.
 - .2 For pipe: 550 g/m² minimum to ASTM A90.
 - .3 For other fittings: to ASTM A123/A123M.

Part 3 Execution

3.1 EXAMINATION

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

3.2 PREPARATION

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

- .2 Grading:
 - .1 Remove debris and correct ground undulations along fence line to obtain smooth uniform gradient between posts.
 - .1 Provide clearance between bottom of fence and ground surface of 30 mm to 50 mm.
- .3 Layout
 - .1 Contractor to provide full layout of the fences, gates, powered gates and adjacent features and report any potential conflicts to the Departmental Representative prior to construction.

3.3 RESTORATION OF FENCE

- .1 Restore and damaged or temporarily removed sections of fence as shown in the Contract Drawings in accordance with this specification and to match existing.

3.4 ERECTION OF FENCE

- .1 Erect fence along lines as directed by Departmental Representative and to CAN/CGSB-138.3.
- .2 Excavate post holes to dimensions indicated 600 mm depth x 300 mm diameter as directed by Departmental Representative.
- .3 Space line posts 3 m apart, measured parallel to ground surface.
- .4 Space straining posts at equal intervals not to exceed 150 m if distance between end or corner posts on straight continuous lengths of fence over reasonably smooth grade, is greater than 150 m.
- .5 Install additional straining posts at sharp changes in grade and where directed by Departmental Representative.
- .6 Install corner post where change in alignment exceeds 10 degrees.
- .7 Install end posts at end of fence and at buildings.
 - .1 Install gate posts on both sides of gate openings.
- .8 Place concrete in post holes then embed posts into concrete to minimum 450 mm depth.
 - .1 Extend concrete 50 mm above ground level and slope to drain away from posts.
 - .2 Brace to hold posts in plumb position and true to alignment and elevation until concrete has set.
- .9 Install fence fabric after concrete has cured, minimum of 5 days.
- .10 Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface.
 - .1 Install braces on both sides of corner and straining posts in similar manner.
- .11 Install overhang tops and caps.
- .12 Install top rail between posts and fasten securely to posts and secure waterproof caps and overhang tops.
- .13 Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.

- .14 Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals.
 - .1 Knuckled selvedge at bottom.
 - .2 Twisted selvedge at top.
- .15 Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450 mm intervals.
 - .1 Give tie wires minimum two twists.
- .16 Install barbed wire strands and clip securely to lugs of each projection.
- .17 Install grounding rods as required.

3.5 INSTALLATION OF GATES

- .1 Install gates in locations as indicated.
- .2 Level ground between gate posts and set gate bottom approximately 40 mm above ground surface.
- .3 Determine position of centre gate rest for double gate.
 - .1 Cast gate rest in concrete as directed.
 - .2 Dome concrete above ground level to shed water.
- .4 Install gate stops where indicated.

3.6 TOUCH UP

- .1 Clean damaged surfaces with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas as indicated.
 - .1 Pre-treat damaged surfaces according to manufacturers' instructions for zinc-rich paint.

3.7 CLEANING

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

END OF SECTION

Part 1 General**1.1 RELATED REQUIREMENTS**

- .1 Section 32 11 23 Aggregate Base Courses.
- .2 Section 31 23 33.01 Excavating, Trenching and Backfilling.

1.2 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA B300, Standard for Hypochlorites.
 - .2 ANSI/AWWA B303, Standard for Sodium Chlorite.
 - .3 ANSI/AWWA C207, Standard for Steel Pipe Flanges for Waterworks Service, 4 Inch through 144 Inch (100 mm through 3,600 mm).
 - .4 ANSI/AWWA C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
 - .5 ANSI/AWWA C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
 - .6 ANSI/AWWA C651, Standard for Disinfecting Water Mains.
 - .7 ANSI/AWWA C800, Standard for Underground Service Line Valves and Fittings.
 - .8 ANSI/AWWA C900, Standard for Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch through 12 Inch (100 mm - 300 mm), for Water Transmission and Distribution.
 - .9 AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) through 3 In. (76 mm), for Water Service
- .2 Master Municipal Contract Documents (MMCD), Platinum Edition Volume II - 2009, British Columbia. Contractor to maintain a copy on-site at all times.
- .3 ASTM International
 - .1 ASTM A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
 - .3 ASTM B88M(2011), Standard Specification for Seamless Copper Water Tube Metric.
 - .4 ASTM C117, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .5 ASTM C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .6 ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.

- .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .5 CSA International
 - .1 CAN/CSA-B137 Series-09, Thermoplastic Pressure Piping Compendium. (Consists of B137.0, B137.1, B137.2, B137.3, B137.4, B137.4.1, B137.5, B137.6, B137.8, B137.9, B137.10, B137.11 and B137.12).
 - .1 CAN/CSA-B137.1, Polyethylene Pipe, Tubing, and Fittings for Cold-Water Pressure Services.
 - .2 CAN/CSA-B137.3, Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.
 - .2 CSA G30.18-09, Carbon and Steel Bars for Concrete Reinforcement.
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S520, Standard for Fire Hydrants.
 - .2 CAN/ULC-S543, Standard for Internal-Lug, Quick Connect Couplings for Fire Hose.

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 and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Pipe certification to be on pipe.

1.4 SCHEDULING OF WORK

- .1 Schedule Work to minimize interruptions to existing services.
- .2 Submit schedule of expected interruptions for approval and adhere to interruption schedule as approved by Departmental Representative.
- .3 Notify Departmental Representative and occupants minimum of 24 hours in advance of service interruption.
- .4 Notify fire department of planned or accidental interruption of water supply to hydrants.
- .5 Advise local police department of anticipated interference with movement of traffic.

Part 2 PRODUCTS

2.1 PIPE, JOINTS AND FITTINGS

- .1 Polyvinyl chloride pressure pipe: to AWWA C900, DR 18 (pressure class 235 psi), gasket bell end, cast iron outside diameter.
 - .1 Joints: push-on integrally thickened bell and spigot type to ASTM D3139 with single elastomeric gasket to ASTM F477.
- .2 PVC injection-moulded fittings shall be DR18, conforming to AWWA C907 and certified to CSA B137.2. PVC compound is 12454B according to ASTM D1784.

- .3 Bolts to be carbon steel, Grade B to ASTM A307, heavy hex style, zinc plated to ASTM B633.
- .4 Bolt sizes to AWWA C110
- .5 Nuts and washers: to be carbon steel, Grade A, to ASTM A563. Washers to be flat hardened steel to ASTM F436. Nuts and washers to be zinc plated to ASTM B633.
- .6 Tie rods to be continuous threaded, quenched and tempered alloyed steel to ASTM A354, Grade BC. To be zinc plated to ASTM B633. Tie rods to be minimum 19mm diameter or greater.
- .7 Couplings:
 - .1 Minimum pressure class: 225 psi
 - .2 To AWWA C219, with compression gaskets.
 - .3 Epoxy coated to AWWA C213
 - .4 Stainless steel bolts and nuts to ASTM F593.

2.2 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise.
- .2 Gate valves: to AWWA C500 with working pressure of 250 psi, standard iron body, bronze mounted wedge valves with non-rising stems, stem seal to be O-ring type, joints as shown in the Contract Drawings.
- .3 Cast iron valve boxes:
 - .1 Base to be large round type.
 - .2 Top of box to be marked "WATER".

2.3 SERVICE CONNECTIONS

- .1 Underground services line valves and fittings 19 to 50mm to AWWA C800 suitable for 1035 kPa working pressure
- .2 HDPE pressure pipe: to CSA-B137.1 and AWWA C901, minimum pressure rating 200 psi.
- .3 Corporation stops to be bronze to ASTM B62, AWWA thread inlet, compression type outlet
- .4 Curb stops to be bronze to ASTM B62, compression type, inverted key, ball or cylinder type construction utilizing rubber O-ring seals.
 - .1 All fitting and valve connections on polyethylene to have solid fluted stiffening liners manufactured from stainless steel to ANSI T304 designed for the appropriate type and ID of pipe.
- .5 Service valve boxes:
 - .1 Curb stop valve boxes on 25mm diameter and smaller services to be telescoping assembly comprised of threaded cast iron top with bronze pentagon centre plug, 25 NPS iron pipe, cast iron base allowing threaded insertion of 25 NPS pipe and accommodation for curb stop valve and 14mm diameter steel operating rod attached to curb stop valve with bronze cotter pin.

- .6 Service connections for PVC pipe:
 - .1 Service connections less than 100 mm: corporation stop, tapped to main using AWWA threads, complete with stainless service saddle. Service saddle to consist of circumferential band type complete with side bars and fingers, keeper bar, stud bolts, nuts, washers and gaskets.
 - .2 Service connections 100 mm and over: use tee fitting or tapping valve and sleeve.
- .7 Tee connections: for services above 100mm. Tee connections to be fabricated of same material and to same standards as specified pipe fittings and to have ends matching pipe to which they are joined.

2.4 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to: Section 31 23 33.01 – Excavating, Trenching and Backfilling
- .2 Concrete mixes and materials required for bedding cradles, encasement, supports, thrust blocks: to Section 03 30 00 - Cast-in-Place Concrete.

2.5 BACKFILL MATERIAL

- .1 As per Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.6 PIPE DISINFECTION

- .1 Sodium hypochlorite, Calcium hypochlorite to AWWA B300 to disinfect water mains.
- .2 Disinfect water mains in accordance with AWWA C651.

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 distribution piping installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate and inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .2 Proceed with installation only after unacceptable conditions have been remedied.

3.2 PREPARATION

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects.
 - .2 Remove defective materials from site.

3.3 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Ensure trench depth allows coverage over pipe of 0.9 m minimum from finished grade.

3.4 GRANULAR BEDDING

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated below bottom of pipe.
- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to 95% minimum of corrected maximum dry density.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling with compacted bedding material.

3.5 PIPE INSTALLATION

- .1 Terminate and cap building water service 1m outside building wall opposite point of connection to main with allowances made for testing and disinfection.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection; otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Lay pipes to AWWA C600 manufacturer's standard instructions and specifications.
 - .1 Do not use blocks except as specified.
- .3 Join pipes in accordance with manufacturer's recommendations.
- .4 Bevel or taper ends of PVC pipe to match fittings.
- .5 Handle pipe by methods recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
- .6 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.
- .7 Face socket ends of pipe in direction of laying. For mains on grade of 2% or greater, face socket ends up-grade.
- .8 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
- .9 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.
- .10 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.

- .1 Cut, handle, and dispose of AC pipe in accordance with all applicable WorkSafeBC, environmental, provincial and federal regulations/guides.
- .11 Align pipes before jointing.
- .12 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .13 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
- .14 Complete each joint before laying next length of pipe.
- .15 Minimize deflection after joint has been made.
- .16 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
- .17 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
- .18 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
- .19 Do not lay pipe on frozen bedding.
- .20 Do hydrostatic and leakage test and have results approved by Departmental Representative before completing surface works.
- .21 Backfill remainder of trench.

3.6 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.
- .2 Support valves located in valve boxes or valve chambers by means of bedding same as adjacent pipe. Valves not to be supported by pipe.

3.7 SERVICE CONNECTIONS

- .1 Terminate building water service 1m outside building wall.
 - .1 Install coupling necessary for connection to building plumbing.
 - .2 If plumbing is already installed, make connection, otherwise cap or seal end of pipe and place temporary marker to locate pipe end.
- .2 Do not install service connections until satisfactory completion of hydrostatic, leakage tests, and disinfection of water main.
- .3 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .4 Place temporary location marker at ends of plugged or capped unconnected water lines.
 - .1 Each marker to consist of a stake extending from pipe end at pipe level to 60 mm above grade.

- .2 Paint exposed portion of stake blue with designation "WATER SERVICE LINE".

3.8 THRUST BLOCKS AND RESTRAINED JOINTS

- .1 For thrust blocks: do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
- .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Departmental Representative.
- .3 Keep joints and couplings free of concrete.
- .4 Do not backfill over concrete within 48 hours after placing.
- .5 For restrained joints: use restrained joints as shown in Contract Documents.

3.9 HYDROSTATIC AND LEAKAGE TESTING

- .1 Do tests in accordance with AWWA C600.
- .2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
- .3 Notify Departmental Representative at least 48 hours in advance of proposed tests.
 - .1 Perform tests in presence of Departmental Representative.
- .4 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete.
- .5 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
- .6 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
- .7 Open valves.
- .8 Expel air from main by slowly filling main with potable water.
 - .1 Install corporation stops at high points in main where no air-vacuum release valves are installed.
 - .2 Remove stops after satisfactory completion of test and seal holes with plugs.
- .9 Apply leakage test pressure of 1380 kPa minimum after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 2 hours.
- .10 Define leakage as amount of water supplied in order to maintain test pressure for 2 hours.
- .11 Do not exceed allowable leakage, including lateral connections.
- .12 Locate and repair defects if leakage is greater than amount specified.
- .13 Repeat test until leakage is within specified allowance for full length of water main.

3.10 PIPE SURROUND AND BACKFILL

- .1 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround, cover, and backfill pipes as per Section 31 23 33.01 – Excavating, Trenching, and Backfilling

3.11 FLUSHING AND DISINFECTING

- .1 Complete all flushing and disinfection to AWWA C651
- .2 Flushing and disinfecting operations: witnessed by Departmental Representative.
 - .1 Notify Departmental Representative at least 5 days in advance of proposed date when disinfecting operations will begin.
 - .2 Complete disinfection works concurrent with pressure test.
- .3 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 0.9 m/s, within pipe until foreign materials have been removed and flushed water is clear and a minimum of one pipe volume has been flushed.
- .4 Provide connections and pumps for flushing as required with approved and certified backflow prevention device.
- .5 Open and close valves, hydrants and service connections to ensure thorough flushing.
- .6 When flushing has been completed introduce strong solution of chlorine of minimum 25 mg/L free chlorine into water main and ensure that it is distributed throughout entire system.
- .7 Rate of chlorine application to be proportional to rate of water entering pipe.
- .8 Chlorine application to be close to point of filling water main and to occur at same time.
- .9 Operate valves, hydrants and appurtenances while main contains chlorine solution.
- .10 Flush line to remove chlorine solution after 24 hours.
 - .1 Provide de-chlorination per AWWA standards for all discharge to the environment using ascorbic acid in a manner approved by the Departmental Representative
- .11 Measure chlorine residuals at extreme end of pipe-line being tested.
 - .1 After 24 hours, take further samples to ensure that there is still not less than 10 ppm of chlorine residual remaining throughout system.
- .12 Perform bacteriological tests on water main, after chlorine solution has been flushed out.
- .13 Take samples in accordance with AWWA C651.
- .14 Should contamination remain or recur during this period, repeat disinfecting procedure.
- .15 Contractor to coordinate, deliver and pay for all testing
- .16 Take water samples at service connections, in suitable sequence, to test for chlorine residual.

3.12 TIE-INS

- .1 Provide a shutdown and tie-in plan to the Departmental Representative for review 5 days prior to any planned shutdowns.
- .2 All water service tie-ins to be completed by District or Ucluelet forces unless otherwise instructed by Departmental Representative.

3.13 CLEANING

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

OF SECTION

Part 1 General

1.1 SECTION INCLUDES

- .1 Provision of rigid conduit - encased underground service ducts.

1.2 REFERENCES

- .1 Canadian Standards Association (CSA)
 - .1 CSA A23.1/A23.2-2015, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

1.3 REGULATORY REQUIREMENTS

- .1 Co-ordinate and meet requirements of power supply authority. Ensure availability of power when required.

Part 2 Products

2.1 MATERIALS

- .1 Underground ducts: Direct Buried Underground Cable Ducts, rigid type DB2, size as indicated.
- .2 Conductors: aluminum, type, size and number of conductors as per power supply authority requirements and noted on drawings.
- .3 Meter socket and metering: as per power supply authority requirements.
- .4 Concrete: to CSA A23.1/A23.2 latest edition.

Part 3 Execution

3.1 INSTALLATION

- .1 Install cables in trenches and in conduit in accordance with Section 26 05 44 - Installation of Cables in Trenches and in Ducts.
- .2 Allow adequate conductor length for connection to supply by power supply authority and to reach connection points located on drawings.
- .3 Coordinate with electrical service provider for all connection requirements and scheduling.
- .4 Install meter socket and conduit.
- .5 Allow adequate conductor length for connection to service equipment.
- .6 Make grounding connections in accordance with Section 26 05 28 - Grounding - Secondary.

3.2 FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Perform additional tests if required by authority having jurisdiction.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 CSA International
 - .1 CSA C22.2 No. 45.1-07, Electrical Rigid Metal Conduit-Steel (Tri-National standard, with UL 6 and NMJ-J-534-ANCE-2007).
- .2 Transport Canada
 - .1 TP 312-1993(R2018), Aerodrome Standards and Recommended Practices.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's printed product literature and data sheets for runway and taxi inset lighting 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 airfield runway and taxiway inset lighting for incorporation into manual.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Tools:
 - .1 Inset units installation jigs: to ensure light bases are installed correctly.
 - .2 Tee-bolts: for installation of inset unit top assemblies.
 - .3 Steel cover plates: of same strength and dimensions as light fixture.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect runway and taxi inset lighting
 - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse as specified in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

Part 2 Products

2.1 LIGHT BASES

- .1 Products: to FAA AC 150/5345-42D.
- .2 For new asphalt pavement: light base, bottom section, 445 mm deep for [L-868, size B light unit, complete with 4 openings 90 degree apart with threaded hubs with plugs of sufficient size and quantity to suit conduit system.
 - .1 Light base middle section: complete with anchor bars to lock section into concrete encapsulation and slotted holes in bottom flange for azimuth adjustment, for L-868, size B light unit.
- .3 For new asphalt pavement: light base top section, for mounting on middle section of light unit for L-868, size B light unit.
- .4 Base extension, 286 mm bolt circle, for L-868, size B light unit, for mounting on top of light unit bases, in new asphalt overlay.
- .5 Spacer ring, height to suit, for L-868, size B light unit, with 286 mm bolt circle.
- .6 Flange ring, 13 mm height with pavement ring for L-868, size B light unit, with 286 mm bolt circle.

2.2 LIGHT FIXTURES

- .1 Products: to TP 312.
- .2 FATO / Heliport light unit, with omni-directional optical assembly green LED lamp, suitable for installation on flange ring, mounted on top light base.

2.3 ACCESSORY MATERIALS

- .1 Secondary conductors: #12 stranded copper 600V, type RWU90.
- .2 Concrete used to encapsulate light units and conduit to Section 03 30 00 - Cast-in-Place Concrete.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for airfield runway and taxiway inset lighting installation in accordance with manufacturer's 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 from Departmental Representative.

3.2 GENERAL REQUIREMENTS

- .1 Install Heliport inset lighting components, systems and assemblies as indicated.
 - .1 Modifications can be made by Departmental Representative due to conditions encountered before or during progress of Work.

- .2 Obtain acceptance of Work from Departmental Representative before and after each stage of installation, including:
 - .1 Preparation (digging, coring, trenching).
 - .2 Installation of conduit and cable.
 - .3 Installation and alignment of components of light units.
 - .4 Preparation for paving, and recoring on completion of paving.
- .3 Review each stage of assembly with manufacturers' designated agents.

3.3 PREPARATION

- .1 Install control measures in accordance with project's Erosion and Sedimentation Control Plan:
 - .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control plan, specific to site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
 - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
 - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .2 In compacted base course for new asphaltic concrete pavement, form hole of diameter 300 mm larger than that of light base, and 150 mm deeper than underside of light base.
- .3 In compacted base course, for concrete paving, form hole of 900 mm diameter, and 150 mm deeper than underside of light base.

3.4 TRENCHING

- .1 For new asphalt or concrete paving, after excavation in compacted base course for bottom light base sections is completed, form trench in compacted base between light base centres 150 mm wide and 75 mm deeper than conduit connection to light base.

3.5 INSTALLATION: BOTTOM LIGHT BASE SECTION IN BASE COURSE FOR NEW CONCRETE

- .1 Place light base in hole and set, using spacers built into jig, so that top of light base assembly, including cover plate and mud plate, is 20 mm below holding plate of jig.
- .2 When light bases are ready to be cast in pavement, remove cover plate and bolt only mud plate to light base so that, as paving proceeds, light base is 35 mm below finished paved surface.
- .3 Using 'bridge' to support worker, spanning paving lane behind paving train, insert 'cookie cutter' around base and work it down into wet concrete at least 25 mm below top of base.
 - .1 Wipe hoop lightly with vegetable oil before insertion for easier removal.
 - .2 Remove wet concrete inside hoop down to mud plate.
- .4 Remove mud plate, clean top flange of light base, and ensure no wet concrete remains on bottom of mud plate.
 - .1 Re-bolt mud plate to base.
- .5 Finish edge around hoop with special curved trowel to provide radius around edge of opening.
- .6 If pavement is to be laid in more than one pass, use two-piece light base.
- .7 Place bottom section of base, and set azimuth and slope.

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- .8 On first pass, remove wet concrete and mud plate from top of bottom section and clean top flange of bottom section.
- .9 Apply thin layer of self-levelling sealant between flange of bottom light base section and bottom flange of top light base section.
 - .1 Bolt two sections together using recommended torque.
- .10 After mud plate is attached to top section, ensure that top of this section is 35 mm below required elevation of second pass.
- .11 During second pass, carry out procedures as for one piece base.
- .12 When concrete has set, remove metal hoop.
- .13 Measure depth of concrete between top of paving and mud plate and use dimension to select proper thickness of spacer ring, along with flange ring, to bring top light unit flush with surface.

3.6 INSTALLATION: REFERENCE FOR ELEVATION OF LIGHT BASES IN NEW CONCRETE PAVEMENT

- .1 Where possible, pave lanes having few or no lights before those having many lights. These lanes will then provide reference for elevation of light unit bases to be installed by placement of legs at one end of installation jig on paved lane, and legs at other end on compacted base course.
- .2 Where this installation has no adjacent lane to use as reference for elevation of light unit bases, place legs of installation jig on compacted base.

3.7 INSTALLATION: CONDUIT IN TRENCHES

- .1 Install 38 mm diameter, rigid PVC conduit in trench.
 - .1 Ensure that conduit in trench will remain 75 mm from bottom of trench after concrete filling is completed.
- .2 Connect conduit to bottom light base threaded hub using waterproof flexible coupling.
- .3 Insert conduit into light base grommets opening with conduit penetrating into light base approximately 30 mm for PVC conduit.
- .4 Fill trench with concrete coincidentally with that poured for bottom light base sections.

3.8 ALIGNMENT

- .1 Utilize siting device on installation jig in order to align base.
 - .1 Set and mark position of base relative to pavement.
 - .2 For middle base unit, utilize siting device on jig to align middle section to correct azimuth utilizing slotted holes in bottom flange of middle light base section.
 - .1 Tighten bolts using recommended torque.
- .2 Install units with as tangential to curve for curved portions of taxiway and high speed exits.
- .3 Effectively secure jig before pouring concrete or other encapsulating material around base and into conduit trenches.
 - .1 Encapsulate opening in compacted base around light base with concrete or sealing compound, as appropriate, to a point level with top of mud plate.
- .4 Check and adjust light bases for azimuth, elevation and slope before concrete or other encapsulating materials harden.
- .5 Remove jig only after concrete or other encapsulating material is cured and firm.

3.9 INSTALLATION: INSET LIGHT UNIT TOP ASSEMBLY

- .1 Using clean gloves, set specified bulb in socket of top assembly.
- .2 Place filters in light unit top assemblies to show color as indicated.
- .3 Remove foreign material from base:
 - .1 Clean rust or other foreign material from gasket groove and matching machined flange surfaces of both base and top.
 - .2 Clean and dry bolt holes to ensure that bolts can be positioned so that top assembly is tightened evenly.
- .4 After cleaning, apply coating of lubricant supplied with top assembly to gasket.
- .5 Use two T-bolts to facilitate handling. Ensure correct alignment and prevent damage to gasket.
- .6 Set top assembly on base receptacle with bolt holes aligned.
- .7 After alignment, apply coat of silicone lubricant to hold-down bolts:
 - .1 Install and tighten in sequence until all bolts are tightened to recommended torque.
 - .2 For curved portions of taxiways and high speed exits, ensure that light beam of installed unit is as noted in drawings.

3.10 TESTING ALIGNMENT

- .1 Assist Departmental Representative in final testing of inset light units to ensure correct installation as follows:
 - .1 Horizontal angular beam is within required spread and tolerance.
 - .2 In line tolerance of light fixtures, as well as tangential locations for lights on curve is correct.
 - .3 Measurement of vertical beam angle spread of complete system, by means of flight test organized by Departmental Representative is correct.
- .2 Departmental Representative to retain and pay testing firm to provide written report to confirm installed fixtures meet requirement as stipulated in TP 312. Contractor to take and pay for corrective action to rectify problem areas with respect to installed fixture as identified in report.

3.11 FIELD QUALITY CONTROL

- .1 Site Test, Inspections:
 - .1 Perform tests as directed by Departmental Representative to ensure [lighting systems] are functional.
 - .2 Arrange for spot check site inspections as directed by Departmental Representative given 5 working days minimum notice.
 - .3 Obtain test reports, within 3 days of review, and submit, immediately, to Departmental Representative.

3.12 CLEANING

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

- .3 Waste Management: separate waste materials in accordance with 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.13 PROTECTION

- .1 Protect installed products and components from damage during construction.
- .2 Repair damage to adjacent materials caused by airfield runway and taxiway inset lighting installation.

END OF SECTION