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## PROJECT SPECIFICATIONS

# LOMBARDY PUBLIC SCHOOL PARKING, SEPTIC AND SITE WORKS. PHASE 2 - MECHANICAL & ELECTRICAL UPGRADES

Upper Canada District School  
Tender Number 26-058

## Issued for Tender

Lombardy, ON

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**Date: April 15, 2026**

File: Project No. 209-00237-00

**Lombardy Public School  
Parking, Septic and Site Works –  
PHASE 2, MECHANICAL & ELECTRICAL UPGRADES  
Project No. 209-00237-00 (Architecture49/WSP Inc.)  
ISSUED FOR TENDER**

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The tender for the project described as Lombardy Public School Mechanical & Electrical Upgrades located in Lombardy, Ontario, (UCDSB Tender No. 26-058 is based upon those documents identified in this Appendix together with such Addenda as are listed in the tender submitted:

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**Part 1 General**

**1.1 EXAMINATION**

- .1 The Contractor and all sub-contractors shall familiarize themselves with conditions at the site. Each one shall bear complete responsibility for familiarization with conditions and the affect that same may have on work.
- .2 Every sub-contractor and the Contractor shall examine the contract documents, the conditions on site and the work in place prior to commencing the various portions of this work.
- .3 Each sub-contractor and the Contractor shall report in writing to the Consultant and the Contractor any defects affecting the work of that trade.
- .4 Commencement of work shall be construed as evidence of acceptance of underlying surfaces, conditions, arrangement and location as satisfactory.
- .5 Refer to Instructions to Tenderers and Supplementary Conditions for additional contractual information.

**1.2 SUPERVISION**

- .1 The site superintendent of this project is the person or alternate named in the Prequalification submission, unless, for reasons beyond the control of the Contractor, neither the named site superintendent nor the named alternate are able to act individually as site superintendents for the project, in which case the Contractor must provide a replacement site superintendent. The Owner further reserves the right to have the Contractor replace any site superintendent with a replacement site superintendent if the Owner deems the current site superintendent's performance to be unsatisfactory.  
  
The Owner reserves the right to determine whether a proposed replacement site superintendent is acceptable. A proposed replacement site superintendent may only act as the site superintendent for the project with the Owner's express written consent.
  - .2 The overall superintendence of the project, ensuring the complete performance of all sub-contractors and suppliers as laid down in the specifications, is the responsibility of the Contractor. A fully competent site superintendent shall be in charge of the work at all times throughout the contract. The superintendent shall study the plans and specifications in detail and be completely familiar with the project at the outset. Once conversant with the documents, he shall relate them to the existing conditions. Any errors or discrepancies in dimensions, details, etc., in the plans and specifications or their relationship to the existing conditions shall be reported to the Consultant for clarification or correction before beginning the work. Allow Consultant time for clarification or correction as required.
  - .3 Ensure that all necessary job dimensions are taken and all trades and coordinated for the proper execution of the work. Assume complete responsibility for the accuracy and completeness of such dimensions, and for coordination.
  - .4 Verify that all work as it proceeds is executed in accordance with dimensions and positions indicated, which maintain levels and clearances to adjacent work as set out by requirements of the drawings; and ensure that work installed in error is rectified before construction continues. Verify that all work as it proceeds is executed in accordance with dimensions and positions indicated, which maintain levels and clearances to adjacent
-

work as set out by requirements of the drawings; and ensure that work installed in error is rectified before construction continues.

- .5 Check and verify all dimensions referring to the work and the interfacing of all services. Verify with the trade concerning all dimensions pertaining to the work of other trades.
- .6 Any errors, discrepancies, or trade conflicts arising during construction shall, when necessary, be referred to the Consultant for clarification and/or decision. Allow Consultant time for deliberation as required.

### **1.3 COOPERATION AND COORDINATION**

- .1 Coordinate all sub-contractors and suppliers so that work proceeds smoothly without interruption and in strict accordance with reviewed schedules. Coordinate so that work is executed in proper sequence, items to be built-in are built-in on time, erected work is protected against damage from the work of other trades and defective work is removed and made good to the satisfaction of the Consultant.
- .2 Study all documents which describe, or are related to, any operation before commencement of that operation. Report discrepancies discovered between elements of documentation and obtain ruling on required interpretation before beginning work. Allow Consultant at least 5 (five) full working days to make ruling.
- .3 Ensure that material, equipment, services and operatives are brought to site at proper times, in sufficient quantity and quality and in accordance with requirements of work.
- .4 Contractor shall ensure that each subcontractor informs him of requirements for site conditions and surfaces necessary for the execution of the work and that he provides setting drawings, templates and all other information necessary for the location and installation of material, holes, sleeves, inserts, anchors, accessories, fastenings, connections and access panels. The Contractor shall inform other sub-contractors whose work is affected by these requirements and preparatory work.
- .5 Contractor and sub-contractors shall cooperate fully with other contractors and sub-contractors working on this project. Perform necessary coordination to install equipment supplied, or supplied and installed by Owner.
- .6 Remove and replace ceilings as required to accommodate the installation of phone, data, security and other service lines in ceiling space which are installed by other contractors.
- .7 Consultant's normal hours of operation are between 8:00am and 5:00pm Monday to Thursday, and between 8:00am and 12:00 noon on Friday. Account for these hours of operation when communicating with the Consultant, when providing the Consultant with sufficient notice, and/or when allowing the Consultant time for deliberation as required.

### **1.4 SCHEDULING AND CONTRACTOR'S USE OF SITE**

- .1 Use of site for execution of the work are as otherwise noted or indicated.
- .2 Work to be performed as described:
  - .1 The school is available from 7:00 am each day.
  - .2 The following work must be completed by August 31, 2026
    - .1
    - .2

**.3**

- .3 The school is available for scheduled weekend work or after hours as required.
- .4 During July and August and Custodian work hours are from 6 am to 2 pm. Contractor will be responsible to arm the security system each day after 2 pm.
- .5 Arrange with UCDSB Representative for security codes and access.
- .6 Confine operation, storage access and parking to owner's discretion.
- .7 Do not unreasonably encumber site with materials or equipment.
- .8 Move stored products or equipment which interfere with operations of owner or other contractors.
- .9 Obtain and pay for additional storage or work areas needed for operations.
- .10 Maintain project grounds and public areas free of rubbish and waste materials.

**1.5 DOCUMENTS REQUIRED**

- .1 Maintain at job site, copies of contract drawings, specifications, addenda, regulatory authority approved drawings, permits and orders, change orders, site instructions, other modifications to contract, field test reports, inspection reports, job minutes, reviewed schedule, manufacturers' installation and application instructions, Material Safety Data Sheets, set of drawings for as-builts, latest copy of Ontario Building Code, Occupational Health and Safety Act and Regulations for Construction Projects.

**1.6 PROJECT MEETINGS**

- .1 Hold project/site meetings as required, frequency, and locations as directed by Consultant and/or UCDSB Representative. Notify all parties concerned of meetings. When requested by the Consultant, ensure requested sub-contractors attend.
- .2 Record minutes of meetings. Within (3) three days of the meeting, distribute draft copies of the minutes by email to the Owner and Consultant for review and comment. Allow (3) days from their receipt of draft minutes for the Owner and Consultant to respond with revisions. Within (3) three days of receipt of revisions, incorporate Owner and Consultant's revisions in revised meeting minutes and distribute to all parties. At each site meeting provide hard copies of previous site meeting minutes to Owner and Consultant.

**1.7 INSPECTION, TESTS AND APPROVAL**

- .1 At least forty-eight hours' notice, in writing, shall be given to the Consultant in order that all inspections and tests called for by these specifications may be implemented. Failure to give such notice will result in complete retesting if deemed necessary by the Consultant.

No work shall be covered up until inspection and acceptance by the Consultant or Inspector.

**1.8 BUILDING AND OTHER PERMITS**

- .1 The Owner shall apply for the main building permit and pay for permit fees. The Contractor shall apply for and pay all other required fees such as, road cut fees, ESA plans review, Hydro Inspection fees, landfill dumping fees, and the like. The Owner will

make the building permit application in advance of tender award to facilitate approval process.

- .2 Provide Authorities with such plans and information as may be required for the issuance of Acceptance Certificates.
- .3 Obtain all Inspection Certificates required by Authorities having jurisdiction. Hand over copies of same to Consultant.

## **1.9 SETTING OUT LINES AND LEVELS**

- .1 Contractor shall confirm all elevations and/or dimensions of existing conditions on site and allow for same in tendering price.
- .2 Employ qualified Ontario Land Surveyor to establish and layout in the field all grid lines, exterior wall and other main lines and levels, verify known geodetic elevation, establish benchmarks or permanent monuments and correlate geodetic elevations with public utility elevations.
- .3 Verify and record on the record drawings, elevation of footing bearing surfaces, top of footings, new services, existing utilities encountered, all related to finished floor elevation or geodetic elevations.
- .4 Install substantial batter boards, lines, stakes, etc, as required during the progress of the work.

## **1.10 CUTTING AND PATCHING**

- .1 Execute cutting (including excavation), fitting and patching required to make the work fit properly together. Cut and patch for process, mechanical and electrical work.
- .2 Coordinate work with other trades so that there is a minimum of cutting, fitting and patching.
- .3 Drilling, cutting, fitting and patching and making good where necessary due to failure to deliver items to be built in time or installation in wrong location, shall be executed as directed at no cost to the Owner.
- .4 Drilling and cutting of load bearing structural members shall be done on prior express written permission of the Consultant for each instance.
- .5 Cut holes accurately, with smooth, true, clean edges. Fit units to tolerances specified or shown or, if not noted, to best standard practice for applicable work.
- .6 Holes in blockwork shall be drilled and/or saw cut and not made with a hammer gun.
- .7 Patched work shall be invisible. Size holes and openings for pipes to allow for expansion and contraction of such pipes.
- .8 Employ tradesmen skilled in the work and execute work to standards specified for that work on this project.
- .9 Patch as required to maintain integrity of fire separations, ratings and assemblies. Patch as required to maintain air and moisture tightness of construction.

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**1.11 CONCEALMENT**

- .1 Conceal pipes, ducts, and wiring in floor, wall and ceiling construction except where indicated otherwise on architectural drawings. Do not fasten anything to any existing Siporex concrete structure and/or metal roof deck.

**1.12 LOCATION OF EQUIPMENT AND FIXTURES**

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate.
- .2 Locate equipment, fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Consultant of impending installation and obtain his acceptance for actual location.
- .4 Submit field drawings to indicate relative position of various services and equipment.
- .5 The Contractor will take all necessary steps to have equipment that was removed or replaced as part of any Work disposed of or decommissioned in accordance with appropriate disposal or decommissioning processes, applicable laws, and in accordance with commercially reasonable environmental practices.
- .6 The contractor will provide before and after pictures of equipment nameplates.
- .7 The Contractor must submit written proof or evidence or acknowledgement that the disposal of all materials was done in accordance with all current disposal requirements.
  - .1 Acceptable Documents are invoices OR disposal certificates from the disposal facility. This documentation must be on the disposal facility's letterhead, invoice, or certificate. Minimum Information Required:
    - .1 building name and address
    - .2 equipment description (lamps, motors, cooling equipment, etc.)
    - .3 equipment quantities
    - .4 disposal facility name

**1.13 INSERTS, SLEEVES AND ANCHORS**

- .1 Provide all sleeves, inserts, anchors, hangers, supports, adhesives and the like necessary for execution of the work.
- .2 Co-ordinate work with other trades. Arrange and pay for installation of sleeves, inserts, anchors, etc. by appropriate trade.
- .3 Employ workmen skilled in the work and execute work to the standards specified for that work on the project.

**1.14 PUBLIC AND PRIVATE UTILITIES AND SERVICES**

- .1 Verify limitations imposed on project work by presence of utilities and services, and ensure no damage occurs to them.
  - .2 Notify service authorities concerned so that they protect, remove, relocate, or disconnect them as they may require.
-



- .3 Make arrangements and pay for connection charges for services required for project work.
- .4 Where unknown services are encountered, immediately advise Consultant and confirm findings in writing.

#### **1.15 SURVEY PINS**

- .1 Property markers, iron pins and square iron pins, bars, etc., disturbed or lost in the course of construction shall be replaced by an Ontario Land Surveyor at no cost to the Owner.

#### **1.16 RUBBISH**

- .1 Do not burn or bury rubbish and work materials on site.
- .2 Dispose of rubbish and surplus material off site.
- .3 Do not dispose of volatile or corrosive materials in sewers and drains.
- .4 Dispose of waste in a manner not detrimental to public, private or Owner's property, or to any portion of the Work completed or under construction.
- .5 Except if expressly stated otherwise, materials indicated for removal become the Contractor's property and shall be taken from the site.
- .6 Dispose of rubbish and waste in accordance with governing regulations.

#### **1.17 RECYCLING**

- .1 In accordance with Ontario Regulation 102/94;
  - .1 Conduct a solid Waste Audit before construction begins;
  - .2 Prepare a solid Waste Reduction Workplan and post summary visible to all workers.
- .2 In accordance with Ontario Regulation 103/94;
  - .1 Establish Source Separation Programs to collect, handle and store;
    - .1 brick, concrete block and concrete
    - .2 corrugated cardboard
    - .3 wood
    - .4 drywall
    - .5 steel
  - .2 Ensure;
    - .1 use of program
    - .2 that materials are recycled
    - .3 that workers are instructed on how to source separate, what is to be collected, and in what form materials will be collected.
- .3 Submit record copy of solid Waste Reduction Workplan to Consultant within 21 days of contract award.

#### **1.18 OCCUPANCY PERMIT**

- .1 Prior to acceptance and takeover by the Owner, obtain and submit to the Owner an

Occupancy Permit for the Work.

**1.19 SMOKING POLICY**

- .1 Smoking is not permitted within the building at any time and/or on School property.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used

**END OF SECTION**

**Part 1 General**

**1.1 CASH ALLOWANCES**

- .1 Refer to CCDC 2, GC 4.1. – Cash Allowances.
- .2 Include in Contract Price specified cash allowances.
- .3 Cash allowances, unless otherwise specified, cover net cost to Contractor of services, products, construction machinery and equipment, freight, handling, unloading, storage installation and other authorized expenses incurred in performing Work.
- .4 Contract Price, and not cash allowance, includes Contractor's overhead and profit in connection with such cash allowance.
- .5 Contract Price will be adjusted by written order to provide for excess or deficit to each cash allowance.
- .6 Where costs under a cash allowance exceed amount of the allowance, the Contractor will be compensated for excess incurred and substantiated plus allowance for overhead and profit as set out in Contract Documents.
- .7 Progress payments on accounts of work authorized under cash allowances are to be included in the Consultant's monthly certificate for payment.
- .8 Prepare a schedule jointly with the Consultant to show when items called for under cash allowances to be authorized by Consultant for ordering purposes so that progress of Work will not be delayed.
- .9 Amount of each allowance is as follows:
  - .1 For Construction of the following items:

Hydro One Service Upgrade: \$ 50,000

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1            ADMINISTRATIVE**

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

**1.2            CONSTRUCTION START-UP MEETING**

- .1      After award of Contract, but before start of Work, a Start-Up Meeting will be held to discuss and resolve administrative procedures and responsibilities.
  - .2      Senior representatives of Departmental Representative, Contractor, major Subcontractors, field inspectors, and supervisors will be in attendance.
  - .3      Departmental Representative will establish time and location of meeting and notify parties concerned minimum five days before meeting.
  - .4      Departmental Representative will chair Start-Up Meeting, record minutes, and distribute minutes to all attending parties within four working days of meeting.
  - .5      Agenda to include:
    - .1          Appointment of official representative of participants in the Work.
    - .2          Schedule of Work, progress scheduling.
    - .3          Critical work sequencing and long-lead items.
    - .4          Communication protocols.
    - .5          Procedures for processing field decisions and Change Orders.
    - .6          Procedures for RFIs.
    - .7          Submittal procedures.
    - .8          Requirements for temporary facilities, site sign, offices, storage sheds, utilities, and fences.
    - .9          Site security.
    - .10        Proposed changes, change orders, procedures, approvals required, mark-up percentages permitted, time extensions, overtime, administrative requirements.
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- .11 Departmental Representative-supplied products.
- .12 Record drawings and specifications.
- .13 Maintenance manuals.
- .14 Take-over procedures, acceptance, and warranties.
- .15 Monthly progress claims, administrative procedures, photographs, holdbacks.
- .16 Appointment of inspection and testing agencies or firms.
- .17 Insurances, transcript of policies.
- .18 Life safety issues.
- .6 Submit Construction Progress Schedule and Shop Drawing Submittal Schedules at initial start-up meeting.

### **1.3 PROGRESS MEETINGS**

- .1 During course of Work, schedule progress meetings once every two weeks, throughout progress of Work.
  - .2 Contractor, major Subcontractors, Departmental Representative, involved in Work are to be in attendance.
  - .3 Agenda to include the following:
    - .1 Review, approval of minutes of previous meeting.
    - .2 Contractor's Construction Schedule:
      - .1 Review progress since last meeting.
      - .2 Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule.
      - .3 Determine corrective measures and procedures to regain projected schedule, and secure commitments from parties involved to do so.
      - .4 Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within Contract Time.
      - .5 Review progress schedule, during succeeding work period.
    - .3 Review present and future needs of each entity present, including following:
      - .1 Interface requirements.
      - .2 Sequence of operations.
      - .3 Status of submittal and submittal schedules.
      - .4 Safety.
      - .5 Deliveries.
      - .6 Off-site fabrication delivery schedules.
      - .7 Access.
      - .8 Site utilization.
      - .9 Temporary facilities and controls.
      - .10 Progress cleaning.
      - .11 Quality and work standards.
      - .12 Status of correction of deficient items.
      - .13 Field observations, problems and conflicts.
      - .14 Status of RFIs.
-

- .15 Status of proposal requests.
- .16 Pending changes.
- .17 Status of Change Orders.
- .18 Documentation of information for payment requests.
- .19 Life safety issues.
- .4 Problems which impede construction schedule.
- .5 Other business.

**END OF SECTION**

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**Part 1 General**

**1.1 GENERAL**

- .1 Refer to Instructions to Tenderers and Supplementary Conditions for additional contractual information concerning submittals.
- .2 Refer to individual sections of specifications for detailed information on submittal requirements.
- .3 Schedule submissions at least three (3) weeks before dates reviewed submission will be needed.
- .4 Do not proceed with work until relevant submissions are reviewed and returned.
- .5 Shop drawings which have not been requested will be returned to the Contractor with no action taken by the Consultant. Shop drawings to which the Consultant's standard "Received" stamp is affixed, have not been reviewed by the Consultant.

**1.2 IDENTIFICATION OF SUBMITTALS**

- .1 In the top right hand corner on the body of each submittal clearly identify the project name (RPS), applicable specification section number in NMS format (e.g. 05 50 00), description of contents (e.g. access ladders), the Owner's name (UCDSB), Consultant's name (A49/WSP), Contractor's name, sub-contractor's name, supplier's name, and the date of submission, all in that order. Indicate origin and intended use in work.
- .2 Accompany each submittal with a transmittal letter recording the information listed in .1 above.
- .3 Permanently identify samples with the information listed in .1 above.
- .4 For electronic submittals, provide electronic file names that identify name of project (RPS) applicable specification section number in NMS format (e.g. 05 50 00), description of contents where applicable (e.g. access ladders) and the date (eg YYMMDD), separating each field with an underscore (e.g. RPS\_055000\_accessladder\_100521.pdf).

**1.3 DOCUMENTATION REQUIRED BEFORE CONSTRUCTION START**

- .1 Refer to Upper Canada District School Board's Tender Document for a complete list.

**1.4 STATUTORY DECLARATION**

- .1 Submit, with each monthly progress claim, a Statutory Declaration certifying that all payments for any liability for which Owner might become responsible if unpaid, have been paid.
- .2 Statutory Declaration shall be a form CCDC 9A or 9B.

**1.5 WSIB CLEARANCE CERTIFICATES**

- .1 Submit with each monthly progress claim, Workplace Safety and Insurance Board Clearance Certificate.
-

## **1.6 CONSTRUCTION SCHEDULE**

- .1 Within fourteen (14) days of authorization to proceed, submit an electronic copy of proposed construction schedule for Consultant's acceptance.
- .2 Schedule shall be in Microsoft Office Project 2007 or newer version. File under Tender No.(as per UCDSB), Project No.209-00237-00 with date and .MPP format. Show clearly proposed progress of all main items. Indicate each trade or operation separately. Order chronologically for beginning of each item of work. Identify first workday of each week. Identity critical sequence of work.
- .3 Include or show separately shop drawing review, decision dates for allow a fabrication and delivery lead time. Show dates for beginning and completion of each element of construction including subtrade work, concrete placement, equipment installation and testing.
- .4 Include or show separately delivery dates for equipment and materials which have a critical delivery period.
- .5 Identify work of separate blocks or phases, or other logically grouped activities. Show projected percentage of completion for each item of work as of 1st day of each month.
- .6 Predicate schedule on basis of substantial performance prior to date stated in agreement.
- .7 Revise or elaborate on schedule if required by Consultant and submit 6 copies of approved schedule for distribution to Owner.
- .8 Revise and update schedule monthly during construction to reflect actual progress and email to all parties bi-weekly.

## **1.7 SCHEDULE OF VALUES**

- .1 Conform to Owner's (UCDSB) contract documents and relevant conditions.
- .2 Itemize separately: individual sections of specifications, different phases of the work, bonds & permits, mobilization field supervision and layout, temporary facilities and controls, major equipment, material costs delivered, installation costs, each allowance, clean up, hand over and commissioning.

## **1.8 SHOP DRAWINGS & PRODUCT DATA**

- .1 Submit shop drawings for Owner's and Consultant's review in accordance with Owner's contract documents.
- .2 The Consultant's review is for conformity to the design concept and general arrangement only. The Consultant's review shall not relieve the Contractor, his sub-contractors and suppliers of their responsibility for errors or omissions, or for the Consultant's failure to observe any deviations in the shop drawings or for meeting all requirements of the Contract Documents. It is the Contractor's responsibility to verify all dimensions and conditions on the site.
- .3 For non-custom items of equipment, manufacturer's publications or catalogue excerpts are acceptable if suitably annotated in ink, crossing out all non-applicable information, and clearly noting model name, model number, and performance/power criteria.



- .4 Submit all shop drawings in PDF (Portable Document Format).
- .5 In the top right-hand corner on the body of each shop drawing submittal clearly identify the project name (RPS), Contractor's name, applicable specification section number in NMS format (e.g. 05 50 00), description of materials and items (e.g. access ladders), the date of submission (YY/MM/DD) and complete identification of all locations in which materials/items are to be installed.
- .6 Accompany shop drawings by transmittal letter containing information outlined in .5 along with the number of drawings in the submission, the title of each drawing, a description of each drawing and other pertinent data.
- .7 For electronic shop drawing submittals, provide electronic file names that identify name of project (LPS) applicable specification section number in NMS format (e.g. 05 50 00), description of contents where applicable (e.g. access ladders) and the date (e.g. YYMMDD), separating each field with an underscore (e.g. LPS\_055000\_accessladder\_100521.pdf).
- .8 Submitted shop drawings which have not been thoroughly reviewed, coordinated, stamped, dated and signed by a person responsible in Contractor's office will be returned without review for resubmittal. Shop drawings that are stamped, dated and signed by a responsible person in the Contractor's office but that contain errors or oversights that a thorough review would have noted, and/or that do not contain mark-ups that a thorough review would have noted will be returned without review for resubmittal.
- .9 Present submittals in SI metric units; where printed material is provided in imperial units, clearly convert all values to metric.
- .10 Individual submissions will not be reviewed until all related information is available. Incomplete submissions will be rejected and returned to Contractor and Contractor may be charged for Consultant's time and expense involved.
- .11 Delete product data information not relevant to project.
- .12 Supplement standard information to provide details applicable to project.
- .13 Submit electronic PDF submissions to the appropriate Consultant address as listed on the front page of the document, to the attention of the appropriate individual.

## **1.9 SAMPLES**

- .1 Submit samples requested in various sections of specification and as may be reasonably required by Consultant.
- .2 Submit samples of adequate size and range of colours or textures to represent material in intended use on project.
- .3 Unless the precise colour and pattern is specifically described in the contract documents, wherever a choice of colour or pattern is available in a specified product, submit accurate colour and pattern charts to the Consultant for selection and acceptance. Submit manufacturer's printed colour charts- do not submit colour charts electronically.
- .4 Material used on project shall match accepted samples for quality, colour and texture, finish and performance. Do not proceed with work until samples are reviewed and

returned with Consultant's signed stamp marking them "reviewed" or "reviewed as noted". If samples are marked "reviewed as noted" incorporate and address review notes before proceeding with the work.

#### **1.10 MOCK-UPS**

- .1 Mock-Up: Field erected example of work complete with specified materials and workmanship.
- .2 Provide mock-ups requested in various sections of specifications and as may be reasonably required by the Consultant.
- .3 Erect mock-ups at locations acceptable to Consultant.
- .4 Reviewed and accepted mock-ups will become standards of workmanship and material against which installed work will be verified.

#### **1.11 RECORD DRAWINGS**

- .1 Maintain contract drawings at site office for record purposes. Record accurately deviations from contract documents caused by site conditions, change orders, site instructions, and addenda. Mark in red ink. Provide one table for this set to be placed on.
- .2 Include depth of various elements of foundation, horizontal and vertical location of new, maintained, rerouted and abandoned underground utilities and of utilities concealed in construction. All unseen or hidden components must be located by dimension.
- .3 Ensure that drawings are always up to date and in good condition.
- .4 Submit as built record drawings in electronic PDF format and in AutoCAD format on USB Thumb drive or Flash drive and two hard copies to Consultant just prior to Substantial Completion.
- .5 Consult Mechanical and Electrical Divisions for other particular requirements.

#### **1.12 PROGRESS REPORTS**

- .1 Contractor shall prepare daily reports of his operations. Daily report shall contain at least the following information:
  - .1 weather conditions
  - .2 manpower on the job in each trade
  - .3 major items of equipment on the job
  - .4 a summary of work accomplished that day
  - .5 materials, equipment, of construction related work items arriving or leaving site
  - .6 inspection reports
  - .7 significant events
  - .8 any tests made and their final results, if known
  - .9 any oral instructions received
  - .10 visitors to the job
- .2 Contractor shall maintain a file of copies of all daily reports on the site and make it available to Consultant or Owner upon request.

### **1.13 MANUALS OF INSTRUCTION AND MAINTENANCE**

- .1 Prior to substantial performance, inspection, submit to Consultant, one (1) hard copy and one (1) USB drive (i.e. thumb or flash drive) in PDF format of Instruction and Maintenance Manuals as follows:
  - .1 Bind data in 215 x 279mm, vinyl covered three-ring loose-leaf binders.
  - .2 Enclose title sheet, labelled "Instruction and Maintenance Manual" with project name, list of contents, date and names of Owner, Consultant, and Contractor.
  - .3 Organize contents into applicable sections of work to parallel project specification breakdown. Mark each section by labelled tabs protected with celluloid covers fastened to hard paper dividing sheets.
- .2 All operation and maintenance manuals to be submitted in English only.
- .3 Neatly type lists and notes. Use clear drawings, diagrams or manufacturer's literature.
- .4 Contents:
  - .1 As called for in individual sections of these specifications.
  - .2 Maintenance instructions for exterior and interior floor, wall, and ceiling surfaces as well as all installed fittings as printed by manufacturer.
  - .3 Operating and maintenance instructions for mechanical and electrical equipment, bound separately.
  - .4 Colour schedule; hardware schedule.
  - .5 Copies of all guarantees and warranties.
  - .6 Complete set of final approved shop drawings, bound separately, indicating corrections and charges made during fabrication and installation.
  - .7 Names, addresses, and phone numbers of sub-contractors and suppliers.
  - .8 WHMIS Manual described in Section 01 35 30.
  - .9 All contents listed to be also in PDF format and submitted on USB drive (thumb or flash drive).

### **1.14 MAINTENANCE MANUALS**

- .1 Turn over materials and spare parts for items noted in various sections of specifications to Owner's authorized representative and obtain receipt. Submit receipt to Consultant. Submit materials in unbroken cartons or if not available in cartons, strongly packed. Identify colour, room number, unit number or area materials used.

### **1.15 DOCUMENTS REQUIRED BEFORE SUBSTANTIAL PERFORMANCE**

- .1 Documents required prior to Substantial Performance include:
  - .1 As-built record Drawings.
  - .2 Manuals of Instruction and Maintenance including:
    - .1 Warranties
    - .2 Final approved shop drawings
    - .3 Schedules
    - .4 WHMS Manual.
  - .3 Mechanical
    - .1 Testing, Adjusting and Balancing (TAB) reports
    - .2 Operation and Maintenance Manual
    - .3 Demonstration and Operating and Maintenance Instruction
    - .4 Individual equipment certification and training session outlined in Mechanical Sections.
  - .4 Electrical

- .1 Operation and Maintenance Manual
- .2 Electrical Inspection Certificate
- .3 F/A verification certificate (where applicable)
- .4 Demonstration and Operating and Maintenance Instruction

**Part 2            Products**

**2.1                NOT USED**

- .1 Not Used.

**Part 3            Execution**

**3.1                NOT USED**

- .1 Not Used.

**END OF SECTION**

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**Part 1 General**

**1.1 SAFETY REGULATIONS**

- .1 The Contractor shall comply with the latest edition and amending regulations of the following documents, and in the case of conflicts between documents, the more stringent rule shall apply:
  - .1 National Building Code, Part 8: Safety Measures at Construction and Demolition Sites.
  - .2 Occupational Health and Safety Regulation for Construction Projects, Revised Statutes of Ontario, Chapter 321, as amended Regulation 691.
  - .3 The Workplace Safety & Insurance Act 1997, and regulations as amended.
  - .4 Ontario Building Code 1997 Regulation 403/97 as amended.
  - .5 Ontario Fire Prevention & Protection Act; Bill 84.
  - .6 Regulation 309 - Environmental Protection Act, revised Ontario Regulation 464/85.
  - .7 Bill 79 - An Act to amend the Occupational Health and Safety Act, Chapter 29, Statutes of Ontario, 1987.
  - .8 Bill C-70, An Act to Amend the Hazardous Projects Act and the Canada Labour Code, June 1987.
  - .9 Workers' Compensation Board First Aid Regulations (950).
  - .10 The Occupational Health and Safety Act - Revised Statutes of Ontario, Revised Regulation 692/80.
  - .11 All other applicable Laws.
  - .12 Designated Substance Reports

**1.2 TEMPORARY STAIRS, HOISTS, SCAFFOLD, ETC.**

- .1 Furnish and maintain all equipment such as stairs, ladders, ramps scaffolds, hoists, runways, derricks, chutes, elevators, etc., as required for proper execution of work.
- .2 Construct and maintain scaffolding in rigid, secure and safe manner. Erect scaffolding independent of walls. Remove promptly when no longer required.
- .3 Where such structures are of a complicated nature, employ the services of a Registered Professional Engineer to design such scaffolding, framework, or other temporary supports.
- .4 Provide all necessary temporary barricades, fencing, guardrails, night lights, and barriers as necessary for the work.

**1.3 SAFETY EQUIPMENT**

- .1 Enforce use of CSA approved hardhats and safety boots for all entering or working on construction site. Refuse admission to those refusing to conform to this regulation.
  - .2 Provide and maintain adequate lighting where workmen or public may be subject to hazards and in all working areas.
  - .3 Comply with the requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding use, handling, storage, and disposal of hazardous materials, and regarding labelling and the provision of material safety data sheets.
    - .1 Establish and maintain a manual for WHMIS. Include all WHMIS data sheets as required above. Turn over the complete manual to Consultant at completion of
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- the work.
- .2 WHMIS manual to include, but not be limited to all:
  - .1 adhesives
  - .2 solvents
  - .3 sealants
  - .4 sprayed on fireproofing
  - .5 resilient flooring
  - .6 carpet, paint, varnish, other coatings
  - .7 membrane waterproofing and air barriers
  - .8 special coatings, sealers, waxes
  - .9 solder, brazing and welding and other metal filler
  - .10 pressure treated wood and surface treatment of cuts
  - .11 other products where particles or vapours may become airborne after installation
- .4 In addition to the requirements of the Occupational Health and Safety Act, and Regulations for Construction Projects, provide temporary safeguards and protection against:
  - .1 Accident or injury to any workmen or other persons on the site, adjacent work and property, roads and walks.
  - .2 Damage to any part of the work and to any adjoining or adjacent structure, properties, pavements, walks, services, and other similar items by frost, weather, overloading, and any other cause resulting from the execution of the work.
- .5 Make good with material identical with existing and adjoining surfaces any damage resulting from the execution of the work to any part of the work or any buildings, pavements, landscaping, poles, hydrants, services, etc., on or surrounding.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

.1        Definitions:

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

.2        Reference Standards:

- .1        Canadian Environmental Protection Act.
- .2        Ontario Environmental Protection Act, Ontario Regulation 127/01 Airborne Contaminant Discharge Monitoring and Reporting.
- .3        Ontario Environmental Protection Act, Ontario Regulation 419/05 Air Pollution – Local Air Quality R.S.O. 1990, c. E.19.
- .4        Ontario Environmental Protection Act, Ontario Regulation 463/10 Ozone Depleting Substances and Other Halocarbons.
- .5        Ambient Air Quality Criteria (AAQC) – Ontario Ministry of the Environment and Climate Change.
- .6        Sheet Metal and Air Conditioning Manufacturer's Association International (SMACNA).

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Before commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Departmental Representative.

**1.3            ENVIRONMENTAL PROTECTION PLAN:**

- .1        Include comprehensive overview of known or potential environmental issues to be addressed during construction.
  - .2        Address topics at level of detail commensurate with environmental issue and required construction tasks.
  - .3        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        Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.
    - .6        Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.
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- .7 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off project site.
- .8 Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.
- .4 Departmental Representative's review of Contractor's Environmental Protection Plan shall not be construed as approval and does not reduce Contractor's overall responsibility for construction environmental protection.

#### **1.4 FIRES**

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

#### **1.5 NOISE CONTROL**

- .1 Limit hours of Work activities in accordance with Section 01 14 00 – Work Restrictions to minimize noise disturbance to humans.
- .2 Maintain equipment and machinery to minimize unnecessary noise pollution.
- .3 Apply noise control technology on heavy machinery and equipment where possible.
- .4 Complete Work shall in accordance with local municipal noise bylaws.

#### **1.6 POLLUTION CONTROL**

- .1 Maintain temporary pollution control features installed under this contract.
- .2 Control emissions from equipment and plant to local authorities' emission requirements.
- .3 Prevent sandblasting and other extraneous materials from contaminating air beyond application area, by providing temporary enclosures.
- .4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris.

#### **1.7 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 may 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**

.1            Not Used.

**Part 3            Execution**

**3.1            CLEANING AND WASTE MANAGEMENT**

.1            Progress and Final Cleaning: clean in accordance with Section 01 74 00 – Cleaning and  
01 74 19 – Waste Management and Disposal.

**END OF SECTION**

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**Part 1 General**

**1.1 GENERAL**

- .1 Specific testing & inspection requirements are outlined in various sections of specifications.

**1.2 APPOINTMENT**

- .1 Owner shall appoint an independent testing company or companies to conduct tests and/or perform inspections of materials and workmanship under this contract, unless noted otherwise. Contractor to inform UCDSB Rep within 48 hours written notice.

**1.3 OTHER TESTING**

- .1 Where no testing requirements are specified but Owner decides that testing is required, Owner reserves right to have such testing or inspections performed.
- .2 Payment for extra testing requested by Owner shall be an addition to the contract as outlined in Part 6, Changes in the Work.

**1.4 SCHEDULING**

- .1 Notify Consultant at outset of project of requirements for testing services so that requisite testing and inspection activities can be coordinated into work on schedule.

**1.5 NOTIFICATION**

- .1 Notify Consultant two weeks in advance of date when the first work will be ready for inspection.
- .2 Notify testing company at least 48 hours in writing before such inspection or test is required.
- .3 When testing laboratory is ready to test according to the above notification, but is prevented from testing or taking specimens due to incompleteness of work, all extra costs for testing attributable to the delay shall be deducted by Owner from contract price.

**1.6 COOPERATION**

- .1 Provide representatives of testing company with access to work at all times. Permit testing laboratory to take materials and specimens required for testing and assist as requested. Deliver samples of material to testing company as specified.
- .2 Make good work disturbed by inspection & test.

**1.7 REPORTS**

- .1 Testing company shall promptly issue test reports simultaneously and directly to Contractor (1 copy), Owner (1 copy), Consultant (1 copy).

**1.8 FAILURE TO MEET REQUIREMENTS**

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- .1 Non-compliance: When initial tests indicate non-compliance with contract documents, costs of initial test associated with non-compliance shall be deducted by Owner from contract price.
- .2 Re-testing: When initial tests indicate non-compliance with the contract documents, all subsequent re-testing occasioned by non-compliance shall be performed by same testing company and costs thereof deducted by Owner from contract price.

## **1.9 CONTRACTUAL RESPONSIBILITY**

- .1 Review of construction by the Consultant and inspection and testing by an independent Inspection and Testing Agency, are precautions against oversight or error and to satisfy the Owner that the work is in conformity with the Contract Documents. This is not intended to be the means of quality control. Review, inspection, and testing, are based on representative samples of the work and do not relieve the Contractor from carrying out his own quality control and for completing all work in accordance with contract documents.
- .2 Costs for uncovering and making good work that is covered before required inspection or testing is completed and approved, are the Contractor's responsibility.
- .3 Contractor shall furnish all labour and facilities and be responsible for:
  - .1 Inspection and testing required by laws, ordinances, rules, regulations or order of public authority.
  - .2 Inspection and testing performed exclusively for Contractor's convenience.
  - .3 Testing, adjustment and balancing of conveying mechanical and electrical equipment and systems.
  - .4 Mill tests and certificates of compliance.
  - .5 Tests specified to be carried out by the Contractor.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

## **Part 3 Execution**

### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 American Society of Heating, Refrigerating and Air-Conditioning s (ASHRAE).
  - .1 ASHRAE 52.2-2017, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particulate Size.
- .2 Canadian Standards Association (CSA) Group.
  - .1 ASME A112.19.3-2017/CSA B45.4-17, Stainless Steel Plumbing Fixtures.
  - .2 CAN/CSA-Z809-16, Sustainable Forest Management (SFM).
- .3 Forest Stewardship Council (FSC).
  - .1 FSC-STD-CAN-01-2018 EN V1-0, FSC National Forest Stewardship Standard of Canada.
- .4 Green Seal Environmental Standards (GS).
  - .1 GS-11-2015, Paints, Coatings, Stains, and Sealers.
- .5 National Air Duct Cleaners Association (NADCA).
  - .1 ACR 2013, The NADCA Standard for Assessment, Cleaning & Restoration of HVAC Systems.
- .6 Sheet Metal and Air Conditioning National Contractors Association (SMACNA).
  - .1 ANSI/SMACNA 008-2008, IAQ Guidelines for Occupied Buildings Under Construction.
- .7 Underwriters Laboratories (UL).
  - .1 UL 2761-2011, Sealants and Caulking Compounds.
  - .2 UL 2762-2011, Adhesives.
  - .3 UL 2778-2011, Products made from Recycled Plastic.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submittals required:
  - .1 Submit name and experience of Green Design Co-ordinator to Departmental Representative for approval.
  - .2 Compliance Report indicating requirement to purchase energy efficient and environmentally benign products.
  - .3 Use Report indicating understanding of requirement to use materials and methods of construction, which improve energy and water efficiency, reduce hazardous by-products, and use recycled materials, or materials, which can be reused.
  - .4 Ensure Energy Report: indicates Energy Star EnerGuide ratings of new equipment and appliances.
  - .5 Building systems and material evaluation report.
- .3 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 43 - Environmental Procedures and 01 35 29 - Health and Safety Requirements. Indicate VOC emissions, prior to installation or use:
  - .1 Adhesives.
  - .2 Caulking compounds.

- .3 Sealants.
- .4 Insulating materials.
- .5 Fireproofing or fire stopping materials.
- .6 Paints.
- .7 Carpets.
- .8 Floor and wall patching or levelling materials.
- .9 Lubricants.
- .10 Clear finishes for wood surfaces.
- .4 Construction Schedule:
  - .1 Submit schedule of construction prior to start of work, in co-ordination with scheduling requirements, including:
    - .1 Sequence of finish applications and allowances for curing times.
    - .2 Identification of finish types.
    - .3 Schedule and duration of proposed temporary ventilation.
    - .4 Delivery schedules of manufactured materials which are anticipated to off-gas in timely manner, which will allow for airing of those materials prior to their scheduled installation.
    - .5 Indicate and schedule commissioning procedures and temporary usages of building mechanical systems, identifying types of filtration and schedule for filter replacement.
- .5 IAQ Management Plan:
  - .1 Submit Indoor Air Quality (IAQ) Management Plan for construction and preoccupancy phases of building.

### 1.3 HAZARDOUS MATERIALS

- .1 Follow methods and procedures specified in Departmental Representative's Designated Substances Report.
- .2 Take measures to ensure chemical spills do not enter drains.
- .3 Provide proper storage and containment of herbicides and indoor pesticides.
  - .1 Design and construction of storage spaces for hazardous materials in accordance with authorities having jurisdiction.
  - .2 Include ventilation of areas, which contain potential sources of air contamination.
    - .1 Comply with standards for storage of flammable, combustible and hazardous materials, explosives, compressed gas cylinders, and reactive, corrosive and oxidizing materials.
  - .3 Storage conditions, ventilation requirements, construction materials storage areas, containers, drums and tanks, compatibility issues, and labelling: in accordance with federal and municipal guidelines supplemented as follows:
    - .1 Confine storage of chemicals and hazardous wastes to designated areas with security of access.
    - .2 Ensure access to hose bib and water for mixing concentrated chemicals.
    - .3 Include containment to prevent spills from entering drains.
    - .4 Include venting to exterior.
    - .5 Keep storage areas under negative pressure, where possible.

#### 1.4 BUILDING ENVELOPE

- .1 Maintain integrity of building envelope using air barriers and vapour retarders and avoid thermal bridging to provide thermal comfort and prevent condensation.
  - .1 Air leakage through air barrier system within roof area: not to exceed  $0.15 \text{ l/s}\cdot\text{m}^2$  @ 75 Pa.
  - .2 Air leakage through air barrier system within area of exterior walls (excluding window): not to exceed  $0.30 \text{ l/s}\cdot\text{m}^2$  @ 75 Pa.

#### 1.5 GENERAL BUILDING DESIGN

- .1 Green design facilitation is used on this project to support green design integration.
  - .1 Green Design Co-ordinator provided by Contractor.
  - .2 Submit name and experience of Green Design Co-ordinator to Departmental Representative for approval.
  - .3 Have Green Design Co-ordinator report to Departmental Representative.
- .2 Indicate in writing to Departmental Representative.
  - .1 Compliance Report: indicating requirement to purchase energy efficient and reduced environmental impact products.
  - .2 Use Report: indicate understanding of requirement to use materials and methods of construction, which improve energy and water efficiency, reduce hazardous by-products, and use recycled materials, or materials which can be reused.
  - .3 Energy Report: to indicate that new equipment and appliances meet energy efficiency criteria.

#### 1.6 INDOOR AIR QUALITY (IAQ)

- .1 IAQ Performance.
  - .1 Comply with following minimum indoor air performance requirements. Total volatile organic compounds level requirements include formaldehyde:
    - .1 Product emission rate measured in g/L.
    - .2 4-Phenyl Cyclohexene (4-PC) Emission Rates as per the Carpet and Rug Institutes Green Label Plus program:
      - .1 Product emission rate measured in  $\mu\text{g}/\text{m}^2\text{hr}$ .
  - .2 Indoor Environmental Quality.
    - .1 Reduce quantity of indoor air contaminants that are odorous or potentially irritating to provide installer and occupant health and comfort as indicated.
    - .2 Minimize cross-contamination of regularly occupied occupancy areas by chemical pollutants.
      - .1 Include drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.
- .2 Construction IAQ Management Plan.
  - .1 Develop and implement Indoor Air Quality (IAQ) Management Plan for construction and preoccupancy phases of building as follows:
    - .1 During construction: meet or exceed minimum requirements of ANSI/SMACNA 008 IAQ Guideline for Occupied Buildings under Construction.
    - .2 Protect stored on-site or installed absorptive materials from moisture damage.
    - .3 Replace filtration media immediately prior to occupancy.

- .1 Filtration media: in accordance with ASHRAE 52.2, Minimum Efficiency Reporting Value (MERV) of 13.
  - .4 Conduct minimum 2 week building flush-out with new filtration media at 100% outside air after construction ends and prior to occupancy.
    - .1 Test contaminant levels in building.
  - .5 Adopt IAQ management plan during construction procedures, including:
    - .1 Protection of HVAC system during construction to control pollutant sources, and interrupt pathways for contamination.
    - .2 Sequence installation of materials to allow dissipation of high emissions from finishes that off-gas high quantities of emissions during curing to avoid contamination of absorptive materials.
    - .3 Erect appropriate noise and dust barriers where demolition or construction procedures are to occur adjacent to occupied space.
      - .1 Take necessary steps to minimize interference with occupants in occupied spaces.
    - .4 Permanent HVAC system may be used as approved in writing by Departmental Representative to move both supply and return air during construction process. Meet following conditions:
      - .1 Install and maintain filters with efficiency rating of MERV 13.
      - .2 Do not use permanent diffusers.
      - .3 Do not use plenum type return air system.
      - .4 Seal HVAC duct system to prevent spread of airborne particulate and other contaminants.
      - .5 Vacuum dust systems following building flush out.
        - .1 Use portable HEPA vacuums, certified clean in accordance with NADCA specifications.
- .3 Environmental Tobacco Smoke (ETS) Control.
  - .1 Smoking will not will be permitted at site during construction.
- .4 Carbon Dioxide (CO<sup>2</sup>) Monitoring.
  - .1 Provide carbon dioxide detectors to assess and monitor air quality and ventilation rates.

## **1.7 GENERAL CONSTRUCTION MATERIALS/PRACTICES**

- .1 Materials and Resources.
  - .1 Use uncontaminated demolition materials for fill and hardcore and/or granular base.
  - .2 Incorporate reused building materials as indicated.
  - .3 Use products and services that meet criteria of EcoLogo guidelines.
  - .4 Provide list of non-endorsed products and services, provided the green labelled product or services are capable of meeting specified performance requirements.
- .2 Construction Waste Management.
  - .1 Follow recommendations and requirements of this projects construction, renovation and demolition (CRD) waste management plan in accordance with Section 01 74 19 - Waste Management and Disposal.
  - .2 Recycled Content.
    - .1 Use materials with post-consumer and post-industrial recycled content.

- .3 Local/Regional Materials.
  - .1 Use systems and materials having 20%, of total products or materials manufactured within 800 kilometres if transported by truck or 2400 kilometres if transported by rail or water of project site.
- .4 Rapidly Renewable Materials.
  - .1 Use systems and materials that originate from renewable sources.
- .5 Wood.
  - .1 Use lumber sourced from independently certified well-managed forests in accordance with CAN/CSA-Z809 or FSC.
  - .2 Materials made from composite wood materials or agricultural products: must not contain urea-formaldehyde resins.
- .6 Insulation.
  - .1 Utilize insulation materials meeting following requirements:
    - .1 Board-type thermal insulation materials must contain, when calculated on 12-month rolling basis:
      - .1 Over 35% recycled material by weight of finished product if made from glass fibre.
      - .2 Over 45% recycled material by weight of finished product if made from mineral composition.
    - .2 Loose-fill and spray-on thermal insulation materials must contain, when calculated on 12-month rolling basis:
      - .1 Over 75% recycled material by weight of finished product, if made from cellulose fibre.
      - .2 Over 35% recycled material by weight of finished product if made from glass fibre.
      - .3 Over 50% recycled material by weight of finished product, if made from mineral wool.
  - .3 Use insulation materials manufactured or installed that do not include CFC s.

## **1.8 PAINTS, STAINS, AND VARNISHES**

- .1 Use paints and coatings with VOC limits to UL 2768.

## **1.9 SEALANTS, ADHESIVES AND COMPOUNDS**

- .1 Use adhesives with VOC limits to UL 2762.
- .2 Use sealant products with VOC limits to UL 2761.

## **1.10 HVAC EQUIPMENT**

- .1 Identify sources of external contamination in writing to Departmental Representative.
- .2 Include filtration system with MERV 13 to ASHRAE 52.2.
- .3 Storage Tanks.
  - .1 Include on site storage tanks to federal guidelines and local codes.
  - .2 Include ladders and access for cleaning and inspection of filters.
  - .3 Include access to air-handling units for service and inspection.



**1.11 LIGHTING**

- .1 Integrate lighting controls as specified related to room occupancy, circulation space, day-lighting, and number of work stations (in office areas) using stepped dimming day-light controls.
- .2 Lighting Fixtures.
  - .1 Include high efficiency lamps and luminaries with electronic ballasts. Lamps and luminaries to have following requirements:
    - .1 Fit electronic ballasts to luminaries.
    - .2 Include task lighting as indicated.
    - .3 Include personal controls as indicated.

**1.12 PLUMBING FIXTURES**

- .1 Water Efficiency.
  - .1 Include kitchen and bathroom faucets with low flow models aerators.
  - .2 Include efficient equipment to heat and supply service water to meet water-use target of less than 0.5 m<sup>3</sup>/m<sup>2</sup>/year.
- .2 Water Use Reduction.
  - .1 Install water meters where indicated.
  - .2 Use low flow hand-operated electronic proximity sensor faucets.
  - .3 Include low flow toilets to ASME A112.19.3/CSA B45.4, maximum 6 Litres/flush.
  - .4 Include urinals to ASME A112.19.3/CSA B45.4, maximum flow rate of 0.06 Litres/flush cycle complete with adjusting flush valves for minimum acceptable volume electronic proximity devices.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

## **1 GENERAL**

### **1.01 RELATED REQUIREMENTS**

- .1 Section 32 11 16.01 - Granular Sub-base
- .2 Section 32 11 23 - Aggregate Base Courses
- .3 Section 32 12 16.01 - Asphalt Paving

### **1.02 REFERENCE STANDARDS**

- .1 Ministry of Transportation, Ontario (MTO)
  - .1 Ontario Traffic Manual, Book 7.
  - .2 MTO Special Provision No. 199F01 Temporary Roadway Closures (attached)

### **1.03 PROTECTION OF PUBLIC TRAFFIC**

- .1 Comply with requirements of Acts, Regulations and By-Laws in force for regulation of traffic or use of roadways upon or over which it is necessary to carry out Work or haul materials or equipment.
- .2 When working on travelled way:
  - .1 Place equipment in position to minimize interference and hazard to travelling public.
  - .2 Keep equipment units as close together as working conditions permit and preferably on same side of travelled way.
  - .3 Do not leave equipment on travelled way overnight.
- .3 Close lanes of road only after receipt of written approval from the Authorities having jurisdiction.
  - .1 Before re-routing traffic erect suitable signs and devices to Temporary Traffic Control Measure Manual, Ontario Traffic Manual.
- .4 Keep travelled way graded, free from potholes and of sufficient width for required number of lanes of traffic.
  - .1 Provide 8 m wide minimum temporary roadway for traffic in two-way sections through Work and on detours.
  - .2 Provide 5 m wide minimum temporary roadway for traffic in one-way sections through Work and on detours.
- .5 Provide gravelled or paved detours or temporary roads as directed by the Consultant:
  - .1 Place and compact granular sub-base in accordance with Section 32 11 16.01 - Granular Sub-base.
  - .2 Place and compact granular base in accordance with Section 32 11 23 - Aggregate Base Courses.
  - .3 Place and compact asphalt pavement in accordance with Section 32 12 16.01 - Asphalt Paving].
- .6 Provide and maintain road access and egress to property fronting along Work under Contract and in other areas as indicated, except where other means of road access exist that meet approval of UCDSB Representative Consultant.

### **1.04 INFORMATIONAL AND WARNING DEVICES**

- .1 Provide and maintain signs, and other devices required to indicate construction activities or other temporary and unusual conditions resulting from Project Work which requires road user response.

- .2 Supply and erect signs, delineators, barricades and miscellaneous warning devices to Ontario Traffic Manual, Book 7: Temporary Conditions.
- .3 Place signs and other devices in locations recommended in Ontario Traffic Manual, Book 7: Temporary Workplace Traffic Control Manual.
- .4 Meet with UCDSB Representative and Consultant prior to commencement of Work to prepare list of signs and other devices required for project. If situation on site changes, revise list to approval of the Consultant.
- .5 Continually maintain traffic control devices in use:
  - .1 Check signs daily for legibility, damage, suitability and location. Clean, repair or replace to ensure clarity and reflectance.
  - .2 Remove or cover signs which do not apply to conditions existing from day to day.

#### **1.05 CONTROL OF PUBLIC TRAFFIC**

- .1 Provide competent flag personnel, trained in accordance with, and properly equipped to [Ontario Traffic Manual, Book 7: Temporary Workplace Traffic Control Manual for situations as follows:
  - .1 When public traffic is required to pass working vehicles or equipment that block all or part of travelled roadway.
  - .2 When it is necessary to institute one-way traffic system through construction area or other blockage where traffic volumes are heavy, approach speeds are high and traffic signal system is not in use.
  - .3 When workmen or equipment are employed on travelled way over brow of hills, around sharp curves or at other locations where oncoming traffic would not otherwise have adequate warning.
  - .4 Where temporary protection is required while other traffic control devices are being erected or taken down.
  - .5 For emergency protection when other traffic control devices are not readily available.
  - .6 In situations where complete protection for workers, working equipment and public traffic is not provided by other traffic control devices.
  - .7 At each end of restricted sections where pilot cars are required.
  - .8 Delays to public traffic due to contractor's operators: 5 minutes maximum.
- .2 Where roadway, carrying two-way traffic, is restricted to one lane, for 24 hours each day, provide portable traffic signal system.
  - .1 Adjust, as necessary, and regularly maintain system during period of restriction.
  - .2 Ensure signal system meets requirements of Ontario Traffic Manual, Book 7: Temporary Workplace Traffic Control Manual.

## **2 PRODUCTS**

### **2.01 NOT USED**

- .1 Not Used.

## **3 EXECUTION**

### **3.01 NOT USED**

- .1 Not Used.

**END OF SECTION**

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**Part 1            General**

**1.1                CONSTRUCTION OFFICES**

- .1 Contractor to provide their own construction trailer during school occupied months. Coordinate with owner for location. Provide the latest and any necessary documentation and/or drawings to facilitate the work and construction and/or for site meetings on reference including but not limited to; Tender drawings, tender or latest specifications, shop drawings, Change orders, Site reports, site instructions, construction schedule, etc. Prior to site meeting, accommodate for 6-10 people furnished with table and chairs (coordinate with school staff for temporary supply of furnishings required).

**1.2                STORAGE SHEDS**

- .1 Provide and maintain, in accepted locations on site, temporary offices and sheds for storage of materials, tools and equipment. Construct temporary buildings with raised floors, weatherproof, of neat appearance and subject to Consultant's acceptance.
- .2 Store materials and equipment in areas on site designated by Owner.

**1.3                SANITARY FACILITIES**

- .1 Contractor to provide a temporary portable facility for the project in accordance with governing regulations and ordinances. Using school's washroom facilities will not be allowed.

**1.4                FENCING**

- .1 Provide temporary fencing for construction site as required and/or wherever required by applicable laws and by-laws and as shown on drawings.
- .2 Unless otherwise noted, temporary fencing to be 51mm x 102mm welded wire mesh panels with interlocking frames made from 16-gauge 32mm square metal tubing c/w stabilizing feet pinned in place with reinforcing bars, or similar system approved by Consultant. Panels to be no less than 1829 high. Fasten interlocking panels together with tamper resistant fence clamps to prevent dismantling, and provide lockable gates as required for access. Snow fencing will not be permitted as a substitute.
- .3 Construct/erect fencing and other protection at least to Municipal and provincial standards.

**1.5                ENCLOSURE**

- .1 Provide temporary enclosures as required by construction operations and to ensure continuous execution of the work.
  - .2 Provide temporary weather-tight enclosures and protection for exterior openings until permanent exterior doors, windows and roof closures are installed.
  - .3 Erect enclosures to allow accessibility for installation of materials and working inside of enclosure.
  - .4 Design enclosures to withstand wind pressure.
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**1.6 POWER AND LIGHTING**

- .1 Provide and pay for all temporary power and lighting for use of trades as required to perform the work except as otherwise permitted.
- .2 Pay for all permits and/or installation costs and make necessary arrangements.
- .3 Electrical power and lighting systems installed under this contract may be used for construction requirements provided that guarantees are not affected thereby. Make good damage. Replace lamps which have been used over a period of 3 months.

**1.7 WATER SUPPLY**

- .1 Provide and pay for temporary water supply for use of all trades, except as otherwise permitted.
- .2 Pay for all permits and/or installation costs and make necessary arrangements.
- .3 Permanent water supply system installed under this contract may be used for construction requirements provided that guarantees are not affected thereby. Make good any damage.

**1.8 STREETS AND TRAFFIC**

- .1 Provide all necessary flagmen, detour signs, warning lights, signs and barricades, necessary to direct and protect pedestrian and vehicular traffic during the work.
- .2 Conform to all Provincial, Regional, and Municipal Regulations and requirements.
- .3 Remove mud and clay from vehicles leaving site so as to meet Municipal regulations.
- .4 Provide dust control to meet Municipal regulations.

**1.9 DRAINAGE**

- .1 Provide temporary drainage and pumping if required or as necessary to always keep project site and adjacent properties free from water.
- .2 Dispose of water in a manner not detrimental to public and private property, or any portion of work completed or under construction.

**1.10 POLLUTION CONTROL**

- .1 Contractor shall provide their own dumpster and any associated disposal fees as required. Confirm with Owner exact placement of dumpster location. Upon dumpster removal, if existing asphalt is damaged, provide new asphalt and compacted sub grade material as required at no cost to the Owner. Upon dumpster removal, if existing grass is damaged, provide new sod and 100 mm thick topsoil all as required at no cost to the Owner.
  - .2 Cover dry materials and rubbish to prevent blowing dust and debris.
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**1.11 FIRE PROTECTION**

- .1 Provide and maintain temporary fire extinguishing equipment until Owner's extinguishing equipment is in place.
- .2 Keep all fire hydrants free of obstructions of all kinds.
- .3 Maintain fire protection systems in operation at all times except for local area being worked on.
- .4 Organize work to maintain required fire exit paths in safe condition.
- .5 Keep fire routes clear for emergency access. Keep clear of snow and obstructions. Do not store materials nor park vehicles in fire routes.
- .6 Relocate or cover combustible materials in the vicinity during welding, cutting or other hot work including foam plastic insulation, in walls and roofs.

**1.12 ROOFING PROTECTION**

- .1 Provide and maintain protection from anything that may damage or be detrimental to the waterproofing qualities of the various membranes. Include protection from construction work such as falling objects, wheel and foot traffic, failure to remove debris, scaffolding, hoisting equipment.
- .2 Minimum Protection: 6mm waferboard over 25mm Type 1 polystyrene over 6 mil polyethylene.

**1.13 PROTECTION OF OFF-SITE AND PUBLIC PROPERTY**

- .1 Protect surrounding private and public property from damage during performance of work, including, but not limited to, existing buildings, wells, septic systems, trees and other plants, lawns, fencing, service poles, wires, rail tracks, underground services, pavement, survey benchmarks and documents which may be affected by the Work.
- .2 In the event of damage, be responsible for any damage incurred, and immediately make repair to match or exceed pre-construction conditions, to the satisfaction of the Consultant and owner.

**1.14 DUST SCREENS**

- .1 As the work progresses erect temporary enclosures to divide off areas of finishing work from other areas. Enclosures to be neatly constructed and dust tight.

**1.15 REMOVAL OF TEMPORARY FACILITIES**

- .1 Remove all temporary facilities from site, including pre-existing temporary fencing, and roads when directed by Consultant.
- .2 Repair or replace items damaged by temporary facilities to Consultant's acceptance.

**1.16 OVERLOADING**

- .1 Ensure no part of Work is subjected to loading that will endanger its safety or will cause permanent deformation.
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#### **1.17 GUARD RAILS AND BARRICADES**

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

#### **1.18 WEATHER ENCLOSURES**

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

#### **1.19 ACCESS TO SITE**

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

#### **1.20 CONSTRUCTION FENCING**

- .1 Provide fencing around construction area limits for duration of Work:
  - .1 Fence panels: 1 830 mm high wire mesh, secured to portable bases.
  - .2 Include lockable access gates for worker and vehicular traffic.
  - .3 Post signage on fencing in accordance with requirements of Section 01 52 00 Construction Facilities.
- .2 Remove fencing at time selected by Departmental Representative before Substantial Completion.

#### **1.21 FIRE ROUTES**

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

#### **1.22 PROTECTION FOR OFF-SITE AND PUBLIC PROPERTY**

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

#### **1.23 PROTECTION OF BUILDING FINISHES**

- .1 Provide protection for finished and partially finished building finishes and equipment during performance of Work.
- .2 Provide necessary screens, covers, and hoardings.

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

**1.24 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19 - Waste Management And Disposal.
- .2 01 74 19 - Waste Management And Disposal.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**



## **1.1 SUMMARY**

- .1 Section includes administrative and procedural requirements for selection of products for use in Project, and product delivery, storage, and handling.

## **1.2 DEFINITIONS**

- .1 Product or Products:
  - .1 Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature, that is current as of date of Contract Documents.
  - .2 New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  - .3 Comparable Product: Product that is demonstrated and approved through submittal process to have indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

## **1.3 REFERENCE STANDARDS**

- .1 Canadian Construction Documents Committee (CCDC).
  - .1 CCDC 2-2020, Stipulated Price Contract.
- .2 Canadian Standards Association (CSA Group).
  - .1 CSA S136-16, North American Specification for the Design of Cold-Formed Steel Structural Members.
  - .2 CSA S136S1:19, Supplement 1 to the North American Specification for the Design of Cold-Formed Steel Structural Members.
- .3 Within text of each specifications section, reference may be made to reference standards.
- .4 Conform to these reference standards, in whole or in part as specifically requested in specifications.
- .5 When there is question as to whether products or systems are in conformance with applicable standards, Consultant reserves right to have such products or systems tested to prove or disprove conformance.
- .6 Cost for such testing will be borne as follows:
  - .1 By Consultant in event of conformance with Contract Documents.
  - .2 By Contractor in event of non-conformance with Contract Documents.
- .7 Conform to latest date of issue of referenced standards in effect on date of submission of Bids, except where specific date or issue is specifically noted.
- .8 When Product is specified by reference standard or performance specifications, upon request of Consultant, obtain independent testing laboratory report from manufacturer, stating Product meets or exceeds specified requirements.

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#### **1.4 SUBMITTALS**

- .1 Comparable Product Requests: Submit request for consideration of each comparable product. Identify products to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - .1 Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
  - .2 Consultant's Action: When necessary, Consultant will request additional information or documentation for evaluation within one week of receipt of comparable product request. Consultant will notify Contractor of approval or rejection of proposed comparable product request within ten working days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
    - .1 Use product specified if Consultant does not issue a decision on use of comparable product request within time allocated.
- .2 Basis-of-Design or Standard of Acceptance Product Submittal: Comply with requirements in Section 01 33 00 – Submittal Procedures. Show compliance with requirements.

#### **1.5 QUALITY OF MATERIALS**

- .1 Products, materials, equipment, and articles (referred to as products throughout specifications) incorporated in Work to be new, unless indicated otherwise, not damaged or defective, and of best quality (compatible with specifications) for purpose intended. If requested, furnish evidence as to type, source and quality of products provided.
  - .2 Acquire, in a 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 before 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 Consultant based upon requirements of Contract Documents.
  - .5 Unless otherwise indicated in specifications, maintain uniformity of manufacturer 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.
  - .7 Compatibility of Options: When Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.
-

## **1.6 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 Consultant 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 Consultant at commencement of Work and should it subsequently appear that Work may be delayed for such reason, Consultant reserves right to substitute more readily available products of similar character, at no increase in Contract Price or Contract Time.

## **1.7 PRODUCT SELECTION PROCEDURES**

- .1 General Product Requirements: Provide products that comply with Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
  - .1 Provide Products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  - .2 Standard Products: Where available, and unless custom products or non-standard options are specified, provide standard Products of types that have been produced and used successfully in similar situations on other projects.
  - .3 Owner reserves right to limit selection to Products with warranties not in conflict with requirements of Contract Documents.
  - .4 Where Products are accompanied by term "as selected", Consultant will make selection.
  - .5 Descriptive, performance, and reference standard requirements in Specifications establish relevant characteristics of products.
- .2 Product Selection Procedures:
  - .1 Product: Where Specifications name a single manufacturer and Product, provide the named Product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - .2 Manufacturer: Where Specifications name a single manufacturer, provide product by named manufacturer that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
  - .3 Basis-of-Design or Standard of Acceptance Product: Where Specifications name product, or refer to product indicated on Drawings, provide indicated product or comparable product by another manufacturer. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on product indicated. Comply with requirements in "Comparable Products" Article for consideration of unnamed products by another manufacturer.
  - .4 Visual Matching Specification: Where Specifications require "match Consultant's sample", provide product that complies with requirements and matches Consultant's sample. Consultant's decision will be final on whether proposed product matches.
    - .1 When no product available within specified category matches and complies with other specified requirements, comply with requirements in Article "Substitutions During Construction" for proposal of product.
- .3 When materials are specified only by reference standard, select any material that meets or exceeds the specified standard.

- .4 Where materials are required to be listed on "Canadian General Standards Board, Qualified Products List" select any manufacturer so listed.

## **1.8 COMPARABLE PRODUCTS**

- .1 Conditions for Consideration: Owner and Consultant will consider Contractor's request for comparable product when following conditions are satisfied. When following conditions are not satisfied, Consultant may return requests without action, except to record non-compliance with these requirements:
  - .1 Evidence that proposed product does not require revisions to Contract Documents, that it is consistent with Contract Documents and will produce indicated results, and that it is compatible with other portions of the Work.
  - .2 Detailed comparison of significant qualities of proposed product with those named in Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  - .3 Evidence that proposed product provides specified warranty.
  - .4 List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  - .5 Samples, when requested.

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

- .1 Deliver, handle and store products in manner to prevent damage, adulteration, deterioration, soiling, and loss, including theft and vandalism. Comply with manufacturer's instructions.
- .2 Delivery and Handling:
  - .1 Schedule delivery to minimize long-term storage at Place of the Work and to prevent overcrowding of construction spaces.
  - .2 Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
  - .3 Deliver products to Place of the Work in undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
  - .4 Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.
- .3 Storage:
  - .1 Store materials in a manner that will not endanger Project structure.
  - .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 Do not store products on site unless they can be used within a reasonable amount of time (e.g. Windows on site before rough openings are ready to receive windows).
- .4 Touch-up damaged factory finished surfaces to Consultant's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

#### **1.10 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 Owner. Unload, handle and store such products.

#### **1.11 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 Consultant in writing, of conflicts between specifications and manufacturer's instructions, so that Consultant may establish course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes Consultant to require removal and re-installation at no increase in Contract Price or Contract Time.

#### **1.12 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 Consultant if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. Consultant 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 the Consultant, whose decision is final.

#### **1.13 CO-ORDINATION**

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

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**1.14 CONCEALMENT**

- .1 In finished areas, conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation, inform Consultant if there is interference. Install as directed by the Consultant.
- .3 Do not obstruct access space above removable ceiling tiles or behind access doors, panels or plates.

**1.15 REMEDIAL WORK**

- .1 Refer to CCDC 2 and Section 01 73 00 – Execution.
- .2 Perform remedial work by specialists familiar with materials affected. Perform in manner to neither damage nor put at risk any portion of Work.

**1.16 LOCATION OF FIXTURES**

- .1 Location of equipment, fixtures and outlets indicated or specified are to be considered as approximate and may be moved by the Consultant or Owner up to 1 800 mm from location shown without change to Contract Price, provided notice is given to Contractor before related work has commenced.
- .2 Locate equipment fixtures and distribution systems to provide minimum interference and maximum usable space and in accordance with manufacturer's recommendations for safety, access and maintenance.
- .3 Inform Consultant of conflicting installation. Install as directed.

**1.17 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.

**1.18 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.

#### **1.19 SHEET METAL AND WIRE GAUGE INTERPRETATION**

- .1 Unless otherwise indicated, base metal thicknesses on uncoated thicknesses in accordance with the following interpretation guidelines:
  - .1 Steel sheet: manufacturer's standard gauge (msg).
  - .2 Stainless steel sheet: "United States Standard Gauge (Revised)".
  - .3 Non-ferrous sheet metal: "Brown & Sharpe Gauge".
  - .4 Ferrous wire thickness: "US Steel Wire Gauge"
  - .5 Non-ferrous wire thickness: "American Wire Gauge".
  - .6 Cold-formed light weight steel framing members: CSA S136.

#### **1.20 PROTECTION OF WORK IN PROGRESS**

- .1 Adequately protect Work completed and in progress. Work damaged or defaced due to failure in providing such protection is to be removed and replaced, or repaired, as directed by the Consultant, at no increase in Contract Price.
- .2 Protect Work against damage by on-going construction processes, vandalism, and other causes.
- .3 Prevent overloading of any part of building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated without written approval of the Consultant.

**END OF SECTION**

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**Part 1 General**

**1.1 CODES AND STANDARDS**

- .1 Conform to or exceed the minimum requirements of the National Building Code, Ontario Building Code Act, CMHC Residential Standards, Ministry of Housing Guide for Family Housing, and all Provincial and Municipal By-Laws and regulations affecting the work and working conditions. Latest editions and revisions and most conservative provisions, in the opinion of the Consultant, apply.
- .2 Part 3 of the Ontario Building Code shall serve as a minimum quality of work and materials.
- .3 All materials or assembly of materials or manufactured items or tests of these shall conform to applicable requirements of the Canadian Standards Association, the Canadian General Standards Board specifications, or in the absence of these, the standards of the American Society for Testing and Materials.
- .4 Where contract documents exceed these minimum code standards, specified standards, and referenced documents, perform the work in accordance with the additional requirements of the Contract Documents.
- .5 Wherever in this document codes and standards are referenced, the latest addition or amendment in effect at the time of tender, shall apply.

**1.2 ALTERNATE OR EQUIVALENT MATERIALS AND PRODUCTS**

- .1 Where the specifications stipulate a product, equivalent products will not be considered.
- .2 Where the terms "equivalent" and/or "alternate" are used, named manufacturers or unnamed product models, and non-named manufacturers may submit their product information and samples to the Consultant for review and consideration for approval at least 10 days in advance of tender close.
- .3 Submissions noted in .2 above MUST be accompanied by a typed sheet clearly listing the pertinent characteristics and performance requirements of the specified piece of equipment, fixture or material, and then clearly demonstrating equivalence of the proposed alternate or equivalent to the specified piece of equipment, fixture or material. Submissions must also clearly note the specific model number, name, make, performance characteristics, power requirements and all other pertinent data related to the proposed alternate or equivalent as required by the Consultant and/or Owner to make an appropriate determination of equivalence. Submissions failing to include any of the above will be rejected outright and not considered.
- .4 Clarifications and acceptance of "equivalents" or "alternates" will be issued in the form of an addendum during the tender period, a copy of which will be forwarded to those firms who have taken out documents and to the OCA plans examination room. If proposed "alternates" or "equivalents" are not issued in the form of an addendum, provide specified products only.

**1.3 V.O.C.'S**

- .1 Adhesives and cleaning agents, shall whenever possible, and consistent with performance requirements, be V.O.C. free or of low V.O.C. content.
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#### **1.4 UNIFORMITY OF SOURCE**

- .1 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .2 Like products visible in the finished work shall be identical in appearance, colour, texture, sheen, configuration, arrangement and other characteristic affecting uniformity of appearance in the work.

#### **1.5 TRADE NAMES**

- .1 Wherever an item or class of material is specified exclusively by trade names or by names of the maker by catalogue reference, only such items shall be used approval of the substitution is secured through an addendum.

#### **1.6 MANUFACTURER'S DIRECTIONS**

- .1 All manufactured articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned as recommended by the manufacturer.
- .2 Do not rely on labels or enclosures provided with products. Obtain written instructions from manufacturers.
- .3 Notify Consultant in writing of any conflict between these specifications and manufacturer's instructions. Consultant will determine which document is to be followed.

#### **1.7 WORKMANSHIP**

- .1 Execute work in accordance with the best standard practice utilizing mechanics skilled in their trades. Adequately brace and anchor with proper provision for expansion shrinkage. Erect work true to lines, levels, dimensions, square and plumb. Finish surfaces to be without perceptible sag, warp or surface defects and suitable for the purpose intended. Work shall conform to site conditions and measurements.

#### **1.8 PATCHING**

- .1 In patching and making good, and in extending existing construction match in colour and texture all finishes visible within one area and all items of a similar nature to the full satisfaction of the Consultant.

#### **1.9 HANDLING**

- .1 Deliver, store and handle all material and products in a manner to prevent damage and deterioration. Ensure they are not exposed to an environment which would increase their moisture content beyond that specified.
- .2 Package materials and products to protect them from damage or adulteration. Packaging shall be secure and retained unopened and with labels intact until use. Label packages with manufacturer's name, and to describe contents, quantity, location in building if applicable, and other information as may be specified.
- .3 Handle equipment in accordance with manufacturer's and supplier's recommendations.

- .4 Repair or replace damaged material as directed by Consultant.

#### **1.10 PROTECTION**

- .1 Protect all work against damage until takeover by the Owner. Remove and replace, at own expense, any damaged work that cannot be repaired or restored to the Consultant's satisfaction.
- .2 Provide protection against spread of dust and dirt beyond work areas.
- .3 Take particular care of all finished work as construction progresses and cover it with the necessary protective materials. Inspect all surfaces, wash and clean as directed upon removal or protective coverings.
- .4 Note all buried services and take care not to damage them.

#### **1.11 CONFINING OF OPERATIONS**

- .1 All materials and equipment shall be confined so as to prove no hazard to those frequenting the site. It is the responsibility of each trade to ensure that all materials, equipment, plant, tools, etc., that have not been incorporated into the construction are safely stored.

#### **1.12 LOCAL INDUSTRY**

- .1 Obtain specified construction materials and equipment from suppliers in the same locality as the project in-so-far as possible.

#### **1.13 FASTENINGS**

- .1 Supply all fastenings, anchors, supports and accessories required for fabrication and erection work.
- .2 Where exposed use metal fastenings and accessories, etc., of same texture, colour and finish as base metal on which they occur.
- .3 Use metal fastenings of same material as the metal component they are anchoring and of metal which will not set up an electrolytic action which would cause damage to the fastening or metal component under moist conditions. Use isolating material to permanently prevent the occurrence of electrolysis due to materials being fastened. In general, use non-corrosive or hot dip galvanized steel anchors for exterior anchors for windows, sheet metal roofing and anchors occurring on or in exterior walls or slabs.
- .4 Use fastenings of such type and size and install in such a manner to provide positive permanent anchorage of the unit to be anchored in position. Install anchors at required spacing to provide required load bearing or shear capacity.
- .5 Keep exposed fastenings to a minimum, evenly spaced and neatly laid out.
- .6 Supply adequate instructions and/or templates, and if necessary, supervise installation where fastenings or accessories are required to be built into work performed by other subcontractors or suppliers.
- .7 Fastenings shall be of a permanent type. Do not use wood plugs.

- .8 Do not use fastenings which cause spalling or cracking of material to which anchorage is being made.
- .9 Do not use powder activated fastenings on any portion of the work except in conformance with Occupational Health and Safety Act, the Regulations for Construction Projects.
- .10 Protect all metals from other materials which may cause corrosion or deterioration - example, concrete on aluminum.

#### **1.14 CLEANING: GENERAL**

- .1 Conduct cleaning and disposal operations to comply with local ordinances and anti-pollution laws.
- .2 Store volatile wastes in covered metal containers, and remove from premises daily.
- .3 Prevent accumulation of wastes which create hazardous conditions.
- .4 Provide adequate ventilation during use of volatile or noxious substances.
- .5 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

#### **1.15 CLEANING DURING CONSTRUCTION**

- .1 Maintain project grounds and public properties free from accumulations of waste materials and rubbish.
- .2 Provide on-site dump containers for collection of waste materials, and rubbish.
- .3 Remove waste materials and rubbish from work on a daily basis and remove from site on a regular basis.
- .4 Vacuum clean interior of building areas of this contract's dirt when ready to receive finishes and continue vacuum cleaning at least daily until building is ready for substantial completion or occupancy. Sweep floors and pavements clean on a daily basis.
- .5 Schedule cleaning operations so that resulting dust and other contaminants will not fall on wet, newly painted surfaces.

#### **1.16 FINAL CLEANING**

- .1 In preparation for substantial completion or occupancy, conduct inspection of sight-exposed interior and exterior surfaces.
- .2 Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials, from sight exposed interior and exterior finished surfaces including glass and other polished surfaces.
- .3 Clean lighting reflectors, lenses, and other lighting surfaces.
- .4 Clean and polish all glass, mirrors, hardware, tile, chrome, aluminum, stainless steel, plastic laminate and plumbing, mechanical and electrical fixtures and equipment.

- .5 Broom clean paved surfaces; rake clean other surfaces of grounds.
- .6 Remove debris and surplus materials from roof areas and accessible concealed spaces.
- .7 Remove snow and ice from all access routes to exits and exits from building.
- .8 Replace heating, ventilating and air conditioning filters, clean ductwork and clean coils.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

SPEC NOTE: Use this Section to specify requirements for progressive and final cleaning of the Work and waste management and disposal.

### 1.1 REGULATORY REQUIREMENTS

- .1 Comply with applicable regulatory requirements when disposing of waste materials.
- .2 Obtain permits from authorities having jurisdiction and pay disposal fees where required for disposal of waste materials and recyclables.

### 1.2 GENERAL CLEANING REQUIREMENTS

- .1 Provide adequate ventilation during use of volatile or noxious substances. [Do not rely on building ventilation systems for this purpose.]
- .2 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .3 Prevent cross-contamination during the cleaning process.
- .4 Notify the *Consultant* of the need for cleaning caused by *Owner* or other contractors.

### 1.3 PROGRESSIVE CLEANING AND WASTE MANAGEMENT

- .1 Maintain the *Work* in a tidy and safe condition, free from accumulation of waste materials and construction debris.
- .2 Provide appropriate, clearly marked, containers for collection of waste materials and recyclables. [Locate containers [ ] [where indicated on *Drawings*].]
- .3 Remove waste materials and recyclables from work areas, separate, and deposit in designated containers at end of each *Working Day*. Collect packaging materials for recycling or reuse.
- .4 Remove waste materials and recyclables from *Place of the Work* [daily] [weekly] [at regular intervals].
- .5 Clean interior building areas prior to start of finish work and maintain free of dust and other contaminants during finishing operations.
- .6 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly finished surfaces nor contaminate building systems.

SPEC NOTE: Include the following sentence only where the Contractor will have care, custody and control of a site with adjacent public sidewalks.

- .7 [Clear snow and ice from public sidewalks as required to comply with applicable municipal regulatory requirements.]

### 1.4 FINAL CLEANING

- .1 Before final cleaning, arrange a meeting at *Place of the Work* to determine the acceptable standard of cleaning. Ensure that [*Owner,*] *Consultant, Contractor* [and cleaning company] are in attendance.
- .2 Remove from *Place of the Work* surplus *Products*, waste materials, recyclables, *Temporary Work*, and *Construction Equipment* not required to perform any remaining work.

SPEC NOTE: Edit the following paragraphs to suit project specific conditions.

- .3 Provide professional cleaning by a qualified, established cleaning company.
- .4 Lock or otherwise restrict access to each room or area after completing final cleaning in that area.
- .5 Re-clean as necessary areas that have been accessed by *Contractor's* workers prior to *Owner* occupancy.
- .6 Remove stains, spots, marks, and dirt from finished surfaces, electrical and mechanical fixtures, furniture fitments, walls, floors [and] [\_\_\_\_\_].
- .7 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, [\_\_\_\_\_] and all other finished surfaces, including mechanical and electrical fixtures. Replace broken, scratched or otherwise damaged glass.
- .8 Remove dust from lighting reflectors, lenses, lamps, bulbs, and other lighting surfaces.
- .9 Vacuum clean and dust exposed wall, floor, and ceiling surfaces, behind grilles, louvers and screens, [above suspended ceiling tiles] [\_\_\_\_\_].
- .10 Clean mechanical, electrical, and other equipment. Replace filters for mechanical equipment if equipment is used during construction.
- .11 Remove waste material and debris from crawlspaces and other accessible concealed spaces.
- .12 Remove stains, spots, marks, and dirt from exterior facades.
- .13 Clean exterior and interior window glass and frames.
- .14 Clean and sweep roofs, [clear roof drains,] [clean gutters and downspouts,] [sunken wells,] [\_\_\_\_\_].
- .15 [Sweep clean] [power wash] [remove snow and ice from] exterior [sidewalks,] [steps,] [driveways,] [roads,] [parking lots,] and other paved surfaces.
- .16 Use leaf blowers to clean landscaped surfaces.

## 1.5 WASTE MANAGEMENT AND DISPOSAL

SPEC NOTE: If the project involves removal of hazardous materials or designated substances such as asbestos, lead paint, PCBs, etc., this article is inadequate. Specify additional requirements in this section or in other sections.

- .1 Dispose of waste materials and recyclables at appropriate municipal landfills and recycling facilities in accordance with applicable regulatory requirements.
- .2 Do not burn or bury waste materials at *Place of the Work*.
- .3 Do not dispose of volatile and other liquid waste such as mineral spirits, oil, paints and other coating materials, paint thinners, cleaners, and similar materials together with dry waste materials or on the ground, in waterways, or in storm or sanitary sewers. Collect such waste materials in appropriate covered containers, promptly remove from *Place of the Work*, and dispose of at recycling facilities or as otherwise permitted by applicable regulatory requirements.
- .4 Cover or wet down dry waste materials to prevent blowing dust and debris.

END OF SECTION

## **1.1 REFERENCES**

- .1 Canadian Construction Documents Committee (CCDC).
- .1 CCDC 2-2008, Stipulated Price Contract.

## **1.2 PROJECT CLEANLINESS**

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris.
- .2 Remove waste materials from site daily at regularly scheduled times.
- .3 Do not burn waste materials on site.
- .4 Clear snow and ice from access to building, remove from site.
- .5 Provide grass cutting service every two weeks during growing season on construction site.
- .6 Arrange with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .7 Provide on-site containers for collection of waste materials and debris.
- .8 Provide and use marked separate bins for recycling. Refer to Section 01 74 19 – Construction Waste Management and Disposal.
- .9 Dispose of waste materials and debris off site.
- .10 Clean interior areas before start of finishing work and maintain areas free of dust and other contaminants during finishing operations.
- .11 Store volatile waste in covered metal containers and remove from premises at end of each working day.
- .12 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .13 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .14 Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.



### 1.3 FINAL CLEANING

- .1 When Work is Substantially Performed remove surplus products, tools, construction machinery and equipment not required for performance of remaining Work.
  - .2 Remove waste products and debris other than that caused by others and leave Work clean and suitable for occupancy.
  - .3 Before final review remove surplus products, tools, construction machinery and equipment.
  - .4 Arrange with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
  - .5 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched or disfigured glass.
  - .6 Remove stains, spots, marks and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, floors, and ceilings.
  - .7 Clean lighting reflectors, lenses, and other lighting surfaces.
  - .8 Vacuum clean and dust building interiors, behind grilles, louvres, and screens.
  - .9 Refer to Section 09 65 19 – Resilient Tile Flooring for cleaning and waxing information on VCT tile.
  - .10 Inspect finishes, fitments and equipment and ensure specified workmanship and operation.
  - .11 Broom clean and wash exterior walks, steps, and surfaces; rake clean other surfaces of grounds.
  - .12 Remove dirt and other disfiguration from exterior surfaces.
  - .13 Clean and sweep roofs, gutters, areaways, and sunken wells.
  - .14 Sweep and wash clean paved areas.
  - .15 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
  - .16 Clean roofs, downspouts, and drainage systems.
  - .17 Remove debris and surplus materials from crawl areas and other accessible concealed spaces.
- Remove snow and ice from access to building.

**END OF SECTION**

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**Part 1            General**

**1.1            GENERAL**

- .1      Designate one person as "Waste Management Coordinator" to be responsible for the development and implementation of A project-specific construction waste management plan and ensuring compliance by all construction personnel with the requirements of this Section and of the Waste Management Plan.
- .2      Comply with the Environmental Protection Act, Ontario Regulations O. Reg. 102/94 and O. Reg. 103/94 for waste management program on construction and demolition projects.

**1.2            WASTE MANAGEMENT PLAN**

- .1      Develop and implement a waste management plan for the project to implement procedures to reduce, reuse and recycle materials, including packaging, to the maximum extent possible.
- .2      Submit two copies of the Waste Management Plan to the Consultant for review before the start of work on site. If, upon review, the Consultant requires revisions to the Plan, make revisions and re-submit within 3 working days.
- .3      Post a copy of the reviewed and accepted Waste Management Plan in a conspicuous location where it can be readily seen by all construction personnel.

**1.3            WASTE DISPOSAL**

- .1      Include in the waste management plan and implement throughout the project a materials source separation program to collect re-usable and recyclable materials in an orderly fashion for diversion from the general waste stream and alternative disposal at appropriate materials recycling and re-use facilities. Provide appropriate on-site disposal bins.
- .2      Collect and separate packaging for disposal at recycling facilities. Include paper, plastic, polystyrene, corrugated cardboard, metal banding, and other recyclable packaging materials.
- .3      Ensure all personnel working on the site are thoroughly familiar with the Waste Management Plan and monitor compliance with the Plan throughout the Project.

**1.4            ENVIRONMENTAL PROTECTION**

- .1      Dispose of unused adhesive, sealant, volatile materials such as mineral spirits, oil or paint thinner, and other volatile materials which could be hazardous to the health, including empty containers, at an official hazardous materials collection site acceptable to the Consultant, in strict accordance with the requirements of the authorities having jurisdiction and in a manner which will protect construction personnel, visitors to the site, and the public from all such hazards.
  - .2      Do not permit such materials to enter waterways, storm or sanitary sewers; do not dispose onto ground or other locations that might pose a health or environmental hazard. Do not bury or burn rubbish and waste materials on site.
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**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            EXECUTION**

**3.1                NOT USED**

.1            Not used.

**END OF SECTION**

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**Part 1            General**

**1.1            TAKE-OVER PROCEDURE**

- .1      Refer also to Owner's contract documents and/or relevant conditions for take over procedures.

**1.2            OCCUPANCY**

- .1      Owner reserves the right to occupy and use portions of work whether partially or entirely completed, or whether completed on schedule or not.
- .2      Partial completion shall not imply acceptance of work in whole or in part, nor shall it imply acknowledgement that the terms of Agreement are fulfilled.

**1.3            SYSTEM DEMONSTRATION**

- .1      Prior to Substantial Performance:
  - .1          Demonstrate operation of each system to Owner and Consultant.
  - .2          Instruct personnel in operation, adjustment and maintenance of equipment and systems, using provided operation and maintenance data as basis for instruction.

**1.4            WARRANTIES**

- .1      Provide extended warranties called for in specifications.
- .2      Refer to individual sections of the specifications for specific requirements of the warranties.
- .3      If validity of extended guarantee is related to proper maintenance and servicing of equipment, etc., full details must be provided in maintenance manuals.

**1.5            SUBMITTALS**

- .1      Refer to Section 01 33 00 for submissions required at project completion.

**1.6            FINAL CLEANING**

- .1      Refer to Section 01 61 00.

**Part 2           Products**

**2.1            NOT USED**

- .1      Not Used.

**Part 3           Execution**

**3.1            NOT USED**

- .1      Not Used.

**END OF SECTION**

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## **PART 1 GENERAL**

### **1.1 RELATED REQUIREMENTS**

- .1 Section 02 41 13.13 – Asphalt Paving Removal.
- .2 Section 31 23 33.01 – Excavating, Trenching and Backfilling.

### **1.2 REFERENCE STANDARDS:**

- .1 Department of Justice Canada (Jus)
  - .1 Canadian Environmental Assessment Act (CEAA).
  - .2 Canadian Environmental Protection Act (CEPA):
    - .1 SOR/2003-2, On-Road Vehicle and Engine Emission Regulations
    - .2 SOR/2006-268, Regulations Amending the On-Road Vehicle and Engine Emission Regulations
    - .3 Transportation of Dangerous Goods Act (TDGA), c. 34
    - .4 Motor Vehicle Safety Act (MVSA)
    - .5 Hazardous Materials Information Review Act
- .2 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S660-08, Standard for Non-metallic Underground Piping for Flammable and Combustible Liquids.
  - .2 ULC/ORD-C58.15, Overfill Protection Devices for Flammable Liquid Storage Tanks.
  - .3 ULC/ORD-C58.19, Spill Containment Devices for Underground Flammable Liquid Storage Tanks.
- .3 United States Environmental Protection Agency (EPA)
  - .1 EPA CFR 86.098-10, Emission standards for 1998 and later model year Otto-cycle heavy-duty engines and vehicles.
  - .2 EPA CFR 86.098-11, Emission standards for 1998 and later model year diesel heavy-duty engines and vehicles.
    - .1 EPA 833/R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.

### **1.3 DEFINITIONS**

- .1 Selective Demolition: Sequencing demolition activities to allow separation and sorting of selected site materials.
- .2 Hazardous Materials: dangerous substances, dangerous goods, hazardous commodities and hazardous products, may include but not limited to: asbestos PCB's, CFC's, HCFC's poisons, corrosive agents, flammable substances, ammunition, explosives, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination: Coordinate with the Consultant for the material ownership including the following:
  - .1 Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain. Demolished materials shall become Contractor's property and shall be removed from Project site.
  - .2 Historic items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to the Owner that may be encountered during demolition remain Owner's property:
    - .1 Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to the Owner.
    - .2 Coordinate with the Owner, who will establish special procedures for removal and salvage operations.
- .2 Scheduling:
  - .1 Meet project timelines without compromising specified minimum rates of material diversion.
  - .2 Notify the Consultant in writing when unforeseen delays occur.

#### **1.5 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.
- .2 Shop Drawings:
  - .1 Submit for approval drawings, diagrams or details showing sequence of demolition work and supporting structures and underpinning, where required by authorities having jurisdiction.
- .3 Hazardous Materials:
  - .1 Provide description of Hazardous Materials and Notification of Filing with proper authorities prior to beginning of Work as required.
- .4 Certificates:
  - .1 Submit copies of certified weigh bills, bills of lading, receipts from authorized disposal sites and reuse and recycling facilities for material removed from site on monthly basis.

#### **1.6 QUALITY ASSURANCE**

- .1 Regulatory Requirements: ensure Work is performed in compliance with authorities having jurisdiction.

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

- .1 Perform work in accordance with Section 01 74 19.
- .2 Waste Management and Disposal.

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19.
  - .2 Protect existing items designated to remain and items designated for salvage. In event of damage to such items, immediately replace or make repairs to approval from the Consultant and at no cost to the Owner.
  - .3 Remove and store materials to be salvaged, in manner to prevent damage.
  - .4 Store and protect in accordance with requirements for maximum preservation of material.
  - .5 Handle salvaged materials as new materials.
- .3 Packaging Waste Management: remove for reuse and return of pallets, crates, padding and packaging materials in accordance with Section 01 74 19.

## **1.8 SITE CONDITIONS**

- .1 Site Environmental Requirements:
- .1 Perform work in accordance with Section 01 74 19.
  - .2 Ensure that selective demolition work does not adversely affect adjacent watercourses, groundwater, and wildlife, or contribute to excess air and noise pollution.
  - .3 Do not dispose of waste of volatile materials including but not limited to, mineral spirits, oil, petroleum-based lubricants, or toxic cleaning solutions into watercourses, storm, or sanitary sewers.
    - .1 Ensure proper disposal procedures are maintained throughout the project.
  - .4 Do not pump water containing suspended materials into watercourses, storm, or sanitary sewers or onto adjacent properties.
  - .5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authorities.
  - .6 Protect trees, plants and foliage on site and adjacent properties where indicated.

## **PART 2 PRODUCTS**

### **2.1 EQUIPMENT**

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

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- .1 Inspect site with the Consultant and verify extent and location of items designated for removal, disposal, alternative disposal, recycling, salvage, and items to remain.
- .2 Locate and protect utilities. Preserve active utilities traversing site in operating condition.

### **3.2 REMOVAL AND DEMOLITION OPERATIONS**

- .1 Remove items as indicated. Remove existing fence as required for completion of the work.
- .2 Do not disturb items designated to remain in place.
- .3 Clear & grub vegetation as designated during demolition.
- .4 Disposal of Material:
  - .1 Dispose of materials not designated for salvage or reuse.
- .5 Removal of pavements, curbs, and gutters:
  - .1 Square up adjacent surfaces to remain in place by saw cutting or other method approved by the Consultant.
  - .2 Protect adjacent joints and load transfer devices.
  - .3 Protect underlying and adjacent granular materials.
  - .4 Prevent contamination with base coarse aggregates, when removing asphalt pavement for subsequent incorporation into hot mix asphalt concrete paving.
- .6 Excavate at least 300 mm below pipe invert, when removing pipes under existing or future pavement area.
- .7 Decommission water wells and monitoring wells in accordance with Municipal and Provincial regulations.
- .8 Stockpile topsoil for final grading and landscaping:
  - .1 Provide erosion control and seeding if not immediately used.
- .9 Backfill:
  - .1 Backfill in areas as indicated and in accordance with Section 31 23 33.01.

### **3.3 STOCKPILING**

- .1 Label stockpiles, indicating material type and quantity.
- .2 Designate appropriate security resources/measures to prevent vandalism, damage, and theft.
- .3 Locate stockpiled materials convenient for use in new construction to eliminate double handling wherever possible.

### **3.4 REMOVAL FROM SITE**

- .1 Remove stockpiled material as directed by the Consultant when it interferes with operations of project.
- .2 Dispose of materials in accordance with applicable regulations.



### **3.5 RESTORATION**

- .1 Restore areas and existing works outside areas of demolition to match condition of adjacent, undisturbed areas.
- .2 Use soil treatments and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.

### **3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .1 Leave Work area clean at end of each day.
    - .1 Remove debris, trim surfaces, and leave work site clean, upon completion of Work
    - .2 Use cleaning solutions and procedures which are not harmful to health, are not injurious to plants, and do not endanger wildlife, adjacent water courses or ground water.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.7 PROTECTION**

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

**END OF SECTION**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- .1 Methods for removal of existing asphalt pavement.

**1.2 RELATED REQUIREMENTS:**

- .1 Section 02 41 13 - Selective Site Demolition.

**1.3 REFERENCE STANDARDS**

- .1 Department of Justice Canada (Jus)
  - .1 Canadian Environmental Assessment Act (CEAA).
  - .2 Canadian Environmental Protection Act (CEPA).
- .2 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 833/R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Action Submittals: Provide following submittals before starting work of this Section:
  - .1 Shop Drawings: Submit shop drawings indicating diagrams or details showing sequence of demolition work.
  - .2 Erosion and Sedimentation Control: submit copy of erosion and sedimentation control plan in accordance with authorities having jurisdiction.

**1.5 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials from recycling in accordance with Section 01 74 19.
- .2 Divert unused asphalt materials from landfill to local facility.

**1.6 SITE CONDITIONS**

- .1 Protect existing site features to remain or identified for salvage or re use; make repairs and restore to a similar condition to existing where damage to these items occurs as directed by Consultant and at no cost to Owner:
  - .1 Remove and store salvaged materials to prevent contamination.
  - .2 Store and protect salvaged materials as required for maximum preservation of material.
  - .3 Handle salvaged materials same as new materials.
- .2 Perform pavement removal work to prevent adverse effects to adjacent watercourses, groundwater and wildlife, and to prevent excess air and noise pollution:
  - .1 Do not pump water containing suspended materials into watercourses, storm or sanitary sewers or onto adjacent properties.

- .2 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with Authorities Having Jurisdiction.
- .3 Protect existing site features and structures, trees, plants and foliage on site and adjacent properties.

## **PART 2 PRODUCTS**

### **2.1 EQUIPMENT**

- .1 Use cold milling, planning or grinding equipment with automatic grade controls capable of operating from string line, and capable of removing part of pavement surface to depths or grades indicated.

## **PART 3 EXECUTION**

### **3.1 PREPARATION**

- .1 Verify extent and location of asphalt identified for removal and items to remain.
- .2 Locate and protect utilities, preserve active utilities traversing site in operating condition.
- .3 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.
  - .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.
- .4 Prior to beginning removal operation, inspect and verify with the Consultant areas, depths and lines of asphalt pavement to be removed.

### **3.2 PROTECTION**

- .1 Protect existing pavement not designated for removal from damage. In event of damage, immediately replace or make repairs to approval of the Consultant at no additional cost.

### **3.3 REMOVAL**

- .1 Remove existing asphalt pavement to lines and grades as indicated.
- .2 Use equipment and methods of removal and hauling which do not damage or disturb underlying pavement.
- .3 Sawcut along lines designated on contract drawings to provide a clean true edge on existing asphalt.
- .4 Prevent contamination of removed asphalt pavement by topsoil, underlying gravel or other materials.

- .5 Provide for suppression of dust generated by removal process.

### **3.4 FINISH TOLERANCES**

- .1 Finished surfaces in areas where asphalt pavement has been removed to be within +/- 5 mm of grade specified but not uniformly high or low.

### **3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Sweep remaining asphalt pavement surfaces clean of debris resulting from removal operations using rotary power brooms and hand brooming as required.
- .4 Waste Management: separate waste materials for recycling in accordance with Section 01 74 19.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 22 05 05 – Selective Demolition for Plumbing.
- .2 Section 23 05 05 – Selective Demolition for Heating, Ventilating, and Air Conditioning (HVAC).
- .3 Section 26 05 05– Selective Demolition – Electrical.

**1.2 REFERENCE STANDARDS**

- .1 American Society for Testing and Materials International (ASTM).
  - .1 ASTM C475/C475M-17, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- .2 Canadian Standards Association (CSA Group).
  - .1 CSA-S269.2-16, Access Scaffolding for Construction Purposes.
- .3 Department of Justice Canada (Jus).
  - .1 Canadian Environmental Assessment Act (CEAA).
  - .2 Canadian Environmental Protection Act (CEPA).
    - .1 SOR/2003-2, On-Road Vehicle and Engine Emission Regulations.
    - .2 SOR/2006-268, Regulations Amending the On-Road Vehicle and Engine Emission Regulations.
    - .3 Transportation of Dangerous Goods Act (TDGA), c. 34.
    - .4 Motor Vehicle Safety Act (MVSA).
    - .5 Hazardous Materials Information Review Act.
- .4 National Fire Protection Association (NFPA).
  - .1 NFPA-241 2019, Standard for Safeguarding Construction, Alteration, and Demolition Operations.

**1.3 DEFINITIONS**

- .1 Remove: Detach items from existing construction and legally dispose of them off site, unless indicated to be removed and salvaged or removed and reinstalled.
  - .2 Remove and Salvage: Detach items from existing construction and deliver them to ready for reuse Departmental Representative.
  - .3 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, and reinstall them where indicated.
  - .4 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed, removed and salvaged, or removed and reinstalled.
  - .5 Waste Management Coordinator (WMC): Contractor representative responsible for supervising waste management activities as well as coordinating related, required submittal and reporting requirements.
  - .6 Draft Construction Waste Management Plan (Draft CWM Plan): Detailed inventory of materials in building indicating estimated quantities of reuse, recycling and landfill, prepared in accordance with Section 01 74 19- Waste Management and Disposal and as follows:
-

- .1 Involves quantifying by volume/weight amounts of materials and wastes generated during construction, demolition, deconstruction, or renovation project.
- .7 Construction Waste Management Plan (CWM Plan): Written plan addressing opportunities for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19- Waste Management and Disposal.
- .8 Construction Waste Management Report (CWM Report): Written report identifying actual materials that formed CWM Plan for reduction, reuse, or recycling of materials prepared in accordance with Section 01 74 19- Waste Management and Disposal.
- .9 Hazardous Substances: Dangerous substances, dangerous goods, hazardous commodities and hazardous products may include asbestos, mercury and lead, PCB s, poisons, corrosive agents, flammable substances, radioactive substances, or other material that can endanger human health or wellbeing or environment if handled improperly as defined by the Federal Hazardous Products Act (RSC 1985) including latest amendments.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- .1 Coordination: Coordinate with Departmental Representative for the material Ownership as follows:
  - .1 Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain Departmental Representative's property, demolished materials shall become Contractor's property and shall be removed from Project site.
  - .2 Coordinate selective demolition work so that work of this Section adheres to aesthetic criteria established by the Drawings and specified dimensions with all elements in planes as drawn, maintaining their relationships with all other building elements.
- .2 Pre- Demolition Meeting: Convene pre-installation meeting on-site 1 week prior to beginning work of this Section with Contractor and Departmental Representative in accordance with Section 01 31 19 - Project Meetings to:
  - .1 Confirm extent of salvaged and demolished materials.
  - .2 Review Contractor's demolition plan.
    - .1 Verify existing site conditions adjacent to demolition work.
    - .2 Coordination with other construction sub trades.
- .3 Hold project meetings bi-weekly.
- .4 Ensure subcontractor representatives, WMC key personnel, site supervisor, and project manager attend.
- .5 WMC must provide written verbal report on status of waste diversion activity at each meeting.
- .6 Departmental Representative will provide verbal written notification of change to meeting schedule established upon contract award 24 hours prior to scheduled meeting.

#### **1.5 ACTION AND INFORMATION SUBMITTALS**

- .1 Action Submittals: Provide the following submittals before starting any work of this Section:
  - .1 Schedule of Selective Demolition Activities: Coordinate with Section 01 32 16 – Construction Progress Schedule – Bar (GANTT) Chart, and indicate the following:

- .1 Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
- .2 Coordinate with Departmental Representative's building manager user group ongoing site operations, and limit the number of interruptions during regular business hours.
- .3 Interruption of utility services.
- .4 Coordination for shutoff, capping, and continuation of utility services.
- .5 Use of elevator and stairs.
- .2 Demolition Plan: Submit a plan of demolition area indicating extent of temporary facilities and supports, methods of removal and demolition prepared by a professional in accordance with requirements of Authority Having Jurisdiction, and as follows:
  - .1 Proposed Noise Control and Dust Control Measures: Submit statement or drawing that indicates the measures proposed for use, proposed locations, and proposed time frame for their operation. Departmental Representative reserves the right to make modifications where proposed methods interfere with the Departmental Representative's ongoing operation
  - .2 Inventory: Submit a list of items that have been removed and salvaged after selective demolition is complete.
  - .3 Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
  - .4 Pre- demolition Videotape Photographs: Submit videotape photographs indicating existing conditions of adjoining construction and site improvements prior to starting Work. Include finish surfaces that may be misconstrued as damage caused by selective demolition operations.
- .2 Informational Submittals: Provide the following submittals when requested by the Departmental Representative:
  - .1 Qualification Data: Submit information for companies and personnel indicating their capabilities and experience to perform work of this Section including; but not limited to, lists of completed projects with project names and addresses, names and addresses, for work of similar complexity and extent.

## 1.6 QUALITY ASSURANCE

- .1 Regulatory Requirements: Perform work as follows; use most restrictive requirements where differences occur between the municipal, provincial and federal jurisdictions:
  - .1 Provincial and Federal Requirements: Perform work in accordance with governing environmental notification requirements and regulations of the Authority Having Jurisdiction.
  - .2 Municipal Requirements: Perform hauling and disposal operations in accordance with regulations of Authority Having Jurisdiction.
- .2 Qualifications: Provide proof of qualifications when requested by Departmental Representative:
  - .1 Demolition Firm Qualifications: An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this Project:
    - .1 Conform to the provincial Occupational Health and Safety Act and Regulation.
    - .2 Conform to WSIB Regulations.

- .3 Conform to City of local municipal bylaws and regulations governing this type of work.

## **1.7 SITE CONDITIONS**

- .1 Departmental Representative will occupy portions of building immediately above and below selective demolition area:
  - .1 Conduct selective demolition so that Departmental Representative operations will not be disrupted.
  - .2 Provide not less than 72 hours notice to Departmental Representative of activities that will affect Departmental Representative operations.
- .2 Maintain access to existing means of egress, walkways, corridors, exits, and other adjacent occupied or used facilities:
  - .1 Do not close or obstruct means of egress, walkways, corridors, exits, or other occupied or used facilities without written acceptance from authorities having jurisdiction.
- .3 Departmental Representative assumes no responsibility for condition of areas to be selectively demolished:
  - .1 Conditions existing at time of Pre Bid Site Review will be maintained by Departmental Representative where practical.
- .4 Discovery of Hazardous Substances: It is not expected that Hazardous Substances will be encountered in the Work; immediately notify Departmental Representative if materials suspected of containing hazardous substances are encountered and perform the following activities:
  - .1 Refer to Section 01 41 00– Regulatory Requirements for directives associated with specific material types.
  - .2 Hazardous materials will be as defined in the Hazardous Materials Act.
  - .3 If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Departmental Representative. Hazardous materials will be removed by Departmental Representative under a separate contract or as a change to the Work.
- .5 A report on Hazardous Substances is available at the Departmental Representative's offices for review and use:
  - .1 Examine report to become aware of locations where hazardous materials may be present.
  - .2 Do not disturb Hazardous Substances or items suspected of containing Hazardous Substances.

## **Part 2 Products**

### **2.1 TEMPORARY SUPPORT STRUCTURES**

- .1 Design temporary support structures required for demolition work and underpinning and other foundation supports necessary for the project using a qualified professional registered or licensed in province of the Work.

### **2.2 DESCRIPTION**

- .1 This section of the Work includes, but is not necessarily limited to, the following:



- .1 Demolition, removal completely from site, and disposal of all identified components, materials, equipment and debris.
- .2 Selective demolition to allow new walls, bulkheads, ceilings and other materials to meet existing construction as indicated.
- .3 All material from demolition shall be removed from site immediately with no salvage, selling, sorting or burning permitted on site.
- .4 Retain items indicated on drawings for reuse in new construction where indicated.

## **2.3 DEBRIS**

- .1 Make all arrangements for transport and disposal of all demolished materials from the site.

## **2.4 EQUIPMENT**

- .1 Provide all equipment required for safe and proper demolition of the building interiors indicated.

## **2.5 REPAIR MATERIALS**

- .1 Use repair materials identical to existing materials:
  - .1 If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.
  - .2 Use a material whose installed performance equals or surpasses that of existing material.
  - .3 Comply with material and installation requirements specified in individual Specification Sections.
- .2 Floor Patching and Levelling Compounds: Cement based, trowelable, self levelling compounds compatible with specified floor finishes; gypsum based products are not acceptable for work of this Section.
- .3 Prefinished Sheet Steel: Prefinished sheet steel, colour radiation cabinets, bent and profiled.
- .4 Gypsum Board Patching Compounds: Joint compound to ASTM C475/C475M, bedding and finishing types thinned to provide skim coat consistency to patch and prepare existing gypsum board walls ready for new finishes in accordance with Section 09 21 16– Gypsum Board Assemblies.
- .5 Hoarding and Dust Screens: Refer to Section 01 56 00- Temporary Barriers and Enclosures for stud framing and gypsum board sheathing materials.

## **2.6 EXISTING MATERIALS**

- .1 Items to be retained for re use in new construction include, but are not limited to the following:
  - .1 Lockers and cabinets
  - .2 Ceiling components
  - .3 Paper towel dispensers and other miscellaneous items identified on drawings
  - .4 Vertical blind vanes, and curtains and tracks
  - .5 Confirm with Departmental Representative any materials that appear to be in re usable condition prior to disposal.

- .6 Confirm with Departmental Representative any materials scheduled for re use that are not in re usable condition prior to installation.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verify that utilities have been disconnected and capped.
- .2 Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- .3 Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- .4 Notify the Departmental Representative where existing mechanical, electrical, or structural elements conflict with intended function or design:
  - .1 Investigate and measure the nature and extent of conflict and submit a written report to Departmental Representative.
  - .2 Departmental Representative will issue additional instructions and Consultant will revise drawings as required to correct conflict.
- .5 Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

#### **3.2 UTILITY SERVICES**

- .1 Coordinate existing services indicated to remain and protect them against damage during selective demolition operations.
- .2 Locate, identify, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.
  - .1 Arrange to shut off affected utilities with utility companies.
  - .2 If utility services are required to be removed, relocated, or abandoned, before proceeding with selective demolition provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.
  - .3 Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.
  - .4 Cut off pipe or conduit to a minimum of 25 mm below slab, and remove concrete mound. Patch concrete using cementitious grout.
- .3 Coordinate with Mechanical and Electrical Divisions for shutting off, disconnecting, removing, and sealing or capping utilities.
- .4 Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

#### **3.3 PREPARATION**

- .1 Identify and mark all equipment and materials identified to be retained by Departmental Representative or to be re used in subsequent construction. Separate and store items to be retained in an area away from area of demolition and protect from accidental disposal.
- .2 Post warning signs on electrical lines and equipment that must remain energized to serve other areas during period of demolition.

- .3 Confirm that all electrical and telephone service lines entering buildings are not disconnected.
- .4 Do not disrupt active or energized utilities crossing the demolition site.
- .5 Provide and maintain barricades, warning signs, protection for workmen and the public during the full extent of the Work. Read drawings carefully to ascertain extent of protection required.
- .6 Mark all materials required to be re used, store in a safe place until ready for re installation.
- .7 Adjust all junction boxes, receptacles and switch boxes flush with new wall construction where additional layers to existing construction are indicated.
- .8 Remove permanent marker lines used or found on exposed surfaces and at surfaces indicated for subsequent finish materials. Mechanically remove permanent marker lines and associated substrates where permanent marker lines occur and patch surface. Sealing or priming over permanent marker lines is not acceptable.

### **3.4 CONCRETE SLAB REINFORCING**

- .1 Locate location of reinforcing steel in concrete slabs prior to cutting or coring using non-destructive, non ionizing radio frequency locators.
- .2 Core concrete slabs to avoid reinforcing steel, electrical conduit or water pipes; adjust core location and coordinate with where slab features interfere with core drilling.
- .3 Notify Departmental Representative immediately for further instructions where coring or cutting will damage existing slab features.

### **3.5 SELECTIVE DEMOLITION**

- .1 Demolish and dismantle work in a neat and orderly manner and in strict accordance with all regulations.
- .2 At end of each work day, leave Work in safe condition so that no part is in danger of toppling or falling.
- .3 Demolish in a manner to minimize dusting and to prevent migration of dust.
- .4 Selling or burning of materials on the site is not permitted.
- .5 Remove concrete bases by cutting and chipping, take precautions against slab cracking and degradation. Grind edges smooth, fill and make level with self levelling grout.
- .6 Fill all openings in gypsum board walls with gypsum board and steel framing , skim coat to make wall smooth and even.
- .7 Remove existing carpet, resilient flooring and adhesive remnants as follows:
  - .1 Vacuum existing carpet thoroughly, prior to removal, using vacuum equipped with power head/sweeper.
  - .2 Apply fine mist water spray to carpet as required to minimize dust generation during removal. Avoid spraying near electrical outlets.
  - .3 Demolish existing carpet and resilient floor finishes, remove and dispose of off site.
  - .4 Remove adhesive to the greatest extent possible using scrapping tools and as follows:
    - .1 Do not use solvent based cleaners to remove adhesive remnants.

- .2 Lightly shot blast or grind floor using machine designed for purpose to remove adhesive remnants.
- .3 Vacuum floor ready for application of skim coating.
- .4 Repair all slab depressions and damage with cementitious patching compound.
- .5 Skim coat floor with minimum 1 mm thick cementitious floor underlayment compatible with new flooring materials.
- .5 Floor substrate shall be smooth, free from ridges and depressions, and adhesive remnants that could telegraph through resilient flooring materials and carpets.
- .6 Recycle materials in accordance with Section 01 74 19– Waste Management and Disposal.
- .8 Demolish existing ceramic tile finishes. Remove setting bed or adhesive to the greatest extent possible using mechanical scrapping tools and as follows:
  - .1 Saw cut edge of tile for clean and even transition joint between existing tile to remain and new flooring materials.
  - .2 Lightly shot blast or grind floor to remove remnants of setting materials.
  - .3 Vacuum floor ready for application of skim coating.
  - .4 Repair all slab depressions and damage with cementitious patching compound. Skim coat floor with minimum 1 mm thick cementitious floor underlayment compatible with new flooring materials.
- .9 Demolish completely all ceiling panels and grid as indicated.
- .10 Remove all wall coverings scheduled for demolition. Patch and repair wall surfaces with skim coat of gypsum board joint compound leaving wall surfaces smooth and even ready for new wall finishes.
- .11 Patch and repair all walls, floor and ceilings damaged during demolition with material matching adjacent walls, prepare ready for new finishes.
- .12 Patch and repair all radiation cabinets, mechanical equipment and electrical fixtures damaged or exposed during demolition to match adjacent finished surfaces.

### **3.6 PATCHING AND REPAIRING**

- .1 Floors and Walls:
  - .1 Where walls or partitions that are demolished extend from one finished area into another, patch and repair floor and wall surfaces in the new space.
  - .2 Provide a level and smooth surface having uniform finish colour, texture, and appearance.
  - .3 Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform colour and appearance.
  - .4 Patch with durable seams that are as invisible as possible.
  - .5 Provide materials and comply with installation requirements specified in other Sections of these Specifications.
  - .6 Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
  - .7 Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

- .2 Ceilings: patch, repair, or re hang existing ceilings as necessary to provide an even plane surface of uniform appearance.

### **3.7 PROTECTION**

- .1 Prevent debris from blocking drainage inlets and systems and ground draining, and protect material and electrical systems and services that must remain in operation.
- .2 Arrange demolition and shoring work so that interference with the use of adjoining areas by the Departmental Representative and users is minimized.
- .3 Maintain safe access to and egress from occupied areas adjoining.
- .4 Provide and maintain fire prevention equipment and alarms accessible during demolition.

### **3.8 CLEANING**

- .1 Develop Construction Waste Management Plan related to Work of this Section and in accordance with Section 01 74 19– Waste Management and Disposal.
- .2 Waste Management: Separate waste materials for reuse recycling in accordance with Section 01 74 19 - Waste Management and Disposal, and as follows:
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.
- .3 Divert excess materials from landfill to site approved Departmental Representative.
- .4 Promptly as the Work progresses, and on completion, clean up and remove from the site all rubbish and surplus material. Remove rubbish resulting from demolition work daily.
- .5 Maintain access to exits clean and free of obstruction during removal of debris.
- .6 Keep surrounding and adjoining roads, lanes, sidewalks, municipal rights of way clean and free of dirt, soil or debris that may be a hazard to vehicles or persons.
- .7 Transport material designated for alternate disposal using approved receiving organizations facilities haulers listed in CWM Plan and in accordance with applicable regulations.
  - .1 Written authorization from Departmental Representative is required to deviate from receiving organizations haulers facilities listed in CWM Plan.
- .8 Dispose of materials not designated for alternate disposal in accordance with applicable regulations.
  - .1 Disposal facilities must be those approved of and listed in CWM Plan.
  - .2 Written authorization from Departmental Representative is required to deviate from disposal facilities listed in CWM Plan.

**END OF SECTION**

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**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 02 41 13 – Selective Site Demolition.

**1.2 REFERENCE STANDARDS**

- .1 Canadian Environmental Protection Act.
  - .1 Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations.
- .2 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 WHMIS Safety Data Sheets (SDS).
- .3 National Research Council Canada (NRC)
  - .1 National Fire Code of Canada (NFC).

**1.3 DEFINITIONS**

- .1 Dangerous Goods: product, substance, or organism specifically listed or meets hazard criteria established in Transportation of Dangerous Goods Regulations.
- .2 Hazardous Material: product, substance, or organism used for its original purpose; and is either dangerous goods or material that will cause adverse impact to environment or adversely affect health of persons, animals, or plant life when released into environment.
- .3 Hazardous Waste: hazardous material no longer used for its original purpose and that is intended for recycling, treatment or disposal.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for hazardous materials and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit two copies of WHMIS Safety Data Sheets (SDS) in accordance with Section 01 35 30 and Section 01 35 43 to the Consultant for each hazardous material required prior to bringing hazardous material on site.
  - .3 Hazardous waste classification: identify waste codes applicable to each hazardous waste material based on applicable federal and provincial acts, regulations, and guidelines. Waste profiles, analyses, and classification submitted to contract offices for review and approval

**1.5 DELIVERY, STORAGE AND HANDLING**

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

- .3 Transport hazardous materials and wastes in accordance with Transportation of Dangerous Goods Act, Transportation of Dangerous Goods Regulations, and applicable provincial regulations.
- .4 Storage and Handling Requirements:
  - .1 Store and handle hazardous materials and wastes in accordance with applicable federal and provincial laws, regulations, codes, and guidelines.
  - .2 Store and handle flammable and combustible materials in accordance with National Fire Code of Canada (NFC) requirements.
  - .3 Keep no more than 45 litres of flammable and combustible liquids such as gasoline, kerosene and naphtha for ready use.
    - .1 Store flammable and combustible liquids in approved safety cans bearing the Underwriters' Laboratory of Canada or Factory Mutual seal of approval.
    - .2 Storage of quantities of flammable and combustible liquids exceeding 45 litres for work purposes requires the written approval of the Consultant.
  - .4 Transfer of flammable and combustible liquids is prohibited within buildings.
  - .5 Transfer flammable and combustible liquids away from open flames or heat-producing devices.
  - .6 Solvents or cleaning agents: non-flammable or have flash point above 38 degrees C.
  - .7 Store flammable and combustible waste liquids for disposal in approved containers located in safe, ventilated area. Keep quantities to minimum.
  - .8 Observe smoking regulations, smoking is prohibited in areas where hazardous materials are stored, used, or handled.
  - .9 Storage requirements for quantities of hazardous materials and wastes in excess of 5 kg for solids, and 5 litres for liquids:
    - .1 Store hazardous materials and wastes in closed and sealed containers.
    - .2 Label containers of hazardous materials and wastes in accordance with WHMIS.
    - .3 Store hazardous materials and wastes in containers compatible with that material or waste.
    - .4 Segregate incompatible materials and wastes.
    - .5 Ensure that different hazardous materials or hazardous wastes are stored in separate containers.
    - .6 Store hazardous materials and wastes in secure storage area with controlled access.
    - .7 Maintain clear egress from storage area.
    - .8 Store hazardous materials and wastes in location that will prevent them from spilling into environment.
    - .9 Have appropriate emergency spill response equipment available near storage area, including personal protective equipment.
    - .10 Maintain inventory of hazardous materials and wastes, including product name, quantity, and date when storage began.
    - .11 Ensure personnel have been trained in accordance with Workplace Hazardous Materials Information System (WHMIS) requirements.
    - .12 Report spills or accidents immediately to the Consultant. Submit a written spill report to the Consultant within 24 hours of incident.

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**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Description:
  - .1 Bring on site only quantities hazardous material required to perform Work.
  - .2 Maintain WHMIS Safety Data Sheets (SDS) in proximity to where materials are being used. Communicate this location to personnel who may have contact with hazardous materials.
  - .3 Spill Response Materials: provide spill response materials which can be used for absorbing/shoveling and containing hazardous materials.
  - .4 Provide personal protective equipment

**PART 3 EXECUTION**

**3.1 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 00.

**END OF SECTION**



**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 03 30 00 - Cast-in-Place Concrete.
- .2 Section 32 16 00 - Curbs, Gutters, and Sidewalks

**1.2 REFERENCE STANDARDS**

- .1 CSA Group (CSA)
  - .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  - .2 CAN/CSA O86, Engineering Design in Wood.
  - .3 CSA O121, Douglas Fir Plywood.
  - .4 CSA O151, Canadian Softwood Plywood.
  - .5 CSA O153, Poplar Plywood.
  - .6 CAN/CSA O325.0, Construction Sheathing.
  - .7 CSA O437 Series, Standards for OSB and Waferboard.
  - .8 CSA S269.1, Falsework and Formwork.
  - .9 CAN/CSA S269.3, Concrete Formwork.
- .2 Underwriters' Laboratories of Canada (ULC)
  - .1 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for proprietary materials used in formwork liners and coatings and include product characteristics, performance criteria, physical size, finish, and limitations.
  - .2 Submit 2 copies of WHMIS SDS.

**1.4 DELIVERY, STORAGE AND HANDLING**

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

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**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Formwork materials: At the discretion of the Contractor.
  - .1 Provide a smooth surface free of distortions, of adequate strength to support concrete at temperature and rate poured without distortion and easily removed without damaging the concrete.
  - .2 Formwork shall be free of sawdust, dust, dirt and other foreign materials.
  - .3 For concrete without special architectural features, use wood and wood product formwork materials to CSA O121, CAN/CSA O86, CSA O437 Series, or CSA O153.
  - .4 For concrete with special architectural features, use formwork materials to CSA A23.1/A23.2.
  - .5 Rigid insulation board: to CAN/ULC-S701.
- .2 Form release agent:
  - .1 Colourless mineral oil which will not stain concrete, or absorb moisture or impair natural bonding or colour characteristics of coating intended for use on concrete.
  - .2 Non-toxic.
- .3 Form stripping agent: Colourless mineral oil, non-toxic, free of kerosene, with viscosity between 70 and 110s Saybolt Universal at 40 degrees C, flashpoint minimum 150 degrees C, open cup.
- .4 Corners: Chamfered, wood strip type; 25 x 25 mm size; maximum possible lengths.
- .5 Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- .6 Falsework materials: to CSA S269.1.

**PART 3 EXECUTION**

**3.1 EARTH FORMS**

- .1 Earth forms are not permitted.

**3.2 FABRICATION AND ERECTION**

- .1 Verify existing conditions, lines, levels, and centres before proceeding with formwork/falsework and ensure dimensions agree with drawings.
- .2 Fabricate and erect falsework in accordance with CSA S269.1.
- .3 Refer to architectural drawings for concrete members requiring architectural exposed finishes.
- .4 Do not place shores and mud sills on frozen ground.
- .5 Provide site drainage to prevent washout of soil supporting mud sills and shores.
- .6 Fabricate and erect formwork in accordance with CAN/CSA S269.3 to produce finished concrete conforming to shape, dimensions, locations and levels indicated within tolerances required by CSA A23.1/A23.2.

- .7 Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- .8 Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- .9 Align form joints and make watertight.
  - .1 Keep form joints to minimum.
- .10 Use 25 mm chamfer strips on external corners and 25 mm fillets at interior corners joints, unless specified otherwise.
- .11 Form chases, slots, openings, drips, recesses, expansion and control joints as indicated.
- .12 Build in anchors, sleeves, and other inserts required to accommodate Work specified in other sections.
  - .1 Ensure that anchors and inserts will not protrude beyond surfaces designated to receive applied finishes, including painting.
- .13 Obtain approval before framing openings in structural members which are not indicated on Drawings.
- .14 Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- .15 If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement, before proceeding request instructions from Consultant.
- .16 Form all necessary openings or chases for piping, ductwork and similar items where indicated or as required for the work.
- .17 Clean formwork in accordance with CSA A23.1/A23.2, before placing concrete.

### **3.3 APPLICATION - FORM RELEASE AGENT**

- .1 Apply form release agent on formwork in accordance with manufacturer's recommendations.
- .2 Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- .3 Do not apply form release agent where concrete surfaces will receive special finishes which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete

### **3.4 REMOVAL AND RESHORING**

- .1 Leave formwork in place for following minimum periods of time after placing concrete.
  - .1 2 days for walls and sides of beams.
  - .2 2 days for columns.
  - .3 5 days for beam soffits, slabs, decks and other structural members, or 3 days when replaced immediately with adequate shoring to standard specified for falsework.
  - .4 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, and replace immediately with adequate reshoring.

- .3 Provide necessary reshoring of members where early removal of forms may be required or where members may be subjected to additional loads during construction as required.
- .4 Space reshoring in each principal direction at not more than 3000 mm apart.
- .5 Re-use formwork and falsework subject to requirements of CSA A23.1/A23.2.

### **3.5 CLEANING**

- .1 Progress Cleaning: leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.
- .3 Waste Management: separate waste materials for reuse and recycling.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED WORK SPECIFIED ELSEWHERE**

- .1      Concrete Forming and Accessories:      Section 03 10 00
- .2      Cast-In-Place Concrete:                      Section 03 30 00
- .3      Concrete Walks, Curbs and Gutters:      Section 32 16 15

**1.2            REFERENCES**

- .1      CAN/CSA-A23.1-A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .2      CAN3-A23.3, Design of Concrete Structures for Buildings.
- .3      ASTM A82, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
- .4      ASTM A185, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- .5      CSA G30.18, Billet-Steel Bars for Concrete Reinforcement.
- .6      CAN/CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .7      CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

**1.3            SOURCE QUALITY CONTROL**

- .1      Provide Consultant with certified copy of mill test report of reinforcing steel, showing physical and chemical analysis, minimum 3 weeks prior to commencing reinforcing work.
- .2      Upon request inform Consultant of proposed source of material to be supplied.

**1.4            SHOP DRAWINGS**

- .1      Submit shop drawings in accordance with Section 01 33 00 - Submittals.
  - .2      Shop drawings consist of bar bending details, lists and placing drawings.
  - .3      On placing drawings, indicate sizes, spacing, location and quantities of reinforcement and mechanical splices, with identifying code marks to permit correct placement without reference to structural drawings. Indicate sizes, spacing and location of chairs, spacers and hangers. Do drawings in accordance with Reinforcing Steel Manual of Standard Practice - by Reinforcing Steel Institute of Ontario.
  - .4      Detail lap lengths and bar development lengths to CAN3-A23.3, unless otherwise indicated. Provide type B tension lap splices unless otherwise indicated.
  - .5      Review is for general conformity only. It does not in any way relieve the Contractor from making the work conform to the Contract Documents.
-

- .6 Work done prior to the receipt of reviewed shop drawings is done at the risk of the Contractor.

## **1.5 SUBSTITUTES**

- .1 Substitution of different size bars permitted only upon written acceptance of the Consultant.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Reinforcing steel: billet steel, grade 400, deformed bars to CSA G30.18, unless indicated otherwise.
- .2 Welded steel wire fabric: to ASTM A185. Provide in flat sheets only, minimum 152 x 152 x MW 18.7 x MW 18.7 unless noted otherwise.
- .3 Chairs, bolsters, bar supports, spacers: to CAN/CSA-A23.1/A23.2.
- .4 Mechanical splices: subject to acceptance of the Consultant.
- .5 Plain round bars: to CAN/CSA-G40.20/G40.21.

### **2.2 FABRICATION**

- .1 Fabricate reinforcing in accordance with CAN/CSA-A23.1/A23.2, and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Ontario.
- .2 Obtain Consultant's acceptance for locations of reinforcement splices other than shown on placing drawings.
- .3 Upon acceptance of Consultant's, weld reinforcement in accordance with CSA W186.
- .4 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

## **Part 3 Execution**

### **3.1 FIELD BENDING**

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

### **3.2 PLACING REINFORCEMENT**

- .1 Place reinforcing steel as indicated on reviewed placing drawings and in accordance with CAN/CSA-A23.1/A23.2.
- .2 Provide the Consultant with 48 hrs. notice prior to placement of concrete to allow for

rebar inspection.

- .3 Remove all debris from reinforcement prior to placement of concrete.
- .4 Provide reinforcing for concrete surround for electrical duct bank.
- .5 Install concrete brick support chair spaced 900 mm o.c. in both directions to support the welded wire mesh or rebar in slabs on grade. Concrete brick chairs to be cut such that the reinforcing is in the centre of the slab.

### **3.3 FIELD REVIEW**

- .1 Review of construction by the Consultant is for general conformity only. It does not relieve the Contractor from making the work conform to the Contract documents.

**END OF SECTION**

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**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 32 16 00 – Curbs, Gutters, and Sidewalks.

**1.2 REFERENCES**

- .1 Abbreviations and Acronyms:
  - .1 Cement: hydraulic cement or blended hydraulic cement (XXb - where b denotes blended).
    - .1 Type GU or GUb - General use cement.
- .2 Reference Standards:
  - .1 ASTM International
    - .1 ASTM C260, Standard Specification for Air-Entraining Admixtures for Concrete.
    - .2 ASTM C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
    - .3 ASTM D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
  - .2 CSA International
    - .1 CSA A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
    - .2 CSA A283, Qualification Code for Concrete Testing Laboratories.
    - .3 CSA A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).

**1.3 QUALITY ASSURANCE**

- .1 Provide test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture will meet specified requirements.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.
- .2 Provide testing results and reports for review by Consultant and do not proceed without written approval when deviations from mix design or parameters are found.

**1.5 DELIVERY, STORAGE AND HANDLING**

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



- .2 Concrete delivery: ensure continuous concrete delivery from plant meets CSA A23.1/A23.2.

- .2 Packaging Waste Management: remove for reuse pallets, crates, padding, and packaging materials.

## **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 MATERIALS**

- .1 Cement: to CSA A3001, Type GU.
- .2 Blended hydraulic cement: Type GUb to CSA A3001.
- .3 Water: to CSA A23.1.
- .4 Aggregates: to CSA A23.1/A23.2.
- .5 Admixtures:
  - .1 Air entraining admixture: to ASTM C260.
  - .2 Chemical admixture: to ASTM C494. Consultant to approve accelerating or set retarding admixtures during cold and hot weather placing.
- .6 Grout for all other purposes: Portland cement grout or concrete, water reducing and plasticizing agents to CSA A23.1/A23.2.
  - .1 Compressive strength: 10 MPa at 28 days.
  - .2 Slump Flow: 550 mm +/- 70 mm.
  - .3 Aggregate size: 20 mm maximum.
  - .4 Able to be pumped.
- .7 Curing compound: to CSA A23.1/A23.2 white.
- .8 Premoulded joint fillers:
- .9 Bituminous impregnated fiber board: to ASTM D1751

### **2.3 MIXES**

- .1 Alternative 1 - Performance Method for specifying concrete: to meet Consultant performance criteria to CSA A23.1/A23.2.
  - .1 Compressive strength: 35 MPa at 28 days.
  - .2 Concrete curbs and gutters: Exposure Class C-2.
  - .3 Provide quality management plan to ensure verification of concrete quality to specified performance.
  - .4 Concrete supplier's certification: both batch plant and materials meet CSA A23.1 requirements.

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**PART 3 EXECUTION**

**3.1 PREPARATION**

- .1 Obtain Consultant's written approval before placing concrete.
  - .1 Provide 24 hours minimum notice prior to placing of concrete.
- .2 During concreting operations:
  - .1 Development of cold joints not allowed.
    - .1 Concrete to remain in plastic state for placement of additional concrete.
  - .2 Ensure concrete delivery and handling facilitates placing with minimum of re-handling, and without damage to existing structure or Work.
- .3 Ensure reinforcement and inserts are not disturbed during concrete placement.
- .4 Prior to placing of concrete obtain Consultant's approval of proposed method for protection of concrete during placing and curing in adverse weather.
- .5 Protect previous Work from staining.
- .6 Clean and remove stains prior to application for concrete finishes.
- .7 Maintain accurate records of poured concrete items to indicate date, location of pour, quality, air temperature and test samples taken.
- .8 Do not place load upon new concrete until authorized by Consultant.

**3.2 INSTALLATION/APPLICATION**

- .1 Do cast-in-place concrete work to CSA A23.1/A23.2.
- .2 Joint fillers:
  - .1 Furnish filler for each joint in single piece for depth and width required for joint, unless otherwise authorized by Consultant.
  - .2 When more than one piece is required for joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening.
  - .3 Locate and form isolation, construction and expansion joints as indicated.
  - .4 Install joint filler.

**3.3 SURFACE TOLERANCE**

- .1 Concrete tolerance to CSA A23.1.

**3.4 FIELD QUALITY CONTROL**

- .1 Site tests: conduct tests as follows and submit report as described in PART 1 - ACTION AND INFORMATIONAL SUBMITTALS.
  - .1 Concrete pours.
  - .2 Slump.
  - .3 Air content.
  - .4 Compressive strength at 7 and 28 days.
  - .5 Air and concrete temperature.
- .2 Inspection and testing of concrete and concrete materials will be carried out by testing laboratory to CSA A23.1/A23.2.

- .1 Ensure testing laboratory is certified to CSA A283.
- .3 Consultant may take additional test cylinders during cold weather concreting. Cure cylinders on job site under same conditions as concrete which they represent.
- .4 Inspection or testing by Consultant will not augment or replace Contractor quality control nor relieve Contractor of his contractual responsibility.

### **3.5 CLEANING**

- .1 Waste Management: separate waste materials for reuse and recycling.
  - .1 Divert unused concrete materials from landfill to local concrete facility.
  - .2 Provide appropriate area on job site where concrete trucks can be safely washed.
  - .3 Divert unused admixtures and additive materials (pigments, fibres) from landfill to official hazardous material collections site.
  - .4 Do not dispose of unused admixtures and additive materials into sewer systems, into lakes, streams, onto ground or in other location where it will pose health or environmental hazard.
  - .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, noncombustible material and remove for disposal.
  - .7 Dispose of waste in accordance with applicable local, Provincial/Territorial and National regulations.

**END OF SECTION**

## PART 1 - GENERAL

### 1.1 GENERAL REQUIREMENTS

- .1 Comply with requirements of Division 1

### 1.2 RELATED WORK

- .1 Submittal Procedures Section 01 33 00
- .2 Cast in place concrete: *\*If applicable* Section 03 30 00
- .3 Sealants, except as specified herein: Section 07 92 00

### 1.3 REFERENCES

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA-A23.1/A23.2-09, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
  - .2 CSA-A23.3-04(R2010), Design of Concrete Structures.
  - .3 CAN/CSA-A23.4-09, Precast Concrete-Materials and Construction/ Qualification Code for Architectural and Structural Precast Concrete Products.
  - .4 CAN/CSA-A3000-98 (April 2001), Cementitious Materials Compendium (Consists of A5-98, A8-98, A23.5-98, A362-98, A363-98, A456.1-98, A456.2-98, A456.3-98).
    - .1 CAN/CSA-A23.5-98, Supplementary Cementing Materials.
  - .5 CAN/CSA G30.18-09, Carbon and Steel Bars for Concrete Reinforcement
  - .6 CAN/CSA-G40.20/G40.21-04 (R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
  - .7 CAN/CSA G164-M92 (R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.
  - .8 CSA G279-M1982 (R1998), Steel for Pre-stressed Concrete Tendons (Metric Version).
  - .9 CAN/CSA-A266.4 Guidelines for Use of Admixtures in Concrete.
  - .10 CSA W48-06 (R2011), Filler Metals and Allied Materials

For Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

- .11 CSA W59-03 (R2008), Welded Steel Construction (Metal Arc Welding) (Metric Version).
- .12 CSA W186-M1990 (R2007), Welding of Reinforcing Bars In Reinforced Concrete Construction.
- .13 Ontario Building Code, 2024
- .14 National Building Code of Canada, 2025

#### 1.4 **WORK SUPPLIED BUT NOT INSTALLED**

- .1 Supply cast in hardware required for anchorage of precast elements to cast in place concrete base.

#### 1.5 **QUALITY ASSURANCE**

- .1 Do precast concrete work in accordance with CSA A23.4-16.
- .2 Do welding in accordance with CSA W59-13.
- .3 Manufacturer of precast concrete elements shall be certified by CPCI and CSA meeting requirements of CSA A23.4-16 for appropriate class of work.
- .4 Provide Consultant with verified copies of quality control tests related to this project as specified in CSA A23.4-16.
- .5 Retain a professional engineer, licensed in the Province of Ontario, with experience in pre-cast architectural work of comparable complexity and scope, to perform following services as part of work of this section:
  - .1 Structural design including anchorages and tie-backs to accommodate live, dead, lateral, thermal, wind, seismic, handling, transportation, erection loads and granular substrate base.
  - .2 Review, stamp and sign fabrication and erection shop drawings.
  - .3 Review quality control tests and mill test reports for compliance with design intent
- .6 Welders shall be certified by the Canadian Welding Bureau to CSA W47.1-09 for appropriate class of work.

## 1.6 QUALIFICATIONS

- .1 Manufacturer shall be certified by CSA and CPCQA, meeting requirements of CSA A23.4-09 for appropriate class of work at the time of tender and for the duration of the project.
- .2 Manufacturer shall be a member of the Canadian Precast Concrete Institute (CPCI) and CSA.
- .3 Manufacturer shall be fully experienced in and equipped for this type of work and shall be able to document minimum ten consecutive years of activity in Structural and Architectural precast concrete and have successfully completed projects of similar size and complexity.
- .4 Manufacturer shall be certified by CPCQA for a minimum of five (5) years.
- .5 Approved Manufacturers:
  - Central Precast Inc.  
25 Bongard Avenue  
Ottawa, Ontario K2E 6V2  
Tel: 1-613-225-9510  
Email: [info@centralprecast.com](mailto:info@centralprecast.com)
  - Anchor Concrete  
1645 Sydenham Road, Kingston,  
Ontario K7L 4V4  
TEL: 1-613-546-6683  
Email: [sales@anchorconcrete.com](mailto:sales@anchorconcrete.com)

## 1.7 DESIGN AND PERFORMANCE CRITERIA

- .1 Design roof and floor slab using 3/8" diameter seven wire low relaxation pre-stressing strands in bottom profile of the units in addition to conventional reinforcement.
- .2 Design precast elements to CSA-A23.3-04 and CAN/CSA A23.4-09 and to resist handling, stockpiling, shipping and erection stresses.
- .3 Design precast elements to carry loads as indicated in accordance with NBCC and OBC. Design shall include resistance to creep, shrinkage and temperature affects, as well as wind and seismic loads.
- .4 Design of precast concrete elements and connections is the responsibility of the manufacturer under this section.
- .5 Design connections/attachments of precast elements to load/forces specified herein. Connections shall be designed to withstand long-term corrosion for exposed elements. Design connections to accommodate and account for shrinkage, temperature effects, as well as wind and seismic loads.  
The stamped engineer will specify standard live roof, wind, floor loads on

the shop drawings.

- .6 Design floor slab to mitigate water migration into the building.
- .7 Design "flat" roof to have minimum 1% slope for water runoff.

#### 1.8 **SUBMITTALS**

- .1 Submit detailed shop drawings showing layout, configurations, sizes, materials, finishes, anchorages, lifting points, unit identification, joint treatment and other pertinent details. Shop drawings shall bear seal and signature of professional engineer responsible for design of precast work.

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

- .1 Arrange lifting devices so they can be readily removed and depressions so left readily repaired.
- .2 Proper lifting devices for the completed unit shall be incorporated to ensure that it will be safely and efficiently handled and not produce distortion, cracking or deflection nor strain or adversely affect the unit.
- .3 Stack units with supports to protect edges.
- .4 Do not permit units to contact earth or other staining influences.
- .5 Repair chipped, checked, cracked, blemished or defective units. Replace units which in the opinion of the Consultant cannot be satisfactorily repaired.
- .6 Provide units with all exposed surfaces clean and in an unblemished condition.

#### 1.10 **WARRANTY**

- .1 At no extra cost to Owner remedy any defects in work of this and other Sections due to faults in materials and workmanship of work provided under this Section for a period of 5 years from date of Substantial Performance.

### **PART 2 - PRODUCTS**

#### 2.1 **MATERIALS**

- .1 Formwork Materials: All forms shall be accurately constructed, well braced and stiffened to avoid deformations under pressure of wet concrete and vibrators.

- .2 Formwork to CSA A23.4-16: Elastomeric form liner or approved equivalent to create acceptable pattern in precast concrete in profile and texture as selected by Consultant.
- .3 Form release agent: Chemically active, non-staining, VOC compliant, release agents containing compounds that react with free lime present in concrete forming water insoluble soaps, preventing concrete from sticking to forms. Ensure that form release agents are compatible with sealant.
- .4 Cement, aggregates, water, admixtures: to CSA A23.1-14.
- .5 Use same brands and sources of cement and aggregate for entire project to aid in uniformity of colouration and other mix characteristics.
- .6 Aggregates and colour pigments: Natural concrete smooth texture.
- .7 Reinforcing steel: to CAN/CSA G30.18-09. All reinforcing steel to be weldable grade 400W.
- .8 Prestressing steel: to CSA G279
- .9 Anchors and supports: to CSA-G40.20/G40.2 1, Type 350 W galvanized after fabrication.
- .10 Welding materials: CSA W48.
- .11 Galvanizing: hot dipped galvanizing with minimum zinc coating of 610 g/m<sup>2</sup> to CSA G164.
- .12 Zinc-rich primer: to CGSB-1.181 MPI #25.
- .13 Air entrainment admixtures: to CSA A23.1-14.
- .14 Shims and spacers: Plastic.
- .15 Backer rod: As supplied by NCA.
- .16 Precast caulking: Construction Silicon by DOW or approved equivalent.

## 2.2

### CONCRETE MIXES

- .1 Use concrete mix designed to produce minimum 35 MPa compressive cylinder strength at 28 days, with a maximum water/cement ratio of 0.4 to CSA A23.1-14.
- .2 Air entrainment of concrete mix: to CSA A23.1-14: 5 to 7%
- .3 Calcium chloride should not be used.



## 2.3 FABRICATION

- .1 Manufacture units in accordance with CSA A23.4-16, to profiles and joint layout shown. Make units in lengths indicated. Do not introduce additional intermediate joints unless approved by Consultant.
- .2 Fabricate precast architectural concrete units in accordance with CSA A23.4-16, including requirements of Appendix C.
- .3 Mark each precast unit, on a face which will be concealed in final assembly, with casting date and identification code corresponding to shop drawing layout, to facilitate unit identification and erection.
- .4 Form liner:
  - .1 Verify lines and levels of formwork and form liner patterns are within allowable tolerances.
  - .2 On multiple use liners, clean liner before each use in accordance with manufacturer's written instructions.
  - .3 Do not use damaged liner when continued use or repair will diminish aesthetics of the Work.
  - .4 Apply form release agent according to manufacturer's written instructions. Schedule concrete pour immediately after application of release agent to avoid precipitation, dust, and debris. Protect reinforcing steel from exposure to release agents.
  - .5 Store and use form liner panels at temperatures as indicated by manufacturer.
  - .6 Prevent cement paste from bleeding form liner joints, form liner accessories joints, and tie holes.
  - .7 Cast precast panels face down in moulds designed to withstand high frequency vibration. Thoroughly vibrate concrete to achieve consolidation and minimize voids.

## 2.4 FINISHES

- .1 Outside panel profile: Finish and colour of precast units to be selected from manufacturer's standard range.
- .2 Inside panel face: Steel troweled finish.
- .3 Exposed panel surfaces shall be of uniform, well blended appearance.
- .4 Stain or Sealers:

- .1 Concrete Floor Sealer (CONC-1): Water-based acrylic curing and sealing compound, non-yellowing, clear, low gloss, for application in interior conditions, meeting following requirements:
  - .1 ASTM C 309, Type 1, Class B.
  - .2 ASTM C 1315, Type 1, Class A.
  - .3 USDA accepted.
  - .4 Maximum VOC content: 100 g/L, less water, to SCAQMD Rule 1168.
  - .5 Acceptable Product: Vocomp-20 by W.R. Meadows.
- .2 Concrete Penetrating Sealer - Exterior: Clear, breathable, 100% silane penetrating sealing compound for application in outdoor conditions to concrete cast with low water-cement ratio (0.3 to 0.45) concrete, where relative moisture content is maximum 80%.
  - .1 Waterproofing performance: Minimum 85% after abrasion (144-gram abrasion)
  - .2 Vapour transmission performance: Minimum 85%.
  - .3 Acceptable Products: MasterProtect H1000 by Master Builders Solutions, Sealmaster 100% by Technical Barrier Systems inc. Dry-Trete 1000L by DRE Industries, Inc., Protectosil 300 S by Evonik Degussa Corporation, SW-244-100VOC by Sherwin Williams, SIL-ACT ATS 100 by Advanced Chemical Technologies, Sikagard SN-100 by Sika Canada Inc., Pentreat 244-100 by W.R. Meadows.
- .3 Concrete Penetrating Sealer - Interior: Water-based, silane and siloxane based penetrating sealing compound for interior walls and ceiling.
  - .1 Drying Time: 1 - 2 hours @ 21 deg C
  - .2 Acceptable Product: Intraguard by WR Meadows.

## 2.5 ACCESSORIES

- .1 Doors and Frames: Refer to Steel Doors and Frames section 08 11 14
- .2 Door hardware: Refer to Finish Hardware section 08 71 00
- .3 Vents/louvers: as specified by electrical/mechanical consultants.

## **PART 3 – EXECUTION**

### **3.1 SITE PREPERATION**

- .1 Contractor is to provide a clear and level granular area at a minimum of 600mm wider and longer than the building footprint with the building centered on the base.
- .2 Granular base is to be designed by a professional Engineer to withstand the loads of the precast building.
- .3 Prior to start of installation on site examine granular base for levelness and size.
- .4 Report to Consultant any unsatisfactory conditions as soon as they are discovered.
- .5 Ensure that the surrounding area is sloped away from the building structure.

### **3.2 ACCESS**

- .1 Contractor must provide level unobstructed area, with sufficient load bearing capacity for both the mobile crane and delivery trucks, large enough for a tractor trailer to park adjacent to the prepared base. The crane must be able to place its outriggers within 1.5m of the edge of the base. The truck and crane must be able to get side by side under their own power. No overhead lines may be within a 22m radius of the centre of the base. A minimum of 600mm is required between this building and any obstructions.

### **3.3 INSTALLATION**

- .1 All work shall be executed using workers skilled in the trade of precast installation.
- .2 Set each precast unit plumb and true in position to which it is assigned.
- .3 Anchor securely and rigidly to supporting concrete work.
- .3 Supply and install all anchors, fixing devices, supports, set in precast work, including all necessary bolts, nuts, washers.
- .4 Provide and install sufficient temporary bracing to brace precast units adequately at all stages of construction, to withstand safely all loads which units will be subjected to. Complete all connections prior to removing any temporary bracing if required.

3.4 **CLEANING**

- .1 Clean soiled precast concrete surfaces by approved means.
- .2 Repair panels which have visual defects to the satisfaction of the Consultant.

3.5 **FIELD QUALITY CONTROL**

- .1 Structural Engineer responsible for the design of precast concrete work, or his/her authorized representative, shall inspect the work upon completion and shall issue a report to the Consultant.

**END**

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**Part 1 General**

**1.1 SUMMARY**

- .1 Section includes new and restoration masonry work.

**1.2 REFERENCES**

- .1 Definitions:
  - .1 Refer to ASTM E2260-30 for definition of the following terms specific to this Section: In-Situ Mortar, Repointing, Raking.
  - .2 Tooling: Finishing of masonry joints using tool to provide final contour.
  - .3 Low-Pressure Spray: 690 to 2750 kPa; 0.25 to 0.4 L/s.
- .2 ASTM International
  - .1 ASTM A 276-04: Specification for Stainless Steel Bars and Shapes
  - .2 ASTM A 580/A 580M, Specification for Stainless Steel Wire
  - .3 ASTM C 954-11: 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
  - .4 Thickness ASTM E2260-03 (2012), Standard Guide for Repointing (Tuckpointing) Historic Masonry
- .3 CSA International
  - .1 CAN/CSA-A179-04(R2009), Mortar and Grout for Unit Masonry.
  - .2 CAN/CSA-A370-04(R2009), Connectors for Masonry.
  - .3 CAN/CSA A371-04(R2009), Masonry Construction for Buildings.
  - .4 CSA S304.1-04(R2010), Design of Masonry Structures.
- .4 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Division 01.
  - .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 Submit WHMIS MSDS in accordance with Division 01.
  - .3 Shop Drawings:
    - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
    - .2 Placing drawings, indicate sizes, spacing, location and quantities of reinforcement and connectors.
  - .4 Test Reports: Mortar
  - .5 Quality-Control Program for Masonry Repointing
  - .6 Cleaning Program
-

#### **1.4 QUALITY ASSURANCE**

- .1 Masonry Contractor:
  - .1 Use single Masonry Contractor for masonry work.
  - .2 Experienced in performing historic brick masonry work on projects of similar complexity to Services of this Contract.
- .2 Masons: Specializing in masonry installations with a certificate of qualification with 5 years minimum historic brick masonry work on projects of similar size and complexity to Services of this Contract.
  - .1 Masons employed on this project must demonstrate ability to reproduce mock-up standards.
- .3 Quality-Control Program For Masonry Repointing: Prepare a written quality-control program for masonry repointing to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage due to worker fatigue.
- .4 Cleaning Program: Prepare a written cleaning program for Cleaning of Existing Brickwork that describes cleaning process in detail, including materials, methods, and equipment to be used, protection of surrounding materials, and control of runoff during operations.
- .5 Cleaning and Repair Appearance Standard: Cleaned and repaired surfaces are to have a uniform appearance as viewed from 15 m away by Consultant. Perform additional general cleaning, and spot cleaning of small areas that are noticeably different, so that surface blends smoothly into surrounding areas.

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

- .1 Deliver, store and handle materials in accordance with Division 01.
- .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.

#### **1.6 SITE CONDITIONS**

- .1 Ambient Conditions:
  - .1 Assemble and erect components when temperatures are above 4 degrees C.
  - .2 Perform cleaning operations when temperatures are above 4 degrees C and predicted to remain so for at least seven days after completion of cleaning
- .2 Weather Requirements: to CSA-A371 and to IMIAC - Recommended Practices and Guide Specifications for Hot and Cold Weather Masonry Construction.
- .3 Cold weather requirements:
  - .1 To CSA-A371 with following requirements.
    - .1 Maintain temperature of mortar between 5 degrees C and 50 degrees C until batch is used or becomes stable.

- .2 Maintain ambient temperature of masonry work and its constituent materials between 5 degrees C and 50 degrees C and protect site from windchill.
- .3 Maintain temperature of masonry above 0 degrees C for minimum of 7 days, after mortar is installed.
- .4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10 degrees C, before applying mortar.
- .2 Hot weather requirements:
  - .1 Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
  - .2 Keep masonry dry using waterproof, non-staining coverings that extend over walls and down sides sufficient to protect walls from wind driven rain, until masonry work is completed and protected by flashings or other permanent construction.
  - .3 Do not apply mortar to substrates with a temperature of 32 degrees C and above unless otherwise indicated.
- .3 Spray mortar surface at intervals and keep moist for maximum of three days after installation.

## 1.7 SEQUENCING AND SCHEDULING

- .1 Perform masonry restoration work in the following sequence:
  - .1 Remove plant growth
  - .2 Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
  - .3 Repair masonry, including replacing existing masonry with new masonry materials.
  - .4 Rake out mortar from joints to be repointed.
  - .5 Point mortar and sealant joints.
  - .6 Inspect for open mortar joints and repair before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
  - .7 Remove paint.
  - .8 Clean existing brickwork.

## Part 2 Products

### 2.1 MATERIALS

- .1 Brick Units: single fired extruded clay brick units in accordance with ASTM C-1405, Grade S, Type I, Class Exterior, Division Solid. Provide brick units to match existing.

### 2.2 REINFORCEMENT AND CONNECTORS

### 2.3 MASONRY

- .1 Masonry ties and connectors: to CSA-A370 and CSA-S304. Adjustable anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall.
  - .1 At stud framing backup walls:
    - .1 Components:

- .1 Connector plate: 1.6 mm thick by length equal to full width of stud plus thickness of sheathing, insulation and air space; Type 304 stainless steel.
  - .2 V-Tie: V-shape wire tie, 4.8 mm dia. by length to provide placement of V-tie legs at centreline of solid unit veneer; Type 304 stainless steel.
  - .3 Fasteners for steel studs: corrosion-resistant, self-tapping sheet metal screws, length to penetrate 19 mm beyond stud face.
  - .4 Insulating strips: closed cell polyethylene foam strips, 3 mm thick. Same size as connector plate in contact with stud.
  - .5 Insulation Support: polyethylene, friction fit, used to secure insulation in place.
- .2 Acceptable products: Fero Corporation "Side Mounting Rap-Tie System", Blok-Lok Limited, "BL-607".

## 2.4 MORTAR – REPOINTING AND REBUILDING

- .1 Repointing Mortar:
- .1 Comply with CAN/CSA-A179, Proportion Specification, Type N unless otherwise indicated; with cementitious material limited to portland cement and lime.
  - .2 Colour: Ground coloured natural aggregates of colour necessary to produce mortar colour matching existing as determined by the Consultant. Use colouring admixture not exceeding 10% of cement content by mass, or integrally coloured masonry cement
  - .3 Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match
- .2 Rebuilding (Setting) Mortar: Same as pointing mortar except mortar pigments are not required.

## 2.5 MIXES

- .1 Coloured mortars: Incorporate colour and admixtures into mixes in accordance with manufacturer's instructions.
- .1 Use clean mixer for coloured mortar.
- .2 Pointing mortar: Prehydrate pointing mortar by mixing ingredients dry, then mix again adding just enough water to produce damp unworkable mix that will retain its form when pressed into ball. Allow to stand for not less than 1 hour nor more than 2 hours then remix with sufficient water to produce mortar of proper consistency for pointing.

## 2.6 CLEANING MATERIALS

- .1 Water: Potable.
- .2 Hot Water: Water heated to a temperature of 60 to 71 deg C.
- .3 Job-Mixed Detergent Solution: Solution prepared by mixing 0.5 L of tetrasodium polyphosphate, 125 mL of laundry detergent, and 20 L of hot water for every 20 L of solution required.
- .4 Job-Mixed Mold, Mildew, and Algae Remover: Solution prepared by mixing 0.5 L of tetrasodium polyphosphate, 5 L of 5 percent sodium hypochlorite (bleach), and 15 L of hot water for every 20 L of solution required.



### Part 3 Execution

#### 3.1 EXAMINATION

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections are acceptable for product installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate and inform Consultant of unacceptable conditions immediately upon discovery.
  - .2 Proceed with installation only after unacceptable conditions have been remedied.

#### 3.2 INSTALLATION

- .1 Do masonry work in accordance with CAN/CSA-A371 except where specified otherwise.
  - .1 Bond and Coursing height: Match existing.
  - .2 Tooling: Tool where exposed to provide smooth compressed concave profile to match existing.
    - .1 Tooling of repointed joints to match standard of acceptance established in mock-up.
- .2 Build masonry plumb, level, and true to line, with vertical joints in alignment.

#### 3.3 CONSTRUCTION

- .1 Exposed masonry:
  - .1 Remove chipped, cracked, and otherwise damaged units, in exposed masonry and replace with undamaged units.
  - .2 Make cuts straight, clean, and free from uneven edges.
- .2 Building-in:
  - .1 Install masonry connectors and reinforcement where indicated on drawings.
  - .2 Build in items required to be built into masonry.
  - .3 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as work progresses.
  - .4 Install loose steel lintels where indicated.
- .3 Provision for movement:
  - .1 Built masonry to tie in with stabilizers, with provision for vertical movement.
  - .2 Control Joints: Leave 12 mm wide vertical joint clear of mortar, full depth wythe of masonry.
    - .1 Install control joint backing rod, sealant to face of control joints at locations indicated, maximum 6 m o.c., full height of wall.
- .4 Build in flashings in masonry in accordance with CAN/CSA-A371.

#### 3.4 BRICK REMOVAL AND REPLACEMENT

- .1 At locations indicated, remove bricks that are damaged, spalled, or deteriorated or are to be reused. Carefully demolish or remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
  - .1 When removing single bricks, remove material from center of brick and work toward outside edges.

- .2 Support and protect remaining masonry that surrounds removal area. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.
- .3 Notify Consultant of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.
- .4 Remove in an undamaged condition as many whole bricks as possible.
  - .1 Remove in-situ mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.
  - .2 Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
  - .3 Store brick for reuse. Store off ground, on skids, and protected from weather.
  - .4 Deliver cleaned brick not required for reuse to Owner unless otherwise indicated.
- .5 Clean bricks surrounding removal areas by removing mortar, dust, and loose particles in preparation for replacement.
- .6 Replace removed damaged brick with other removed brick in good quality, where possible, or with new brick matching existing brick, including size. Do not use broken units unless they can be cut to usable size.
- .7 Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.
  - .1 Maintain joint width for replacement units to match existing joints.
  - .2 Use setting buttons or shims to set units accurately spaced with uniform joints.
- .8 Lay replacement brick with completely filled bed, head, and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.
  - .1 Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
  - .2 Rake out mortar used for laying brick before mortar sets and point new mortar joints in repaired area to comply with requirements for repointing existing masonry, and at same time as repointing of surrounding area.
  - .3 When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.

### **3.5 REPOINTING MASONRY**

- .1 Repoint joints to the following extent:
  - .1 All joints in areas indicated.
- .2 Remove in-situ mortar from joints as follows, according to procedures demonstrated in approved mock-up:
  - .1 Remove mortar from joints to depth of between 2 and 2-1/2 times joint width, but not less than that required to expose sound, unweathered mortar.
  - .2 Remove mortar from masonry surfaces within joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
  - .3 Do not spall edges of masonry units or widen joints. Replace or patch damaged masonry units as directed by Consultant.

- .1 Cut out center of mortar bed joints using angle grinders with diamond-impregnated metal blades. Remove remaining mortar by hand with chisel and resilient mallet. Strictly adhere to submitted quality-control program.
- .3 Notify Consultant of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
- .4 Pointing with Mortar:
  - .1 Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
  - .2 Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 9 mm until a uniform depth is formed. Fully compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
  - .3 After low areas have been filled to same depth as remaining joints, point all joints by placing mortar in layers not greater than 9 mm. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.
  - .4 When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
  - .5 Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours including weekends and holidays.
  - .6 Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

### **3.6 REINFORCING AND CONNECTING**

- .1 Install masonry connectors and reinforcement in accordance with CAN/CSA-A370, CAN/CSA-A371 and CSA S304.1 unless indicated otherwise.
- .2 Prior to placing mortar, obtain Consultant's approval of placement of reinforcement and connectors.

### **3.7 BONDING AND TYING**

- .1 Bond walls of two or more wythes using metal connectors in accordance with CAN/CSA-A371, CSA S304.1 and as indicated.
- .2 Tie masonry veneer to backing in accordance with NBC, CAN/CSA-A371, CSA S304.1 and as indicated.
- .3 Exterior masonry veneer on stud framing backup walls:
  - .1 Spacing: 600 mm oc vertical intervals; 400 mm oc horizontal intervals.
  - .2 Install connector plates on studs with two screw fasteners/plate. Ensure screws are tight and secure. Remove and replace stripped or loose fasteners.
  - .3 Install insulating strip between each connector plate and stud face.
  - .4 Coordinate spacing with cavity wall insulation to ensure connector plates are centred on horizontal joints of insulation boards. Refer to Section 07 21 13 – Board Insulation.

- .5 Install insulation support over each connector plate to hold insulation tight to backup walls.
- .6 Insert wire tie into connector plate and embed into mortar joints of masonry veneer. Ensure wire tie is aligned and level with horizontal joints of masonry veneer.
- .4 Concrete and Steel back-up:
  - .1 Fasten ties to CIP concrete back-up with metal fasteners required by masonry supplier's engineer. Use two fasteners per location.

### **3.8 ANCHORS**

- .1 Supply and install metal anchors as indicated.

### **3.9 LATERAL SUPPORT AND ANCHORAGE**

- .1 Supply and install lateral support and anchorage in accordance with CSA S304.1 and as indicated.

### **3.10 SITE TOLERANCES**

- .1 Tolerances of CAN/CSA-A371 apply.

### **3.11 3.11 FIELD QUALITY CONTROL**

- .1 Consultant will observe progress and quality of portion of the Services completed. Allow Consultant use of lift devices and scaffolding as needed.
- .2 Notify Consultant in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until Consultant have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.
- .3 Site Tests, Inspection: in accordance with Division 01 supplemented as follows:
  - .1 Test and evaluate mortar prior to construction and during construction in accordance with CAN/CSA A179.

### **3.12 CLEANING EXISTING BRICKWORK**

- .1 General:
  - .1 Proceed with cleaning in an orderly manner; work from top to bottom of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water will not wash over cleaned, dry surfaces.
  - .2 Use only those cleaning methods indicated.
    - .1 Use spray equipment that provides controlled application at volume and pressure indicated, measured at spray tip. Adjust pressure and volume to ensure that cleaning methods do not damage masonry.
      - .1 Equip units with pressure gages.
    - .2 For water-spray application, use fan-shaped spray tip that disperses water at an angle of 25 to 50 degrees.
    - .3 For heated water-spray application, use equipment capable of maintaining temperature between 60 and 71 deg C at flow rates indicated.

- .3 Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, and that produces an even effect without streaking or damaging masonry surfaces.
- .4 Water-Spray Applications: Unless otherwise indicated, hold spray nozzle 150 mm from surface of masonry and apply water in horizontal back and forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- .2 Detergent Cleaning:
  - .1 Wet masonry with hot water applied by low-pressure spray.
  - .2 Scrub masonry with detergent solution using medium-soft brushes until soil is thoroughly dislodged and can be removed by rinsing. Use small brushes to remove soil from mortar joints and crevices. Dip brush in solution often to ensure that adequate fresh detergent is used and that masonry surface remains wet.
  - .3 Rinse with cold water applied by low-pressure spray to remove detergent solution and soil.
  - .4 Repeat cleaning procedure above where required to produce cleaning effect established by mockup.
- .3 Mold, Mildew, and Algae Removal:
  - .1 Wet masonry with hot water applied by low-pressure spray.
  - .2 Apply mold, mildew, and algae remover by brush.
  - .3 Scrub masonry with medium-soft brushes until mold, mildew, and algae are thoroughly dislodged and can be removed by rinsing. Use small brushes for mortar joints and crevices. Dip brush in mold, mildew, and algae remover often to ensure that adequate fresh cleaner is used and that masonry surface remains wet.
  - .4 Rinse with cold water applied by low-pressure spray to remove mold, mildew, and algae remover and soil.
  - .5 Repeat cleaning procedure above where required to produce cleaning effect established by mockup.

### **3.13 CLEANING**

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

### **3.14 PROTECTION**

- .1 Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from masonry work.
- .2 Protect masonry and other work from marking and other damage. Protect completed work from mortar droppings. Use non-staining coverings.
- .3 Repair damage to adjacent materials caused by masonry products installation.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED SECTIONS**

- .1        General Instructions – Section 01 11 13
- .2        Safety Requirements – Section 01 35 30
- .3        Preformed Metal Cladding – Section 07 46 43
- .4        Modified Bitumen Membrane Roofing – Section 07 52 00
- .5        Sheet Metal Flashing – Section 07 62 00
- .6        Electrical and Mechanical Requirements – Section 20 05 01 and 526 05 00

**1.2            REFERENCES**

- .1        Canadian Standards Association (CSA International)
  - .1        CSA B111-1974(R1998), Wire Nails, Spikes and Staples.
  - .2        CAN/CSA-G164-M92(R1998), Hot Dip Galvanizing of Irregularly Shaped Articles.
  - .3        CAN/CSA-O141-91(R1999), Softwood Lumber.
  - .4        CSA O151-M1978(R1998), Canadian Softwood Plywood.
- .2        National Lumber Grades Authority (NLGA)
  - .1        Standard Grading Rules for Canadian Lumber 2000.

**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.
- .3        Plywood, OSB and wood based composite panel construction sheathing identification: by grademark in accordance with applicable CSA standards.
- .4        Provide documentation for all the composite wood products used in the building, indicating that they contain no added urea-formaldehyde resins.

**1.4            ANCHORS AND FASTENERS**

- .1        Co-ordinate the location and installation of anchors and fasteners. Confirm types of fasteners to be utilized with Consultant.
- .2        Do not use metals in combination that will set up electrolytic action.
- .3        Use non-corrosive or galvanized steel fastenings as approved by Consultant, or as otherwise specified.
- .4        Space anchors within load bearing or shear capacity.

**1.5            PRECAUTIONS**

- .1        All wood blocking must be sealed in with self-adhering vapour barrier membrane, as detailed, the same day any wood blocking is installed. Refer to Specification 07 52 00.
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## **Part 2 Products**

### **2.1 LUMBER MATERIAL**

- .1 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.
  - .3 Roofing light framing and blocking: species group **PRESSURE TREATED – “CONSTRUCTION GRADE”**
- .2 Furring, blocking, nailing strips, grounds, rough bucks, cants, curbs, fascia backing and sleepers:
  - .1 S2S is acceptable for.
  - .2 Board sizes: "Standard" or better grade.
  - .3 Dimension sizes: "Standard" light framing or better grade.
  - .4 Post and timbers sizes: "Standard" or better grade.
- .3 All parapets to be constructed with pressure treated lumber – Construction Grade.

### **2.2 PANEL MATERIALS**

- .1 Canadian softwood plywood (CSP): to CSA O151, standard construction.
- .2 For electrical equipment mounting boards, provide fire-retardant treated plywood, DFP or CSP, SEL TF grade.
- .3 All parapet sheathing and/or panels to be 19mm pressure treated lumber – Construction Grade.

### **2.3 ACCESSORIES**

- .1 Nails, spikes and staples: to CSA B111.
- .2 Bolts: 12.5 mm diameter unless indicated otherwise, complete with nuts and washers.
- .3 Proprietary fasteners: toggle bolts, expansion shields and lag bolts, screws and lead or inorganic fibre plugs, explosive actuated fastening devices, recommended for purpose by manufacturer.

### **2.4 FASTENERS**

- .1 All fasteners must be designed and approved for use with ACQ/CCA Pressure-Treated Lumber
  - .2 Wood Construction: Construction Screws #8 or greater carbon steel with duradize treating and approved for use with ACQ/CCA (Pressure-Treated) lumber. Standard of Acceptance: Paulin Flat-Head Socket Deck Screw or approved equivalent
-

- .3 Steel Deck Attachment: Corrosion resistant # 12 hex head screws with Cathodic epoxy e-coat. Standard of Acceptance: Dekfast #12 Hex Head or approved equivalent. Contractor to consider fastener spacing @ 150mm (6") OC staggered.
- .4 Misc. Fasteners: to steel - use self-drilling screws; to solid masonry or concrete - use expansion shields, friction fit pins or lag bolts. Use lead or in-organic fibre plugs with specified screws in concrete or masonry.

## **2.5 FINISHES**

- .1 Galvanizing: to CAN/CSA-G164, use galvanized fasteners for exterior work, interior highly humid areas or pressure- preservative treated lumber.

## **2.6 WOOD PRESERVATIVE**

- .1 Surface-applied wood preservative: copper naphthenate or 5% Pentachlorophenol solution, water repellant preservative to CSA 080-M1983 (latest revision). – Standard of Acceptance: **Copper-Green Wood Preservative or approved equivalent**
- .2 Pentachlorophenol use is restricted to building components that are in ground contact and subject to decay or insect attack only. Where used, pentachlorophenol-treated wood must be covered with two coats of an appropriate sealer.
- .3 Structures built with wood treated with pentachlorophenol and inorganic arsenicals must not be used for storing food nor should the wood come in contact with drinking water.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Treat surfaces of material with wood preservative, before installation.
- .2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum 3 minute soak on lumber and one minute soak on plywood.
- .3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.
- .4 Treat material as indicated as follows:
  - .1 Wood cants, fascia backing, curbs, nailers, sleepers on roof deck.

### **3.2 INSTALLATION**

- .1 Comply with requirements of NBC, supplemented by the following paragraphs.
- .2 Install furring and blocking as required to space-out and support casework, cabinets, wall and ceiling finishes, facings, fascia, soffit, siding and other work as required.
- .3 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .4 Install rough bucks, nailers and linings to rough openings as required to provide backing for frames and other work.
- .5 Install wood cants, fascia backing, nailers, curbs and other wood supports as required



and secure using galvanized steel fasteners.

- .6 Install wood backing, dressed, tapered and recessed slightly below top surface of roof insulation for roof hopper.
- .7 Install electrical plywood as specified for electrical equipment.
- .8 Secure to substrate with suitable fasteners, galvanized minimum 9mm diameter of a suitable length, placed in 2 rows at 600mm centers or as otherwise detailed.
- .9 Fasteners should penetrate steel substrate a minimum of 13mm. Use wood blocking to fill void between flutes as required.
- .10 Double the amount of fasteners required for a distance of 2.4m from all outside corners.
- .11 All screws shall be long enough so that not less than half their length penetrates into the second member.
- .12 Splitting of wood members shall be minimized by staggering the nails in the direction of the grain and by keeping nails well in from the edges.
- .13 Install plywood where indicated on drawings. Wood fibres shall be perpendicular to studs. Leave a space of 2mm between sheets to allow for material expansion. Every piece shall have a minimum of 2 fasteners. Minimum distance between 2 fasteners shall be half their length and the minimum distance from the edge of the plywood shall be a quarter of their length

### **3.3 WOOD PRESERVATIVE**

- .1 Treat surfaces of material with wood preservative, before installation
- .2 Apply preservative by dipping, or by brush to completely saturate and maintain wet film on surface for minimum (three) 3-minute soak on lumber and (one) 1-minute soak on plywood.
- .3 Re-treat surfaces exposed by cutting, trimming or boring with liberal brush application of preservative before installation.
- .4 Applied preservative must be completely dry/cured prior to the installation of any subsequent overlying material layers

### **3.4 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.

**END OF SECTION**

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**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Cast in Place Concrete: Section 03 30 00
- .2 Air Barriers Descriptive Section 07 27 10

**1.2 REFERENCES**

- .1 American Society for Testing and Materials International (ASTM)
  - .1 ASTM E 96/E 96M-05, Standard Test Methods for Water Vapour Transmission of Materials.
- .2 Canadian General Standards Board (CGSB)
  - .1 CGSB 71-GP-24M-77(R1983), Adhesive, Flexible, for Bonding Cellular polystyrene Insulation.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S701-05, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Coverings.
  - .2 CAN/ULC-S704-03, Standard for Thermal Insulation Polyurethane and Polyisocyanurate, Boards, Faced.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Material Safety Data Sheets (MSDS).

**1.3 SUBMITTALS**

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

**Part 2 Products**

**2.1 INSULATION**

- .1 Extruded polystyrene (XPS): to CAN/ULC-S701.
    - .1 Type: 2.
    - .2 Thickness: as indicated, minimum 50mm.
    - .3 Edges: square.
    - .4 Dow Styrofoam SM or equivalent by Celfort.
  - .2 Rigid Cellular Polyisocyanurate: to CAN/ULC C-S704, foil faced.
    - .1 Thickness: 100mm as indicated.
    - .2 AP Foil-Faced by John Manville or approved alternate.
-

- .3 Slab insulation, concrete sidewalk, and all slab entrances: DOW HI-40 rigid insulation, 50mm thick unless noted otherwise.

- .4 Interior perimeter of exterior foundation to be 75mm XPS.

## **2.2 ADHESIVE & ACCESSORIES**

- .1 Adhesive (for polystyrene): Low VOC type to CGSB 71-GP-24.
- .2 Mechanical fasteners: Hilti plastic anchors.

## **Part 3 Execution**

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

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

### **3.2 WORKMANSHIP**

- .1 Install insulation after building substrate materials are dry.
- .2 Install insulation to maintain continuity of thermal protection to building elements and spaces.
- .3 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows and other protrusions.
- .4 Cut and trim insulation neatly to fit spaces. Butt joints tightly, offset vertical joints. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.
- .5 Offset both vertical and horizontal joints in multiple layer applications.

### **3.3 EXAMINATION**

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

### **3.4 PERIMETER FOUNDATION INSULATION**

- .1 Interior application: extend boards 600 mm vertically below finish grade as indicated, mechanically fastened with 4 plastic anchors per board on inside face of perimeter foundation walls.
- .2 Under slab application: extend boards as indicated. Lay boards on level compacted fill.

### **3.5 CAVITY WALL INSTALLATION**

- .1 Install polyisocyanurate insulation boards on outer surface of inner wythe of wall cavity over air/vapour retarder membrane indicated in Specifications Section 07 27 10 - Air Barriers Descriptive or Proprietary, 2.1.1.

- .2 Install polyisocyanurate insulation boards on outer surface of concrete block over air/vapour retarder membrane indicated in Specifications Section 07 27 10 – Air Barriers Descriptive or Proprietary, 2.1.1.
- .3 Install polyisocyanate insulation boards with spot application of adhesive and wedge boards tight against substrate with purpose made pvc or plastic wedge blocks by veneer tie manufacturer at each veneer tie location. Install insulation in strict accordance with membrane manufacturer's printed instructions.

**END OF SECTION**

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**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1       Mineral wool insulation blankets.
- .2    Related Requirements:
  - .1       Section 09 21 16 - Gypsum Board: for sound attenuation insulation.

**1.2            REFERENCES**

- .1    ASTM International (ASTM)
  - .1       ASTM C665-12, Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
  - .2       ASTM C1320-10, Standard Practice for Installation of Mineral Fiber Batt and Blanket Thermal Insulation for Light Frame Construction.
  - .3       ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials
- .2    Canadian Gas Association (CGA)
  - .1       CAN/CGA-B149.1-05, Natural Gas and Propane Installation Code Handbook.
  - .2       CAN/CGA-B149.2-10, Propane Storage and Handling Code.
- .3    Underwriters Laboratories of Canada (ULC)
  - .1       CAN/ULC-S604-M91, Standard for Type A Chimneys.

**1.3            SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00 - Submittal Procedures
- .2    Action Submittals:
  - .1       Product Data:
    - .1           Submit manufacturer's printed product literature, specifications and data sheets.

**Part 2           Products**

**2.1            INSULATION**

- .1    Batt and blanket mineral fibre: to ASTM C665, CAN/ULC-S702.
    - .1       Type: 1
    - .2       Flame Spread: maximum 0, to ASTM E84.
    - .3       Smoke Development: maximum 0, to ASTM E84.
    - .4       Thickness: full depth of stud cavity, except as indicated.
    - .5       Acceptable manufacturers: Safe'n'Sound as manufactured by Roxul Inc.
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**Part 3            Execution**

**3.1                MANUFACTURER'S INSTRUCTIONS**

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

**3.2                INSULATION INSTALLATION**

- .1        Install insulation to maintain continuity of thermal protection to building elements and spaces and to ASTM C1320.
- .2        Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
- .3        Do not compress insulation to fit into spaces.
- .4        Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC S604 Type A chimneys and CAN/CGA B149.1 and CAN/CGA B149.2 Type B and L vents.
- .5        Do not enclose insulation until it has been inspected and approved by Engineer.

**3.3                CLEANING**

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

**END OF SECTION**

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**Part 1            General**

**1.1            SUMMARY**

- .1    Section Includes:
  - .1        Foamed-in-place insulation.
  - .2        Foamed-in-place sealant.
- .2    Related Requirements:
  - .1        Section 07 21 13 - Board Insulation
  - .2        Section 07 27 10 - Air/Vapour Barriers
  - .3        Section 08 11 00 - Steel Doors and Frames
  - .4        Section 08 41 26 - All-Glass Entrances and Storefronts
  - .5        Section 08 44 00 - Curtain Wall

**1.2            REFERENCES**

- .1    Underwriters' Laboratories of Canada (ULC)
  - .1        CAN/ULC-S710.1-11, Standard For Thermal Insulation – Bead-Applied One Component Polyurethane Air Sealant Foam, Part 1: Material Specification
  - .2        CAN/ULC-S705.1-01, Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Material – Specifications, Includes Amendments 1, 2
  - .3        CAN/ULC-S705.2-05, Standard for Thermal Insulation – Spray Applied Rigid Polyurethane Foam, Medium Density – Application

**1.3            ADMINISTATIVE REQUIREMENTS**

- .1    Coordination: Coordinate with Section 07 27 10 Air/Vapour Barriers for adhesion testing of membrane air seal/vapour barrier (AVB) where installed under Foamed-in-place Insulation.

**1.4            SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Action Submittals:
  - .1        Product Data: Submit manufacturer's printed product literature, specifications and datasheet for each product indicated.
- .3    Informational Submittals:
  - .1        Compatibility: Submit letter, provided and signed by manufacturer of insulation material, indicating products used on the project are compatible with adjacent materials, and materials with which the insulation will be in contact or sealed.
  - .2        Manufacturer's Instructions: Submit manufacturer's installation instructions and special handling criteria, installation sequence, and cleaning procedures.

**1.5            AMBIENT CONDITIONS**

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

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Use of insulation products manufactured with CFCs as blowing agents is prohibited.
- .2 Spray Foam Insulation: to CAN/ULC S705.1, closed cell, spray applied rigid cellular polyurethane foam air barrier and thermal insulation, medium 29 kg/cu m density.
  - .1 Performance criteria:
    - .1 Fire Performance: less than 500 flame spread, less than 500 smoke developed to CAN/ULC S102.
    - .2 Water vapour permeance: 42ng/Pa-s-sq m to ASTM E96.
    - .3 Long term thermal resistance: RSI 1.95 at 50 mm thickness.
  - .2 Standard of Acceptance: BASF Walltite v3, CertainTeed CertaSpray Closed Cell Foam, Icynene MD-C-200 CDN, Johns Manville JM Corbond III, Heatlok Soya/Polaform Soya by Demilec Soya is an approved alternate.
  - .3 Locations: Around protrusions and penetrations through air seal, and other locations indicated.
- .3 Spray Foam Sealant – General Purpose: one-component, semi-rigid polyurethane sealant, to CAN/ULC-710.1, 16 to 24 kg/m<sup>3</sup>, minimum RSI 0.67 per 25 mm thickness:
  - .1 Standard of Acceptance: Great Stuff Pro Gaps and Cracks Insulating Foam Sealant by Dow Chemical, or comparable product by, but not limited to, RHH Foam Systems Inc., Handi-Foam, Tiger Foam Insulation, and Hilti.
  - .2 Locations: gaps and cracks up to 75 mm in size.
- .4 Spray Foam Sealant – Low Pressure: one-component, semi-flexible polyurethane sealant, to CAN/ULC-S710.1, 27 kg/m<sup>3</sup>:
  - .1 Standard of Acceptance: Great Stuff Pro Window and Door Insulating Foam Sealant by Dow Chemical, or comparable product by, but not limited to, RHH Foam Systems Inc., Handi-Foam, Tiger Foam Insulation, and Hilti.
  - .2 Locations: gaps and cracks adjacent to door, window and curtain wall framing.
- .5 Cementitious Thermal Barrier: ULC rated fire protective coating specially formulated for application over cured polyurethane foam insulation, forming a hard, durable, humidity resistant monolithic surface, minimum 350 kg/m<sup>3</sup> dry density, minimum 23.9 kN/m<sup>2</sup> bond strength, surface burning characteristics 10 flame spread, 0 smoke developed.
  - .1 Standard of Acceptance: Grace Construction Products Monokote Type Z3306.

## **Part 3 Execution**

### **3.1 PREPARATION**

- .1 Clean surfaces which are to receive insulation, of dirt, dust, grease, loose material or other foreign matter which may inhibit adhesion.



- .2 Provide sufficient ventilation during and until insulation has cured, to ensure safe working conditions. Introduce fresh air and exhaust air continuously during the 24 hour period after application to maintain non-toxic, unpolluted, safe working conditions.
- .3 Temporarily brace door frames as may be required to prevent possible bowing of frames due to over expansion of the foamed-in-place insulation.
- .4 Examine substrate surfaces for conditions ready to accept Work.
- .5 Report unsatisfactory conditions in writing.
  - .1 Proceed with Work once unsatisfactory conditions are corrected.
  - .2 Start of Work implies acceptance of conditions.

### **3.2 PROTECTION**

- .1 Provide temporary enclosures to prevent spray and noxious vapour from contaminating air beyond application area.
- .2 Protect workers in accordance with manufacturer's written instructions.
- .3 Protect adjacent surfaces and equipment from damage by over spray, fall-out, and dusting of insulation materials.
- .4 Dispose of waste foam daily and decontaminate empty drums in accordance with foam manufacturer's instructions.

### **3.3 INSTALLATION, GENERAL**

- .1 Where spray-foam insulation or sealant is used to maintain continuity of thermal barrier, and is installed in conjunction with membrane air seal/vapour barrier around frames including metal and aluminum frames or protrusions, ensure that foamed-in-place insulation is installed on exterior side of membrane air seal/vapour barrier.
- .2 Finished surface: free of voids and imbedded objects.
- .3 Apply materials in accordance with manufacturer's written instructions.
- .4 Apply primer when required to properly prepared substrates for special conditions required by foam insulation manufacturer's requirements.

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

- .1 Apply by spray method to uniform monolithic density without voids.
- .2 Install spray-foam insulation around protrusions including mechanical and electrical protrusions, electrical chases, exhaust systems, heating and cooling ducts, sole plates, top plates, wall sections, and elsewhere as required to achieve and maintain continuity of thermal barrier around such protrusions.
- .3 Conduct daily visual inspection, adhesion testing and density measurements as required by CAN/ULC S705.2 and manufacturer's application guidelines.

- .4 Spray apply cementitious thermal barrier coating over foam insulation to minimum 21 mm thickness where foam insulation exposed to building interior.

### **3.5 INSTALLATION AROUND CURTAIN WALL AND ENTRANCE FRAMING**

- .1 Install spray foam sealant around curtain wall frames, and entrance frames to maintain continuity of thermal barrier, after air/vapour barrier has been installed and sealed to framing as specified in Sections 07 27 10, 08 11 00, 08 41 26 and 08 44 00.
- .2 Ensure that spray foam sealant completely fills spaces, without voids, and that foam is continuous at corners.
- .3 Provide thermal barrier to interior spaces as indicated and required by OBC.

### **3.6 CLEAN-UP**

- .1 Remove masking materials and overspray from adjacent areas immediately after foam surface has hardened.
- .2 Repair damaged areas in accordance with manufacturer's instructions.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED SECTIONS**

- .1    Board Insulation: Section 07 21 13

**1.2            SECTION INCLUDES**

- .1    Materials and installation methods providing primary air vapour barrier materials and assemblies.
- .2    Air/vapour barrier materials to provide continuous seal between components of building envelope and building penetrations.

**1.3            REFERENCES**

- .1    Canadian General Standards Board (CGSB)
  - .1    CAN/CGSB-51-33 Water Vapour Permeance.
  - .2    CAN/CGSB-19.13M-M87, Sealing Compound, One Component, Elastomeric Chemical Curing.
  - .3    CAN/CGSB-19.24M-M90, Multi-Component, Chemical Curing Sealing Compound.
- .2    NBCC 1995; Part 5 - Environmental Separation
- .3    Sealant and Waterproofer's Institute - Sealant and Caulking Guide Specification.
- .4    SCAQMD Rule#1168 South Coast Air Quality Management District.
- .5    SCAQMD Rule #1113 South Coast Air Quality Management District.
- .6    GS-11 Green Seal Environmental Standard - Paints.
- .7    GS-03 Green Seal Environmental Standard - Anti-Corrosive Paints.

**1.4            SUBMITTALS**

- .1    Submit shop drawings in accordance with Section 01 33 00 - Submittals.
  - .1    Provide drawings of special joint conditions.
- .2    Submit manufacturer's product data sheets in accordance with Section 01 33 00 - Submittals.
- .3    Submit manufacturer's installation instructions in accordance with Section 01 33 00 - Submittals.

**1.5            QUALITY ASSURANCE**

- .1    Perform Work in accordance with Sealant and Waterproofer's Institute - Sealant and Caulking Guide Specification requirements for materials and installation.
  - .2    Perform Work in accordance with National Air Barrier Association - Professional Contractor Quality Assurance Program and requirements for materials and installation.
  - .3    Maintain one copy of documents on site.
-

## 1.6 QUALIFICATIONS

- .1 Applicator: Company specializing in performing work of this section with minimum 5 years documented experience with installation of air/vapour barrier systems. Completed installation must be approved by the material manufacturer.
- .2 Applicator: Company who is currently licensed by National Air Barrier Association must maintain their license throughout the duration of the project.

## 1.7 PRE-INSTALLATION MEETINGS

- .1 Convene one week prior to commencing Work of this section.

## 1.8 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Avoid spillage. Immediately notify the Consultant if spillage occurs and start clean up procedures.
- .3 Clean spills and leave area as it was prior to spill.

## 1.9 PROJECT ENVIRONMENTAL REQUIREMENTS

- .1 Maintain temperature and humidity recommended by materials manufactures before, during and after installation.

## 1.10 SEQUENCING

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

## Part 2 Products

### 2.1 AIR/VAPOUR BARRIER, AIR BARRIER, PRIMERS & ACESSORIES

- .1 Cold Applied Membrane: to CAN/CGSB-53-3 3, self-adhering membrane consisting of an SBS rubberized asphalt compound integrally laminated to thermoplastic film, min. 1.0mm (40mils) **"Blueskin SA" by Henry Bakor.**
- .2 Primary Sheet-Applied, Vapor Permeable Water Resistive Air Barrier (Basis of Design): Self-adhered vapor permeable, water resistive air barrier consisting of a reinforced, modified polyolefin tri-laminate film surface and patented permeable adhesive technology with split-back poly-release film; having the following typical physical properties: Thickness of 19 mils (0.48 mm), Water Vapor Permeance (ASTM E96), 33 perms, Air Permeance (ASTM E2178), Nail Sealability (ASTM D1970), Surface Burning Characteristics (ASTM E84), Flame Spread Class A, Smoke Development Class A, Low Application Temperature 40 degrees F (5 degrees C). Basis of design: **Henry® Blueskin® VP100 Self-Adhered Water Resistive Air Barrier.** Provide Henry Bakor adhesive/primer compatible with VP100 Air barrier.
- .3 Thru-Wall Flashing: cold Applied Membrane to CAN/CGSB-53-33, self-adhering membrane consisting of an SBS rubberized asphalt compound integrally laminated to a cross-laminated polyethylene film, min. 1.0mm 40mils), "yellow" in color **"Blueskin TWF by Henry Bakor.** Thru-wall flashing product by Soprema, W.R. Meadows, IKO, Grace is

an approved alternate on the proviso that it meets the specification in all aspects.

- .4 Primer: type recommended by air/vapour barrier manufacturer for type of substrate used.
- .5 Tapes for joint sealing of sheathing: type as recommended by air/vapour barrier manufacturer.
- .6 The VOC content of adhesives and sealants used in the interior of the building envelope must be less than the VOC content limits of SCAQMD Rule#1168.
  - .1 Contractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in litres) of each materials used should also be provided.
- .7 The VOC content of paints and coatings used in the interior of the building envelope must be less than the VOC content limits of GS-11 and GS-03 respectively. The VOC content of interior paints and coatings not already covered by GS-11 and GS-03 must be less than the VOC content limits of SCAQMD Rule#1113.
  - .1 Contractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in litres) of each materials used should also be provided.

### **Part 3 Execution**

#### **3.1 EXAMINATION**

- .1 Verify that surfaces and conditions are ready to accept the Work of this section.
- .2 Ensure all surfaces are clean, dry, sound, smooth, continuous and comply with air barrier manufacturer's requirements.
- .3 Report any unsatisfactory conditions to the Consultant in writing.
- .4 Do not start work until deficiencies have been corrected. Commencement of work implies acceptance of conditions.

#### **3.2 PREPARATION**

- .1 Remove loose or foreign matter which might impair adhesion of materials.
- .2 Ensure all substrates are clean of oil or excess dust; all masonry joints struck flush, and open joints filled; and all concrete surfaces free of large voids, spalled areas or sharp protrusions.
- .3 Ensure all substrates are free of surface moisture prior to application of membrane and primer.
- .4 Ensure metal closures are free of sharp edges and burrs.
- .5 Prime substrate surfaces to receive air/vapour barrier and/or air barrier in accordance with manufacturer's instructions.
- .6 Tape all joints of gypsum sheathing to air/vapour barrier and/or air barrier manufacturers printed instructions.

### **3.3            INSTALLATION**

- .1        Install materials in accordance with manufacturer's instructions. Caulk with sealant to ensure complete seal.
- .2        Place liquid seal onto roof vapour retarder and seal with sealant. Caulk to ensure complete air seal. Position lap seal over firm bearing.
- .3        Install seal between window and door frames and adjacent wall seal materials with sealant. Caulk to ensure complete seal. Position lap seal over firm bearing.
- .4        Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

### **3.4            PROTECTION OF WORK**

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

**END OF SECTION**

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## Part 1 General

## 1.1 RELATED SECTIONS

- |    |                                |                  |
|----|--------------------------------|------------------|
| .1 | Submittals:                    | Section 01 33 00 |
| .2 | Sheet Metal Flashing and Trim: | Section 07 62 00 |

## 1.2 REFERENCES

- .1 American National Standards Institute (ANSI).
  - .1 ANSI B18.6.4-99, Thread Forming and Thread Cutting Tapping Screws and Metallic Drive Screws.
- .2 American Society for Testing and Materials International, (ASTM).
  - .1 ASTM A653/A653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanized) by the Hot Dip Process.
  - .2 ASTM D 2832-92(R1999), Guide for Determining Volatile and Nonvolatile Content of Paint and Related Coatings.
- .3 Environmental Choice Program (ECP).
  - .1 CCD-045-95, Sealants and Caulking Compounds.
- .4 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-51.32-M77, Sheathing, Membrane, Breather Type.
- .5 SCAQMD Rule#1168 South Coast Air Quality Management District.
- .6 CSA B111-1974 Wire Nails, Spikes and Staples.

### 1.3 SUBMITTALS

- .1 Product data: submit manufacturer's printed product literature, specifications and data sheet in accordance with Section 01 33 00 - Submittals.
  - .1 Submit two copies of WHMIS MSDS - Material Safety Data Sheets. Indicate VOC's for caulking materials during application and curing.
- .2 Shop Drawings:
  - .1 Submit shop drawings in accordance with Section 01 33 00 - Submittals.
  - .2 Indicate dimensions, profiles, attachment methods, schedule of wall elevations, trim and closure pieces, Z bars, insulation and related work.
  - .3 The VOC content of adhesives and sealants used in the interior of the building envelope must be less than the VOC content limits of SCAQMD Rule#1168.
    - .1 Contractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in litres) of each materials used should also be provided.
- .3 Samples:
  - .1 Submit samples in accordance with Section 01 33 00 - Submittals.
  - .2 Submit duplicate 100 x 100 mm samples of siding material, of colour and profile specified.
- .4 Manufacturer's Instructions:

- .1 Submit manufacturer's installation instructions.

#### **1.4 DESIGN CRITERIA**

- .1 Design preformed metal panel wall to provide for thermal movement of component materials without causing buckling, failure of joint seals, undue stress on fasteners or other detrimental effects.
- .2 Design wall system to accommodate, by means of expansion joints, any movement in wall and between wall and building structure, caused by structural movements without permanent distortion, damage to infills, racking of joints, breakage of seals, or water penetration.
- .3 Design members to withstand dead load and wind loads as calculated in accordance with NBC 2005 and applicable municipal regulations, to maximum allowable deflection of 1/180 of span.
- .4 Provide for positive drainage of condensation occurring within wall construction and water entering at joints, to exterior face of wall in accordance with NRC "Rain Screen Principles".

#### **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.
- .3 Pre-Installation Meetings: conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements.

### **Part 2 Products**

#### **2.1 STEEL CLADDING AND COMPONENTS**

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

#### **2.2 PREFINISHED COATING**

- .1 Prefinished factory applied coating:  
.1 Weather 'XL' Standard Color range.

#### **2.3 FASTENERS**

- .1 Nails: CSA B111. Screws: ANSI B18.6.4. Purpose made cadmium plated steel.

#### **2.4 ACCESSORIES**

- .1 Insulation: poly-isocyanurate insulation, foil faced. Refer to drawings for size.
- .2 Insulation adhesive: purpose made for insulation type and zinc coated sheet metal non-combustible after curing.



- .3 Sealant: Polysulphide, one part, non-sag to CAN/CGSB - 19.3, MC-2-40-B-4, colour to match siding.
- .4 The VOC content of adhesives and sealants used in the interior of the building envelope must be less than the VOC content limits of SCAQMD Rule#1168.
  - .1 Contractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in litres) of each materials used should also be provided.

## **2.5 FABRICATION**

- .1 Exterior panel: Thicknesses (26 ga.) factory preformed coated metal. Panel length as indicated on elevations and section drawings. Colors to be as indicated in 2.2.1.1 above.
  - .1 Ideal Roofing Inc. profile "Industrial Metro" in thicknesses as per 2.5.1 in factory preformed colors. VicWest Inc. and Agway Metals Inc. are approved equivalent.
- .2 Exposed trim: inside corners, outside corners, cap strip, drip cap, undersill trim, starter strip and window/door trim of same material, colour and gloss as cladding, with fastener holes pre-punched.
- .3 Z-bars: 0.72 mm hot dip galvanized sheet steel for structural attachment to building frame.

## **Part 3 Execution**

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

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

### **3.2 INSTALLATION**

- .1 Install metal siding assembly in accordance with reviewed shop drawing and manufacturer's written instructions.
- .2 Install "Z" bar girts to structural wall supports, using self tapping screws. Interlock and seal side and end joints.
- .3 Install continuous starter strips, inside and outside corners, edgings, soffit, drip, cap, sill and door opening flashings as indicated.
- .4 Install insulation using adhesive to ensure continuous thermal barrier in conjunction with air/vapour barrier formed by liner sheet.
- .5 Install exterior panels to "Z" bars. Install and secure all Z-bar framing as required. Fasten cladding to Z-bar framing material as required. Z-bar to be secured to substrate with fasteners designed for specific application
- .6 Maintain joints in exterior cladding, true to line, tight fitting, hairline joints.

- .7 Attach components in manner not restricting thermal movement.
- .8 Caulk junctions with adjoining work with sealant. Do work in accordance with Section 07 92 10 - Joint Sealing.
- .9 Exposed raw/cut edges along the new cladding panels are not acceptable. All raw/cut edges to be fully concealed by overlapping factory finished panel, trim, flashing, pre-fabricated detail, etc.
- .10 Cutting of cladding panels must be completed in a manner that does not damage the panel or paint finish in any location.

### **3.3 CLEANING**

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

**END OF SECTION**

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## **PART 1 – GENERAL**

### **1.1**

#### **Related Sections**

- .1 General Instructions – Section 01 11 13
- .2 Safety Requirements – Section 01 35 30
- .3 Rough Carpentry – Section 06 08 99
- .5 Sheet Metal Flashings and Trim – Section 07 62 00
- .7 Mechanical General Requirements – Section 20 05 01
- .8 Electrical Requirements – Section 26 05 00

### **1.2**

#### **General**

- .1 Provide the necessary labour and materials to perform roofing and patching where mechanical/electrical equipment or components are removed of the existing roofing system, sheet metal flashings, wood blocking insulation and vapour barrier down to the structural deck.
  - .3 Provide the necessary labour and materials to allow for all modifications to the electrical services, mechanical equipment, and natural gas piping system required to complete the project, as per Mechanical and Electrical Specifications.
  - .4 Summary of the Work: General description of work (applies to contract area only, including specific locations of items listed below, as indicated on roof plan drawings):
    - .1 Remove existing remaining curbs system c/w all its associates components to roof deck.
    - .2 Complete and patch roof areas affected by the mechanical removals to match existing roofing system.
    - .2 Dispose of all roofing debris.
    - .3 Provide wood blocking for curbs, parapets and walls.
    - .4 Provide new roof assembly and related metal flashing.
    - .5 Return the site to its original state prior to construction.
  - .6 Refer to “General Instructions” specification for all pertinent information regarding codes and standards including the scheduling and contractor’s use of site.
  - .7 Roofing Contractor to provide written guarantee on company letterhead, ensuring the project will commence as per specified contractual start of work time and continue in an uninterrupted, manner until completion.
  - .8 Contractors will be required to fill out and submit “Hot Work Permit” provided by the Board.
  - .9 Provide a competent supervisor to oversee all work and act as the Contractor’s representative unless otherwise designated.
  - .10 Employ only experienced and qualified workers and ensure that workmanship conforms to the best standard practices, in strict conformance with the manufacturer’s instructions. Replace all work that results from inferior products and/or workmanship.
  - .11 The Roofing Contractor is responsible to co-ordinate the work of all trades as to expedite the project in a timely manner in accordance with the agreed upon work
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- schedule and in a manner that will not compromise the integrity of the building envelope and building interior.
- .12 Address to Consultant all questions on work. Consultant will transmit written instructions through General Contractor.
- .13 Immediately notify Consultant if required work is such as to make it impractical to produce required results.
- .14 Decision as to quality of fitness of workmanship in cases of dispute rest solely with consultant, whose decision is final.
- .15 Co-ordinate all trades to provide smooth, conflict free, flow of work.
- .16 The Roofing Contractor shall have a competent person on duty at all times for emergency calls after construction hours and during weekends. It shall be the Contractor's responsibility to supply the Board's Representative and Consultant with the name and telephone number of the person to be contacted during these periods.
- .17 Proposed extras for discrepancies between provided roof plans and detail locations and actual site conditions will not be considered.
- .18 The Roofing Contractor shall be responsible for the correction of all deficiencies and damages incurred during the project. The Roofing Contractor shall take photographs of or video the site prior to start of work and provide one copy to the Consultant.
- .19 Due to the nature of the site and occupancy of the building and grounds, the Board's Representative shall designate an area for storage and set-up prior to commencement of work. The Contractor shall strictly observe these boundaries at all times throughout the project.
- .20 Absolutely NO changes or alterations to the materials, directions or procedures within the specification sections and or drawings are permitted without written permission from the project Consultant. Failure to comply will result in a written direction to remove all works applied and re-construct as per the tender documents at the Contractor's own expense.
- .21 Do not employ powder, activated guns using explosives unless expressly permitted by the Consultant. If permitted, comply with requirements to CAN3-Z166-M85 (Safety Code Explosive Actuated Tools).
- .22 Except if expressly stated otherwise, materials indicated for removal, become the Contractor's property and shall be promptly taken from site.
- .23 Any demolition performed while building is occupied will require co-ordination between the contractor and the occupant to ensure area immediately below demolition work is kept unoccupied.
- .24 If the contractor would like to complete test cuts, they are to arrange for site access with the UCDSB project manager. These test cuts must be completed
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prior to the question deadline date identified in the tender documents at the Contractor's own expense.

**1.3** .1  
**Roof Assembly**

Supply all labour and materials necessary to complete the new Modified Bitumen Membrane Roofing, in the areas where mechanical equipment will be removed.

**New Typical Roof Assembly for Roof Areas:**

**-1-Ply Modified Bitumen Granulated Cap Sheet Membrane**

**-1-Ply Modified Bitumen Base Sheet Membrane**

**-6mm (1/4") Asphaltic Protection Board**

**2% Tapered polyiso rigid insulation**

**-75mm (3") Rigid Secondary Insulation**

**-75mm (3") Rigid Base Insulation**

**-Vapour Barrier**

**-3mm (1/8") Asphaltic Protection Board**

**-Concrete or metal deck**

**1.4** .1  
**Roof Assembly**  
**Flashing**

Supply all labour and materials necessary to complete the new Modified Bitumen Membrane Roof Flashing, as specified and detailed, in the areas as indicated on the drawings.

**1.5** .1  
**Precautions**

Roofing shall not be carried out when materials are damp and base sheet shall not be applied when ambient temperature is less than minus ten (-10) degrees Celsius. (Postpone roofing work when inclement weather appears imminent).

- .2 Fasteners/Adhesives for each component of the roof assembly (deck sheathing, insulation, sloped insulation, overlay board, roofing membranes): as recommended by roofing system manufacturer to suit concrete or metal deck as applicable, and as required to meet CSA A123.21 wind uplift criteria. Contractor to provide all wind uplift information as per the manufacturer's specifications and project specific standards/requirements.
  - .3 Apply each part of roofing system only when surfaces are clean and dry.
  - .4 Conduct, operations so as to leave deck exposed for minimum period of time. Protect, as required, to prevent water infiltration or environmental damage to building interior. At no time shall the deck be left exposed overnight.
  - .5 Insulation shall not be left exposed to the elements no shall more be laid than can be completely covered in the same day.
  - .6 Provide temporary membrane to render all insulation watertight if for some unforeseen reason work cannot be completed as specified. Remove temporary membrane completely prior to any further roofing operations.
  - .7 Where work must continue over finished roofing membrane, protect
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surface with minimum 13mm thick plywood sheets.

- .8 Strictly adhere to all safety guidelines for the torching of Modified Bituminous Membrane.
- .9 Any sharp projections, that in the opinion of the Consultant may penetrate the vapour barrier, shall be grounded smooth and flush.
- .10 All aspects of the re-roofing operation shall follow in close sequence. No part of the operation shall be so far ahead of the succeeding part that the latter cannot be finished that working day.
- .11 Contractor shall verify that the existing slope and/or added slope will permit the total drainage of water. If in the opinion of the contractor there is a possibility of water ponding, he shall advise the consultant so the situation can be addressed and corrected.

#### **1.6 Warranty**

- .1 Remedy all defects in the Modified Bituminous Membrane Roofing and Membrane Flashings installed hereunder which appear within a period of **Five (5) years** from date of final completion. In addition, submit Membrane Manufacturer's **15-Year Full System Warranty (No Dollar Limit)** upon completion of project.
- .2 Make all necessary repairs and replacements with **48 hours** of receipt of written notification. Provide a written warranty confirming above, issued on the corporate letterhead, signed and sealed by an authorized signing officer.
- .3 Nothing contained in this article shall be construed as in any way restricting or limiting the liability in common law and statutory liability of the Contractor.

### **PART 2 – PRODUCTS**

#### **2.1 Substrate Overlay**

- .1 **Glass Mat Gypsum Roof Board:** Pre-primed with fibreglass mats front & back mechanically bonded to a high-density gypsum core. Boards to be 1.2 m x 2.4 m, 16 mm (5/8") as indicated with pre-primed surface. Standard of acceptance: **Dens Deck Prime Roof Board or approved equivalent**

#### **2.2 Adhesive**

- .1 **Adhesive:** low-rise, 2-component, polyurethane adhesive. Used for securing roof board to structural deck, insulation to vapour retarder, protection board to insulation. Standard of acceptance: **Duotack by Soprema or approved equivalent**. Strictly follow minimum temperature application as per the manufacturer's guidelines. **Note: All adhesive must be applied by an approved manufacturer's applicator.**

#### **2.3 Bitumen & Primers**

- .2 **Self-Adhesive Membrane Primer:** composed of SBS synthetic rubbers, adhesive enhancing resins and volatile solvents designed for use with self-adhesive waterproofing membranes on most substrates. Standard of Acceptance: **Elastocol Stick by Soprema or approved equivalent**.
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- .3 **Black Bituminous Primer:** to be composed of asphalt modified bitumen with thermoplastic polymers and volatile solvents. Standard of Acceptance: **Elastocol 500 by Soprema or approved equivalent.**
- .4 **Roofing Cement:** with water displacing characteristics, to ensure an effective bond to both wet and dry surfaces. The ability to adhere during inclement weather conditions. Composed of selected asphalts, mineral fillers combined with refined solvent, and special chemical ingredients to create a water displacement quality. Standard of Acceptance: **Karnak Amphibikote 155 (wet and dry) or approved equivalent**

#### **2.4** **Vapour Barrier** **Membranes**

- .1 **Parapet, Curbs and Walls:** Modified bitumen membrane with a minimum 100gram/m<sup>2</sup> non-woven polyester reinforcement and a minimum thickness of 2.5mm. Under face to be self-adhesive and covered by a removable silicone release film. Top face to be covered by a thin poly-film. Membrane to satisfy CGSB 37-GP-56M requirements. Standard of Acceptance: **Soprseal Stick 1100T by Soprema or approved equivalent.**
- .2 **Underneath Parapets, Curbs and Walls:** composed of SBS modified bitumen reinforced with composite reinforcement. The surface is sanded. The underface, self-adhesive, is covered with a release protection film. Standard of Acceptance: **Sopralene Stick HR 20 by Soprema or approved equivalent**
- .3 **Roof Field:** membrane composed of a non-woven polyester reinforcement and SBS modified bitumen. Membrane to be a minimum of 3.5mm thick. Standard of Acceptance: **Sopralene 180 SP 3.5 by Soprema or approved equivalent**

#### **2.5 Rigid Insulation**

- .1 **Polyisocyanurate Insulation: (thicknesses as indicated)** closed cell polyisocyanurate foam bonded on top and bottom sides to an organic/inorganic facer. Board size not to exceed 1200mm x 1200mm. Insulation to meet CAN/CGSB 51.26-M and CAN/ULC-S704. Standard of Acceptance: **Sopra-Iso by Soprema or approved equivalent**

#### **2.6 Tapered Insulation (where required)**

- .1 **Tapered Polyisocyanurate (2% as indicated):** tapered insulation system manufactured from Polyisocyanurate only. Modules shall be factory cut to correct slopes and clearly marked to match provided shop drawings. All valley corners and crickets shall be factory mitred. Slope to meet designer's requirements and approval. **Slopes to be 4-way directional to all roof drain locations and all panels must be a minimum 38mm (1.5") thickness to meet each sump as indicated.** Shop drawings indicating layout, thicknesses and type of material to be submitted for approval prior to ordering materials. Tapered insulation package must cover the entire roof surface as indicated. **Tapered insulation package must be designed to slope upwards beginning at each roof drain location and be continuous to the roof area(s) perimeters, with no flat areas, no breaks, no interruptions or no base or secondary insulation layer reductions. The tapered insulation MUST commence above the base or secondary insulation layer(s) (as indicated) at all locations. Flat areas or reduction/removal of base or secondary layer to accommodate tapered**

**insulation will NOT be accepted.** Standard of Acceptance: **Posi-Slope or approved equivalent.**

- .1 Submit the manufacturer's latest specifications including compliance data. **Only manufacturer's data sheets will be acceptable.**
- .2 **Roof Drain Sumps (as indicated):** Manufactured from polyisocyanurate. Modules shall be factory cut/mitred to correct slopes and clearly marked. All roof drains must be sumped a maximum 1.2 m x 1.2 m (4'x4'), with a minimum 2% slope to drain. All sumps to be a minimum of 13mm (0.5") thick
- .3 Insulation slopes and thickness shall be as indicated on the detailed drawings and roof plan and shall be a distinct separate layer with joints staggered over the base insulation. Ensure sump drops in elevation minimum 16mm. Chamfer sump edges to receive protection board.
- .4 Modules shall be factory cut to correct slopes and clearly marked to match provided shop drawings.
- .5 **All valley corners and crickets shall be factory mitred.**

**2.7 Batt/  
Blanket  
Insulation**

- .1 **Batt/Blanket Insulation:** semi-rigid stone wool batt insulation for exterior wood and steel stud applications. To be non-combustible and fire resistant. Standard of Acceptance: **Comfortbatt by Rockwool or approved equivalent**

**2.8  
Insulation  
Overlay**

- .1 **Protection Board:** (as indicated) 3mm (1/8") & 6mm (1/4") thick asphaltic roofing board composed of a mineral fortified asphaltic core between 2 asphaltic saturated fibreglass liners. Board size to be 1220mm x 1520mm. Standard of Acceptance: **Sopraboard by Soprema or approved equivalent**

**2.9  
Modified  
Bitumen  
Membrane**

- .1 Two (2)-ply system made from prefabricated modified bitumen membranes containing minimum 15% of elastomer Styrene Butadiene Styrene (SBS) and reinforced with non-flammable, fireproof and stress resistant insert of glass fibre or polyester.
- .1 **Membrane Base Ply:** SBS—modified bitumen sheet, to CGSB 37-GP-56M Type 2, Class C, Grade 2, supplied in Rolls 1 m wide, for torch installation and to be torched over, Minimum 3.0 mm thick, minimum 180 g/m<sup>2</sup> non-woven Polyester reinforcement. Standard of Acceptance: **Sopralene Flam 180 by Soprema or approved equivalent**
- .2 **Membrane Cap Ply:** SBS-modified bitumen sheet, supplied in rolls 1 m wide, for torch installation, with granule surfacing minimum 3.8 mm thick, minimum 250 g/m<sup>2</sup> non-woven polyester reinforcement, meeting CGSB 37-GP-56-M classification Type 1, Class A, Grade 2. Standard of Acceptance: **Sopralene Flam 250 GR by Soprema or approved equivalent**



- .3 **Membrane Base Flashings:** SBS-modified bitumen sheet, supplied in rolls 1 m wide, for self-adhesive installation and to be torched over, minimum 2.5 mm thick, minimum 130 g/m<sup>2</sup> glass reinforcement. Standard of Acceptance: **Sopraflash Flam Stick by Soprema or approved equivalent.**
- .4 **Membrane Cap Flashings:** SBS-modified bitumen sheet, supplied in rolls 1 m wide, for torch installation and to be torched over, with granule surfacing, minimum 3.8 mm thick, minimum 250 g/m<sup>2</sup> non-woven polyester reinforcement, meeting CGSB 37-GP-56-M classification Type 1, Class A, Grade 2. Standard of Acceptance: **Sopralene Flam 250 GR by Soprema or approved equivalent.**
- .5 **Membrane Reinforcing Ply/Strip:** SBS—modified bitumen sheet, to CGSB 37-GP-56M Type 2, Class C, Grade 2, supplied in Rolls 1 m wide, for torch installation and to be torched over, Minimum 3.0 mm thick, minimum 180 g/m<sup>2</sup> non-woven Polyester reinforcement. Standard of Acceptance: **Sopralene Flam 180 by Soprema or approved equivalent**
- .6 **Sacrificial Membrane** SBS-modified bitumen sheet, supplied in rolls 1 m wide, for torch installation, with granule surfacing minimum 3.8 mm thick, minimum 250 g/m<sup>2</sup> non-woven polyester reinforcement, meeting CGSB 37-GP-56-M classification Type 1, Class A, Grade 2. Standard of Acceptance: **Sopralene Flam 250 GR by Soprema or approved equivalent**
- .7 **Protective (Walkway) Membrane (TBD):** modified bitumen membrane with a non-woven polyester reinforcement a minimum thickness of 5mm. Under face to be covered by a thin poly-film for torch application. Top face to be embedded with ceramic mineral granules. Membrane to satisfy CGSB 37-GP-56M requirements. Colour of granules to be selected by Owner/Consultant and different from cap sheet. Standard of Acceptance: **Soprawalk by Soprema or approved equivalent**

- .2 Low temperature Requirements  
Grade 2 material to pass low temperature requirements at -30°C to CGSB 37-GP-56M.

- .3 Test Results  
Test results from a certified independent laboratory showing conformance to above requirements shall be submitted with tender documents or within 48 hours of tender closing, **if requested.**

- .4 Standard of Acceptance  
S.B.S. Modified Bitumen Membranes as manufactured by the following:  
Soprema, Henry and IKO

## **2.10** **Roof System**

- 1. **Roofing Nails:** to CSA B111, Table 12, of electrogalvanized steel, sufficient length to penetrate wood substrate at least 25mm

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**Accessories**

Nails to have a minimum head diameter of 25mm. Standard of Acceptance: **Electrogalvanized Bulk Roofing Nails by Canada Fine Parts & Supplies or equivalent**

- .2 **Round Top Cap Nails:** In compliance with CSA B-III1979 standard, table 12, nails shall be made of galvanized steel, long enough to penetrate the wood blocking by a minimum 25 mm (1") depth on flashings and parapet walls. **45 mm (1-3/4") Electrogalvanized Bulk Metal Cap Hand Nails by Canada Fine Parts & Supplies or approved equivalent**
- .3 **Deck Sheathing/Base Flashing Fasteners:** Hardened carbon steel # 12 Phillips head fasteners with anticorrosion coating. 3" membrane stress plates manufactured from heavy gauge galvalume with special barbs and ribs. Standard of Acceptance: **Dekfast Pre-Assembled Screws & Plates by SFS Intec or approved equivalent.**

**NOTE:** In locations where the substrate causes interference with the above noted fasteners, Contractor is responsible to supply and install the appropriate length and diameter of fastener to properly support and secure the stress plate and underlying membrane.

- .4 **Bird Screen (Gooseneck Vents):** 20mm x 20mm galvanized wire mesh.
- .5 **Liquid Membrane Flashing:** one-component polyurethane and bitumen liquid membrane, and a flexible 100g/m<sup>2</sup> woven polyester membrane. Standard of Acceptance: **Alsan Flashing & 6" Reinforcement Mesh by Soprema or approved equivalent**
- .6 **Pre-Cast Concrete Paver:** to CSA A231.1, exposed aggregate surface, 600mm x 600mm (24" x 24") size 50mm (2") thick. Colour and finish to be approved by Owner.
- .7 **Rigid Separation Insulation – Where required as per site conditions:** to be extruded foamed polystyrene conforming to CAN/CGSB 51.20-M TYPE 4 AND CAN/ULC-S701. Thickness to be 25mm min. Standard of Acceptance: **Roofmate by Dow or approved equivalent.**
- .8 **Vent Stack Flashings:** 1-piece aluminum construction with flashing sleeve and integral flange, matching aluminum hood and perforated collar, pre-molded urethane insulation liner and EPDM base seal. Standard of Acceptance: **SJ-31 Vandal Proof Stack Jack Flashing by Thaler Roofing Specialties or approved equivalent. Extend vent pipe as required. Extend vent pipe from below deck if required to match height of new flashing**
- .9 **Loose Granules:** composition and colour to match granule surface of roofing membranes. Granules to be embedded into heated asphalt surfaces at joints between rolls or at any other locations where the bitumen bleed-out exceeds the manufacturer's recommendations. Standard of Acceptance: **Granules by Soprema or equivalent.**
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- .10 **Protection Mats:** 19 mm x 1.22m x 1.8 m rubber matting manufactured from recycled materials. Standard of acceptance: **Sopramat by Soprema or equivalent.**
- .11 **Flame Guard Tape:** composed of SBS modified bitumen and a glass mat reinforcement with a sanded surface and self-adhesive underface with a silicone release film. A minimum width of 150 mm for installation at protection boards and vertical transitions. Standard of Acceptance: **Sopraguard Tape by Soprema or approved equivalent.**
- .12 **Overlayment Tape (Substrate Overlay Joints):** composed of a proprietary formulation of elastomeric styrene-butadiene-styrene (SBS) polymer modified bitumen and reinforced with tough, dimensionally stable composite polyester/glass fiber reinforcement. Topside is surfaced with fine mineral aggregate and the underside is surfaced with protective polyolefin release film. Standard of Acceptance: **Sopralap Stick by Soprema or approved equivalent**
- .13 **Misc. Accessory Flashing:** precast blocks made of polyester resin Standard of Acceptance: **Sopramastic Blocks by Soprema or approved equivalent**
- .14 **Accessory Flashing Filler:** is a polyether-based resin, single-component, moisture cure elastomer sealing mastic. Odourless and to have low VOC content. Standard of Acceptance: **Sopramastic PF by Soprema or approved equivalent**
- .15 **Accessory Adhesive:** polyether-based resin, single-component, moisture cure elastomer sealing mastic and adhesive with low VOC content. Standard of Acceptance: **Sopramastic SP2 by Soprema or approved equivalent**
- .16 **Mastic:** solvent-based mastic containing SBS modified bitumen, fibres and mineral fillers. **Sopramastic by Soprema or equivalent**
- .1 **Mechanical Flashings:** Pre-fabricated galvanized steel B-Vents c/w storm collar, height to suit detail (minimum 14" tall), all joints solder welded.
- .18 **Free Standing Supports:** engineered prefabricated support made of high-density polypropylene plastics with UV Protection. HDG structural steel frame, rollers and hardware. Support to be appropriately sized to support item (i.e. gas, electrical, refrigeration). Standard of Acceptance: **PP-10 w/ Roller, PP-10 with Chanel, RB-18 or other by Portable Pipe Hangers only**

## **PART 3 – EXECUTION**

### **3.1 Surface Inspection and Preparation**

- .1 After removal of the existing roof system assemblies and before commencing the work of this section, conduct an inspection of the entire substrate with the Consultant and the Roofing Contractor to approve the condition of the substrate. Ensure that the deck and all parts of the structure that are to be covered with roofing membrane possess a smooth surface with an even finish, free of excessive moisture, ridges, hollows and sharp corners. **Obtain letter from roof material manufacturer's accepting substrate.** Before commencing works, ensure that all surfaces are smooth, dry,

clean and free of ice and debris. The deck must be free of contamination by materials which could affect the adhesion of the roofing or the physical integrity of the membrane itself.

No salt or calcium shall be used to remove ice or snow

- .2 Where steel decking is found to have surface rust, the Contractor shall wire brush the affected area(s) down to clean steel and check for penetration strength. If found satisfactory, apply two (2) coats of zinc coating to the affected area(s). Allow paint to fully dry prior to installation of specified components. Standard of Acceptance: **Ameron's Amercoat 160A or approved equivalent**
- .3 Ensure that the work has been properly completed, that there is a proper slope as indicated, with minimal ponding that may occur.
- .4 Commencement of roofing installation shall be construed as acceptance of the substrate, and thereafter the Contractor shall be fully responsible for satisfactory work as required herein.

### **3.2 Installation**

- .1 Do not install materials under conditions of rain, snow or fog.
- .2 Install roofing elements on clean and dry surfaces, in accordance with the manufacturer's requirements and recommendations.
- .3 Perform work on a continuous basis as surface and weather conditions allow.
- .4 Protect adjoining surfaces against any damage that could result from roofing installation.

### **3.3 Equipment**

- .1 Maintain all equipment and tools in good working order.
- .2 Use torch types recommended by the membrane manufacturer.

### **3.4 Protection**

- .1 **Cover walls and 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.
  - .4 Dispose of rain water off roof and away from face of building until roof drains or hoppers installed and connected.
  - .5 Do not permit traffic across finished roof area unless protected by catwalks, prevent traffic over above roof level. Comply with precautions deemed necessary by the Consultant. Repair damage caused by non-compliance with Consultants requirements.
  - .6 Where work must continue over finished roofing membrane,
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protect the surface with minimum 1/2" thick plywood sheets.

- .7 At end of each day's work or when stoppage occurs due to inclement weather, provide protection for completed and incomplete work.
- .8 Install water cut-offs at the end of a day's work, remove same prior to continuing roof application.

### **3.5 Substrate Overlay**

- .1 Inspect the underside of the deck to ensure fasteners will not be visible, damage the structure or interior surfaces, affect electrical or mechanical services. Fasteners to penetrate the deck a maximum 20 mm.
  - .2 Advise Consultant of any unusual circumstances affecting the work. Be responsible and correct all damage caused by work to match existing materials and finish.
  - .3 **Wood Deck Surfaces:**
    - .1 Install 16mm (5/8") gypsum sheathing over wood decks, as indicated herein. Install gypsum sheathing boards with long side perpendicular to wood deck sheathing. Stagger joints in boards.
    - .2 Apply manufacturer approved primer (Elastocol Stick) along all locations to receive overlayment tape.
    - .3 Install overlayment tape (Sopralap Stick) over all joints, leading edges, perimeters, penetrations, parapets, etc. in gypsum sheathing covering the roof decks. Contractor must ensure all locations are fully protected and sealed from flame spread and flame penetration prior to vapour barrier application.
  - .4 **Steel Deck Surfaces:**
    - .1 Install 16mm (5/8") gypsum sheathing over steel decks, as indicated herein. Install gypsum sheathing boards with long side perpendicular to flutes of deck. Stagger joints in boards. Terminate ends of boards on top of the flutes.
    - .5 Mechanically fasten each board to the roof deck as required by roofing system manufacturer to meet all current wind uplift criteria. Secure gypsum sheathing to both steel and wood decks with screws located and spaced in a pattern to meet manufacturer wind uplift criteria. Use screw-type anti-backout corrosion resistant fasteners with metal plates as generally approved or required by the gypsum manufacturer.
    - .6 Prime metal plates that will be covered with bitumen roofing. Ensure primer is tack-free before proceeding.
  - .7 **Concrete Deck Surfaces:**
    - .1 Remove all unadhered materials throughout the concrete deck. Contractor to leave all existing fully adhered vapour barrier to concrete substrate(s), all locations, and perform repairs only as required. Upon removal, install Flam Tape (or equivalent) membrane at all concrete
-

panel joints – ensure complete joint protection - followed by 1-ply SBS modified bituminous F/F membrane, throughout the exposed concrete surface(s). Ensure no primer, membrane or between concrete panels to interior of building.

- .2 Install 3mm (1/8") protection board by embedding into beads of 2-part urethane adhesive 19 mm (3/4") wide on 150 mm (6") centres over the aerated concrete (Siporex) deck surface. Increase adhesive  
**Note: Contractor to supply and install all additional adhesive as required to ensure a satisfactory bond to the Siporex deck.**

### **3.6 Primer Application**

- .1 Surfaces of gypsum sheathing must be fully coated with black bituminous primer (Elastocol 500) to a full, even and consistent finish prior to any membrane applications (voids or uncoated areas are not acceptable). Contractor must follow manufacturer recommended installation procedures and quantities.
- .2 Treat all surfaces to be roofed with Primer to improve adhesion. Apply by brush or roller at a rate of 350 g/m<sup>2</sup>. Ensure all surfaces are thoroughly covered and primer is allowed to properly flash-off prior to any membrane application.
- .3 Note that the drying time of the primer is related to the ambient temperature and may vary from a few hours to a whole day. Do not proceed until the primer is dry.
- .4 Apply to all metal surfaces (aluminum, copper, etc.,) prior to any membrane installation.
- .5 Apply primer on all substrates that are to receive self-adhering, torch applied & asphalt applied membranes.
- .6 All primer to be installed as per manufacturer's Guidelines and recommendations.

### **3.7 Vapour Barrier Installation**

- .1 **Steel, Wood & Concrete Deck Surfaces:** install vapour barrier onto surface of substrate overlay as noted above.
- .2 Prior to installation of field vapour barriers, install self-adhering vapour barrier at all parapets, walls, curbs, and other vertical surfaces, as detailed on the drawings. Set the vapour barrier removing the release paper and applying pressure to the entire surface with a steel roller. Apply vapour barrier with 75mm side laps. Extend vapour barrier 150mm onto the roof deck.
- .3 Install **1-ply of Sopralene 180 SP 3.5** fully torch applied
- .4 Install batt insulation at openings in deck and carefully apply temporary covers at openings to prevent bleeding of bitumen into building.
-

- .5 Starting at low point and laying across roof slope fully torch adhere vapour barrier to surface of deck/substrate overlay using proper shingling methods. Lap sides 75 mm and ends 150 mm.
- .6 Apply the vapour retarder following the manufacturer's guidelines. Ensure application is free of air pockets, wrinkles, fishmouths, or tears. Check all seams and repair areas where adhesion is lacking and repair them with approved methods.
- .7 Apply a single ply vapour barrier extending up and onto the parapet coping or as detailed.

### **3.8 Installation of Rigid Insulation**

- .1 The combination of base insulation & tapered insulation must have a final combined average R-Value of R34. The base insulation is to be no less than 75mm (3") in thickness in any location – all roof areas. Contractor to provide tapered insulation shop drawings indicating average R-Value for each individual roof section. Contractor to supply and install increased base insulation thickness to achieve R-Value of R-34 in all locations- all roof areas.
- .2 At drain location(s), install 2% sloped insulation sump in a single layer. Finish insulation sump flush with top of surrounding insulation, size to be as indicated herein.
- .3 Install all insulation layers (base, secondary, fillers, tapered, etc.) with 2-part urethane adhesive as per manufacturer's wind uplift requirements. Fit boards tightly together. All gaps between boards shall be filled with insulation. Stagger all joints in boards. Stagger all joints from each other and from the layer below.

### **3.9 Protection Board Installation**

- .1 Install 6mm (1/4") protection board by embedding into beads of 2-part urethane adhesive over the surface of the polyisocyanurate foam insulation. Adhesive to be applied as per manufacturer's wind uplift requirements.
- .2 Lay out in rows in the same direction as the polyisocyanurate foam insulation by with joints staggered at least 456 mm in both directions, stagger joints in alternate rows 610 mm from each
- .3 Do not install more insulation than can be completely roofed in the same day.

### **3.10 Roof Membrane Installation**

- .1 **Base Ply Membrane:** Allow membrane rolls to relax before installation. Torch apply base ply membrane over the Protection board, overlap rolls 75 mm on sides and 150 mm on ends and in shingle-fashion up from bottom of slope. Ensure application is free of air pockets, wrinkles, fishmouths, or tears. Torch seal all seams. Check all seams and repair using a torch.
  - .2 **Cap Ply Membrane:** Torch adhere cap ply membrane to base sheet,
-

using proper shingling methods. Stagger seams in cap sheet a minimum 300 mm with those of the base sheet. Lap sides 75 mm and ends 150 mm. Degranulate surface granules where cap sheet is to be lapped by cap flashings or other overlying membrane. Ensure application is free of air pockets, wrinkles, fishmouths, or tears. Check all seams and repair areas where adhesion is lacking, and repair them, using a torch.

- .3 **Base Ply Flashings:** All membrane flashings are to be 2-ply application. Self adhere all base ply flashings, ensure all deficiencies have been corrected within the membrane below prior to installation of new base ply flashings. Stagger joints at least 100 mm with those of the base ply. Use maximum 1 m lengths of membrane. Check all seams in base ply after application and repair areas where adhesion is lacking, using a torch.

**Upon completion of base flashing applications, install a minimum of two (2) equally spaced rows of pre-assembled fasteners & plates spaced at 300mm OC. This includes but is not limited to: parapets, penetrations, curbs, control joints, expansion joints, raised walls, roof separators, etc. Install a minimum 200mm x 200mm base ply cover patch over each fastener location. At locations where height is equal to or exceeds 450mm (18") a third row of fasteners is to be installed as noted above.**

- .4 **Membrane Reinforcing Ply/Strip:** Upon completion of base membrane applications, **torch apply a membrane reinforcing ply/strip at all 90-degree interfaces** over the surface of the base membrane. This includes but is not limited to: parapets, penetrations, curbs, control joints, expansion joints, raised walls, roof separators, etc. Membrane reinforcing strip to be a minimum of 300mm wide (12"). Membrane reinforcing strip is to extend a minimum of 150mm (6") up the vertical face and 6" across the horizontal plane. Overlap membrane pieces by a minimum of 75 mm on side laps and 150 mm on leading edges and in a shingle-fashion up from bottom of slope. Ensure application is free of air pockets, wrinkles, fishmouths, or tears. Torch seal all seams. Check all seams and repair using a torch.

**Upon completion of base ply membrane applications, install a membrane reinforcing strip (as noted above) at all 90-degree intersections. This includes but is not limited to: parapets, penetrations, curbs, control joints, expansion joints, raised walls, roof separators, etc. Membrane reinforcing strip to be a minimum of 300mm wide (12"). Membrane reinforcing strip is to extend a minimum of 150mm (6") up the vertical face and 6" across the horizontal plane.**

- .5 **Cap Ply Flashings:** After base ply flashings are complete, cap ply flashings shall be laid in strips maximum 1 m wide and torch applied. Overlap 75 mm on sides and 150 mm onto flat roof area. Use chalk line to measure and neatly embed granules (where applicable) at overlay onto cap sheet.
-



- .6 Stagger joints minimum 100 mm from joints in cap sheet, and minimum 300 mm from joints in base sheet flashings. Degranulate as required where other membrane work is to overlay granulated membrane surfaces.

**3.11**  
**Vent Flashings**

- .1 Install spun aluminum vent stack covers at all existing vent pipes. Extend existing vent pipes as required to a minimum height of 400mm above the completed membrane surface. Extension to be same material as existing vent pipe. Provide sufficient allowance for pipe expansion or contraction.
- .2 Prime aluminum flange, center over existing vent stack and set into torch softened base sheet. Flash with one (1) ply of reinforcing membrane, to extend a minimum of 200mm beyond flange. Complete installation with the application of the cap sheet membrane.

**3.13**  
**Sacrificial**  
**Membrane**

- .1 Install sacrificial membrane at all locations as indicated and or required. All locations to be fully-adhered via torch application.
- .2 Sacrificial membrane to be extended 75 mm (3") beyond protection matting in all directions

**3.14**  
**Free Standing**  
**Supports**

- .1 Install free standing gas pipe supports where indicated on the drawings. Refer to Mechanical for provision of free standing pipe supports.
- .2 Install sacrificial membrane, fully-adhered via torch application, at pipe support location. Place support on 19 mm protection mat/pad and adjust roller height to suit site condition. Install steel clamp to secure pipe to support.

**3.15**  
**Protection**  
**Mats**

- .1 19mm rubber protection mats to be installed at all locations as indicated and or required.
- .2 Protection mats to be installed in full size pieces (1.22m x 1.8m) and as per manufacturer's instructions. Leave a 25 mm (1") gap between pieces for expansion.
- .3 Protection mats to be fully adhered in all locations with manufacturer approved adhesive.

**3.17**  
**Roof Top**  
**Mechanical**  
**Units**

- .1 Disconnect existing mechanical units and remove from structural support (i.e. curb, frame, stand, legs, posts or other) by means of crane. Store units in an appropriate manner
- .2 Build a new curb detail, where indicated on Roof Plan Drawing(s). Top of all curbs are to be a minimum of 600 mm above finished roof surface, as detailed.
- .3 To extend ductwork (where applicable), remove last piece of ductwork and replace with new piece. Fabricate new piece to proper shape and dimensions to suite new site conditions. Refer to Mechanical.
- .4 Reinstall unit on curb and reconnect.
-

- .5 Extend all gas and electrical services as required. Refer to Mechanical and Electrical.

### **3.18 Completion of Days Work**

- .1 Install a water tie-off at the edge of completed roofing work at the end of the day, to prevent water entry. Remove this completely at the start of the next days work. Inspect all exposed membrane to assure that it is left in a watertight condition overnight. Ensure that drainage is provided to prevent buildup of water on partially completed works.
- .2 Provide a fire watch on the site, after torching work has been completed for the day, for at least two (2) hours at the end of each day. Walk the entire day's production area to check for smoke and or hot spots using a hand-held infrared thermometer
- .3 Inspect all laps of the membrane application to ensure they are properly bonded. Repair any deficiencies prior to leaving the site for the day.
- .4 Base sheet applications should not be left exposed overnight unless all seams are torch welded prior to leaving the work site.

### **3.19 Cleaning**

- .1 Upon completion of the work of this Section remove from the premises all surplus material, dirt and debris caused by the work of this Section and leave the installation clean.
- .2 Clean any drips, spills and surplus material from adjacent surfaces and make good any damage caused by the work of this Section.

### **3.20 Liquid Membrane**

- .1 Prepare surfaces as recommended by manufacturer; surfaces must be clean, dry, and free of dirt, dust, and particles.
- .2 Apply a base coat of liquid membrane onto surfaces, 150mm from joints, angles, or openings.
- .3 Install reinforcing membrane on service conduit and onto vertical surface; notch reinforcing membrane to allow for better tie-in detail on vertical surface. Apply liquid membrane flashing membrane over reinforcing membrane.
- .4 Install reinforcing membrane on vertical surface round service conduit and over previously installed reinforcing membrane. Apply liquid membrane flashing over second reinforcing membrane.
- .5 Apply finish coat of liquid membrane over dry, previously applied liquid membrane.
- .6 Apply liquid membrane flashing as recommended by the manufacturer, and following written instructions
-

**3.21** .1 Metal flashings are specified in Section 076200. Co-ordinate this work with that section.  
**Metal Flashings**

- 3.22** .1 Patching the cap sheet membrane shall be carried out utilising patches with a minimum size of 450mm x 100mm.  
**General**
- .2 Minimum length of cap sheet on flat run of roof shall not be less than 1000 mm.
- .3 Wrinkled or deformed ends of cap sheets rolls will not be tolerated and therefore, must be discarded prior to application.
- .4 Following completion of new roofing, torch soften and apply a liberal application of approved bulk type mineral granules to cap sheet membrane edges where asphalt has extruded or flowed beyond clean lines and to all surface damage.
- .5 Splices in delivered rolls of membrane are to be removed. Cut back the roll 450mm on both sides of the splices and remove prior to installation.

## **SPECIAL CONDITIONS**

### **SCOPE**

1. Refer to Lombardy Public School drawings.
  2. Replace existing roof system with new System – Soprema, IKO or Henry roof systems, as identified in the specifications – refer to attached specification. Confirm structural deck in applicable roof area.
  3. Disconnect, lift and re-connect any and all roof top equipment as well as all other equipment, lines (gas, refrigeration, communication, electrical) and electrical requirements for this project. Supply plywood and extruded polystyrene insulation for the temporary roof top storage of the roof top units, while the waterproofing is being completed. Also supply plywood and tarps for the temporary waterproofing of open curbs and ducts.
  4. Remove and discard all “not-in-use” roof details as determined by the Consultant. Confirm all “not-in-use details with site School Boards representative.
  5. Existing electrical/mechanical connections that exit roof system externally to any roof top mechanical unit, must have a separate “wood doghouse” service curb installed. Contractor is responsible to identify, disconnect all applicable connections, install appropriate service curb/detail, then reconnect all services to a minimum height of 400 mm above the finished roof surface as per their respective code compliance requirement, TSSA & ESA regulations.
  7. Contractor MUST remove all existing screw fasteners with a drill where existing. No damage to the existing fasteners or deck will be tolerated.
-

8. All roof top mechanical units and curbs (regardless of operation) are to be extended to a minimum height of 600 mm above the finished roof surface.
9. At ALL roof top mechanical unit locations install manufacturer approved 19 mm rubber protection mats (1.22m x 1.8m) with fully torch applied sacrificial 250g cap membrane around all sides of each mechanical unit location. Apply approved adhesive to all mats for securement. Ensure sacrificial ply and protection mats are installed to within 1" of each curb/item. Apply protection to ensure adjacent surfaces are not burnt or damaged during installation
10. Contractor shall supply and install the required mechanical flashings where required at all mechanical pipe details, i.e. B-vents. All joints must be soldered within the mechanical galvanized metal flashing detail.
12. Contractor to be responsible for protection of interior spaces below all roof areas to ensure full and complete shelter of all interior items and surfaces. Contractor to move/re-locate all interior items (i.e. furniture, equipment, fixtures, electronics, etc.) to complete the interior protection as required. Contractor to complete full interior clean-up upon completion of roofing operations and return all items to original locations and condition. Any damage to interior spaces because no protection was installed will be replaced to match same at no cost to the Owner.
15. **Testing** -any hazardous material testing requested by the Roofing Contractor over and above what is documented in the provided DSR report is to be completed at the sole expense of the Roofing Contractor. If any requested testing yields a positive result, the UCDSB will cover the Roofing Contractor's expenses for said tests. The UCDSB will arrange for any testing requested by the Roofing Contractor.

**-END OF SECTION-**

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**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00: Submittal Procedures.
- .2 Section 07 46 13: Preformed Metal Cladding.

**1.2 REFERENCES**

- .1 American Society for Testing and Materials (ASTM International)
  - .1 ASTM A 653/A 653M-01a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .2 ASTM D 523-89(1999), Standard Test Method for Specular Gloss.
  - .3 ASTM D 822-01, Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
- .2 Canadian Roofing Contractors Association (CRCA)
  - .1 Roofing Specifications Manual 1997.
- .3 Canadian Standards Association (CSA International).
  - .1 CSA B111 - (1974(R1998), Wire Nails, Spikes and Staples.
- .4 SCAQMD Rule#1168 South Coast Air Quality Management District.

**1.3 SAMPLES**

- .1 Submit shop drawings in accordance with Section 01 60 00 – Submittals.
- .2 Submit duplicate 50 x 50 mm samples of each type of sheet metal material, colour and finish.

**1.4 WORKMANSHIP**

- .1 Sheet metal flashing work shall be carried out in accordance with the best standard practices; with joints locked, cleated, caulked as required and exposed edges hemmed. Ample allowance shall be made in all work for expansion and contraction.
- .2 Mitred corners shall be straight and true to profiles shown on drawings, with flat surfaces free of distortion and free of face nailing.

**1.5 REFERENCES**

- .1 Standard practices, unless otherwise noted herein, shall be deemed to constitute recommended procedures published in the S.M.A.C.N.A. Architectural Manual.

**1.6 WARRANTY**

- .1 Remedy all defects in the Sheet Metal Flashings installed hereunder, which appear within a period of two (2) years from the date of substantial performance.
  - .2 Make all necessary repairs and replacement within 48 hours of receipt of written notification.
-

- .3 Provide a written warranty confirming the above, issued on the corporate letterhead, and sealed by an authorized company official.
- .4 Nothing contained in the Article shall be construed as in any way restricting or limiting the liability in Common Law and statutory liability of the Contractor.

## **Part 2 Products**

### **2.1 SHEET METAL MATERIALS**

- .1 Zinc coated steel sheet: 0.853mm thickness (22 ga.) for flashings and parapet flashings, commercial quality to ASTM A 653/A 653M, with Z275 designation zinc coating.

### **2.2 PREFINISHED COATING**

- .1 Provide prefinished factory applied coating with color to later selection. Provide anodized aluminum for existing/new windows and/or doors and provide black at block veneer masonry locations at stairwells

### **2.3 ACCESSORIES**

- .1 Isolation coating: alkali resistant bituminous paint.
- .2 Plastic cement: to CAN/CGSB 37.5.
- .3 Underlay for metal flashing: "Blueskin" by Henry Bakor.
- .4 Sealants: Polysulphide, one part, non-sag to CAN/CGSB-19.13, MC-2-40-B-N colour to match siding.
- .5 Cleats: of same material, and temper as sheet metal, minimum 50 mm wide. Thickness same as sheet metal being secured.
- .6 Fasteners: of same material as sheet metal, to CSA B111, ring thread flat head roofing nails of length and thickness suitable for metal flashing application.
- .7 Washers: of same material as sheet metal, 1 mm thick with rubber packings.
- .8 Touch-up paint: as recommended by prefinished material manufacturer.
- .9 The VOC content of adhesives and sealants used in the interior of the building envelope must be less than the VOC content limits of SCAQMD Rule #1168.
  - .1 Contractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in litres) of each materials used should also be provided.

### **2.4 FABRICATION**

- .1 Fabricate metal flashings and other sheet metal work in accordance with applicable CRCA 'FL' series details and as indicated.
- .2 Form pieces in 2400 mm maximum lengths. Make allowance for expansion at joints.
- .3 Hem exposed edges on underside 12 mm. Mitre and seal corners with sealant.

- .4 Form sections square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.

- .5 Apply isolation coating to metal surfaces to be embedded in concrete or mortar.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install sheet metal work in accordance with CRCA FL series details, FL series details and as detailed.
- .2 Use concealed fastenings except where accepted before installation.
- .3 Provide underlay under sheet metal. Secure in place and lap joints 100 mm.
- .4 Lock end joints and caulk with sealant.
- .5 Install surface mounted reglets true and level, and caulk top of reglet with sealant.
- .6 Caulk flashing at cap flashing with sealant.
- .7 Metal flashing shall be as detailed, supplemented by recommendations of the S.M.A.C.N.A. Architectural Manual.
- .8 All raw edges of metal flashing shall be strengthened by a fold at least 13mm wide, set out slightly and presenting a straight line and neat finish. Form flashings in 2.4m lengths, making allowance for expansion. When flashings exceed 600mm in height form flashing in 1.2m lengths.
- .9 Metal shall be formed on a bending brake, shaping trimmed and hard seaming shall be done on bench, as far as practicable, with proper sheet metal working tools. Angles of bends and folds for interlocking metal shall be made with full regard to expansion and contraction to avoid buckling or fullness in service and to avoid damaging surfaces of metal.
- .10 Dry joints are to tight but not dented so as to permit slight adjustments of sheets and yet remain watertight.
- .11 Lock seams at all corners.
- .12 Do not install fasteners through cant strips.
- .13 Apply isolation coating to metal surfaces to be embedded in concrete or mortar, and between dissimilar metals.

### **3.2 ANCHORS AND FASTENERS**

- .1 Space exposed fasteners evenly and in an organized pattern, keep number anchors and to a minimum. Where exposed to view, use metal fasteners of same fasteners material, colour, texture and finish as the metal on which they occur. Obtain approval before installing any exposed fasteners.

### **3.3 CAP FLASHING**

- .1 Supply and install continuous metal starter strips, secure at 600mm O.C.

maximum of 50mm above drip edge, with fastener of sufficient length to penetrate a minimum of 25mm into substrate.

- .2 Supply and install metal cleats at specified spacing. Use fasteners of sufficient length to penetrate a minimum of 25mm into substrate.
- .3 Use concealed fastenings except where approved by Consultant.
- .4 Secure sections of metal in S-lock joints on all faces and allow for sufficient expansion and contraction between each piece. Ensure drip edges are inserted into the drip of the adjacent section.
- .5 Form cap flashings to profiles as shown on the detail drawings. Ensure positive drainage to the interior (roof surface) areas.
- .6 Where height of metal fascia exceeds 150mm, provided stiffening breaks every 150mm maximum. Breaks to be located at equal distance from the top and bottom of the fascia, and from each other.

### **3.4 FASTENING BARS**

- .1 Install metal fastening bars where detailed, secured at 300mm o/c with self-tapping flat head screws. Fastener length to be 19mm. Fasteners to be approved by Consultant.

### **3.5 REGLETS**

- .1 Reglets that are not of sufficient height are not to be reused. New reglets are to be cut a minimum of 400mm above finished roof surface and are to be a minimum of 19mm wide and 25mm deep. Reglets to be cut prior to the application of the membrane flashings.
- .2 For existing reglets greater than 400mm above finished membrane, clean out and secure new metal flashing and caulk. (minimum height shall be 450mm or as detailed).
- .3 Prime reglet prior to the application of the membrane flashings.
- .4 Turn top edge of metal flashing into walls, secure with lead wedge or friction fit pins into reglet and caulk joint at wall.
- .5 Secure sections of metal in S-lock joints on all faces and allow for sufficient expansion and contraction between each piece. Ensure drip edges are inserted into the drip of the adjacent section.

### **3.6 CAULKING**

- .1 Install caulking in accordance with manufacturer's latest recommendations and guidelines.
- .2 Provide foam backer rod for joints greater than 19mm wide and 25mm deep, prior to installing caulking compound.
- .3 Tool finish to satisfaction of Consultant.



### **3.7 CLEANING**

- .1 Finished sheet metal flashing work shall be clean and left in neat, workmanlike condition. Adjoining materials shall be properly cleaned of all soil caused by this trade, debris/soil shall be removed from site to the satisfaction of the Consultant.

**END OF SECTION**

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**Part 1 General**

**1.1 RELATED WORK**

- .1 Fire stopping and smoke seals within mechanical assemblies (i.e. inside ducts, dampers) and electrical assemblies (i.e. inside cable trays) are specified in mechanical and electrical divisions, respectively.

**1.2 REFERENCES**

- .1 Underwriter's Laboratories of Canada (ULC)
  - .1 ULC-S115-1995, Fire Tests of Firestop Systems.
  - .2 ULC-HW49, Vertical or Horizontal Separations. (top of wall)
  - .3 ULC-W452, Nonbearing Assembly Ratings. (shaft wall)
- .2 South Coast Air Quality Management District (SCAQMD) California State SCAQMD Rule #1168.

**1.3 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 01 33 00 - Submittals.
- .2 Submit shop drawings to show proposed material, reinforcement, anchorage, fastenings and method of installation. Construction details should accurately reflect actual job conditions.
- .3 The VOC content of adhesives and sealants used in the interior of the building must be less than the VOC content limits of SCAQMD Rule #1168.
  - .1 Contractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in litres) of each material used should also be provided.

**1.4 PRODUCT DATA**

- .1 Submit product data in accordance with Section 01 33 00 - Submittals.
- .2 Submit manufacturer's product data for materials and prefabricated devices, providing descriptions are sufficient for identification at job site. Include manufacturer's printed instructions for installation.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Fire stopping and smoke seal systems: in accordance with ULC-S115.
    - .1 Asbestos-free materials and systems capable of maintaining an effective barrier against flame, smoke and gases in compliance with requirements of ULC-S115 and not to exceed opening sizes for which they are intended.
    - .2 Firestop system rating: FTH.
  - .2 Service penetration assemblies: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No.40 U19.
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- .3 Service penetration firestop components: certified by ULC in accordance with ULC-S115 and listed in ULC Guide No.40 U19.13 and ULC Guide No.40 U19.15 under the Label Service of ULC.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.
- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork and other mechanical items requiring sound and vibration control: elastomeric seal.
- .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .8 Water (if applicable): potable, clean and free from injurious amounts of deleterious substances.
- .9 Damming and backup materials, supports and anchoring devices: to manufacturer's recommendations, and in accordance with tested assembly being installed as acceptable to authorities having jurisdiction.
- .10 Sealants for vertical joints: non-sagging.

### **Part 3 Execution**

#### **3.1 PREPARATION**

- .1 Examine sizes and conditions of voids to be filled to establish correct thicknesses and installation of materials. Ensure that substrates and surfaces are clean, dry and frost free.
- .2 Prepare surfaces in contact with fire stopping materials and smoke seals to manufacturer's instructions.
- .3 Maintain insulation around pipes and ducts penetrating fire separation.
- .4 Mask where necessary to avoid spillage and over coating onto adjoining surfaces; remove stains on adjacent surfaces.

#### **3.2 INSTALLATION**

- .1 Install fire stopping and smoke seal material and components in accordance with ULC certification and manufacturer's instructions.
- .2 Seal holes or voids made by through penetrations, poke-through termination devices, and unpenetrated openings or joints to ensure continuity and integrity of fire separation are maintained.
- .3 Provide temporary forming as required and remove forming only after materials have gained sufficient strength and after initial curing.
- .4 Tool or trowel exposed surfaces to a neat finish.
- .5 Remove excess compound promptly as work progresses and upon completion.

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**3.3 INSPECTION**

- .1 Notify the Consultant when ready for inspection and prior to concealing or enclosing firestopping materials and service penetration assemblies.

**3.4 SCHEDULE**

- .1 Firestop and smoke seal at:
  - .1 Penetrations through fire-resistance rated masonry, concrete, and gypsum board partitions and walls.
  - .2 Top of fire-resistance rated masonry and gypsum board partitions. At top of gypsum board partitions, install as per ULC Design HW49, ULC W452, HW-D-1020.
  - .3 Intersection of fire-resistance rated masonry and gypsum board partitions.
  - .4 Control and sway joints in fire-resistance rated masonry and gypsum board partitions and walls.
  - .5 Penetrations through fire-resistance rated floor slabs, ceilings and roofs.
  - .6 Openings and sleeves installed for future use through fire separations.
  - .7 Around mechanical and electrical assemblies penetrating fire separations.
  - .8 Rigid ducts: greater than 129 cm<sup>2</sup>: fire stopping to consist of bead of fire stopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.

**3.5 CLEAN UP**

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

**END OF SECTION**

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**Part 1            General**

**1.1            SECTION INCLUDES**

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

**1.2            RELATED SECTIONS**

- .1        Section 01 33 00 - Submittals.
- .2        Section 01 45 00 - Quality Control.

**1.3            REFERENCES**

- .1        American Society for Testing and Materials International, (ASTM)
  - .1        ASTM C 919-02, Standard Practice for Use of Sealants in Acoustical Applications.
- .2        Canadian General Standards Board (CGSB)
  - .1        CAN/CGSB-19.13-M87, Sealing Compound, One-component, Elastomeric, Chemical Curing.
  - .2        CAN/CGSB-19.17-M90, One-Component Acrylic Emulsion Base Sealing Compound.
  - .3        CAN/CGSB-19.24-M90, Multi-component, Chemical Curing Sealing Compound.
- .3        Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1        Material Safety Data Sheets (MSDS).

**1.4            SUBMITTALS**

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

**1.5            DELIVERY, STORAGE, AND HANDLING**

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

floor.

## **1.6 PROJECT CONDITIONS**

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

## **1.7 ENVIRONMENTAL REQUIREMENTS**

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

## **Part 2 Products**

### **2.1 SEALANT MATERIALS**

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

### **2.2 SEALANT MATERIAL DESIGNATIONS**

- .1 Exterior sealants: Dow Corning 790, no alternate.
- .2 Silicones One Part.
  - .1 To CAN/CGSB-19.13.
- .3 Acrylic Latex One Part.
  - .1 To CAN/CGSB-19.17.
- .4 Acoustical Sealant.

- .1 To ASTM C 919.
- .5 Other interior sealants: Dow Corning 790, Tremco Dymeric, Tremco Dymonic.
- .6 Preformed Compressible and Non-Compressible back-up materials.
  - .1 Polyethylene, Urethane, Neoprene or Vinyl Foam.
    - .1 Extruded closed cell foam backer rod.
    - .2 Size: oversize 30 to 50 %.
  - .2 Neoprene or Butyl Rubber.
    - .1 Round solid rod, Shore A hardness 70.
  - .3 Bond Breaker Tape.
    - .1 Polyethylene bond breaker tape which will not bond to sealant.

## **2.3 SEALANT SELECTION**

- .1 Perimeters of exterior openings where frames meet exterior facade of building (i.e. brick, block, precast, masonry): Sealant type: Dow Corning 790.
- .2 Control and expansion joints in exterior surfaces of unit masonry walls: Sealant type: Dow Corning 790.
- .3 Coping joints and coping-to facade joints: Sealant type: Dow Corning 790.
- .4 Seal interior perimeters of exterior openings as detailed on drawings: Sealant type: Tremco Dymonic.
- .5 Interior control and expansion joints in floor surfaces: Sealant type: Tremco Dymeric. Sealant to be compatible with finished flooring manufacturer's written specifications.
- .6 Perimeters of interior hollow metal frames, as detailed and itemized: Sealant type: latex.
- .7 Interior masonry vertical control joints (block-to-block, block-to-concrete, and intersecting masonry walls): Sealant type: Tremco Dymonic.
- .8 Joints at tops of non-load bearing masonry walls at the underside of poured concrete: Sealant type: Tremco Dymonic.
- .9 Perimeter of bath fixtures (e.g. sinks, tubs, urinals, stools, waterclosets, basins, vanities): Sealant type: clear silicone.
- .10 Exposed interior control joints in drywall: Sealant type: Tremco Dymonic.

## **2.4 JOINT CLEANER**

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

## **Part 3 Execution**

### **3.1 PROTECTION**

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

### **3.2 SURFACE PREPARATION**

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

### **3.3 PRIMING**

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

### **3.4 BACKUP MATERIAL**

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

### **3.5 MIXING**

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

### **3.6 APPLICATION**

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



- .3 Remove masking tape after initial set of sealant.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED WORK**

- |    |  |                  |
|----|--|------------------|
| .1 | Joint Sealing                                | Section 07 92 10 |
| .2 | Finish Hardware (and Door Hardware Schedule) | Section 08 71 10 |
| .3 | Glazing:                                     | Section 08 80 50 |
| .4 | Exterior Painting:                           | Section 09 91 13 |
| .5 | Interior Painting:                           | Section 09 91 23 |
| .6 | Wood Doors                                   | Section 08 21 00 |

**1.2            REFERENCES**

- |    |   |
|----|---|
| .1 | ASTM A525-86 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.                     |
| .2 | ASTM A526M-85 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.                         |
| .3 | CAN4 S104M-M80 Fire Tests of Door Assemblies.   |
| .4 | CAN4 S105M-M85 Fire Door Frames.  |
| .5 | CAN/CGSB 181.1 Coating, Zinc-Rich, Organic, Ready Mixed.  |
| .6 | Canadian Steel Door and Frame Manufacturers' Association, (CSDFMA) Canadian Manufacturing Specifications for Steel Door and Frames, 1982. |
| .7 | NFPA 80-1986 Fire Doors and Windows.  |

**1.3            REQUIREMENTS OF REGULATORY AGENCIES**

- |    |  |
|----|--|
| .1 | Steel fire rated doors and frames: labelled and listed by an organization accredited by Standards Council of Canada in conformance with CAN4 S104M-80 revised 1985 and CAN4 S105M-1985 for ratings specified or indicated. |
| .2 | Install labelled steel fire rated doors and frames to NFPA 80 except where specified otherwise.  |

**1.4            SHOP DRAWINGS**

- |    |  |
|----|--|
| .1 | Submit shop drawings in accordance with Section 01 33 00 - Submittals.   |
| .2 | Indicate each type of door, material, steel core thicknesses, mortises, reinforcements, location of exposed fasteners, glazed openings, arrangement of hardware and fire rating. |
| .3 | Indicate each type frame material, core thickness, reinforcements, glazing stops, location of anchors and exposed fastenings and finishes.                                       |
-

**Part 2**

**Products**

**2.1**

**MATERIALS**

- .1 Galvanized steel sheet: lock-forming quality to ASTM A527, Coating Designation mill phosphatized.
- .2 Doors: 1.12mm base material thickness.
- .3 Door Core:
  - .1 Hollow steel: vertically stiffened with steel ribs and all voids filled with semi-rigid fibrous insulation minimum density 48 kg/m<sup>3</sup>.
- .4 Frames:
  - .1 Steel frames to exterior and interior openings 1.520mm base thickness.
- .5 Provide other door and frame components in accordance with CSDFMA requirements.
- .6 Primer:
  - .1 For galvanized steel sheet: CAN/CGSB 181.1.
- .7 Foam-in-place insulation spray polyurethane to CGSB 51-GP-23M Class 1.

**2.2**

**FABRICATION**

- .1 Fabricate doors and frames as detailed, to Canadian Steel Door and Frame Manufacturers' Association, (CSDFMA) Canadian Manufacturing Specifications for Steel Doors and Frames, 1982; except where specified otherwise. Reinforce door and frames to suit hardware requirements specified Section 08 71 10 - Finish Hardware.
- .2 Blank, reinforce, drill and tap doors and frames for mortised hardware. Reinforce doors and frames for surface mounted hardware.
- .3 Apply, at factory, touch up primer to doors and frames manufactured from galvanized steel where coating has been removed during fabrication.

**2.3**

**DOORS**

- .1 Make provision for glazing as indicated and provide necessary glazing stops.
- .2 Construct rail and stile doors in same manner as flush doors.
- .3 Construct matching panels in same manner as doors.
- .4 Fabricate doors with longitudinal edges mechanically interlocked and spot welded along edges at 300mm o.c.
- .5 Fabricate doors with top and bottom channels flush and filled solid, extending full width of door and welded to both faces.
- .6 Where doors have louvers supplied by mechanical, coordinate with mechanical specifications (Section 23 37 13) - Diffusers, Registers and Grilles for preparation of doors to accept louvers.

**2.4**

**FRAMES**

- .1 Cut mitres and joints accurately and weld continuously on inside of frame profile.

- .2 Grind welded corners and joints to flat plane, fill with metallic paste filler and sand to uniform smooth finish.
- .3 Provide adjustable jamb anchors for fixing at floor.
- .4 Install 3 bumpers on strike jamb for each single door and 2 bumpers at head for pairs of doors.
- .5 Fabricate thermally broken frames for exterior doors and exterior glazed screens using steel core, separating exterior portion of frame from interior portion with polyvinyl chloride thermal breaks.
- .6 Make provision for glazing as indicated and provide necessary glazing stops.

### **Part 3 Execution**

#### **3.1 INSTALLATION GENERAL**

- .1 Install in accordance with National Fire Codes, Volume 4, produced by National Fire Protection Association (NFPA) 80.

#### **3.2 DOOR INSTALLATION**

- .1 Install doors and hardware in accordance with hardware templates and manufacturer's instructions and Section 08 71 00 - Finish Hardware.
- .2 Provide even margins between doors and jambs and doors and finished floor and thresholds as follows.
  - .1 Hinge side: 1.0 mm.
  - .2 Latchside and head: 1.5 mm.
  - .3 Finished floor, top of carpet, noncombustible sill and thresholds: 13 mm.
- .3 Adjust operable parts for correct function.

#### **3.3 FRAME INSTALLATION**

- .1 Set frames plumb, square, level and at correct elevation.
- .2 Secure anchorages and connections to adjacent construction.
- .3 Brace frames rigidly in position while building-in. Install temporary horizontal wood spreader at third points of door opening to maintain frame width. Provide vertical support at centre of head for openings over 1200 mm wide. Remove temporary spreaders after frames are built-in.
- .4 Make allowances for deflection of structure to ensure structural loads are not transmitted to frames.
- .5 Where noted provide foam in place insulation to seal at head and jambs. Do not distort frames out of line.

#### **3.4 FINISH REPAIRS**

- .1 Touch up with primer, galvanized finish damaged during installation.

**END OF SECTION**

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**PART 1      General**

**1.1      RELATED   SECTIONS**

- .1      Section 07 92 10 - Joint Sealers.
- .2      Section 07 27 10 - Air Barriers
- .3      Section 08 71 00 - Finish hardware
- .4      Section 08 80 50 - Glazing

**1.2      REFERENCES**

- .1      ASHRAE/IES 90.1-1989
- .2      ANSI/ASHRAE/USGBC/IES 189.1-2009
- .3      Aluminum Association (AA): AA DAF 45-03(R2009), Designation System for Aluminum Finishes.
- .4      American Architectural Manufacturers Association (AAMA)
  - .1      AAMA CW-10-04, Care and Handling of Architectural Aluminum From Shop to Site.
  - .2      AAMA CW-11-85, Design Wind Loads and Boundary Layer Wind Tunnel Testing.
  - .3      AAMA T1R-A1-04, Sound Control for Fenestration Products.
  - .4      AAMA 501-05, Methods of Test for Exterior Walls.
  - .5      AAMA 611-98, Voluntary Specifications for Anodized Finishes Architectural Aluminum.
  - .6      AAMA 612-02, Voluntary Specifications, Performance Requirements, and Test Procedures for Combined Coatings of Anode Oxide and Transparent Organic Coatings on Architectural Aluminum.
  - .7      AAMA 2603-02, Voluntary Specification Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
  - .8      AAMA 2604-05, Voluntary Specification Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
- .5      ASTM International
  - .1      ASTM A 36/A 36M-08, Specification for Carbon Structural Steel.
  - .2      ASTM A 123/A 123M-09, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - .3      ASTM A 167-99(2009), Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
  - .4      ASTM A 653/A 653M-09a, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .5      ASTM B 209-07, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - .6      ASTM B 221-08, Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
  - .7      ASTM E 283-04, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
  - .8      ASTM E 330-02, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls, by Uniform Static Air Pressure

- Difference.
- .9 ASTM E 331-00(2009), Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform Static Air Pressure Difference.
- .10 ASTM E 413-04, Classification for Rating Sound Insulation.
- .11 ASTM E 1105-00(2008), Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference.
- .6 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 1.108-M89, Bituminous Solvent Type Paint.
  - .2 CAN/CGSB-12.20-M89, Structural Design of Glass for Buildings.
- .7 CSA International
  - .1 CSA G40.20/G40.21-04(R2009), General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
  - .2 CSA S136-07, North American Specification for the Design of Cold Formed Steel Structural Members.
  - .3 CAN/CSA-S157/S157.1-05, Strength Design in Aluminum/Commentary on CAN/CSA-S157, Strength Design in Aluminum.
  - .4 CSA W59.2-M1991(R2008), Welded Aluminum Construction.
- .8 Society for Protective Coatings (SSPC)
  - .1 SSPC - Paint 20-02(R2004), Zinc Rich Coating, Type I - Inorganic and Type II - Organic.
  - .2 SSPC - Paint 25 - 97(R2004) BCS, Zinc Oxide, Alkyd, Linseed Oil and Primer for Use Over Hand Cleaned Steel Type 1 and Type 2.
- .9 South Coast Air Quality Management District (SCAQMD), California State, Regulation XI. Source Specific Standards
  - .1 SCAQMD Rule 1113-A2007, Architectural Coatings.
  - .2 SCAQMD Rule 1168-A2005, Adhesives and Sealants Applications.

### 1.3 SYSTEM DESCRIPTION

- .1 Design Criteria
  - .1 Design frames and doors in exterior walls to:
    - .1 Accommodate expansion and contraction within service temperature range of - 35 to 35 degrees C.
    - .2 Limit deflection of mullions to maximum 1/175th of clear span when tested to ASTM E 330 under wind load of 1.2 kpa submit certificate of tests performed.
    - .3 Movement within system.
    - .4 Movement between system and perimeter framing components or substrate.
    - .5 Design all connections between all frames and surrounding structure (including but not limited to foundation, concrete block, steel structure, steel studs, blocking, etc) and clearly indicate designed connections on manufacturer's shop drawings along with demonstration that the connections meet the load requirements outlined above.

### 1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Co-ordination: co-ordinate work of this Section with installation of fire stopping, air barrier placement, vapour retarder placement, flashing placement, installing ductwork to rear of

louvres, rough carpentry and components or materials.

## **1.5 EXAMINATION**

- .1 Examine the structure to which work is to be fixed and report any deficiency which is detrimental to the proper installation of the work.
- .2 Verify all dimensions on site, and site dimension to ensure that adjustments in fabrication and installation are provided for and clearances to other construction have been maintained.
- .3 Report any defects discovered to the Architect and do not commence work before these have been remedied. Commencement of work shall be construed as acceptance of underlying conditions.

## **1.6 ACTION AND INFORMAL 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 curtain wall and windows components, anchorage and fasteners, glass and infill, and internal drainage details and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario.
  - .2 Indicate system dimensions, framed opening requirements and tolerances, adjacent construction, anchor details anticipated deflection under load, affected related Work, weep drainage network, expansion and contraction joint location and details, and field welding required.
- .4 Samples: Submit two samples of finish and colour for review in accordance with Section 01 33 00 - Submittals..
- .5 Test Reports:
  - .1 Submit substantiating engineering data, test results of previous tests by independent laboratory which purport to meet performance criteria, and supportive data:
    - .1 Window classifications A3, B3, C3 for opening windows, and A2, B2, C2 for fixed sash.
    - .2 Enamelled finish.
    - .3 Air tightness fixed rating.
    - .4 Water tightness B-7 rating.
    - .5 Wind load resistance C-5 rating.
    - .6 Condensation resistance I @58.1.
    - .7 Sash strength and stiffness – projecting.
    - .8 Ease of operation - windows with operable lights.
    - .9 Forced entry resistance.
    - .10 Mullion deflection - combination and composite windows.

## **1.7 MAINTENANCE DATA**

- .1 Provide operation and maintenance data for windows for incorporation into manual specified in Section 01 77 00 - Closeout Submittals.



## **1.8 WASTE MANAGEMENT**

- .1 Provide covered storage area to protect materials and products from sunlight, moisture, staining, and impact or other damage.
- .2 Separate protective materials for reuse or recycling.
- .3 Separate corrugated cardboard in accordance with the Waste Management Plan and place in designated areas for recycling.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Use the least toxic sealants, adhesives, sealers, and finishes necessary to comply with the requirements of this section. Refer to Section 07 92 00.
- .6 Close and seal tightly all partly used sealant containers and store protected in well ventilated fire-safe area at moderate temperature.
- .7 Place used sealant tubes and other containers in areas designated for hazardous materials.
- .8 Separate strapping, and wood and metal spreader bars for reuse or recycling.
- .9 Fold up metal banding, flatten, and place in designated area for recycling.

## **1.9 WARRANTY**

- .1 From the date of Certificate of Substantial Performance, the hermetically sealed glazing units shall be warranted for a period of **five (5) years** against vision obstruction due to the formation of dust or film on the internal surfaces, caused by the failure of the hermetic seal other than through glass breakage.
- .2 All other parts of the work shall be warranted against defects due to faulty materials and/or workmanship for a period of **three (3) years** from the date of the Certificate of Substantial Performance.
- .3 Repair and/or replace when so directed by the Architect, within the said periods, any and all portions of work which fail to perform according to the requirements of these Specifications.

## **1.10 PROTECTION**

- .1 Apply temporary protective coating to finished surfaces. Remove coating after erection. Do not use coatings that will become hard to remove or leave residue.
- .2 Leave protective covering in place until final cleaning of building.

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**PART 2 Products**

**2.1 MATERIALS**

- .1 Aluminum
  - .1 All aluminum extrusions shall be 6063 TS aluminum alloy with T5 temper. Sash members shall be tubular, with nominal wall thickness of 1.6mm generally and 2.3mm at areas receiving operating hardware.
  - .2 All aluminum doors and frames shall be given an anodic oxide treatment to obtain an Architectural Class 2 Anodic Coating in accordance with Aluminum Association specification AA-M12C22A31, #17, Clear.
- .2 Exterior aluminum sills shall be break formed aluminum sheet metal to suit job condition, minimum 3mm thick, complete with joint covers, end caps and drip deflectors, drains, anchoring devices. Finish to be #17, Clear.
- .3 Weatherstripping shall be flexible vinyl spline with durometer rating 60 ±5.
- .4 All screws, bolts and fastenings, shall be either cadmium plated or stainless steel.
- .5 Aligning corner clips shall be aluminum.
- .6 Hermetically Sealed Glazed Units: shall be made from two sheets of optically clean glass separated by an insulate spacer in accordance with CAN/CGSB-12.8-M76. Refer to Specification Section 08 80 50 – Glazing.
- .7 Screens shall be fabricated from extruded aluminum sections with mechanical corners. Mesh shall be 18/16 aluminum wire cloth held in place by continuous Koroseal spline. Frames for insect screens shall be same colour as window frame.

**2.2 FABRICATION**

- .1 Fabricate in accordance with CAN/CSA-A440 supplemented as follows:
- .2 Fabricate units square and true with maximum tolerance of plus or minus 1.5 mm for units with a diagonal measurement of 1800 mm or less and plus or minus 3 mm for units with a diagonal measurement over 1800 mm.
- .3 Face dimensions detailed are maximum permissible sizes.
- .4 Brace frames to maintain squareness and rigidity during shipment and installation.
- .5 Finish steel clips and reinforcement with shop coat primer to 380 g/m2 zinc coating to CAN/CSA-G164.
- .6 Provide 2mm thick aluminum drip flashing at the head of ALL windows and curtain walls.

**2.3 HARDWARE**

- .1 Hardware for operable window sashes shall be:
  - .1 Four Bar Hinge-zinc plated finish, max. 50 degree opening, size to suit operator size and weight.

- .2 For operating sashes, provide 100mm "Limiters" to restrict extension of the sash while in open position.
- .3 Provide two (2) cam locking handles complete with pull rings. Provide sash pull pole for access pull ring (2 of).

## **2.4 ISOLATION COATING**

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

## **2.5 GLAZING**

- .1 Glaze windows in accordance with CAN/CSA-A440. Refer to Section 08 80 50 for glass and glazing material.

## **2.6 AIR BARRIER AND VAPOUR BARRIERS**

- .1 Equip window frames with factory or site installed air and vapour barrier material for sealing to building air and vapour barrier as follows:
  - .1 Material: identical to, or compatible with, building air barrier and vapour retarder materials to provide required air tightness and vapour diffusion control throughout exterior envelope assembly.
  - .2 Material width: adequate to provide required air tightness and vapour diffusion control to building air barrier and vapour barrier from interior.

## **2.7 PANNING**

- .1 Provide 25mm x minimum 25mm extruded aluminum square snap on type panning, clear anodized finish to match new frames as required to cover gap between window/door frames and existing brick or interior finishes.

## **2.8 INSULATED SANDWICH PANELS**

- .1 At exposed exterior face of curtain wall framing, provide 3mm thick aluminum both sides of 19mm plywood sheathing for one sandwich panel unit for installation between exterior aluminum cap and rear mullion. Finish shall be same colour as frame.
- .2 Insulate behind sandwich panels with minimum 100mm thick semi-rigid insulation Curtainrock board insulation as manufactured by Roxwool Inc.
- .3 Where back-up insulated sandwich panels are exposed to view in the building interior, 3mm thick aluminum shall be used. Finish shall match window frame.
- .4 Where back-up insulated back-up panels are not exposed to view in the building interior, use 0.9mm thick (20 gauge) galvanized sheet steel at interior face of panel.

## **2.9 CURTAIN WALL**

- .1 Acceptable Products:
  - .1 Prevest: 3400 Series
  - .2 Kawneer: 1600 System 1

.3 Alumicor: 2500 Series

Overall mullion depth including caps shall be:

.1 Minimum 150 mm and 191mm. Refer to drawings.

.2 Provide reinforcing of mullions as required. Caps shall be 19 mm.

The system shall be designed to meet wind load requirements, maximum stress of 0.96 KPA (20 PSI) and have a maximum deflection of L/200 of the span.

.2 The entire curtain wall system shall be designed according to the "Open Rain Screen" principle and shall provide:

.1 Gaskets, sleeved spigotted joints, and seals necessary to ensure rain water does not enter the cavities of the system.

.3 Mullion sections shall be tubular extruded sections when the system is designed for spigot joinery, and split mullion extruded sections when screw spline joinery is to be used. Incorporate split mullions as required to allow for thermal expansion, and at curved windows.

.4 All horizontal sections shall form equalized pressure and sealed gutter members.

.5 Vertical expansion and construction joints shall be sleeved spigotted joints between mullion ends in combination with an applied sealant.

.6 Provide structural steel supports, brackets and all anchoring to building structure, anchors shall have three-way adjustment. Welding shall be completed after curtain wall is aligned. Touch up painting of welded areas shall be done on site.

## **2.10 VENTILATING SASH FABRICATION**

.1 Operating windows shall conform to CAN/CSA-A440-M90 classification A3, B3, C2, I60, S2, and G2.

.2 Windows shall be designed to withstand wind load criteria as laid down in the Ontario Building Code with a maximum deflection of L/200 span.

.3 Ventilating sashes shall be bottom hinged and projecting in, or top hinged and projecting out, located as shown on the drawings.

.4 Acceptable Products:

.1 Kawneer Series 526 Isoport

.2 Alumicor Series 1350

.3 Prevost Series 1300

All operable windows to be thermally broken and rain screen principle.

.5 One piece sill adaptor shall be sloped to exterior for weathering.

- .6 Entire perimeter of sash shall close on double flexible vinyl weatherstripping inserted into integral grooves in extruded aluminum sash and weathering section giving two point weathering contact.
- .7 Positive aligning corner clips, inserted into integral grooves to exterior face of sash.
- .8 Glazing stops shall be snap-in type installed from the interior and held in place by means of integral groove in sash surround.
- .9 Sash members shall be factory assembled with corners machine cut at 45 deg. With concealed structural corner fastening.
- .10 As required, reinforce sashes to size of units.

## **2.11 ALUMINUM DOORS FABRICATION**

- .1 Acceptable Products:
  - .1 Prevost, Series 2250 with optional 166 mm (6 1/2") bottom rail and 102 mm (4") midrail.
  - .2 Alumicor, Canadiana Insuldoor 400A with optional 104.8 mm (4 1/8") midrail and a 143mm (5 5/8") top rail.
  - .3 Kawneer, Insulclad 360 with a 100mm (4") midrail and a 127mm (5") top rail.
- .2 Glazing stops: interlocking snap-in type for dry glazing. Exterior stops: tamperproof type.
- .3 Provide thermally broken doors for exterior.
- .4 Hardware: Supplier by Specification Section 08 71 00.
- .5 Insulated Panels (if required, refer to drawings): Solid lower panel consisting of .80 aluminum sheet each side or 3/4" plywood core. Finish to match door and frame.
- .6 Fabricate doors and frames to profiles and maximum face sizes as indicated. Provide minimum 22 mm bite for insulating glazed units.
- .7 Provide structural steel reinforcement as required.
- .8 Fit joints tightly and secure mechanically.
- .9 Conceal fastenings.
- .10 Mortise, reinforce, drill and tap doors, frames and reinforcements to receive hardware using templates provided under Section 08 71 00 - Door Hardware

## **PART 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions: verify conditions of substrates previously installed under other Sections or Contracts are acceptable for aluminum curtain wall installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate.
  - .2 Verify dimensions, tolerances, and method of attachment with other work.

- .3 Verify wall openings and adjoining air barrier and vapour retarder materials are ready to receive work of this Section.
- .4 Inform Consultant of unacceptable conditions immediately upon discovery.
- .5 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 INSTALLATION OF CURTAIN WALL SYSTEMS, WINDOWS AND DOORS**

- .1 Install in accordance with CAN/CSA-A440.
- .2 Install in accordance with approved shop drawings and with manufacturer's instructions.
- .3 Install framing plumb, level, square, free from warp, twist or other defect, and anchor securely to provide adequate resistance.
- .4 Provide all steel angles, brackets, supports, and anchors required for complete installation.
- .5 Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- .6 Make adequate provisions for thermal expansion of framing. Fasteners at window heads shall allow for minimum 12mm deflection of the building structure.
- .7 Secure and shim windows with non-corrosive and inorganic material. Anchor clips, blocking, shims, and all other attachments shall be concealed.
- .8 Install steel reinforcing in aluminum frames where necessary to meet performance requirement.
- .9 Provide all fastening and clips required for positive fastening of framing to concrete wall and concrete block wall.
- .10 Aluminum shall be isolated from dissimilar materials by means of suitable alkali-resistant material such as bituminous paint, baked enamel, epoxy resin solution or zinc chromate paint. Follow manufacturer's recommendations.
- .11 Use thermal isolation where components penetrate or disrupt building insulation.
- .12 Coordinate attachment and seal of perimeter air barrier and vapour retarder materials.
- .13 Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- .14 Install doors and hardware in accordance with hardware templates and manufacturer's instructions.
- .15 Adjust door components to ensure smooth operation.
- .16 Install glass and infill panels in accordance with Section 08 80 50 – Glazing. Place sealant on the up-slope side of the pressure plate cover caps; finish the surface with a slope to encourage drainage over the cap. Cover caps to conceal screws and ensure continuous sightline.

- .17 Install perimeter sealant to method required to achieve performance criteria. Backing materials, and installation criteria in accordance with Section 07 92 00 - Joint Sealants

### **3.3 SILL INSTALLATION**

- .1 Install aluminum sills with uniform wash to exterior, level in length, straight in alignment with plumb upstands and faces.
- .2 Site measure every window opening to ensure accurate fit.
- .3 Secure sills in place with anchoring devices located at joints of continuous sills and evenly spaced 600 mm oc in between.
- .4 Fasten expansion joint cover plates and drip deflectors with self tapping stainless steel screws.

### **3.4 CAULKING**

- .1 Seal joints between windows and window sills with sealant. Bed sill expansion joint cover plates and drip deflectors in bedding compound. Caulk between sill upstand and window-frame. Caulk butt joints in continuous sills.
- .2 Apply sealant in accordance with Section 07900 - Joint Sealers. Conceal sealant within window units except where exposed use is permitted by Architect.

### **3.5 DELIVERY AND STORAGE**

- .1 Deliver, store and handle windows to prevent damage. Replace all damaged products with new, undamaged products which confirm to the Specification.
- .2 Cross brace large window units for shipping and protect finished surfaces with protective wrappings.

### **3.6 PROTECTION DURING CONSTRUCTION**

- .1 During construction protect windows and glass against damage from plaster, mortar, and any other cause.
- .2 Protect pre-finished aluminum surfaces with protective coatings and wrappings, until installation of glazing commences. Ensure that method of protection does not damage finish.

### **3.7 CLEANING**

- .1 Before turning the building over to the Owner During, clean the exposed glass and aluminum surfaces. Do not use abrasive materials on anodized and painted surfaces.

**END OF SECTION**

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**Part 1            General**

**1.1               SUMMARY**

- .1      Section Includes: Finish Hardware for door openings, except as otherwise specified herein.
  - 1.      Door hardware for steel (hollow metal) doors.
  - 2.      Door hardware for aluminum doors.
  - 3.      Keyed cylinders as indicated.
- .2      Intent of Hardware Groups
  - .1      Should items of hardware not definitely specified be required for completion of the Work, furnish such items of type and quality comparable to adjacent hardware and appropriate for service required.
  - .2      Where items of hardware aren't definitely or correctly specified, are required for completion of the Work, a written statement of such omission, error, or other discrepancy to Consultant, prior to date specified for receipt of bids for clarification by addendum; or, furnish such items in the type and quality established by this specification, and appropriate to the service intended.

**1.2               SUBMITTALS**

- .1      Comply with Section 01 33 00 - Submittals.
  - .2      Special Submittal Requirements: Combine submittals of this Section with Sections listed below to ensure the "design intent" of the system/assembly is understood and can be reviewed together.
  - .3      Product Data: Manufacturer's specifications and technical data including the following:
    - .1      Detailed specification of construction and fabrication.
    - .2      Manufacturer's installation instructions.
    - .3      Wiring diagrams for each electric product specified. Coordinate voltage with electrical before submitting.
    - .4      Submit copies of catalog cuts with hardware schedule. Refer to submittals specification section.
  - .4      Shop Drawings - Hardware Schedule: Submit complete reproducible copy of detailed hardware schedule in a vertical format. Refer to submittals' specification section.
    - .1      List groups and suffixes in proper sequence.
    - .2      Completely describe door and list architectural door number.
    - .3      Manufacturer, product name, and catalog number.
    - .4      Function, type, and style.
    - .5      Size and finish of each item.
    - .6      Mounting heights.
    - .7      Explanation of abbreviations and symbols used within schedule.
    - .8      Detailed wiring diagrams, specially developed for each opening, indicating all electric hardware, security equipment and access control equipment, and door and frame rough ins required for specific opening.
-



- .5 Templates: Submit templates and "reviewed Hardware Schedule" to door and frame supplier and others as applicable to enable proper and accurate sizing and locations of cutouts and reinforcing.
  - .1 Templates, wiring diagrams and "reviewed Hardware Schedule" of electrical terms to electrical for coordination and verification of voltages and locations.
- .6 Samples:
  - .1 1 sample of Lever and Rose/Escutcheon design, (pair).
  - .2 3 samples of metal finishes
- .7 Contract Closeout Submittals: Comply with Division 1 including specific requirements indicated.
  - .1 Operating and maintenance manuals: Submit 3 sets containing the following.
    - .1 Complete information in care, maintenance, and adjustment, and data on repair and replacement parts, and information on preservation of finishes.
    - .2 Catalog pages for each product.
    - .3 Name, address, and phone number of local representatives for each manufacturer.
    - .4 Parts list for each product.
  - .2 Copy of final hardware schedule, edited to reflect, "As installed".
  - .3 Copy of final keying schedule
  - .4 As installed "Wiring Diagrams" for each piece of hardware connected to power, both low voltage and 110 volts.
  - .5 One set of special tools required for maintenance and adjustment of hardware, including changing cylinders.

### **1.3 QUALITY ASSURANCE**

- .1 Comply with Division 1.
  - .1 Statement of qualification for distributor and installers.
  - .2 Statement of compliance with regulatory requirements and single source responsibility.
  - .3 Distributor's Qualifications: Firm with 3 years' experience in the distribution of commercial hardware.
    - 1. Distributor to employ full-time Architectural Hardware Consultants (AHC) for the purpose of scheduling and coordinating hardware and establishing keying schedule.
    - 2. Hardware Schedule shall be prepared and signed by an AHC or equivalent.
  - .4 Installer's Qualifications: Firm with 3 years' experience in installation of similar hardware to that required for this Project, including specific requirements indicated.

- .5 Regulatory Label Requirements: Provide testing agency label or stamp on hardware for labeled openings.
  - 1. Provide ULC listed hardware for labeled and 20-minute openings in conformance with requirements for class of opening scheduled.
  - 2. Underwriters Laboratories requirements have precedence over this specification where conflict exists.
- .6 Single Source Responsibility: Except where specified in hardware schedule, furnish products of only one manufacturer for each type of hardware.
- .2 Review Project for extent of finish hardware required to complete the Work. Where there is a conflict between these Specifications and the existing hardware, notify the Consultant in writing and furnish hardware in compliance with the Specification unless otherwise directed in writing by the Consultant.

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

- .1 Packing and Shipping: Comply with Division 1
  - .1 Deliver products in original unopened packaging with legible manufacturer's identification.
  - .2 Package hardware to prevent damage during transit and storage.
  - .3 Mark hardware to correspond with "reviewed hardware schedule".
  - .4 Deliver hardware to door and frame manufacturer upon request.
- .2 Storage and Protection: Comply with manufacturer's recommendations.

#### **1.5 PROJECT CONDITIONS**

- .1 Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thickness, profile, swing, security and similar requirements indicated, as necessary for the proper installation and function, regardless of omissions or conflicts in the information on the Contract Documents.
- .2 Review Shop Drawings for doors and entrances to confirm that adequate provisions will be made for the proper installation of hardware.

#### **1.6 WARRANTY**

- .1 Manufacturer's Warranty:
  - .1 Closers: Ten years
  - .2 Exit Devices: Three Years
  - .3 Locksets & Cylinders: Three years
  - .4 All other Hardware: Two years.

#### **1.7 OWNER'S INSTRUCTION**

- .1 Instruct Owner's personnel in operation and maintenance of hardware units.

## 1.8 MAINTENANCE

- .1 Extra Service Materials: Deliver to Owner extra materials from same production run as products installed. Package products with protective covering and identify with descriptive labels. Comply with Division 1 Closeout Submittals Section.
- .1 Special Tools: Provide special wrenches and tools applicable to each different or special hardware component.
- .2 Maintenance Tools: Provide maintenance tools and accessories supplied by hardware component manufacturer.
- .3 Delivery, Storage and Protection: Comply with Owner's requirements for delivery, storage and protection of extra service materials.

## Part 2 Products

### 2.1 MANUFACTURERS

- .1 The following manufacturers are accepted subject to compliance with requirements of the Contract Documents. Acceptance of manufacturers other than those listed shall be in accordance with Division 1.

<u>Item:</u>	<u>Manufacturer:</u>	<u>Accepted Alternative:</u>
Hinges	Stanley	Hagar, McKinney, Ives
Continuous Hinges	Hagar-Roton	Select, McKinney, Ives
Locksets/Cylinders	Sargent	No Substitution
Exit Devices	Sargent AD 8500	Stanley Apex 200, VonDuprin 98F firerated to accept 7 pin Stanley/Best Cylinder
Closers	LCN 4040XP, 4041	No substitution
Automatic Operators	Stanley MagicForce	No substitution
Push/Pull Plates	Gallery	CBH
Protection Plates	Gallery	CGH
Overhead Stops *	Glynn Johnson	Rixon, Hagar, Sargent, Gallery
Door Stops	Gallery	CBH
Flush Bolts	Gallery	CBH
Coordinator & Brackets	Ives	Hager
Key Cabinet	Telkee	or as Accepted by Consultant
Threshold & Gasketing	KN Crowder	Pemko

\* hardware supplier to ensure OH stop is compatible with LCN closer.

### 2.2 MATERIALS

- .1 Hinges:
1. Template screw hole locations
  2. Minimum of 2 permanently lubricated non-detachable bearings
  3. Equip with easily seated, non-rising pins
  4. Sufficient size to allow 180-degree swing of door
  5. Furnish hinges with five knuckles and flush bearings

6. Provide hinge type as listed in schedule.
7. Furnish 3 hinges per leaf to 7 foot 6 inch height. Add one for each additional 30 inches in height or fraction thereof.
8. Tested and approved by BHMA for all applicable ANSI Standards for type, size, function and finish
9. UL10B listed for Fire

.2 Geared Continuous Hinges:

1. Tested and approved by BHMA for ANSI A156.26-1996 Grade 1
2. Anti-spinning through fastener
3. UL10B listed for 3-hour Fire rating
4. Non-handed
5. Lifetime warranty
6. Provide Fire Pins for 3-hour fire ratings
7. Sufficient size to permit door to swing 180 degrees

.3 Cylindrical Type Locks & Latches:

1. Tested and approved by BHMA for ANSI A156.13, Series 1000, Operational Grade 1, Extra-Heavy Duty, Security Grade 2 and be UL10C
2. Fit ANSI A115.1 door preparation
3. Functions and design as indicated in the hardware groups
4. Solid, 19mm throw, anti-friction latchbolt made of self-lubricating stainless steel
5. Deadbolt functions shall have a 25mm throw bolt made of hardened stainless steel
6. Latch bolt and Deadbolt are to extend into the case a minimum of 9.5mm when fully extended
7. Auxiliary deadlatch to be made of one-piece stainless steel, permanently lubricated
8. Provide sufficient curved strike lip to protect door trim
9. Lever handles must be of forged or cast brass, bronze or stainless-steel construction and conform to ANSI A117.1. Levers that contain a hollow cavity are not acceptable
10. Lock shall have self-aligning, thru-bolted trim
11. Levers to operate a roller bearing spindle hub mechanism
12. Spindle to be designed to prevent forced entry from attacking of lever  
Provide locksets with removable and interchangeable core cylinders.
13. Each lever to have independent spring mechanism controlling it
14. Core face must be the same finish as the lockset
15. Where UNR (universal) locks are shipped, installer is to install locks and adjust all locks to the functions required by the end user.

.4 Exit Devices shall:

1. Tested and approved by BHMA for ANSI 156.3, Grade 1
2. Provide a deadlocking latch bolt.
3. Non-fire rated exit devices shall have cylinder dogging.
4. Touchpad shall be "T" style
5. Exposed components shall be of architectural metals and finishes.
6. Lever design shall match lockset lever design
7. Provide strikes as required by application.

8. Fire exit devices to be listed for UL10C
  9. UL listed for Accident Hazard.
  10. **All exit devices should function at any time to exit the building.**
- .5 Cylinders:
1. Provide the necessary cylinders housing, collars, rings & springs as recommended by the manufacturer for proper installation.
  2. Provide the proper cylinder cams or tail piece as required to operate all locksets and other keyed hardware items listed in the hardware sets. **Provide owner with "Sargent" manufacturer cores. Refer to 2.4 "Keys and Keying below.**
  3. Coordinate and provide as required for related sections.
- .6 Door Closers shall:
1. Tested and approved by BHMA for ANSI 156.4, Grade 1
  2. UL10C certified
  3. Closer shall have extra-duty arms and knuckles
  4. Conform to ANSI 117.1
  5. Maximum 2 - 61.9 mm case projection with non-ferrous cover
  6. Separate adjusting valves for closing and latching speed, and backcheck
  7. Provide adapter plates, shim spacers and blade stop spacers as required by frame and door conditions
  8. Full rack and pinion type closer with 38 mm minimum bore
  9. Mount closers on non-public side of door, unless otherwise noted in specification
  10. Closers shall be non-handed, non-sized and multi-sized 1 through 6
  11. Provide parallel arm unless noted otherwise.
- .7 Door Bolts: Flush bolts for wood or metal doors.
- .1 Provide a set of Automatic bolts ANSI/BHMA 156.3 Type 25 for hollow metal label doors.
  - .2 Provide a set of Automatic bolts ANSI/BHMA 156.3 Type 27 at wood label doors.
  - .3 Manual flush bolts ANSI/BHMA 156.16 at openings where allowed by local authority.
  - .4 Provide Dust Proof Strike ANSI/BHMA 156.16 with flush bolts without thresholds.
- .9 Coordinator and Brackets: Provide a surface mounted coordinator when automatic bolts are used in the hardware set.
1. Coordinator shall comply with ANSI/BHMA A1156.3 Type 21A full width of the opening.
  2. Provide mounting brackets for soffit applied hardware.
  3. Provide hardware preparation (cutouts) for latches as necessary.
- .10 Kickplates: Provide with four beveled edges ANSI J102, 200 mm high by width less 50 mm on single doors and 25 mm on pairs of doors. Furnish oval-head countersunk screws to match finish.
- .11 Mop plates: Provide with four beveled edges ANSI J103, 100 mm high by width less 25 mm on single doors and 25 mm on pairs of doors. Furnish oval-head countersunk screws to match finish.
- .12 Push Plates: Provide with four beveled edges ANSI J301, 1.25mm thickness, size as indicated in hardware set. Furnish oval-head countersunk screws to match finish.

- .13 Pulls: Provide ANSI J401 Pull as listed in hardware set. Provide proper fasteners for door construction.
- .14 Push Pull Bars: Provide ANSI J504, 25.4 mm Dia. Pull and push bar model and series as listed in hardware set. Provide proper fasteners for door construction.
- .15 Doorstops: Provide a dome floor or wall stop for every opening as listed in the hardware sets.
  - 1. Wall stop and floor stop shall be wrought bronze, brass or stainless steel.
  - 2. Provide fastener suitable for wall construction.
  - 3. Coordinate reinforcement of walls where wall stop is specified.
  - 4. Provide dome stops where wall stops are not practical. Provide spacers or carpet riser for floor conditions encountered
- .16 Over Head Stops: Provide a Surface mounted or concealed overhead when a floor or wall stop cannot be used or when listed in the hardware set.
  - .1 Surface overhead stops shall be heavy duty bronze or stainless steel.
- .17 Seals: All seals shall be finished to match adjacent frame color. Seals shall be furnished as listed in schedule. Material shall be UL listed for labeled openings.
- .18 Weatherstripping: Provide at head and jambs only those units where resilient or flexible seal strip is easily replaceable. Where bar-type weatherstrip is used with parallel arm mounted closers install weatherstrip first.
  - .1 Weatherstrip shall be resilient seal of (Neoprene, Polyurethane, Neoprene, Vinyl, Pile, Nylon Brush, Silicone)
  - .2 UL10C Positive Pressure rated seal set when required.
  - .3 UL10B classified seal set for rated fire doors.
  - .4 Weatherstrip to be installed before certain items of hardware as described in schedule.
- .19 Door Bottoms/Sweeps: Surface mounted or concealed door bottom where listed in the hardware sets.
  - .1 Door seal shall be resilient seal of (Neoprene, Polyurethane, Neoprene, Nylon Brush, Silicone)
  - .2 UL10C Positive Pressure rated seal set when required.
  - .3 UL10B classified seal set for rated fire doors.
- .20 Thresholds: Thresholds shall be aluminum beveled type with maximum height of 12 mm for conformance with ADA requirements. Furnish as specified and per details. Provide fasteners and screws suitable for floor conditions. Width of threshold to be depth of door frame plus extend onto exterior landing min 12.7mm. Site verify depth of threshold at each entrance. Incorrectly installed depth and failure to confirm site conditions of threshold will be replaced at no cost to owner.
- .21 Key Control: Provide one wall mounted key cabinet complete with hooks, index and tags.
- .22 Silencers: Furnish silencers on all interior frames, 3 for single doors, 2 for pairs. Omit where any type of seals occurs.
- .23 Automatic Operators:
  - .1 Be listed under UL10C and UL3 25.

- .2 Be capable of functioning on doors weighing up to 158 kg.
- .3 Confirm to ANSI A156.10 and A156.19 and be suitable for use in both full energy and low energy applications.
- .4 Be non-handed.
- .5 Incorporate the following adjustment capabilities: opening force, closing force, open speed, close speed, and open check speed.
- .6 Incorporate a non-ferrous cover not exceeding 150mm square in section.
- .7 Incorporate a separate On-Off-Hold Open switch within Hood.
- .8 Be controlled by microprocessor and incorporate a position encoder.
- .9 Readily function with standard activation and safety sensors provide activation devices as required.
- .10 Function as a manual door closer without power applied and shall power open/spring close with power applied.
- .11 Function with 115 VAC electrical service for operator and standard low voltage connections for activation.
- .12 Units must be FURNISHED and INSTALLED.
- .13 Automatic operator to be Stanley Magic Force series. **No Alternate**

## 2.3 FINISH

- .1 Designations used in Schedule of Finish Hardware - 3.05, and elsewhere to indicate hardware finishes are those listed in ANSI/BHMA A156.18 including coordination with traditional U.S. finishes shown by certain manufacturers for their products
- .2 Powder coat door closers to match other hardware, unless otherwise noted.
- .3 Aluminum items shall be finished to match predominant adjacent material. Seals to coordinate with frame color.

## 2.4 KEYS AND KEYING

- .1 Cylinders to be keyed into school's existing system.
- .2 Furnish keys in the following quantities:
  - .1 2 each Change keys each keyed cylinder.
- .3 Hardware supplier to supply cylinders in school's existing keyway.
- .4 **Keying of new cylinders into School's existing system is by General Contractor. General Contractor is to provide locksmith to key to school's keying system. General Contractor is to coordinate with Owner including School Maintenance staff for keying. Keying services to be purchased by General Contractor and is not School Board's scope of work.**
- .5 Finish hardware supplier to provide keying schedule.

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**Part 3            Execution**

**3.1                EXAMINATION**

- .1        Verification of conditions: Examine doors, frames, related items and conditions under which Work is to be performed and identify conditions detrimental to proper and or timely completion.
  - .1            Do not proceed until unsatisfactory conditions have been corrected.

**3.2                HARDWARE LOCATIONS**

- .1        Mount hardware units at heights indicated in the following publications except as specifically indicated or required to comply with the governing regulations.
  - .1            Recommended Locations for Builder's Hardware for Standard Steel Doors and Frames, by the Door and Hardware Institute (DHI).
  - .2            NWWDA Industry Standard I.S.1.7, Hardware Locations for Wood Flush Doors.

**3.3                INSTALLATION**

- .1        Install each hardware item per manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed on the substrate. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.
- .2        Conform to local governing agency security ordinance.
- .3        ADA Standard: Conform to ANSI A117.1 for positioning requirements for disabled.
- .4        Installed hardware using the manufacturer's fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use "Riv-Nuts" or similar products.

**3.4                FIELD QUALITY CONTROL AND FINAL ADJUSTMENT**

- .1        Contractor/Installers, Field Services: After installation is complete, contractor shall inspect completed door openings on site to verify installation of hardware is complete and properly adjusted, in accordance with both the Contract Documents and final shop drawings.
    - .1            Check and adjust closers to ensure proper operation.
      - .1                Adjust closer to complete full closing cycle in less than 4 to 6 seconds without abrupt change of speed between "Sweep" and "Latch" speeds.
      - .2                Adjust "Backcheck" according to manufacturer's instructions.
      - .3                Set exterior doors closer to have 8.5 lbs maximum pressure to open, interior non-rated at 5 lbs, rated openings at 12 lbs
    - .2            Check latchset, lockset, and exit devices are properly installed and adjusted to ensure proper operation.
      - .1                Verify levers are free from binding.
-



- .2 Ensure latch bolts and dead bolts are engaged into strike and hardware is functioning.
- .3 Report findings, in writing, to Consultant and hardware supplier outlining corrective actions and recommendations.

### 3.5

#### MANUFACTURE LIST:

<u>Code</u>	<u>Name</u>
<b>MK</b>	<b>Master Key</b>
IVE	Ives
GS	Gallery Specialty Hardware
HA	Hager
KN	K.N. Crowder, Inc.
LCN	LCN Closers
PR	Precision
RO	Rockwood
RX	Rixson
SAR	Sargent
ST	Stanley
TK	Telkee
GLY	Glynn Johnson

#### Finish List

<u>Code</u>	<u>Description</u>
AL	Aluminum
CA	Clear Anodized
EN	Sprayed Finish, Aluminum
PC	Prime Coat
26D	Satin Chrome
32D	Satin Stainless Steel
626	Satin Chromium Plated
628	Satin Aluminum, Clear Anodized
630	Satin Stainless Steel
652	Satin Chromium Plated
USP	Spray Primed
GREY	Grey
US26D	Chromium Plated, Dull
US32D	Stainless Steel, Dull

  

<u>Code</u>	<u>Description</u>
12	UL FIRE LABEL EXIT DEVICES
16	CYLINDER DOGGING FEATURE
55	SIGNAL SWITCH
56	REMOTE DOGGING/LATCH RETRACTION
NRP	NON REMOVEABLE PIN STD/HEAVY WT HINGE
TAC	TACTILE LEVERS
C208	CYLINDER CAM
R705	STRAIGHT CYLINDER RING – 7.9mm

### 3.6 SCHEDULE OF FINISH HARDWARE:

#### **Heading No.1**

1 Pair of Existing Doors

#### **Doors V-01, Existing 2x alum doors**

1	Provide aluminum thermal broken Handicap threshold. Max 12.7mm high. Provide full depth of door frame plus extend over exterior expansion joint and concrete slab/landing (over concrete slab/landing min 12.7mm). Provide shop drawing. Site verify depth required.		
2	Continuous Hinge	780-112 HD +/-2153mm – LHR/RHR	Clear
1	Exit device	16-31-AD8510 F, LHR MK	US32D
1	Exit device	16-31-AD8504 F, RHR MK	US32D
1	Cylinder	34 MK (For exterior)	26D
2	Cylinder	41 MK (Cyl. Dogging)	26D
2	Door Pull	1180-2 x #4B x 57	US32D
1	Electric strike	HES 9600 (12 volt) c/w shim * Strike supplier to confirm voltage	US32D
1	Auto Operator	Stanley Magic Force (No Alternate) *Operator arm to clear overhead stop	CLA
3	Cylinder & Core	42 MK	US26D
2	Surface Closer	4040 XP LONG AL Closer to be top jamb mounted	AL
2	Mounting Plate	4040 XP-18G	US32D
2	Overhead Door Stop	104S US32D	US32D
2	Door Sweep	W-38S x 965mm	CA
1	Card Reader	by Low Voltage Cabling Contractor (Installed on Center Mullion)	
2	Door Contact	DPS-M	BLK
1	WIRE HARNESS	Power Supply to Frame	

#### **Heading No.2**

1 PR Double Doors, Exterior from Vestibule V-02

#### **V-02, 2x 883 x 2150 x 57 – AL DR x AL FR LHR/RHR**

2	Continuous Hinge	780-112 HD +/-2153mm – LHR/RHR	Clear
1	Exit device	16-31-AD8510 F, LHR MK	US32D
1	Exit device	16-31-AD8504 F, RHR MK	US32D
1	Cylinder	34 MK (For exterior)	26D
2	Cylinder	41 MK (Cyl. Dogging)	26D
2	Door Pull	1180-2 x #4B x 57	US32D
1	Electric strike	HES 9600 (12 volt) c/w shim * Strike supplier to confirm voltage	US32D
1	Auto Operator	Stanley Magic Force (No Alternate) *Operator arm to clear overhead stop	CLA
3	Cylinder & Core	42 MK	US26D
2	Surface Closer	4040 XP LONG AL Closer to be top jamb mounted	AL
2	Mounting Plate	4040 XP-18G	US32D
2	Overhead Door Stop	104S US32D	US32D

2	Door Sweep	W-38S x 965mm	CA
1	Card Reader	by Low Voltage Cabling Contractor (Installed on Center Mullion)	
2	Door Contact	DPS-M	BLK
1	WIRE HARNESS	Power Supply to Frame	

Cylinders to match existing locks.

Weatherstrip and thermally broken threshold by door supplier

Door supplier to ensure door can accommodate overhead stop

Door supplier to provide adjustments and/or strike to mount on the base of the frame, stop removed where strike is and exit device placement adjusted.

#### **Mode of Operation**

Exit device to be locked at all times.

Electric strike is on at all times

Card Reader is connected to electric strike and to the Kantech Controller

Refer to Electrical.

#### **Heading No.3**

1 Single Door, Exterior from Vestibule V-03

**Door V-03**, 965 x +/-2107 x 57 – AL DR x AL FR LHR

1	Continuous Hinge	780-112 HD 2125mm	AL
1	Exit device	16-31-AD8504 F,	US10B/613
1	Cylinder	34 MK (For exterior)	26D
1	Cylinder	41 MK (Cyl. Dogging)	26D
1	Door Pull	1180-2 x #4B x 57	US10B/613
1	Surface Closer	4040 XP LONG AL	AL/US10B/613
		Closer to be top jamb mounted	
1	Mounting Plate	4040 XP-18G	AL/US10B/613
1	Overhead Door Stop	104S	US10B/613

Weatherstrip and thermal broken threshold by door supplier

Door supplier to ensure door can accommodate overhead stop

#### **Heading No.4**

1 PR Double Doors, Exterior from Vestibule V-04

1 PR Double Doors, Exterior from Vestibule V-05

**Doors V-04**, 2x 965 x +/-2107 x 57 – AL DR x AL FR LHR/RHR

**Doors V-05**, 2x 965 x +/-2107 x 57 – AL DR x AL FR LHR/RHR

4	Continuous Hinge	780-112 HD +/-2153mm – LHR/RHR	Clear
2	Exit device	16-31-AD8510 F, LHR MK	US32D
2	Exit device	16-31-AD8504 F, RHR MK	US32D
4	Door Pull	1180-2 x #4B x 57	US32D
2	Electric strike	HES 9600 (12 volt) c/w shim	US32D
		* Strike supplier to confirm voltage	
2	Cylinder	34 MK (For exterior)	26D
4	Cylinder	41 MK (Cyl. Dogging)	26D
4	Surface Closer	4040 XP LONG AL	AL
		Closer to be top jamb mounted	
4	Mounting Plate	4040 XP-18G	US32D
4	Overhead Door Stop	104S US32D	US32D
4	Door Sweep	W-38S x 965mm	CA

2	Card Reader	by Low Voltage Cabling Contractor (Installed on Center Mullion)
4	Door Contact	DPS-M BLK
2	WIRE HARNESS	Power Supply to Frame

Cylinders to match existing locks.

Weatherstrip and thermally broken threshold by door supplier

Door supplier to ensure door can accommodate overhead stop

Door supplier to provide adjustments and/or strike to mount on the base of the frame, stop removed where strike is and exit device placement adjusted.

#### **Mode of Operation**

Exit device to be locked at all times.

Electric strike is on at all times

Card Reader is connected to electric strike and to the Kantech Controller

Refer to Electrical.

#### **Heading No.5.**

1 PR Double Doors, Exterior from Vestibule V-06

**Doors V-06**, 2x 883 x +/-2107 x 57 – AL DR x AL FR LHR/RHR

2	Continuous Hinge	780-112 HD +/-2153mm – LHR/RHR	Clear
1	Exit device	16-31-AD8510 F, LHR MK	US32D
1	Exit device	16-31-AD8504 F, RHR MK	US32D
1	Cylinder	34 MK (For exterior)	26D
2	Cylinder	41 MK (Cyl. Dogging)	26D
2	Door Pull	1180-2 x #4B x 57	US32D
1	Electric strike	HES 9600 (12 volt) c/w shim	US32D
		* Strike supplier to confirm voltage	
1	Auto Operator	Stanley Magic Force (No Alternate)	CLA
		*Operator arm to clear overhead stop	
1	Sequencer c/w Input relays	by Auto Operator Supplier/Installer–Camden	CX-33
2	Actuators	Wireless Actuator Kit-CM-RFL602D-69WT	
2	Overhead Door Stop	104S	US32D
2	Door Sweep	W-38S x 965mm	CA
1	Surface Closer	4040 XP LONG AL	US32D
		Closer to be top jamb mounted	
1	Key Switch	960N-MA x 28	SS
		(In mullion. Exact location on site)	
1	Mounting plate	4040 XP-18G	
1	Card Reader	by Low Voltage Cabling Contractor (Installed on Center Mullion)	P225XSF
2	Door Contact	DPS-M	BLK
1	POWER SUPPLY	BPS-24-1	LGR
1	WIRE HARNESS	Power Supply to Frame	
1	WIRE HARNESS	Power Supply	

Cylinders to match existing locks.

Weatherstrip and thermally broken threshold by door supplier

Door supplier to ensure door can accommodate overhead stop

Door supplier to provide adjustments and/or strike to mount on the base of the frame, stop removed where strike is and exit device placement adjusted.

Auto Operator supplier/installer is responsible for the mode of operation. Auto operator installer/supplier is to provide an anodized aluminum custom mounting plate from operator hood to door frame.

**Mode of Operation:**

Exit device to be locked at all times.

Pushing inside actuator momentarily opens electric strike and begins operator cycle at all times.

Pushing Outside actuator begins operator cycle at all times but does not operate electric strike. Actuator is turned off by key switch at lock up.

Provide AiPhone to electric strike.

Card Reader is connected to electric strike and to the Kanteck controller

**Consult with owner for wiring sequence of electric strike and accessible automatic BF operator prior to construction.**

**Heading No.6**

**Door G-01**, 1x +/-915 x +/-2134 x 45 – HM DR x Existing HM FR to remain. Site Verify for new door.

1 Single Door, Exterior from Gym (North side), LHR-Confirm on site

**Door G-02**, 1x +/-915 x +/-2134 x 45 – HM DR x Existing HM FR to remain. Site Verify for new door.

1 Single Door, Exterior from Gym (south side), RHR confirm on site

2	Continuous Hinge	780-112 HD +/-2130mm – RHR	Clear
	Note: Provide any misc. metal, adjustments and repairs to existing hollow metal doors frame such that a new continuous hinge can be installed.		
2	Exit device	16-31-AD8504 F, ETL	US10B/613
2	Cylinder	34 MK (For exterior)	26D
2	Cylinder	41 MK (Cyl. Dogging)	26D
2	Surface Closer	4040 XP SCUSH LONG AL	AL/US10B/613
		Closer to be top jamb mounted	
2	Mounting Plate	4040 XP-18G	AL/US10B/613
2	Overhead Door Stop	104S	US10B/613
4	Kickplate	194S 200mm X 25mm LDW B4E	630
2	Weatherstripping	W-20S (Head) x W	628
2	Weatherstripping	W-50S (Jamb) x H	628
2	Door Sweeps	W-24S x W	628
2	Threshold	CT-45 x W	627
2	Door Contact	DPS-M	BLK

Weatherstrip and thermal broken threshold by door supplier

Door supplier to ensure door can accommodate overhead stop

**Heading No.7**

**Door S-01 & S-02**, 2x +/-915 x +/-2134 x 45 – HM DR x Existing HM FR to remain. Site Verify for new doors.

2x Double Doors, Exterior from Storage Room, LHR, RHR, Confirm on site.

6	Hinge	Provide 5 knuckle hinges to fit existing	630
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Note: Provide any misc. metal, adjustments and repairs to existing hollow metal doors frame such that the new hinges can be installed.			
1	Cylinder	34 MK (For exterior)	26D
2	Manual Flush Bolts	IVES FB458	626
1	Storeroom Lock	Best 93K7D 14L CMK	626
2	Surface Closer	LCN 4040 XP SHCUSH LONG AL	689
		Closer to be top jamb mounted	
2	Overhead Door Stop	GLY-90H	630
4	Kickplate	194S 200mm X 25mm LDW B4E	630
1	Weatherstripping	W-20S (Head) x W	628
2	Weatherstripping	W-50S (Jamb) x H	628
2	Door Sweeps	W-24S x W	628
1	Astragal	KNC-W-8S	600
1	Threshold	KNC-CT-45 x W	627
2	Door Contact	SCE-679-05HM	BLK

### **Heading No.8**

**Door S-03**, 1x +/-915+(1x395) x +/-2150 x 45 – HM DR x FR. Site Verify for new doors.

2x Double Doors, Exterior from Electrical Service Building (Pre-cast concrete shed), LHR, RHR, Confirm on site.

6	Hinge	Provide 5 knuckle hinges to fit existing	630
Note: Provide any misc. metal, adjustments and repairs to existing hollow metal doors frame such that the new hinges can be installed.			
1	Cylinder	34 MK (For exterior)	26D
2	Manual Flush Bolts	IVES FB458	626
1	Storeroom Lock	Best 93K7D 14L CMK	626
2	Surface Closer	LCN 4040 XP SHCUSH LONG AL	689
		Closer to be top jamb mounted	
2	Overhead Door Stop	GLY-90H	630
4	Kickplate	194S 200mm X 25mm LDW B4E	630
1	Weatherstripping	W-20S (Head) x W	628
2	Weatherstripping	W-50S (Jamb) x H	628
2	Door Sweeps	W-24S x W	628
1	Astragal	KNC-W-8S	600
1	Threshold	KNC-CT-45 x W	627
2	Door Contact	SCE-679-05HM	BLK

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED SECTIONS**

- .1      Section 08 11 00 - Steel Doors and Frames.
- .2      Section 08 11 16 – Aluminum Entrances & Storefront Framing

**1.2            REFERENCES**

- .1      American Society of Civil Engineers, (ASCE)
  - .1          ASCE/SEI 7-10 – Minimum Design Loads for Buildings and Other Structures
- .2      American Society for Testing and Materials (ASTM)
  - .1          ASTM D 2240, Test Method for Rubber Property - Durometer Hardness.
- .3      Canadian General Standards Board (CGSB)
  - .1          CAN/CGSB-12.1, Tempered or Laminated Safety Glass.
  - .2          CAN/CGSB-12.3, Flat, Clear Float Glass.
  - .3          CAN/CGSB-12.6, Transparent (one-way) Mirrors.
  - .4          CAN/CGSB-12.8, Insulating Glass Units.
  - .5          CAN/CGSB-12.9, Spandrel Glass.

**1.3            SYSTEM DESCRIPTION**

- .1      Performance Requirements:
  - .1          Provide continuity of building enclosure vapour and air barrier using glass and glazing materials as follow:
    - .1              Utilize inner light of multiple light sealed units for continuity of air and vapour seal.
- .2      Limit mullion deflection to L/175; with full recovery of glazing materials.
- .3      Size glass units and glass dimensions to limits established in CAN/CGSB-12.20.
  - .1          Design, and verify maximum glass sizes, thickness, strength, for glass types specified, to support design, and maximum allowable uniform static loads, using design factor of 2.5, in accordance with CAN/CGSB 12.20-M, but thickness shall not be less than as indicated in this Section.
- .4      Glass to withstand seismic loads as calculated in accordance with NBC and OBC.
  - .1          Seismic performance: glass shall withstand the effects of earthquake motions determined according to ASCE/SEI 7-10.
    - .1              Importance Factor of this Building: 1 (Normal).
    - .2              Site Class: C.

**1.4            SUBMITTALS**

- .1      Submit shop drawings, product data and samples in accordance with Section 01 33 00 - Submittal Procedures.
  - .2      Product Data:
-

- .1 Submit manufacturer's printed product literature, specifications and data sheets.
- .3 Manufacturer's Instructions:
  - .1 Submit manufacturer's installation instructions.
- .4 Samples:
  - .1 Provide duplicate 300 x 300 mm samples of each glazing type.

## **1.5 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data including cleaning instructions for incorporation into manual specified in Section 01 33 00 - Submittal Procedures.

## **1.6 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.

## **Part 2 Products**

### **2.1 MATERIALS: FLAT GLASS**

- .1 Float glass: to CAN/CGSB-12.3, Glazing quality, 6 mm thick.
- .2 Safety glass (Temp): to CAN/CGSB-12.1, transparent, 6 mm thick.
  - .1 Type 2-tempered.
  - .2 Class B-float.
  - .3 Category: II - 540 J impact resistance.
  - .4 Horizontal tempering.
- .3 Low emissivity (Low E) coating on glass:
  - .1 Performance requirements based on PPG Solarban 60 sputtered/soft (vacuum coated), edge deleted. Other manufacturers acceptable upon compliance with specification requirements.
  - .2 Refer to the performance requirements specified in the vision glass insulating units.

### **2.2 VISION GLASS – INSULATING-GLASS UNITS**

- .1 Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass, qualified according to CAN/CGSB-12.8, and complying with other requirements specified.
- .2 "VG" – vision glass insulating unit: to CAN/CGSB-12.8, double unit:
  - .1 Outer lite: Clear safety (tempered) glass.
  - .2 Inner lite: clear safety (tempered) glass.
  - .3 Glass thickness: 6 mm each light.



- .4 Inter-cavity space thickness: 12 mm with low conductivity spacers, colour selected by Consultant.
- .5 Overall thickness: 25 mm
- .6 Low “e” glass coating: surface number 2.
- .7 Inert gas fill: Argon.
- .8 Glass performance:
  - .1 Visible light transmittance: 70%
  - .2 Visible Refl. out: 11%
  - .3 Visible Refl. In: 12%
  - .4 Total solar energy transmission: 33
  - .5 Total solar energy reflect: 29
  - .6 Winter nighttime U-factor: 0.24
  - .7 Solar heat gain coefficient: 0.38
  - .8 Shading coef: 0.44
  - .9 L.G.S. ration: 1.85
- .3 “ISP”- Insulated Sandwich Panel – Refer to Section 08 11 16 – Aluminum Entrances & Storefront Framing

## **2.3 MATERIALS AND ACCESSORIES**

- .1 Primer, sealers, cleaners: to manufacturer’s standard.
- .2 Setting blocks: Neoprene, 70-90 Shore A durometer hardness to ASTM D 2240, 100 mm long x 6 mm high x width to suit glass thickness.
- .3 Spacer shims: Neoprene or silicone, 50-60 Shore A durometer hardness to ASTM D 2240, 75 mm long x one half height of glazing stop x thickness to suit application. Self-adhesive on one face.
- .4 Glazing tape:
  - .1 Preformed butyl compound, paper released backed.

## **Part 3 Execution**

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

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

### **3.2 EXAMINATION**

- .1 Examine framing glazing, with Installer present, for compliance with the following:
  - .1 Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  - .2 Presence and functioning of weep system.
  - .3 Minimum required face or edge clearances.
  - .4 Effective sealing between joints of glass-framing members.

- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 PREPARATION

- .1 Clean contact surfaces with solvent and wipe dry.
- .2 Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- .3 Prime surfaces scheduled to receive sealant.

### 3.4 GLAZING, GENERAL

- .1 Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- .2 Glazing channel dimensions, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Site conditions during installation.
- .3 Protect glass edges from damage during handling and installation. Remove damaged glass from site and legally dispose of off site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- .4 Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.
- .5 Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- .6 Do not exceed edge pressures stipulated by glass manufacturers for installing glass lights.
- .7 Provide spacers for glass lights where length plus width is larger than 1270 mm as follows:
  - .1 Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
  - .2 Provide 3-mm minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- .8 Provide edge blocking where indicated or needed to prevent glass lights from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- .9 Set glass lights in each series with uniform pattern, draw, bow, and similar characteristics.

- .10 Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- .11 Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

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

- .1 Perform work in accordance with FGMA Glazing Manual for glazing installation methods.
- .2 Cut glazing tape to length and set against permanent stops, projecting 1.6 mm above sight line.
- .3 Place setting blocks at 1/4 points, with edge block maximum 150 mm from corners.
- .4 Rest glazing on setting blocks and push against tape for full contact at perimeter of light or unit.
- .5 Place glazing tape on free perimeter of glazing in same manner described.
- .6 Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
- .7 Knife trim protruding tape.
- .8 Install ceramic fire rated glass in UL labelled doors and UL labelled glazed steel screen frames as detailed on the drawings. Install ceramic fire rated glass in any door and/or steel frame that is within the line of fire separation as depicted on the drawings.

### **3.6 CLEANING**

- .1 Perform cleaning after installation to remove construction and accumulated environmental dirt.
- .2 Remove traces of primer, caulking.
- .3 Remove glazing materials from finish surfaces.
- .4 Remove labels after work is complete.
- .5 Clean glass and mirrors using approved non-abrasive cleaner in accordance with manufacture's instructions.
- .6 Wash film using cleaning solution recommended by film manufacturer.
- .7 Upon completion of installation, remove surplus materials, rubbish, tools and equipment barriers.

### **3.7 PROTECTION OF FINISHED WORK**

- .1 After installation, mark light with an "X" by using removable plastic tape or paste. Do not mark heat absorbing or reflective glass units.

**END OF SECTION**

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**Part 1            General**

**1.1               RELATED REQUIREMENTS**

- .1      Section 06 10 00 - Rough Carpentry.
- .2      Section 07 21 16 - Blanket Insulation.
- .3      Section 07 92 00 - Joint Sealants.
- .4      Section 09 22 16 - Non-Structural Metal Framing.
- .5      Section 09 91 23 – Interior Painting.

**1.2               REFERENCE STANDARDS**

- .1      American Society for Testing and Materials International (ASTM).
  - .1      ASTM C473-19, Standard Test Methods for Physical Testing of Gypsum Panel Products.
  - .2      ASTM C475/C475M-17, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
  - .3      ASTM C840-20, Standard Specification for Application and Finishing of Gypsum Board.
  - .4      ASTM C919-19. Standard Practice for Use of Sealants in Acoustical Applications.
  - .5      ASTM C954-18, Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
  - .6      ASTM C1002-20, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
  - .7      ASTM C1047-19, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
  - .8      ASTM C1177/C1177M-17, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
  - .9      ASTM C1178/C1178M-18, Standard Specification for Glass Mat Water-Resistant Gypsum Backing Board.
  - .10     ASTM C1280-18, Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.
  - .11     ASTM C1396/C1396M-17, Standard Specification for Gypsum Board.
  - .12     ASTM D3273-16, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
- .2      Association of the Wall and Ceilings Industries International (AWCI).
  - .1      AWCI GA-214-2015 Recommended Levels of Gypsum Board Finish.
- .3      Underwriters Laboratories of Canada (ULC).
  - .1      CAN/ULC-S702.1:2014-AMD1, Standard for Mineral Fibre Thermal Insulation for Buildings, Part 1: Material Specification First Amendment to Third Edition.

**1.3               SUBMITTALS**

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

- .1 Submit manufacturer's instructions, printed product literature and data sheets for gypsum board assemblies and include product characteristics, performance criteria, physical size, finish and limitations.

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

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging.
- .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 assemblies from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

#### **1.5 AMBIENT CONDITIONS**

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

### **Part 2 Products**

#### **2.1 MATERIALS**

- .1 Standard board: to ASTM C1396/C1396M, Type X, 12.7 and 15.9 mm thick as indicated, 1200 mm wide by maximum practical length, ends square cut, edges bevelled. CGC and CertainTeed are approved manufacturers.
- .2 Moisture / Mould /Abuse resistant board: to ASTM C1396/C1396M, ASTM C473, ASTM C1629, 15.9 mm thick, Type X, 1200 mm wide by maximum practical length.
  - .1 Moisture Resistance: to ASTM C473, not greater than 5% after 2 hours.
  - .2 Mould Resistance: to ASTM D32373, score 10.
  - .3 Abuse Resistance: to ASTM C1629.
    - .1 Abrasion: Level 3.
    - .2 Indentation: Level 1.
    - .3 Soft Body Impact: Level 2.
    - .4 Hard Body Impact: Level 1.
- .3 Metal furring runners, hangers, tie wires, inserts, anchors: to ASTM C1280, galvanized.
- .4 Resilient drywall furring: 0.5 mm base steel thickness galvanized steel for resilient attachment of standard gypsum board. Use 0.91 mm for abuse/water resistant board.
- .5 Steel drill screws:

- .1 For wood and metal framing: to ASTM C1002, except as indicated.
- .2 For metal framing 0.91 mm and thicker: to ASTM C954.
- .6 Casing beads, corner beads, control joints and edge trim: to ASTM C1047, metal, zinc-coated by hot-dip process, 0.5 mm base thickness, perforated flanges, one-piece length per location.
- .7 Acoustic insulation: Batt and blanket mineral fibre: to CAN/ULC-S702.1, Type 1, Formaldehyde Free, install full depth of stud cavity or as indicated.
- .8 Sealants: in accordance with Section 07 92 00 - Joint Sealants.
- .9 Insulating strip: rubberized, moisture resistant, 3 mm thick closed cell neoprene strip, 12 mm wide, with self-sticking permanent adhesive on one face, lengths as required.
- .10 Joint compound: to ASTM C475, asbestos-free.
- .11 Joint tape:
  - .1 Standard board: paper.
  - .2 Moisture/Mould/Abuse resistant board: glass mesh.
  - .3 Glass mat water-resistant: glass mesh.
  - .4 Tile Backing Panels: As recommended by panel manufacturer.
- .12 Access Doors:
  - .1 Access Door Type **AD1**: Wall application recessed Access Door in public areas. Designed for flush installation in gypsum board and plaster wall assemblies while providing an invisible architectural appearance. Provide Access Door with factory installed layer of 16 mm GWB.
    - .1 Material: mill finish aluminum.
      - .1 Mounting frame: recessed aluminum angle extrusion.
      - .2 Door: recessed aluminum angle extrusion, rounded safety corners, concealed hinges, key operated cylinder cam latch, Abloy compatible, anchor straps, fitted with layer of 16 mm GWB. Door panel: removable.
- .13 Perimeter gypsum board trim at linear metal ceiling junctions:
  - .1 Straight two-piece pre-engineered and pre-finished extruded aluminum gypsum board trim, 102 mm high, integrated and pre-punched tapping flange for gypsum board attachment, colour to later selection to manufacturer's full colour range. Refer to drawings. Inside corners to be mitered at 45 degrees.

## **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 Proceed with installation only after unacceptable conditions have been remedied.

### **3.2 ERECTION**

- .1 Do application and finishing of gypsum board to ASTM C840 except where specified otherwise.

- .2 Erect hangers and runner channels for suspended gypsum board ceilings to ASTM C840 except where specified otherwise.
- .3 Support light fixtures by providing additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .4 Install work level to tolerance of 1:1200.
- .5 Frame with furring channels, perimeter of openings for access panels, light fixtures, diffusers and grilles.
- .6 Furr for gypsum board faced vertical bulkheads within and at termination of ceilings.
- .7 Acoustic insulation
  - .1 Install insulation to maintain continuity acoustical separation.
  - .2 Fit insulation closely around electrical boxes, pipes, ducts, frames and other objects in or passing through insulation.
  - .3 Do not compress insulation to fit into spaces.
  - .4 Keep insulation minimum 75 mm from heat emitting devices such as recessed light fixtures, and minimum 50 mm from sidewalls of CAN/ULC-S604 Type A chimneys and CSA B149.1 Type B and L vents.

### 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 framing or furring using screw fasteners for all layers. Maximum spacing of screws 300 mm on centre.
  - .1 Single-Layer Application:
    - .1 Apply gypsum board on ceilings before application of walls to ASTM C840.
    - .2 Apply gypsum board vertically or horizontally, providing sheet lengths that will minimize end joints.
  - .2 Double-Layer Application:
    - .1 Install gypsum board for base layer and exposed gypsum board for face layer.
    - .2 Apply base layers at right angles to supports unless otherwise indicated.
    - .3 Apply base layer with joints over supports and face layer joints offset at least 250 mm with base layer joints.
- .3 Apply water-resistant gypsum board where epoxy paint to be applied and as indicated on plans. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads.
- .4 Apply glass mat water-resistant gypsum backing board where wall tiles to be applied. Apply water-resistant sealant to edges, ends, cut-outs which expose gypsum core and to fastener heads.
  - .1 Joint treatment: to Section 09 30 13 - Ceramic Tiling.
- .5 Install ceiling boards in direction that will minimize number of end-butt joints. Stagger end joints at least 250 mm.
- .6 Install gypsum board on walls vertically to avoid end-butt joints. At high walls, install boards horizontally with end joints staggered over studs, except where local codes or fire-rated assemblies require vertical application.



- .7 Install gypsum board with face side out.
- .8 Do not install damaged or damp boards.
- .9 Locate edge or end joints over supports. Stagger vertical joints over different studs on opposite sides of wall.

### 3.4 APPLICATION - SEALANT:

- .1 STC-Rated Assemblies:
  - .1 Seal construction at full periphery of partitions, behind control joints, at openings, and penetrations with 12 mm continuous bead of acoustical sealant.
  - .2 Install acoustical sealant at each gypsum board layer in assembly except:
    - .1 For double-layer gypsum board application install maximum two continuous beads, one at each base layer.
  - .3 Comply with ASTM C919 and manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around and through assemblies, including sealing partitions above acoustical ceilings.

### 3.5 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 around perimeter of suspended ceilings.
- .3 Install casing beads where gypsum board butts against surfaces having no trim concealing junction and where indicated. Seal joints with sealant.
- .4 Install insulating strips continuously at edges of gypsum board and casing beads abutting metal window and exterior door frames, to provide thermal break.
- .5 Construct control joints of preformed units set in gypsum board facing and supported independently on both sides of joint.
- .6 Locate control joints where indicated, at changes in substrate construction, at approximate 10 m spacing on runs greater than 20 m, and at approximate 15 m spacing on ceilings.
- .7 Install control joints straight and true.
- .8 Install access doors to electrical and mechanical fixtures specified in respective sections.
  - .1 Rigidly secure frames to furring or framing systems.
- .9 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.
- .10 Gypsum Board Finish: finish gypsum board walls and ceilings to following levels in accordance with AWCI GA-214 Levels of Gypsum Board Finish:
  - .1 Levels of finish:
    - .1 Level 0: No tapping, finishing or accessories required.
      - .1 Location: temporary construction, behind solid paneling where fire or smoke seal is not required.

- .2 Level 1: embed tape for joints and interior angles in joint compound. Surfaces to be free of excess joint compound; tool marks and ridges are acceptable.
  - .1 Location: gypsum board above ceilings, interior side of exterior walls above finished ceilings. Concealed fire separations.
- .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.
  - .1 Location: where gypsum board is to be painted except as indicated below.
- .11 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.
- .12 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.
- .13 Sand lightly to remove burred edges and other imperfections. Avoid sanding adjacent surface of board.
- .14 Completed installation to be smooth, level or plumb, free from waves and other defects and ready for surface finish.

### 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.
- .2 Waste Management: separate waste materials for reuse and recycling.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### 3.7 PROTECTION

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

### 3.8 SCHEDULES

- .1 Construct ULC fire rated assemblies where indicated.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED REQUIREMENTS**

- .1 Section 07 84 00 – Firestopping.
- .2 Section 09 21 16 - Gypsum Board Assemblies.
- .3 Division 22 – Plumbing.

**1.2 REFERENCE STANDARDS**

- .1 American Society for Testing and Materials, (ASTM International).
  - .1 ASTM A653/A653M-20, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .2 ASTM C645-18, Specification for Non-structural Steel Framing Members.
  - .3 ASTM C754-18, Standard Specification for Installation of Steel Framing Members to Receive Screw Attached Gypsum Panel Products.
  - .4 ASTM C1513-18, Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.
  - .5 ASTM E119-18ce1, Standard Test Methods for Fire Tests of Building Construction and Materials.
  - .6 ASTM E814-13a, Standard Test Method for Fire Tests of Penetration Firestop Systems.
- .2 Canadian Standards Association (CSA Group).
  - .1 CSA S136-16, North American Specification for the Design of Cold-Formed Steel Structural Members.
  - .2 CSA A136S1:19, Supplement 1 to the North American Specification for the Design of Cold-Formed Steel Structural Members.
- .3 Definitions:
  - .1 Steel Thickness:
    - .1 Base Steel Thickness: Thickness of bare steel exclusive of coatings.
    - .2 Design Thickness: Target or "nominal" thickness used to determine structural properties of the cold formed Products.
    - .3 Minimum Thickness: Design thickness minus minimum allowable under-tolerance required by CSA S136 (95% of design thickness) or material specification; whichever is more stringent.
    - .4 Designation Thickness: For the purposes of this specification; thicknesses provided will be minimum base steel thicknesses in accordance with CSA S136 as interpreted by Section 01 61 00 and determined by the following table:

Designation Thickness	Minimum Base Steel Thickness		Gauge No. (For reference Only)	Colour
(mils)	(in)	(mm)	Ga	
18	0.0179	0.455	25	Not Painted
33	0.0329	0.836	20	White
43	0.0428	1.087	18	Yellow
54	0.0538	1.367	16	Green

### **1.3 SUBMITTALS**

- .1 Make submittals in accordance with Contract Conditions and Section 01 33 00 - Submittal Procedures.
- .2 For Load-Bearing Metal Framing Above Glazed Partitions and Below Window Sills: Submit Shop Drawings stamped and signed by Professional Engineer registered or licensed in Province of Ontario Canada for load-bearing stud framing as indicated on Drawings.
  - .1 Indicate materials and details in full size scale for top of wall framing, profiles of components, junction between studs and adjacent surfaces, elevations of wall, anchorage details, description of related components, fasteners, and sealants.
  - .2 Indicate location of manufacturer's nameplates.
  - .3 Show size and location of seismic restraints. Include seismic design calculations.
  - .4 Coordinate design and details with fireproofing details with the requirements of Section 07 84 00 – Firestopping.

### **1.4 CLOSEOUT SUBMITTALS**

- .1 Product Data: Supply data for load-bearing structural stud framing for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.
- .2 Record Documentation: In accordance with Section 01 78 00 - Closeout Submittals.
  - .1 List of materials used in framing work.
  - .2 Warranty: Submit warranty documents.

### **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.
- .3 Include firestop top track seal manufacturer's printed installation instructions.
- .4 Stud walls supporting elements other than gypsum board to be engineered. Provide signed and sealed engineering shop drawings by a professional engineer licensed in the Province of Ontario for those specific areas.

### **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19 – Construction Waste Management and Disposal.

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**Part 2 Products**

**2.1 MATERIALS**

- .1 Non-load bearing channel stud framing (includes "firestop top track seals" for interior gypsum board assemblies): to ASTM C645, stud size indicated, roll formed from hot dipped galvanized steel sheet, for screw attachment of gypsum board. Knock-out service holes at 460 mm centres. Minimum base thickness as follows:
    - .1 General interior framing: minimum 0.455 mm thick (25 ga.), based on 359 N/m<sup>2</sup> (7.5 psf) lateral load and L/240 deflection.
    - .2 Framing at abuse-resistant gypsum board walls: 1.024 mm thick (18 ga.).
    - .3 Jamb framing, behind abuse resistant gypsum board, wall mounted televisions, millwork: 0.912 mm.
  - .2 Floor and ceiling tracks: to ASTM C645, in widths to suit stud sizes, 32 mm flange height.
  - .3 Deflection systems:
    - .1 Single track: To ASTM C645, roll formed from hot dipped galvanized steel sheet, Z120 (G40) coating designation to ASTM A653/A653M, single slotted ceiling track.
      - .1 Movement: Allowing up to 25 mm vertical movement
      - .2 Dimensions: 1.09 mm thick x width required.
      - .3 UL classification: 1 and 2 hour fire rating, to ASTM E119 and ASTM E814 for fire and hose stream testing.
  - .4 Metal channel stiffener: 38 x 38 mm size, 1.4mm thick cold rolled steel, coated with rust inhibitive coating.
  - .5 Plenum barrier framing: 0.455 mm (25ga) studs, 41 mm x 32 mm flange, roll formed, hot dipped galvanized.
  - .6 Firestop Top Track Seal: One-piece, pre-formed, polyurethane foam based, firestop seal for use with standard head-joint top tracks and slip-type head joints in fire-rated construction at top of partition to maintain continuity of the fire-resistance-rated assembly indicated. Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle-over the top track.
    - .1 Use only firestop top track seal product that has been CAN/ULC S-115 tested for specific fire-rated construction conditions conforming to construction assembly type, space requirements and fire-rating required for each application.
    - .2 Performance Requirements:
      - .1 Movement: +/- 50 percent.
      - .2 Surface Burning Characteristics CAN/ULC S102: Flame Spread: 15; Smoke Developed: 35.
      - .3 Mold-Mildew Performance ASTM G21-96): Class 0.
      - .4 VOC (LEED): 22 g/l
    - .3 Acceptable Product: Subject to compliance with requirements, provide the following:
      - .1 Model CFS-TTS "Firestop Top Track Seal" by Hilti Canada.
      - .2 CFS-TTS MD Firestop Top Track Seal for Metal deck by Hilti Canada
-

- .7 Smoke and Acoustic Track Seal: One-piece, pre-formed, polyurethane foam based, smoke and acoustic seal for use with standard head-joint top tracks and slip-type head joints in non-fire-rated construction at top. Provide in width and configuration required to accommodate depth and installation of studs and designed to saddle-over the top track.
  - .1 Performance Requirements:
    - .1 Movement: +/- 50 percent.
    - .2 Acoustic Performance: 62
    - .3 Mold-Mildew Performance ASTM G21-96): Class 0.
    - .4 VOC (LEED): 0.2 lb/gal
  - .2 Acceptable Product: Subject to compliance with requirements, provide the following:
    - .1 Model CS-TTS SA "Smoke & Acoustic Top Track Seal" by Hilti Canada.
- .8 Insulating strip: rubberized, moisture resistant 3 mm thick foam strip, 12 mm wide, with self sticking adhesive on one face, lengths as required.
- .9 Fasteners: To ASTM C1513, pan head, corrosion resistant, sized to suit application.

### **Part 3 Execution**

#### **3.1 ERECTION**

- .1 Installation standard to ASTM C754.
- .2 Align partition tracks at floor and ceiling and secure at 600 mm on centre maximum.
- .3 Install tracks (runners) at floors and overhead supports.
  - .1 Fire-Resistance-Rated Partitions:
    - .1 Firestop Top Track Seal: Install to maintain continuity of fire-resistance-rated assembly indicated. Install in accordance with the firestop manufacturer's printed installation instructions.
  - .2 Non-Fire Resistance Rated Partitions:
    - .1 Smoke and Acoustic Track Seal: Install to comply with smoke and acoustic device manufacturer's written installation instructions for products and applications indicated.
- .4 Install damp proof course under stud shoe tracks of partitions on slabs on grade.
- .5 Place studs vertically at 400 mm on centre and not more than 50 mm from abutting walls, and at each side of openings and corners.
  - .1 Position studs in tracks at floor and ceiling.
  - .2 Cross brace steel studs as required to provide rigid installation to manufacturer's instructions.
- .6 Erect metal studding to tolerance of 1:1000.
- .7 Attach studs to bottom track using screws.

- .8 Co-ordinate simultaneous erection of studs with installation of service lines. When erecting studs ensure web openings are aligned.
- .9 Co-ordinate erection of studs with installation of door/window frames and special supports or anchorage for work specified in other Sections.
- .10 Provide two studs extending from floor to ceiling at each side of openings wider than stud centres specified.
  - .1 Secure studs together, 50 mm apart using column clips or other approved means of fastening placed alongside frame anchor clips.
- .11 Erect track at head of door/window openings and sills of sidelight/window openings to accommodate intermediate studs.
  - .1 Secure track to studs at each end, in accordance with manufacturer's instructions. Install intermediate studs above and below openings in same manner and spacing as wall studs.
- .12 Frame openings and around built-in equipment, cabinets, access panels, on four sides. Extend framing into reveals.
  - .1 Check clearances with equipment suppliers.
- .13 Reinforcing:
  - .1 Provide 19 mm plywood blocking secured between studs for attachment of wall mounted items attached to steel stud partitions except where sheet steel indicated.
    - .1 Cut plywood to fill space between webs of adjacent studs, kerf plywood as required to nest in stud flanges.
    - .2 Locate where required by work of other Sections.
  - .2 Provide sheet steel reinforcing where indicated for attachment of wall mounted items.
    - .1 Install stud framing behind entire perimeter of sheet steel reinforcing.
    - .2 Secure reinforcing to face of studs.
    - .3 Withstand minimum 227 kg pull force.
- .14 Install steel studs or furring channel between studs for attaching electrical and other boxes.
- .15 Extend partitions to ceiling height except where noted otherwise on drawings.
- .16 Maintain clearance under beams and structural elements occurring above steel stud partitions to avoid transmission of structural loads to studs. Provide deflection system.
- .17 Install two continuous beads of acoustical sealant under studs and tracks around perimeter of sound control partitions.
- .18 Regulatory Requirements: Install firestop materials in accordance with ULC Fire Resistance Directory or UL Products Certified for Canada (cUL) or Intertek Laboratories.

### **3.2 CLEANING**

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

**END OF SECTION**

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**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 09 21 16 – Gypsum Board Assemblies.

**1.2 REFERENCE STANDARDS**

- .1 American Society for Testing and Materials (ASTM International).
  - .1 ASTM C423-17, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
  - .2 ASTM C635/C635M-17, Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
  - .3 ASTM C636/C636M-19, Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.
  - .4 ASTM E1264-19, Standard Classification for Acoustical Ceiling Products.
  - .5 ASTM E1414/E1414M-21a, Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum.
  - .6 ASTM E1477-98a(2017), Standard Test Method for Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers.
- .2 Health Canada/Workplace Hazardous Materials Information System (WHMIS).
  - .1 Safety Data Sheets (SDS).
- .3 Underwriter's Laboratories of Canada (ULC).
  - .1 CAN/ULC-S102:2018, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
- .4 Canadian Standards Association (CSA).
  - .1 CAN/CSA S832-06 (R2011), Seismic Risk Reduction of Operational and Functional Components (OFCs) of Buildings.
- .5 Ceilings and Interior Systems Construction Association (CISCA).
  - .1 Guidelines for Seismic Restraint for Direct Hung Suspended Ceiling Assemblies.
- .6 Ministry of Municipal Affairs and Housing.
  - .1 Ontario Building Code (2012).

**1.3 SUBMITTALS**

- .1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
  - .1 Submit duplicate 300 x 300 mm samples of each type acoustical units.
- .2 Submit shop drawings in accordance with Section 01 33 00 – Submittal Procedures.
  - .1 Submit reflected ceiling plans for special grid patterns as indicated.
  - .2 Indicate lay-out, insert and hanger spacing and fastening details, splicing method for main and cross runners, and acoustical unit support at ceiling fixture.
- .3 Seismic Design: Submit shop drawings stamped by a professional engineer licensed in the Province of Ontario for all ceiling suspension systems and components to provide seismic restraints.

## **1.4 SAMPLES**

- .1 Submit samples in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit one representative module of each type ceiling suspension system.
- .3 Ceiling system to show basic construction and assembly, treatment at walls, recessed fixtures, splicing, interlocking, finishes, acoustical unit installation.

## **1.5 QUALITY ASSURANCE**

- .1 Source Limitations: Obtain all acoustical ceiling framing components through one source from a single manufacturer.
- .2 Installer Qualifications: Must be experienced in the installation of ceiling systems like those specified in this Section.

## **1.6 DESIGN REQUIREMENTS**

- .1 Maximum Deflection: 1/360th of span to ASTM C635/C635M deflection test.
- .2 Seismic Restraining: Seismic Engineer licensed in the Province of Ontario, to calculate the design forces of the seismic restraints for the ceiling suspension system, in accordance with OBC requirements.
  - .1 Seismic Supplier to submit stamped drawing indicating design force calculations, connection to structures, forces in hanger rods, and conformance with OBC requirements.
  - .2 Consultant will provide site soil classification and the building importance level to the seismic supplier.
  - .3 Consultant will review seismic forces transferred to the structure at restraint points.
  - .4 Seismic restraint of ceiling grids to be in accordance with the Ceilings and Interior Systems Construction Association (CISCA).
  - .5 Hardware used for seismic restraint to be seismically rated by an independent testing facility lab.
  - .6 Power actuated fasteners and drop-in anchors not permitted for tension loads due to the seismic restraint of non-structural elements.
  - .7 Where ceiling area exceeds 232 m<sup>2</sup>, provide seismic separation joint to break ceiling up into areas not exceeding 232 m<sup>2</sup>.
  - .8 Provide perimeter angles and horizontal restraints at each 232 m<sup>2</sup> ceiling areas.

## **1.7 STORAGE AND HANDLING**

- .1 Store materials inside, level, under cover. Protect from weather, damage from construction operations and other causes, in accordance with manufacturer's printed instructions.
- .2 Handle materials to prevent damage to edges or surfaces. Protect metal accessories and trim from being bent or damaged.

## **1.8 EXTRA MATERIALS**

- .1 Provide extra materials in the manufacturer's unopened packaging, with the manufacturer's label intact, as detailed below:

- .1 Suspension System Components – Minimum 5 percent of each type installed.

## **Part 2 Products**

### **2.1 ACOUSTICAL CEILING PANELS**

- .1 Acoustic tile: to CAN/CGSB-92.1 CertainTeed **PBT 197** colour white non-directional fissured tile, fire-rated 610x1220 as indicated on drawings. No Alternate. (Site verify T-bar grid spacing as required)

### **2.2 ACOUSTICAL SUSPENSION SYSTEM**

- .1 Acoustic T-Bar suspension system: CertainTeed Fire Secure Stab system, fire rated system, colour white, 24 mm wide.
- .2 Intermediate duty system to ASTM C635/C635M.
- .3 Basic materials for suspension system: Commercial quality cold rolled steel, zinc coated.
- .4 Suspension System: Fire rated, two directional exposed tee bar grids.
- .5 Exposed tee bar grid components: shop painted satin sheen, white. Components die cut. Main tee with double web, rectangular bulb and rolled cap on exposed face. Cross tee with rectangular bulb; web extended to form positive interlock with main tee webs; lower flange extended and offset to provide flush intersection.
- .6 Hanger Wire: Galvanized soft annealed steel wire, 2.6 mm diameter for access tile ceilings.
- .7 Hanger Inserts: Purpose made.
- .8 Accessories: Splices, clips, wire ties, retainers, and wall molding flush, to complement suspension system components, as recommended by system manufacturer.
- .9 Install outside bullnose track at all bullnose corner unit blocks.

## **Part 3 Execution**

### **3.1 INSTALLATION OF SUSPENSION SYSTEM**

- .1 Installation: In accordance with ASTM C636/C636M, CAN/CSA S832, and CISCA, except where specified otherwise.
- .2 Do not erect ceiling suspension system until work above ceiling has been reviewed and accepted by the Consultant.
- .3 Secure hangers to overhead structure using attachment methods acceptable by the Consultant. Do not suspend from or secure to steel deck.
- .4 Install hangers spaced at maximum 1200 mm centres and within 150 mm from ends of main tees.
- .5 Lay out system according to reflected ceiling plan.
- .6 Install wall moldings to provide correct ceiling height.

- .7 Completed suspension system to support super-imposed loads, such as lighting fixtures diffusers grilles and speakers.
- .8 Support at light fixtures diffusers with additional ceiling suspension hangers within 150 mm of each corner and at maximum 600 mm around perimeter of fixture.
- .9 Interlock cross member to main runner to provide rigid assembly.
- .10 Finished ceiling system to be square with adjoining walls and level within 1:1000.

### **3.2 INSTALLATION OF ACOUSTIC PANELS**

- .1 Install acoustical panels and tiles in ceiling suspension system.
- .2 Co-ordinate ceiling work to accommodate components of other sections, such as light fixtures, diffusers, speakers, sprinkler heads, to be built into acoustical ceiling components.
  - .1 Installation: In accordance with ASTM C636/C636M except where specified otherwise. Provide aluminum faced grid in kitchen.

### **3.3 MAINTENANCE**

- .1 Provide 2 percent of amount of main tees, cross tees and ceiling tiles installed.
- .2 Store on site in location directed by Owner.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED SECTIONS**

- .1      Section 01 33 00 - Submittals
- .2      Section 08 11 14 - Steel Doors and Frames
- .3      Section 09 91 23 – Interior Painting
- .4      Section 32 17 23 - Pavement Markings & Traffic Signs

**1.2            REFERENCES**

- .1      Architectural Painting Specifications Manual, Master Painters Institute (MPI).
- .2      Systems and Specifications Manual, SSPC Painting Manual, Volume Two, Society for Protective Coatings (SSPC).
- .3      Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings) of the Environmental Protection Agency (EPA).
- .4      National Fire Code of Canada.
- .5      SCAQMD Rule#1168 South Coast Air Quality Management District.
- .6      SCAQMD Rule#1113 South Coast Air Quality Management District
- .7      GS-11 Green Seal Environment Standard - Paints.
- .8      GS-03 Green Seal Environmental Standard - Anti-Corrosive Paints.

**1.3            QUALITY ASSURANCE**

- .1      Contractor shall have a minimum of five years proven satisfactory experience. When requested, provide a list of last three comparable jobs including, job name and location, specifying authority, and project manager.
  - .2      Qualified journeymen who have a "Tradesman Qualification Certificate of Proficiency" shall be engaged in painting work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.
  - .3      Conform to latest MPI requirements for exterior painting work including preparation and priming.
  - .4      Materials (primers, paints, coatings, varnishes, stains, lacquers, fillers, thinners, solvents, etc.) shall be in accordance with MPI Painting Specification Manual "Approved Product" listing and shall be from a single manufacturer for each system used.
  - .5      Other paint materials such as linseed oil, shellac, turpentine, etc. shall be the highest quality product of an approved manufacturer listed in MPI Painting Specification Manual and shall be compatible with other coating materials as required.
-

- .6 Retain purchase orders, invoices and other documents to prove conformance with noted MPI requirements when requested by Consultant.
- .7 Standard of Acceptance:
  - .1 Walls: No defects visible from a distance of 1000 mm at 90° to surface.
  - .2 Soffits: No defects visible from floor at 45° to surface when viewed using final lighting source.
  - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

#### **1.4 ENVIRONMENTAL PERFORMANCE REQUIREMENTS**

- .1 Provide paint products meeting MPI "Environmentally Friendly" E2 ratings based on VOC (EPA Method 24) content levels.

#### **1.5 SUBMITTALS**

- .1 Submit product data and manufacturer's installation/application instructions for paints and coating products to be used in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit WHMIS MSDS - Material Safety Data Sheets in accordance with Section 01 33 00 – Submittals.
- .3 Upon completion, submit records of products used. List products in relation to finish system and include the following:
  - .1 Product name, type and use.
  - .2 Manufacturer's product number.
  - .3 Colour numbers.
  - .4 MPI Environmentally Friendly classification system rating.
  - .5 Manufacturer's Material Safety Data Sheets (MSDS).
- .4 The VOC content of paints and coatings used in the interior of the building envelope must be less than the VOC content limits of GS-11 and GS-03 respectively. The VOC content of interior paints and coatings not already covered by GS-11 and GS-03 must be less than the VOC content limits of SCAQMD Rule#1113.
  - .1 Contractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in litres) of each materials used should also be provided.

#### **1.6 SAMPLES**

- .1 Submit samples in accordance with Section 01 33 00 - Submittals.
- .2 Submit 200 x 300 mm sample panels of each paint or stain with specified paint or coating in colours, gloss/sheen and textures required to MPI Painting Specification Manual standards.
- .3 When accepted, samples shall become acceptable standard of quality for appropriate on-site surface with one of each sample retained on-site.
- .4 Submit selection of colours from manufacturer's full range of colours/finishes.

## **1.7 EXTRA MATERIALS**

- .1 Submit maintenance materials in accordance with Section 01 33 00 - Submittals.
- .2 Submit one - four litre can of each type and colour of finish coating. Identify colour and paint type in relation to established colour schedule and finish system.
- .3 Deliver to Contractor and store where directed.

## **1.8 DELIVERY, HANDLING AND STORAGE**

- .1 Deliver and store materials in original containers, sealed, with labels intact.
- .2 Labels shall clearly indicate:
  - .1 Manufacturer's name and address.
  - .2 Type of paint or coating.
  - .3 Compliance with applicable standard.
  - .4 Colour number in accordance with established colour schedule.
- .3 Remove damaged, opened and rejected materials from site.
- .4 Provide and maintain dry, temperature controlled, secure storage.
- .5 Observe manufacturer's recommendations for storage and handling.
- .6 Store materials and supplies away from heat generating devices.
- .7 Store materials and equipment in a well-ventilated area with temperature range 7° C to 30° C.
- .8 Store temperature sensitive products above minimum temperature as recommended by manufacturer.
- .9 Keep areas used for storage, cleaning and preparation, clean and orderly to approval of Consultant. After completion of operations, return areas to clean condition to approval of Consultant.
- .10 Remove paint materials from storage only in quantities required for same day use.
- .11 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
- .12 Fire Safety Requirements:
  - .1 Provide one 9 kg Type ABC fire extinguisher adjacent to storage area.
  - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from Site on a daily basis.
  - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with Applicable Law.

## **1.9 SITE REQUIREMENTS**

- .1 Heating, Ventilation and Lighting:

- .1 Perform no painting work unless adequate and continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above 10° C for 24 hours before, during and after paint application until paint has cured sufficiently.
- .2 Where required, provide continuous ventilation for seven days after completion of application of paint.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
  - .1 Unless specifically accepted by the Consultant and applied product manufacturer, perform no painting work when:
    - .1 ambient air and substrate temperatures are below 10 ° C.
    - .2 substrate temperature is over 32 ° C unless paint is specifically formulated for application at high temperatures.
    - .3 substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.
    - .4 the relative humidity is above 85% or when dew point is less than 3 ° C variance between air/surface temperature.
    - .5 rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.
  - .2 Conduct moisture tests using a properly calibrated electronic Moisture Meter, except test concrete floors for moisture using a simple "cover patch test".
- .3 Surface and Environmental Conditions:
  - .1 Apply paint finish only in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
  - .2 Apply paint only to adequately prepared surfaces and to surfaces within moisture limits noted herein.
  - .3 Apply paint only when previous coat of paint is dry or adequately cured.
  - .4 Apply paint finishes only when conditions forecast for entire period of application fall within manufacturer's recommendations.
  - .5 Do not apply paint when:
    - .1 Temperature is expected to drop below 10 ° C before paint has thoroughly cured.
    - .2 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's limits.
    - .3 Surface to be painted is wet, damp or frosted.
  - .6 Provide and maintain cover when paint must be applied in damp or cold weather. Heat substrates and surrounding air to comply with temperature and humidity conditions specified by manufacturer. Protect until paint is dry or until weather conditions are suitable.
  - .7 Schedule painting operations such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning.
  - .8 Remove paint from areas which have been exposed to freezing, excess humidity, rain, snow or condensation. Prepare surface again and repaint.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Paint materials listed in the latest edition of the MPI Approved Products List (APL) are acceptable for use on this project. Acceptable manufacturers are Sika and PPG and/or



approved painting manufacturer alternates.

- .2 For exposed exterior concrete surfaces, provide "SIKAGARD A-50" by SIKA. Prepare and apply in strict accordance with manufacturer's written instructions.
- .3 For exposed steel surfaces, provide preparation of surface and application of: 1 coat epoxy primer, 1 coat epoxy and 2 coats Polyurethane. "PPG" is a suitable manufacturer. "PPG Amercoat 370" for first coat, PPG Aquapon 35 for second coat and "PPG Pitthane Ultra for third and fourth coats.
- .2 Paint materials for paint systems shall be products of a single manufacturer.
- .3 Only qualified products with E2 "Environmentally Friendly" rating are acceptable for use on this project.

## 2.2 COLOURS

- .1 The Consultant will provide Colour Schedule after Contract award.
- .2 Selection of colours will be from manufacturer's full range of colours.
- .3 Where specific products are available in a restricted range of colours, selection will be based on the limited range.
- .4 Second coat in a three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

## 2.3 MIXING AND TINTING

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

## 2.4 GLOSS/SHEEN RATINGS

- .1 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following values:

Gloss Level Category/	Units @ 60°/	Units @ 60°/
G1 - matte finish	0 to 5	max. 10
G2 - velvet	0 to 10	10 to 35

finish		
G3 - eggshell	10 to 25	10 to 35
finish		
G4 - satin	20 to 35	min. 35
finish		
G5 -	35 to 70	
semi-gloss		
finish		
G6 - gloss	70 to 85	
finish		
G7 - high	> 85	
<u>gloss finish</u>		

- .2 Gloss level ratings of painted surfaces shall be as specified herein and as noted on Finish Schedule.

## 2.5 EXTERIOR PAINTING SYSTEMS

- .1 Structural Steel and Metal Fabrications to:
- .1 EXT 5.1H-G6 – finish to later selection. Prior to prime and paint prepare all exposed steel as per SSPC-6 (blast cleaning).
- .2 Galvanized Metal: not chromate passivated
- .1 EXT 5.3D - Pigmented polyurethane finish for use in high contact/high traffic areas.
- .3 Dressed Lumber:
- .1 EXT 6.3E – Varnish for Wood finish. MPI#29 – EXT. Varnish with UV inhibitor – MPI GLOSS LEVEL 6 – 7.

## Part 3 Execution

### 3.1 GENERAL

- .1 Perform preparation and operations for exterior painting in accordance with MPI Painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.
- .3 Prepare existing steel column surfaces and epoxy paint as per 2.1.3.

### 3.2 EXISTING CONDITIONS

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to Consultant damages, defects, unsatisfactory or unfavorable conditions before proceeding with work.
- .2 Conduct moisture testing of surfaces to be painted using a properly calibrated electronic moisture meter, except test concrete floors for moisture using a simple "cover patch test" and report findings to Consultant. Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

### 3.3 PROTECTION

- .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore such surfaces as directed by Consultant.
- .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
- .3 Protect factory finished products and equipment.
- .4 Removal of light fixtures, surface hardware on doors, and other surface mounted equipment, fittings and fastenings shall be done prior to undertaking painting operations by General Contractor. Items shall be securely stored and re-installed after painting is completed by the Contractor.
- .5 As painting operations progress, place "WET PAINT" signs in pedestrian and vehicle traffic areas to acceptance of the Consultant.

### **3.4 CLEANING AND PREPARATION**

- .1 Clean and prepare exterior surfaces in accordance with MPI Painting Specification Manual requirements. Refer to the MPI Manual in regard to specific requirements and as follows:
  - .1 Remove dust, dirt, and other surface debris by brushing, wiping with dry, clean cloths or compressed air.
  - .2 Wash surfaces with a biodegradable detergent (and bleach where applicable) and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
  - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
  - .4 Allow surfaces to drain completely and allow to dry thoroughly.
  - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
  - .6 Use trigger operated spray nozzles for water hoses.
  - .7 Many water-based paints cannot be removed with water once dried. However, minimize the use of kerosene or any such organic solvents to clean up water-based paints.
- .2 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
- .3 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- .4 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements.
- .5 Touch up of shop primers with primer as specified in applicable section. Major touch-up including cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas, shall be by supplier of fabricated material.
- .6 Do not apply paint until prepared surfaces have been accepted by the Consultant.

### **3.5 APPLICATION**

- .1 Method of application to be as accepted by the Consultant. Apply paint by brush or roller. Conform to manufacturer's application instructions unless specified otherwise.
- .2 Brush and Roller Application:
  - .1 Apply paint in a uniform layer using brush and/or roller of types suitable for application.
  - .2 Work paint into cracks, crevices and corners.
  - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
  - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces shall be free of roller tracking and heavy stipple unless accepted by the Consultant.
  - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access and only when specifically accepted by the Consultant.
- .4 Apply coats of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .6 Sand and dust between coats to remove visible defects.
- .7 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as projecting ledges.
- .8 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.

### **3.6 MECHANICAL/ELECTRICAL EQUIPMENT**

- .1 Unless otherwise specified, paint exterior exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as noted otherwise.
- .2 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .3 Do not paint over nameplates.

### **3.7 FIELD QUALITY CONTROL**

- .1 Advise the Consultant when each surface and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been accepted.
- .2 Co-operate with the Consultant and provide access to areas of work.

### **3.8 RESTORATION**

- .1 Clean and re-install all hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to accepted of the Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as accepted by the Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED SECTIONS**

- .1      Section 01 33 00: Submittals.
- .2      Section 01 45 00: Quality Control.
- .3      Section 01 78 00: Closeout Submittals.
- .4      Section 06 20 00: Finish Carpentry.
- .5      Section 06 40 00: Architectural Woodwork.
- .6      Section 08 11 14: Steel Doors and Frames.

**1.2            REFERENCES**

- .1      Architectural Painting Specifications Manual, Master Painters Institute (MPI).
- .2      Systems and Specifications Manual, SSPC Painting Manual, Volume Two, Society for Protective Coatings (SSPC).
- .3      Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings) of the Environmental Protection Agency (EPA).
- .4      National Fire Code of Canada.
- .5      SCAQMD Rule#1168 South Coast Air Quality Management District.
- .6      SCAQMD Rule#1113 South Coast Air Quality Management District.
- .7      GS-11 Green Seal Environmental Standard - Paints.
- .8      GS-03 Green Seal Environmental Standard - Anti-Corrosive Paints.

**1.3            QUALITY ASSURANCE**

- .1      Contractor shall have a minimum of five years proven satisfactory experience. When requested, provide a list of last three comparable jobs including, job name and location, specifying authority, and project manager.
  - .2      Qualified journeymen who have a "Tradesman Qualification Certificate of Proficiency" shall be engaged in painting work. Apprentices may be employed provided they work under the direct supervision of a qualified journeyman in accordance with trade regulations.
  - .3      Conform to latest painting manufacturer's requirements for interior painting work including preparation and priming.
  - .4      Other paint materials such as linseed oil, shellac, turpentine, etc. shall be the highest quality product of an approved manufacturer and shall be compatible with other coating materials as required.
  - .5      Retain purchase orders, invoices and other documents to prove conformance when
-

- requested by the Consultant.
- .6 Standard of Acceptance:
  - .1 Walls: No defects visible from a distance of 1000 mm at 90° to surface.
  - .2 Ceilings: No defects visible from floor at 45° to surface when viewed using final lighting source.
  - .3 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

#### **1.4 SCHEDULING OF WORK**

- .1 Submit work schedule for various stages of painting to the Consultant for acceptance. Submit schedule minimum of 48 hours in advance of proposed operations.
- .2 Obtain written acceptance from the Consultant for any changes in work schedule.
- .3 Schedule painting operations to prevent disruption of occupants in and about the building.

#### **1.5 SUBMITTALS**

- .1 Submit product data and manufacturer's installation/application instructions for each paint and coating product to be used in accordance with Section 01 33 00 - Submittals.

#### **1.6 SAMPLES**

- .1 Submit full range colour sample chips in accordance with Section 01 33 00 - Submittals. Indicate where colour availability is restricted.
- .2 Submit 200 x 300 mm sample panels of each paint or clear coating with specified paint or coating in colours, gloss/sheen and textures required to MPI Painting Specification Manual standards.
- .3 When accepted, sample panels shall become acceptable standard of quality for appropriate on site surface with one of each sample retained on site.

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

- .1 Labels shall clearly indicate:
  - .1 Manufacturer's name and address.
  - .2 Type of paint or coating.
  - .3 Compliance with applicable standard.
  - .4 Colour number in accordance with established colour schedule.
- .2 Remove damaged, opened and rejected materials from site.
- .3 Provide and maintain dry, temperature controlled, secure storage.
- .4 Observe manufacturer's recommendations for storage and handling.
- .5 Store materials and supplies away from heat generating devices.
- .6 Store materials and equipment in a well ventilated area with temperature range 7° C to 30° C.
- .7 Store temperature sensitive products above minimum temperature as recommended by

manufacturer.

- .8 Keep areas used for storage, cleaning and preparation, clean and orderly to acceptance of the Consultant. After completion of operations, return areas to clean condition to acceptance of the Consultant.
- .9 Remove paint materials from storage only in quantities required for same day use.
- .10 Comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.
- .11 Fire Safety Requirements:
  - .1 Provide one 9 kg Type ABC fire extinguisher adjacent to storage area.
  - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers and remove from Site on a daily basis.
  - .3 Handle, store, use and dispose of flammable and combustible materials in accordance with applicable law.

## 1.8 SITE REQUIREMENTS

- .1 Heating, Ventilation and Lighting:
  - .1 Perform no painting work unless adequate and continuous ventilation and sufficient heating facilities are in place to maintain ambient air and substrate temperatures above 10 ° C for 24 hours before, during and after paint application until paint has cured sufficiently.
  - .2 Where required, provide continuous ventilation for seven days after completion of application of paint.
  - .3 Coordinate use of existing ventilation system with the Contractor and ensure its operation during and after application of paint as required.
  - .4 Provide temporary ventilating and heating equipment where permanent facilities are not available or supplemental ventilating and heating equipment if ventilation and heating from existing system is inadequate to meet minimum requirements.
  - .5 Perform no painting work unless a minimum lighting level of 323Lux is provided on surfaces to be painted.
- .2 Temperature, Humidity and Substrate Moisture Content Levels:
  - .1 Unless specifically accepted by the Owner, Consultant and the applied product manufacturer, perform no painting work when:
    - .1 Ambient air and substrate temperatures are below 10 ° C.
    - .2 Substrate temperature is over 32 ° C unless paint is specifically formulated for application at high temperatures.
    - .3 Substrate and ambient air temperatures are expected to fall outside MPI or paint manufacturer's prescribed limits.
    - .4 The relative humidity is above 85% or when the dew point is less than 3 ° C variance between the air/surface temperature.
  - .5 Rain or snow are forecast to occur before paint has thoroughly cured or when it is foggy, misty, raining or snowing at site.
- .2 Perform no painting work when the maximum moisture content of the substrate exceeds:
  - .1 12% for plaster and gypsum board.
  - .2 Conduct moisture tests using a properly calibrated electronic Moisture Meter, except test concrete floors for moisture using a simple "cover patch test".



.3 Test concrete, masonry and plaster surfaces for alkalinity as required.

- .3 Surface and Environmental Conditions:
- .1 Apply paint finish only in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
  - .2 Apply paint only to adequately prepared surfaces and to surfaces within moisture limits noted herein.
  - .3 Apply paint only when previous coat of paint is dry or adequately cured.
- .4 Additional Interior Application Requirements:
- .1 Apply paint finishes only when temperature at location of installation can be satisfactorily maintained within manufacturer's recommendations.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Paint materials that are acceptable for use on this project are as follows: Dulux X-PERT waterborne alkyd. Benjamin Moore Advance Waterborne Alkyd, Para-Premium Hybrid waterborne alkyd and Sherwin Williams Promar 200. No alternates.
- .2 Paint materials for paint systems shall be products of a single manufacturer.

### **2.2 COLOURS**

- .1 Colours to be determined.
- .2 Main and accent colours to later selection by owner. Only Dulux, Benjamin Moore, Para and Sherwin Williams paints to be used. NO ALTERNATE.
- .3 Selection of colours will be from manufacturer's full range of colours.
- .4 Where specific products are available in a restricted range of colours, selection will be based on the limited range.
- .5 Second coat in a three coat system to be tinted slightly lighter colour than top coat to show visible difference between coats.

### **2.3 MIXING AND TINTING**

- .1 Perform colour tinting operations prior to delivery of paint to Site. On site tinting of painting materials is allowed only with the Consultant.
- .2 Paste, powder or catalyzed paint mixes shall be mixed in strict accordance with manufacturer's written instructions.
- .3 Where thinner is used, addition shall not exceed paint manufacturer's recommendations. Do not use kerosene or any such organic solvents to thin water-based paints.
- .4 Thin paint for spraying according in strict accordance with paint manufacturer's instructions. If directions are not on container, obtain instructions in writing from manufacturer and provide copy of instructions to the Consultant.
- .5 Re-mix paint in containers prior to and during application to ensure break-up of lumps,

complete dispersion of settled pigment, and colour and gloss uniformity.

## 2.4 GLOSS/SHEEN RATINGS

- .1 Paint gloss shall be defined as the sheen rating of applied paint, in accordance with the following values:

Gloss Level Category	Units @ 60°	Units @ 85°
G1 - matte finish	0 to 5	max. 10
G2 - velvet finish	0 to 10	10 to 35
G3 - eggshell finish	10 to 25	10 to 35
G4 - satin finish(pearl)	20 to 35	min. 35
G5 - semi-gloss finish(melamine)	35 to 70	
G6 - gloss finish	70 to 85	
G7 - high gloss finish	> 85	

- .2 Gloss level ratings of painted surfaces shall be as specified herein and as noted on Finish Schedule.

## 2.5 INTERIOR PAINTING SYSTEMS

- .1 Concrete Masonry Units:

- .1 New Block walls (and areas behind removed Chalkboards): G4

- .1 Provide block filler: Dulux type as required ready to receive primer.  
.2 Primer coat: Dulux X-Pert Int/Ext waterborne alkydprimer sealer, 23010.  
.3 Two top coats: G5, Dulux X-Pert Waterborne Alkyd, Semi-Gloss, 22010.

- .2 Existing Block walls: G4

- .1 Provide block filler: Dulux type as required ready to receive primer.  
.2 Provide Zinsser "B-I-N" primer transition paint as required ready to receive primer. During school day operations, use Dulux X-pert Waterborne Alkyd in lieu of "B.I.N".  
.3 Primer coat: Dulux X-Pert Int/Ext waterborne alkydprimer sealer, 23010.  
.4 Two top coats: G5, Dulux X-Pert Waterborne Alkyd, Semi-Gloss, 22010.

- .2 Hollow metal doors and frames (non-cementitious primer) G5 (semi-gloss):

- .1 Primer coat: Rust-Oleum Sierra Performance Griptec Multi-surface Primer 208029.  
.2 Two top coats: Dulux X-pert Waterborne Alkyd Semi-Gloss, 22010.

- .3 Plaster and Gypsum Board:

- .1 Walls: G4 (melamine):  
.1 Primer coat: Dulux X-Pert waterborne alkyd, 23010.

- .2 Two top coats: G4, Dulux X-Pert waterborne alkyd, 22010.
- .4 Concrete surfaces (including ceilings):
  - .1 Provide Zinsser "B-I-N" primer transition paint as required.  
During school day operations, use Dulux X-pert Waterborne Alkyd
  - .2 Two top coats: G4, Dulux X-Pert waterborne alkyd, 22010.
- .5 Wood Cabinetry and millwork:
  - .1 Refer to drawings.
- .6 If alternate paint manufacturer is used (see 2.1.1 listing) contractor to submit paint name and paint number of products listed in 2.5, paragraphs 2.5.1 to and including 2.5.5.

### **Part 3 Execution**

#### **3.1 GENERAL**

- .1 Perform preparation and operations for interior painting in accordance with MPI Painting Specifications Manual except where specified otherwise.
- .2 Apply paint materials in accordance with paint manufacturer's written application instructions.

#### **3.2 EXISTING CONDITIONS**

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to the Consultant damages, defects, unsatisfactory or unfavourable conditions before proceeding with work.
- .2 Conduct moisture testing of surfaces to be painted using a properly calibrated electronic moisture meter, except test concrete floors for moisture using a simple "cover patch test" and report findings to the Consultant. Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.
- .3 Maximum moisture content as follows:
  - .1 Plaster and Gypsum Board: 12%.
  - .2 Concrete: 12%.

#### **3.3 PROTECTION**

- .1 Protect existing building surfaces and adjacent structures from paint spatters, markings and other damage by suitable non-staining covers or masking. If damaged, clean and restore to the satisfaction of the Consultant.
- .2 Protect items that are permanently attached such as Fire Labels on doors and frames.
- .3 Protect factory finished products and equipment.
- .4 Removal of electrical cover plates, light fixtures, surface hardware on doors, bath accessories and other surface mounted equipment, fittings and fastenings shall be done prior to undertaking any painting operations by the Contractor. Items shall be securely stored and re-installed after painting is completed by the Contractor.
- .5 Move and cover furniture and portable equipment as necessary to carry out painting

operations. Replace as painting operations progress.

- .6 As painting operations progress, place "WET PAINT" signs in occupied areas to acceptance of the Consultant.

### **3.4 CLEANING AND PREPARATION**

- .1 Clean and prepare surfaces in accordance with MPI Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:
  - .1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths or compressed air.
  - .2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean warm water using a stiff bristle brush to remove dirt, oil and other surface contaminants.
  - .3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.
  - .4 Allow surfaces to drain completely and allow to dry thoroughly.
  - .5 Prepare surfaces for water-based painting, water-based cleaners should be used in place of organic solvents.
  - .6 Use trigger operated spray nozzles for water hoses.
- .2 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pretreatment as soon as possible after cleaning and before deterioration occurs.
- .3 Where possible, prime surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
  - .1 Apply vinyl sealer to MPI #36 over knots, pitch, sap and resinous areas.
  - .2 Apply wood filler to nail holes and cracks.
  - .3 Tint filler to match stains for stained woodwork.
- .4 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1000 mm.
- .5 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets and corners to be painted by blowing with clean dry compressed air, or vacuum cleaning.
- .6 Touch up of shop primers with primer as specified in applicable section. Major touch-up including cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas, shall be by supplier of fabricated material.
- .7 Do not apply paint until prepared surfaces have been accepted by the Consultant.
- .8 For preparation of existing previously painted oil type painted surfaces, sand as required in strict accordance with paint manufacturer's written specification's and/or instructions. Also, refer to drawing A1.1, General Notes, item no.9.

### **3.5 APPLICATION**

- .1 Method of application to be as accepted by the Consultant. Apply paint by brush or roller. Conform to manufacturer's application instructions unless specified otherwise.

- .2 Brush and Roller Application:
  - .1 Apply paint in a uniform layer using brush and/or roller of types suitable for application.
  - .2 Work paint into cracks, crevices and corners.
  - .3 Paint surfaces and corners not accessible to brush using spray, daubers and/or sheepskins. Paint surfaces and corners not accessible to roller using brush, daubers or sheepskins.
  - .4 Brush and/or roll out runs and sags, and over-lap marks. Rolled surfaces shall be free of roller tracking and heavy stipple unless accepted by the Consultant.
  - .5 Remove runs, sags and brush marks from finished work and repaint.
- .3 Use dipping, sheepskins or daubers only when no other method is practical in places of difficult access and only when specifically accepted by the Consultant.
- .4 Apply coats of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.
- .5 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .6 Sand and dust between coats to remove visible defects.
- .7 Finish surfaces both above and below sight lines as specified for surrounding surfaces, including such surfaces as tops of interior cupboards and cabinets and projecting ledges.
- .8 Finish closets and alcoves as specified for adjoining rooms.
- .9 Finish top, bottom, edges and cutouts of doors after fitting as specified for door surfaces.
- .10 Paint all walls behind lockers.

### **3.6 MECHANICAL/ELECTRICAL EQUIPMENT**

- .1 Unless otherwise specified, paint finished area exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment with colour and finish to match adjacent surfaces, except as noted otherwise.
- .2 Boiler room, mechanical and electrical rooms: paint exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment.
- .3 Other unfinished areas: leave exposed conduits, piping, hangers, ductwork and other mechanical and electrical equipment in original finish and touch up scratches and marks.
- .4 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by manufacturer of equipment.
- .5 Do not paint over nameplates.
- .6 Paint inside of ductwork where visible behind grilles, registers and diffusers with primer and one coat of matt black paint.
- .7 Paint disconnect switches for fire alarm system and exit light systems in red enamel.
- .8 Paint both sides and edges of backboards for telephone and electrical equipment before

- installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories and other unfinished items.
- .9 Do not paint interior transformers and substation equipment.

### **3.7 FIELD QUALITY CONTROL**

- .1 Advise the Consultant when surfaces and applied coating is ready for inspection. Do not proceed with subsequent coats until previous coat has been accepted.
- .2 Co-operate with inspection personnel and provide access to areas of work.

### **3.8 RESTORATION**

- .1 Clean and re-install all hardware items removed before undertaken painting operations.
- .2 Remove protective coverings and warning signs as soon as practical after operations cease.
- .3 Remove paint splashings on exposed surfaces that were not painted. Remove smears and spatter immediately as operations progress, using compatible solvent.
- .4 Protect freshly completed surfaces from paint droppings and dust to accepted of the Consultant. Avoid scuffing newly applied paint.
- .5 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as accepted by the Consultant.

**END OF SECTION**

<u>SECTION NO.</u>	<u>NAME</u>	<u>NO. OF PAGES</u>
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20 05 17	Pipe Welding	3
20 05 20	Seismic Restraints	5
20 05 29	Pipe Hangers and Supports	6
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20 07 13	Thermal Insulation For Ducting	4
20 07 20	Thermal Insulation For Piping	5
20 07 53	Acoustic Duct Lining	3
22 11 18	Domestic Water Piping – Copper	4
22 13 17	Drainage Waste and Vent Piping – Polyvinyl Chloride (PVC)	2
22 42 01	Plumbing Specialties and Accessories	2
23 05 93	Testing, Adjusting and Balancing for HVAC	4
23 05 95	HVAC Commissioning	10
23 09 36	Energy Monitoring and Control System (EMCS) General	37
23 21 13.02	Hydronic Systems - Steel	5
23 21 14	Hydronic Specialties	2
23 23 00	Copper Tubing & Fittings Refrigerant	4
23 31 14	Ductwork – Low Pressure – Metallic to 500 Pa (2 in)	4
23 33 00	Air Duct Accessories	2
23 33 14	Dampers - Balancing	2
23 33 15	Dampers - Operating	2
23 33 16	Dampers – Fire and Smoke	3
23 33 46	Flexible Duct	2
23 34 24	Commercial & Domestic Fans	3
23 34 25	Packaged Roof Exhausters	2
23 37 13	Diffusers, Registers and Grilles	2
23 37 30	Louvers, Intakes and Vents	1
23 72 00	Energy Recovery Units	3
23 74 00	Packaged Outdoor HVAC Equipment	3
23 81 29	Variable Refrigerant Flow Systems	19

## **1 GENERAL**

- .1 This section covers items common to all sections of Division 20, 22, and 23. Division 20 items apply to Divisions 20, 22, and 23.
- .2 Obtain and pay for all required permits and approvals.
- .3 The following codes shall apply:
  - .1 Ontario Building Code; O.B.C.
  - .2 Ontario Building Code; Part 7 Plumbing.
  - .3 Ontario Fire Code
  - .4 National Fire Protection Association; N.F.P.A.
  - .5 Technical Standards and Safety Authority (T.S.S.A.) Safety Act and associated documents.
- .4 All code references shall be the latest edition, including revisions and addenda.
- .5 Materials and equipment to be new and free from blemishes, oxidation, damage, etc. New materials and equipment to be of proven design and quality, and for which replacement parts are readily available. Use current models of equipment.
- .6 It is the intent of the specification that there be one prime contractor for all of Division 20, 22, and 23 work. The prime mechanical shall be responsible for all Division 20, 22, and 23 subtrades. The prime mechanical shall be responsible for overall coordination and commissioning of systems.
- .7 Concealed mechanical services and equipment includes services and equipment in hung ceilings, crawl space and non-accessible chases and furred spaces. Exposed mechanical equipment and services include mechanical equipment and services exposed in finished room, mechanical and equipment rooms.
- .8 All equipment and services provided by the mechanical Subcontractor shall be supplied, installed and connected by mechanical Subcontractor unless noted otherwise in the Specifications or drawings.

## **2 EQUIPMENT INSTALLATION**

- .1 Unions or flanges: provide for ease of maintenance and disassembly.
- .2 Space for servicing, disassembly and removal of equipment and components: provide as recommended by manufacturer or as indicated.
- .3 Equipment drains: pipe to drains, or funnel floor/hub drains.
- .4 Install equipment, rectangular cleanouts and similar items parallel to or perpendicular to building lines.
- .5 Provide and install all necessary vibration control components.
- .6 Provide and install all backflow preventers necessary to protect the potable water system.
- .7 Pipe humidifier and other interior mounted equipment drains, such as fan coils and evaporators to funnel floor/hub drains, or janitor sinks.



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**3 ANCHOR BOLTS AND TEMPLATES**

- .1 Supply and install anchor bolts and templates for equipment provided by this Division.

**4 EQUIPMENT USAGE**

- .1 Consultant may use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing. Trial usage to apply to all systems.
- .2 MERV 8 filters shall be installed on all return/exhaust grilles if the related air handling system is used during construction as per ASHRAE 52.2-2017 and replace all filtration media prior to occupancy.

**5 DEFINITIONS**

- .1 This definition shall apply to all sections and drawings of Division 20, 22, and 23.
- .1 "CONCEALED" - mechanical services and equipment in hung ceilings and non-accessible chases and furred spaces.
- .2 "EXPOSED" - will mean "not concealed" as defined herein, e.g. Mechanical Rooms.
- .3 "PROVIDE" - will mean supply, installation and connection.
- .4 "T.S.S.A." shall mean "Technical Standards and Safety Authority".

**6 PROTECTION OF OPENINGS**

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

**7 ELECTRICAL**

- .1 Electrical work to conform to Electrical Specifications by Division 26, 27, 28 including the following.
- .2 Provide all controls, disconnects, magnetic starters, transformers, relays, wiring and panels for all motors and devices for packaged equipment as indicated in various specification sections.
- .3 Electrical equipment shall bear CSA labels and/or ULC approvals to comply with Ontario Hydro requirements. Conform to the requirements of the Canadian Electrical Code, Ontario Building Code, local, municipal and provincial authorities.
- .4 Control panels to be complete with barriered numbered terminal strip for interconnecting of conductors between master control panel and remote control panel and associated equipment.
- .5 Controls
- .1 All power and control wiring, relays, transformers and wiring related to motorized dampers, thermostats, controllers, sensors, control panels, control devices, valves, pressure limit switches, etc., which are related to control systems to be provided by Division 22 and 23, unless specifically indicated on electrical drawings otherwise. Refer to electrical control schematics.
- .2 All wiring in walls to be run in conduit. All wiring in plenum spaces to be plenum rated type FT6. Refer to Electrical Specifications for further details.
- .3 Control wiring to be copper conductor type RW 90 (XLPE); minimum #14 AWG for power circuits and minimum #18 AWG for control only.
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- .4 Conduit to be E.M.T. minimum 21mmC complete with set screw cast couplings. Provide ground conductor in all conduit runs.
- .5 Use liquid tight flexible conduit for final connection to motorized dampers and vibrating equipment.
- .6 Panels to be complete with required components including but not limited to:
  - .1 One main fused switch suitable current rating for the station load. Pad lockable in both open and closed positions. Mechanically panel interlocked door to prevent opening when handle is in "ON" position.
- .7 Ensure that electrical contractor has provided for auxiliary contacts for the building control systems.

## **8 MOTORS**

- .1 Provide motors for mechanical equipment as specified.
- .2 If delivery of specified motor will delay delivery or installation of any equipment, install motor approved by Consultant for temporary use. Final acceptance of equipment will not occur until specified motor is installed.
- .3 Motors under 373W (1/2hp): speed as indicated, continuous duty, built-in overload protection, resilient mount, single phase, 120V, unless otherwise specified or indicated.
- .4 Motors 373W (1/2hp) and larger: EEMAC Class B, squirrel cage induction, speed as indicated, continuous duty, drip proof, ball bearing, maximum temperature rise 40°C (22°F), 3 phase, 208V, inverter duty unless otherwise specified or indicated.
- .5 Motor efficiency shall be in accordance with CSA C390. Motors 746W (1 hp) and larger to be energy efficient motors conforming to ASHRAE 90.1.
- .6 Power factor correction shall apply to all motors with 3.73kW (5 hp) rating or more.
- .7 All motor starters for loads with a running ampacity (RLA) greater than 20 amps shall be of the solid state reduced voltage type with current ramp and current limit capability. Current limit shall be set at 4 times RLA and ramped to this value over a period of not less 1½ seconds.

## **9 BELT DRIVES**

- .1 Fit reinforced belts in sheave matched to drive. Multiple belts to be matched sets.
- .2 Use cast iron or steel sheaves secured to shafts with removable keys unless otherwise specified.
- .3 For motors under 7.5 kW (10 hp): standard adjustable pitch drive sheaves, having plus or minus 10% range. Use mid-position of range for specified r/min.
- .4 For motors 7.5 kW (10 hp) and over: sheave with split tapered bushing and keyway having fixed pitch unless specifically required for item concerned. Provide sheave of correct size to suit balancing.
- .5 Minimum drive rating: 1.5 times nameplate rating on motor. Keep overhung loads within manufacturer's design requirements on prime mover shafts.
- .6 Motor slide rail adjustment plates to allow for centerline adjusting.

- .7 Provide one complete set of spare belts for every drive supplied under this contract.

## **10 GUARDS**

- .1 Provide guards for unprotected drives.
- .2 Guards for belt drives:
  - .1 Expanded metal screen welded to steel frame.
  - .2 Minimum 1.2 mm (18 Ga.) thick metal tops and bottoms.
  - .3 38 mm (1-1/2 in.) dia. Holes on both shaft centres for insertion of tachometer.
  - .4 Removable for servicing.
- .3 Provide means to permit lubrication and use of test instruments with guards in place.
- .4 Install belt guards to allow movement of motors for adjusting belt tension.
- .5 Guard for flexible coupling:
  - .1 "U" shaped, minimum 1.6 mm (16 Ga.).
  - .2 Securely fasten in place.
  - .3 Removable for servicing.
- .6 Unprotected fan inlets or outlets:
  - .1 Wire or expanded metal screen, galvanized, 19 mm (3/4 in.) mesh.
  - .2 Net free area of guard: not less than 80% of fan openings.
  - .3 Securely fasten in place.
  - .4 Removable for servicing.
- .7 Guards to meet safety requirements of Provincial Ministry of Labour and local authorities having jurisdiction.

## **11 EQUIPMENT SUPPORTS**

- .1 Equipment supports supplied by equipment manufacturer: specified elsewhere in Division 22 and 23.
- .2 Equipment supports not by equipment manufacturer: fabricate from structural grade steel.
- .3 Provide all necessary mechanical equipment vibration control, specified or recommended by equipment manufacturer.
- .4 Size anchor bolts to withstand seismic zone acceleration and velocity forces for region of installation.
- .5 Provide seismic restraint of equipment, ducting, piping, tanks and machinery in accordance with Section 20 05 20 – Seismic Restraints.

## **12 SLEEVES**

- .1 Pipe sleeves: at points where pipes pass through masonry, concrete, or fire rated assemblies and as indicated.
- .2 Schedule 40 steel pipe.
- .3 Sizes: maximum 6 mm (1/4 in.) clearance all around, between sleeve and uninsulated pipe or between sleeve and insulation.

- .4 Terminate sleeves flush with surface of concrete and masonry walls, concrete floors on grade, and 25 mm (1 in.) above other floors. For equipment room floors, terminate minimum 100 mm (4 in.) above floor and provide concrete curb.
- .5 Fill voids around pipes:
  - .1 Caulk between sleeves and pipe in foundation walls and below grade floors with waterproof fire retardant non-hardening mastic.
  - .2 Where sleeves pass through walls or floors, provide space for firestopping. Where pipes pass through fire rated walls, floors, and partitions, maintain fire rating integrity.
  - .3 Ensure no contact between copper tube or pipe and ferrous sleeves.
  - .4 Fill future use sleeves with lime plaster or other easily removable filler.
  - .5 Coat exposed exterior surface of ferrous sleeves with heavy application of zinc rich paint to CAN/CGSB 1.181-99.
- .6 This Division shall prepare sleeving drawings indicating the size and location of openings required in concrete floor slabs, roof slabs/decks, and walls for piping, ductwork, and equipment. In case of failure to provide information in time (i.e. before concrete is poured) any extras incurred shall be at the expense of this Division.
- .7 Where ducts pass through equipment room floors, provide 100 mm (4 in.) high concrete curbs around duct allowing adequate space for fire damper sleeve and room for expansion. Concrete curbs where pipe and ducts pass through equipment room flows shall be by Division 22, 23.

### **13 PREPARATION FOR FIRESTOPPING**

- .1 Firestopping material and installation within annular space between pipes, ducts, insulation, and adjacent fire separation: Section 07 84 00 - Firestopping and Smoke Seals.
- .2 Uninsulated unheated pipes not subject to movement: no special preparation.
- .3 Uninsulated heated pipes subject to movement: wrap with non-combustible smooth material to permit to move without damaging firestopping material.
- .4 Insulated pipes and ducts: ensure integrity of insulation and vapour barrier at fire separation. Insulation material used to meet requirements of ULC listing of firestopping system.

### **14 ESCUTCHEONS**

- .1 On pipes through walls, partitions, floors, and ceilings in finished areas. On pipes through millwork and cabinetry.
- .2 Chrome or nickel plated brass or type 302 stainless steel, one piece type with set screws. Use cast iron types in equipment rooms.
- .3 Outside diameter to cover opening or sleeve.
- .4 Inside diameter to fit around finished pipe.
- .5 Do not use split-type escutcheon plates.
- .6 Secure to pipe on finished surface, but not insulation.

## **15 TESTS**

- .1 Give at least 48h written notice of date for tests.
- .2 Insulate or conceal work only after testing and approval by Consultant.
- .3 Conduct tests in presence of Consultant or authority having jurisdiction.
- .4 Bear costs including retesting and making good.
- .5 Piping:
  - .1 General: maintain test pressure without loss for 4 hours unless otherwise specified.
  - .2 Hydraulically test hydronic piping systems at 1½ times system operating pressure or minimum 860 kPa (125 psig), whichever is greater.
  - .3 Test drainage, waste, and vent piping to Ontario Building Code and authorities having jurisdiction.
  - .4 Test domestic hot, cold, and recirculation water piping at 1½ times system operating pressure or minimum 860 kPa (125 psig), whichever is greater.
- .6 Equipment: test as specified in relevant sections.
- .7 Prior to tests, isolate all equipment or other parts which are not designed to withstand test pressures or test medium.
- .8 Provide written confirmation for each test conducted.
- .9 Provide any equipment required to conduct tests.

## **16 PAINTING**

- .1 To Section 09 91 23 - Interior Painting.
- .2 Apply at least two coats of corrosion resistant primer paint to ferrous supports and site fabricated work.
- .3 Prime and touch up marred finished paintwork to match original.
- .4 Restore to new condition, finishes which have been damaged too extensively to be merely primed and touched up. Items suffering major damage to finish shall be replaced entirely, if in the opinion of the Consultant, the damage is too extensive to be remedied by touch up.
- .5 Convectors, wall fins, unit heaters, cabinet unit heaters (force flows) and other mechanical equipment exposed in finished areas shall be finish painted by manufacturer with minimum baked enamel finish. Color to be selected by Architect during shop drawing submittals.

## **17 ACCESS DOORS**

- .1 Supply access doors to concealed mechanical equipment for operating, inspecting, adjusting and servicing.
- .2 Flush mounted 600 x 600 mm (24 in. x 24 in.) for body entry and 300 x 300 mm (12 in. x 12 in.) for hand entry unless otherwise noted. Doors to open 180°, have rounded safety

corners, concealed hinges, screwdriver latches and anchor straps.

- .3 Material:
  - .1 Special areas such as tiled or marble surfaces: use stainless steel with brushed satin or polished finish as directed by Consultant.
  - .2 Remaining areas: use prime coated steel.
- .4 Installation:
  - .1 Locate so that concealed items are accessible.
  - .2 Locate so that hand or body entry is achieved.
  - .3 Installation by Division 09.
- .5 Standard of Acceptance: Acudor UF-5000.
  - .1 Alternate: Mifab UA.
- .6 Fire rated access panels: 1.6 mm (16 Ga.) mounting frame, 1.0 mm (20 Ga.) sandwich type insulated self-closing door with concealed hinge, 50 mm (2 in.) thickness of fire rated insulation in door, self-latching ring pull latch, primer coated, 1½ hour rating.
  - .1 Standard of Acceptance: Acudor FW-5050.
  - .2 Alternate: Mifab MPFR.
- .7 Access doors must maintain fire rating if installed in a fire rated assembly. Refer to Architectural Drawings for location of fire rated walls and ceilings.

## **18 DEMONSTRATION AND OPERATING AND MAINTENANCE INSTRUCTIONS**

- .1 Supply tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.
- .2 Where specified elsewhere in Mechanical Specification, manufacturers to provide demonstrations and instructions.
- .3 Use operation and maintenance manual, as-built drawings, audio visual aids, etc. as part of instruction materials.
- .4 Instruction duration time requirements as specified in appropriate sections.
- .5 Where deemed necessary, Consultant may record these demonstrations on video tape for future reference.
- .6 Demonstration and Operating and Maintenance Instructions to building operating staff to be completed prior to requesting Certification of Substantial Performance. Provide a written certificate that all training has been completed signed by each manufacturer's representative and the Owner's representative.

## **19 OPERATION AND MAINTENANCE MANUAL**

- .1 Provide operation and maintenance data for products and services supplied. Faxed and/or scanned copies are not acceptable. Printed data must be clear. Digital PDF files shall be from digital sources, not scanned.
- .2 Operation and maintenance manual to be approved by, and final copies deposited with, Consultant before final inspection. Operation and Maintenance Manuals shall be prepared in English.

- .3 Operation data to include:
  - .1 Control schematics for each system including environmental controls.
  - .2 Description of each system and its controls.
  - .3 Description of operation of each system at various loads together with reset schedules and seasonal variances.
  - .4 Operation instruction for each system and each component.
  - .5 Description of actions to be taken in event of equipment failure.
  - .6 Valves schedule and flow diagram.
  - .7 Colour coding chart.
  - .8 Symbol and legend description.
- .4 Maintenance data shall include:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required and task time.
  - .3 Replacement parts list.
  - .4 Warranties.
- .5 Performance data to include:
  - .1 Equipment manufacturer's performance data sheets with point of operation as left after commissioning is complete.
  - .2 Equipment performance verification test results.
  - .3 Special performance data as specified elsewhere.
  - .4 Testing, adjusting and balancing reports as specified in Section 23 05 93 - Testing, Adjusting and Balancing for HVAC.
- .6 Approvals:
  - .1 Submit 1 copy of draft Operation and Maintenance Manual to Consultant in digital format from digital sources for review. Scanned documents are not acceptable. Submission of individual data will not be accepted unless so directed by Consultant. Manuals shall be compiled in digital format (PDFs in separate folders) or compiled in a hard cover, 3-ring, 'D' ring binder complete with inside pockets, index page and index tabs. The name of the project must be clearly visible on the front and spine of each binder.
  - .2 Make changes as required and re-submit as directed by Consultant.
  - .3 Submit one (1) copy of the approved operation and maintenance manual in hard copy format, and one (1) copy on a USB flash drive to the Consultant two weeks prior to substantial completion.
- .7 Additional data:
  - .1 Prepare and insert into operation and maintenance manual when need for same becomes apparent during demonstrations and instructions specified above.
  - .2 The contact information (name, address, contact, telephone number, fax number) of the Mechanical and all Sub-Contractors and all suppliers must be included in the manual.
- .8 Conform also to Section 01 77 00 – Closeout Procedures and Section 01 78 00 – Closeout Submittals.

## **20 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit electronic copies (i.e. PDF files) produced from electronic sources or 6 copies of shop drawings and product data for equipment supplied. Refer to Section 01 33 00 – Submittal Procedures:
  - .1 Faxed and/or scanned copies of product data will not be accepted. PDF files must be prepared from digital sources.

- .2 Shop drawings indicating a range of models and sizes with no selection shown will not be accepted.
- .2 Shop drawings and product data shall show:
  - .1 Mounting arrangements.
  - .2 Operating and maintenance clearances; e.g. access door swing spaces.
  - .3 Make model and nameplate data for each piece of equipment.
  - .4 Size and capacity of each piece of equipment.
  - .5 Electrical characteristics.
- .3 Shop drawings and product data shall be accompanied by:
  - .1 Detailed drawings of bases, supports, and anchor bolts.
  - .2 Acoustical sound power data, where applicable.
  - .3 Points of operation on performance curves.
  - .4 Manufacturer to certify as to current model production.
  - .5 Certification of compliance to applicable codes.
  - .6 All operating and performance data indicated in relevant specification sections.
- .4 Shop drawings shall be submitted by specification section. Do not combine more than one section into one submission.
- .5 Shop drawings shall clearly indicate the materials and/or equipment actually being supplied, all details of construction, accurate dimensions, capacity, operating characteristics and performance. Each shop drawing shall give the identifying number of the specific pump, fan, etc. for which it was prepared (e.g. fan F-7).
- .6 Each shop drawing for non-catalogue items shall be prepared specifically for this project. Shop drawings and brochures for catalogue items shall be marked clearly to show the items being supplied.
- .7 Each shop drawing or catalogue sheet shall be stamped and signed/initialed by the Contractor supplying the material(s) to indicate that he has checked the drawing for conformance with all requirements of the drawings and specifications, that he has co-ordinated this equipment with other equipment to which it is attached and/or connected and that he has verified all dimensions to ensure the proper installation of equipment within the available space and without interference with the work of other trades. Ensure that electrical co-ordination is complete before submitting drawings for review. The General Contractor shall also stamp and sign/initial the shop drawing to indicate that the submittal has been coordinated by all their Sub-Trades. If shop drawings are submitted without the Contractor's stamp and initials, or it is apparent that the contractor has not completed their review, the shop drawings will be returned by the Consultant and identified to be resubmitted.
- .8 Installation of any equipment shall not start until after final review of shop drawings by the Consultant has been obtained.
- .9 When requested, shop drawings shall be supplemented by data explaining the theory of operation - for example: a variable speed motor control - the Consultant may also request that this information be added to the maintenance and operating manual.
- .10 Provide a lead sheet with the project name, issue date, issue number, specification section number, title of section and with space for shop drawing review stamps for the Contractor and Consultant.
- .11 One original shop drawing will be returned. All copies required for the trades, suppliers or other consultants will be printed by the Contractor.



- .12 Any equipment data, requested calculations, written certifications or other similar information specified or shown on the drawings shall be included with shop drawing submittals.
- .13 The Contractor shall make notations with respect to the following aspects and any other deviations from the contract documents:
  - .1 Deviation from specified performance, electrical requirements and equipment specified.
  - .2 Changes in dimensions from equipment indicated or specified, including confirmation that equipment will fit into space allotted. Contractor shall provide written notation how deviations are being addressed and what coordination with other affected trades has been or will be undertaken.
- .14 Consultant review of shop drawings is for general conformance only, and does not relieve the contractor from meeting all aspects of specification. The contractor is solely responsible for the completeness, correctness, and all information presented on shop drawings. There shall be no additional cost to Project for failure of the consultant to complete a thorough review of shop drawings for compliance. The contractor shall not assume consultant has performed a thorough review and the contractor shall be ultimately responsible for completeness of shop drawings and the equipment conformance with specifications.
- .15 Shop drawings shall be submitted in order of delivery requirements. That is, the items which have long deliveries or are to be installed first shall be submitted first. Not all shop drawings shall be submitted at once. The contractor shall coordinate the sequence of submittals with the Consultant at start of project. The Consultant requires 2 weeks to review individual submissions. For submission of complete systems or for multiple units, such as fan coils submissions, the Consultant requires 3 weeks for their review. The Contractor shall allow for Consultant review times in their schedule.

## **21 CLEANING**

- .1 Clean interior and exterior of all systems including strainers.
- .2 In preparation for final acceptance, clean and refurbish all equipment and leave in operating condition including replacement of all filters in all air and piping systems.
- .3 Upon completion remove temporary protection. Remove stains and smudges from paint work. Wash and polish plumbing fixtures.
- .4 During the course of construction, each - Subcontractor shall keep his work tidy and not allow an accumulation of debris resulting from his work.
- .5 Upon completion of this work he shall leave the premises in a broom clean condition.
- .6 Replace broken, damaged or scratched fixtures.

## **22 AS-BUILT DRAWINGS**

- .1 Site records:
  - .1 The Consultant will provide the mechanical contractor with two extra sets of white prints on which the mechanical contractor shall clearly mark, as the job progresses, all changes and deviations from that shown on contract drawings. This shall also include changes to existing mechanical systems, control systems and low voltage control wiring. It will not be sufficient to check off line locations.

- Definite measurements shall be taken for each service line. Drawings shall be kept up-to-date during construction and in addition to field measurements shall include variation orders, field instructions and all other changes. On completion of the building, the mechanical contractor shall forward to the Consultant the two sets of drawings indicating all such changes and deviations for review by the Consultant.
- .2 On a weekly basis, transfer information to reproducibles, revising reproducibles to show all work as actually installed.
  - .3 Use different colour waterproof ink for each service.
  - .4 Make available for reference purposes and inspection at all times.
- .2 As-built drawings:
- .1 Prior to start of Testing, Adjusting and Balancing (TAB), finalize production of as-built drawings.
  - .2 Identify each drawing in lower right hand corner in letters at least 12mm (1/2 in.) high as follows: - AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (date).
  - .3 Submit to Consultant for approval and make corrections as directed.
  - .4 TAB to be performed using as-built drawings.
  - .5 Submit completed reproducible as-built drawings with Operating and Maintenance Manuals.
- .3 Submit copies of as-built drawings for inclusion in final TAB report.
- .4 Conform also to Section 01 77 00 – Closeout Procedures.

## 23

### EXAMINATION OF SITE AND INFORMATION

- .1 The Contractor, before tendering shall examine the site, the existing building construction and services, the Architectural, Structural, Mechanical and Electrical drawings and he shall familiarize himself with the building construction and finish in order that his tender may include everything necessary for the proper completion of the work.
- .2 It shall be this contractor's responsibility that material and equipment be brought in such assemblies and sizes as to enter into the spaces where they are to be located and to be small enough to be hoisted onto the building without difficulty. Any cutting, patching, etc. involved in getting large assemblies into place shall be the responsibility of this contractor.
- .3 Immediately inform the Consultant, in writing, of all discrepancies, errors, omissions, contradictions and ambiguities. The necessary Addendum or bulletin will be issued to all Bidders. Include a complete cross-checking of Drawing and Specifications for sizes and quantities to correspond correctly. Data mentioned in the Specifications and not shown on Drawings, and vice-versa, must be interpreted as part of the Work. Oral, telephone or "Telex" instructions are not valid. All questions must be submitted to the Project Manager. Bring obvious discrepancies or omissions to the attention of the Consultant during the Tender Period. Questions may be presented in writing by bidders up to seven days before tender closing. Where the contractor is not able to obtain directions on questions, they shall prepare quotation based on specifications or drawings and include all items required to comply. Where discrepancies still exist within the documents, contractors shall allow for the more demanding installation, more stringent requirement or more expensive equipment specification. Contractors shall instruct all suppliers and distributors of this time limitation.
- .4 The drawings and specifications are intended to describe complete working systems including all necessary labour and materials. Where items required to complete working

system are not specified or showing on drawings, contractor shall include costs at no additional expense to Project.

## **24 CUTTING AND REMEDIAL WORK**

- .1 Assume full responsibility for laying out mechanical work and for any damage caused by incorrectly located equipment and mechanical services.

## **25 COORDINATION**

- .1 Locate distribution systems, equipment and materials to provide minimum interference and maximum useable space.
- .2 Where interference occurs, Consultant shall approve relocation of equipment and materials.
- .3 This contractor shall notify other Subcontractors who are concerned, of all openings, foundation work, hangers, inserts, anchors, or other provisions necessary in their work for the installation of this work and he shall furnish all information and necessary materials in ample time so that proper provisions can be made for same, and shall supply and correctly and accurately place all inserts, sleeves, anchors, etc.
- .4 Division 20 Contractor shall supply inserts, hangers, sleeves, anchors, etc. which must be placed within concrete forms to other subcontractors that are concerned with their installation. Division 20 Contractor shall inform responsible contractor of locations. Where anchors are required to be drilled and placed, Division 20 Contractor shall be responsible for their supply and installation. Pipe hangers and supports listed in Section 20 05 29 – Pipe Hangers and Supports shall be provided by Mechanical Contractor.

## **26 REQUIREMENTS OF INSPECTION DEPARTMENTS**

- .1 All work shall be installed in accordance with all laws and regulations of all authorities having jurisdiction in each case, particularly all affected departments of the Municipality and Province. Electrical equipment supplied must conform to the regulations of CSA and the local utility. Anything necessary to make the work comply with these requirements shall be provided by this contractor without additional cost to the Project if reasonably could have been foreseen when tendering.
- .2 The contractor shall prepare drawings in addition to Consultant's drawings as may be required by various Inspection Departments having jurisdiction and obtain their approval before proceeding with the work.
- .3 In the event that the Inspection Department's request deviates from the Consultant's layout, contractor shall consult the Consultant before proceeding with same.
- .4 Provide all inspection certificates prior to request for substantial completion. Include copy of inspection certificates in Operation and Maintenance Manuals.

## **27 DRAWINGS**

- .1 The drawings shall be considered to show the general character and scope of the work and not the exact details of the installation. The installation shall be complete with all accessories required for a complete and operative installation.
- .2 The drawings show the approximate location for the special apparatus and the materials throughout the building. The arrangement shown on the drawings is more or less

diagrammatic and as such approximate only, and may be altered, as approved by the Consultant, to meet the requirements of the apparatus, etc., and of the building. Each Subcontractor shall be held responsible for all measurements for his work throughout, and he shall arrange his piping, wiring and apparatus to conform to the Architectural and Structural details in a satisfactory manner and shall cooperate with other contractors to ensure that work shall meet all requirements of diverse Contracts.

- .3 The contractor is particularly cautioned that small scale Consultant's plans must be supplemented by his own detail drawings where necessary for proper coordination of the work.
- .4 Items shown on the drawings but not specified or specified but not shown shall be included.
- .5 Items obviously required to provide a complete working system, but not specified nor shown shall be included.
- .6 In order to show more clearly the arrangement of the work, plans and sections do not show every valve, thermometer, pressure gauge or other system accessory. Refer to the Mechanical Standards details and to the specifications to determine the requirements.
- .7 Certain details indicated on the drawings are general in nature and specific labelled detail references to each and every occurrence of use are not indicated, however, such details shall be applicable to every occurrence on the drawings.
- .8 The location and size of existing services shown on the drawings are based on the best available information. The actual location of existing services shall be verified in the field before work is commenced. Particular attention shall be paid to buried services.
- .9 Changes and modifications necessary to ensure co-ordination and to avoid interference and conflicts with other trades, or to accommodate existing conditions, shall be made at no extra cost to the Project.
- .10 Leave areas clear of piping and ducts where space is indicated reserved for future equipment, and equipment for other trades.
- .11 Adequate space and provisions shall be left for removal of coils and servicing of equipment, with minimum inconvenience to the operation of systems.
- .12 Before fabricating piping or ducting for installation, make certain that such items can be installed as shown on the drawings without interfering with the structure or the work of all other trades. Any problems that cannot be solved in agreement with the other trades affected, shall be submitted to the Consultant for decision. If piping or ducting is prefabricated prior to the investigation and reaching of a solution to possible interference problems, necessary changes in such prefabricated items shall be made at no extra cost to the Project.
- .13 Off-sets in piping or ducting may not be indicated in all cases, but are to be included in the contract as required.
- .14 All piping and ductwork in finished areas shall be concealed in ceiling spaces and shafts or chased into walls. No exposed piping or ductwork shall be installed in such areas unless specifically reviewed by the Consultant. No piping shall be concealed in outside walls.
- .15 Vent pipes, exhaust hoods or other mechanical equipment mounted on roof, or housing for such equipment, shall not be closer to the edge of roof than 1800 mm (6 ft.), unless

specifically reviewed by the Consultant.

- .16 The actual location of thermostats, switches, etc. shall be reviewed by the Consultant before installation.
- .17 Where equipment is shown to be 'roughed-in only' obtain accurate information from the Consultant before proceeding with the work.

## 28

### **INSTALLATION, INTERFERENCE AND SETTING DRAWINGS**

- .1 Installation, interference and setting drawings dimensioned and to scale, shall be submitted for review to the Consultant, as may be required or requested by the Consultant to make clear the work intended or to show its relation to adjacent work or to the work of other trades. When an alternative piece of equipment is to be substituted for equipment shown, drawings of the area involved shall be prepared by this division. Three copies of such drawings shall be submitted for review, of which one will be retained by the Consultant.
- .2 Installation working drawings to 1:50 scale for the mechanical room showing plan and sections of the plant, services, bases, curbs, drains, motor terminals, shall be prepared by this division.
- .3 Interference drawings are required for shafts, ceiling spaces and wherever there is possible conflict in the positioning of mechanical equipment, piping, ductwork subtrades or architectural features.
- .4 The design of the structural framing of the mechanical equipment and major pipe run supports has been based on assumed loadings supplied during the design phase. Well ahead of the construction of the affected areas, prepare and submit drawings for review to the Consultant showing the layout and weights of all finally selected mechanical equipment including details of concrete pads, concentrated pipe loads and point reactions of the equipment onto the structure. Structural design has been based on equipment listed by model number. Alternate equipment shall not exceed weight and dimensions of equipment listed without prior approval of Consultant. If alternate equipment is not approved by Consultant, contractor shall supply equipment listed at no additional cost to project. If alternate equipment is selected, contractor shall provide all structural revisions necessary and pay all cost including engineering.
- .5 Pump capacities, control valve sizing, etc., have been based on equipment specified. Upon submission of shop drawings, contractor shall review with consultant all design and equipment changes and where required to accommodate design or equipment changes contractor shall consult and revise equipment capacities as required. There shall be no extra cost to Project for changes to equipment to accommodate changes discussed above. No installations shall proceed until this coordination has been completed.

## 29

### **ALTERNATES**

- .1 Tenders shall be prepared only on the basis of specified or listed equivalent material.
- .2 The design, space allocation, orientation, piping, control systems, etc., are arranged to suit the material and equipment named by model number in the text of the specifications and shown on the drawings. Assume responsibility for adjustments or extension of the work of this or other Division necessary for the accommodation of equivalent or substitute equipment.
- .3 Structural design has been based on equipment listed by model number. Alternate

equipment shall not exceed weight and dimensions of equipment listed without prior approval of Consultant. If alternate equipment is not approved by Consultant, Contractor shall supply equipment listed at no additional cost to project. If alternate equipment is approved and selected, contractor shall provide all structural revisions necessary and pay all cost including engineering.

**30 ENERGY CONSUMPTION**

- .1 Consultant may reject equipment submitted for approval on basis of performance or energy consumed or demanded.

**31 CONFORMANCE**

- .1 Materials specified by referenced standard, select any material that meets or exceeds the specified standard.
- .2 Materials specified by "Prescriptive" or "Performance" specification, select any material meeting or exceeding specification.
- .3 When materials are specified by a Standard, Prescriptive or Performance specifications, upon request of the Consultant, obtain from manufacturer an independent testing laboratory report showing that the material or equipment meets or exceeds the specified requirements.
- .4 Materials specified by naming one or more materials, select any material named. Where only one name appears in the specification, the tender shall include for the specified equipment. For the purpose of these specifications, the term "Acceptable Material" is deemed to be a complete and working commodity as described by a manufacturer's name, catalogue number, trade name or any combination thereof.
- .5 Manufacturers or subcontractors specified by naming one or more, select any one named. Where only one name appears in the specification, the tender shall include for the specified name.

**32 STATEMENT OF PRICES**

- .1 To form a basis for progress payments the successful bidder shall submit a statement of his estimated prices for the various portions of the work, including labour, materials and equipment shown separately. The total price of all portions of the work shall equal the total price of the work covered under the mechanical division.
- .2 The successful bidder shall confer with the Consultant to determine the breakdown of work for this contract.
- .3 The breakdown shall have commissioning cost separated. A minimum of 2% of the contract value shall be assigned for commissioning.
- .4 The breakdown shall have the EMCS controls separated, with a separate breakdown as per Section 23 09 36 – Energy Monitoring and Control System (EMCS) General.
- .5 Equipment values shall not be paid out in full until the equipment is commissioned and working as intended by the design. Ten percent of the equipment value will be held back until such time that the equipment is commissioned, and all closeout documentation requested is also submitted.
- .6 No "bulking" of the specified and/or non-specified equipment will be tolerated.

(Note that a “supplier” in the wording above includes manufacturers, suppliers, distributors, etc. who sell the specified products. Note that “bulking” in the wording above is with reference to a supplier offering an array of products in various specification sections, with no provisions for the Contractors to select the products in any one individual specification section to prepare their ‘best packaged price’.)

**33 METRIC CONVERSIONS**

- .1 Particular care shall be taken with imperial versus S.I. metric conversions. This applies to all services including, but not limited to, equipment, pipes, ductwork and site services in both new and existing installations.
- .2 When converting from one form of measure to the other, do not round-off numbers.

**34 ASHRAE 90.1**

- .1 All mechanical equipment must meet the minimum efficiency standards set out in ASHRAE 90.1-2013. Submit all necessary information to substantiate conformance.

**35 SCHEDULE**

- .1 This contractor shall provide a schedule outlining all aspects of the work in sufficient detail to track the progress of the work. Include all critical dates, including delivery to and return of shop drawings to Consultant, inspection dates, dates for training and commissioning systems. Submit schedule to Consultant for review at start of project.
- .2 Contractor shall review schedule on a regular basis and at each construction meeting. The contractor shall provide additional workers as required to meet the schedule. Update schedule as required in conjunction with General Contractor and Consultant.

**36 HOISTING AND RIGGING**

- .1 Provide and arrange for transportation, of all equipment and materials to site, and for the rigging, hoisting, storing and setting in place of equipment.

**37 WORKMANSHIP AND QUALIFICATIONS OF WORKERS**

- .1 Perform the work in a neat and careful manner so that items are installed, and will remain, plumb, square and straight. Items not so installed will be rejected and redone at no extra cost to the Consultant.
- .2 When required either by the specifications or manufacturer's instructions, have manufacturer or his accredited agent or the supplier supervise the work.
- .3 Provide qualified tradespeople to perform all the work. Provide an on site supervisor to supervise the work of Division 20, 22, 23. When requested of the Consultant provide documentation demonstrating experience of tradespeople and supervisor. If tradesperson or supervisor does not have adequate experience or qualifications remove from site and provide suitable replacement. Site supervisor to have minimum of 10 years of experience with demonstrated supervisory experience on similar sized projects. Provide resume of site supervisor to Consultant prior to start of project. Consultant has the right to reject or remove at any time any worker or site supervisory if in his opinion the individual does not possess the required experience or qualifications. When personnel have been removed or rejected provide suitable replacement.
- .4 No horseplay will be tolerated on site at any time. The contractor shall be responsible for putting an immediate end to all horseplay.

**38 CERTIFICATES, PERMITS & FEES**

- .1 The contractor shall give all necessary notices, obtain all required permits, and pay all fees, in order that the work herein specified may be carried out, and he shall furnish any certificates needed as evidence that the work installed conforms with the laws and regulations of the Municipality and Province and as approved by the local utility.

**39 SPECIAL TOOLS**

- .1 Provide one set of special tools required to service equipment as recommended by manufacturers.

**40 INSPECTION/TAKEOVER PROCEDURES**

- .1 Conform to Section 01 77 00 – Closeout Procedures.
- .2 Contractor's Inspection: The Contractor and all Subcontractors shall conduct an inspection of the Work, identify deficiencies and defects; repair as required. Notify the Consultant in writing of satisfactory completion of the contractor's Inspection and that corrections have been made. Request a Consultant's review.
- .3 Consultant's review: Consultant and the Contractor will perform a review of the Work to identify obvious defects or deficiencies. The contractor shall correct Work accordingly. If during the Consultant's review it is obvious that the work is incomplete, the Consultant will notify the Contractor without provision of a deficiency list and the contractor shall complete and correct deficiencies as per item .1.
- .4 Final Review: When the items noted above are complete, request a final review of the Work by the Consultant. If Work is deemed incomplete by the Consultant, complete the outstanding items and request another review.
- .5 Declaration of Substantial Performance: When the Consultant consider deficiencies and defects have been corrected and it appears requirements of the Contract have been substantially performed, make application for Certificate of Substantial Performance. All other requirements noted elsewhere shall be completed prior to request for Certificate of Substantial Completion.
- .6 Do not apply for substantial performance until:
  - .1 All systems are complete and operation.
  - .2 All systems have been commissioned and successfully passed testing over the entire range of their operating capacities under automatic control. (Note: seasonal or environmental conditions resulting in the delay of some testing will be accommodated by issuance of conditional certificate).
  - .3 Commissioning and testing reports have been submitted for the Consultant's review.
  - .4 Air and water balancing has been completed and reports have been submitted for the Consultant's review.
  - .5 "As-built" and/or record drawings have been prepared and submitted for the Consultant's review.
  - .6 Final Operations and Maintenance Manuals have been prepared and submitted to the Consultant.
  - .7 The Owner, operating and maintenance personnel have received training on all systems and equipment and the required certificate has been submitted to the Consultant.
  - .8 Controls verification, and training session.



- .9 Unit Ventilator manufacturer's start-up, certification, and training session.
- .10 HVAC unit start-up, certification, and training session.
- .11 Variable Refrigerant Flow system start-up, certification, and training session.
- .12 Consultant's final review has been completed.

#### **41 SCHEDULE, ACCESS, PROTECTION AND CLEAN-UP**

- .1 The construction schedule places restrictions on the duration of construction within areas and the duration of shut-down of equipment. Refer to the General Requirements and General contractor for all requirements.
- .2 Access to the site is limited to location and time of day. Access to areas of the building is limited to location and time of day. Refer to the General Requirements for all requirements.
- .3 Refer to the security and protection requirements in the General Requirements, conform to all requirements. In particular no open flames shall be used without prior written approval of the Consultant. There shall be no smoking, and the site shall be kept clean at all times.
- .4 Contractor shall complete all work required in the various spaces during the time scheduled for that phase. Where work or connections are to be made into systems located in a prior phase, the contractor shall complete the work or connections outside of normal hours of operations. Contractor shall complete all work required to systems. Contractor shall place systems back into operation prior to start of normal hours of operation. Include in tender for all overtime costs.

#### **42 CUTTING AND PATCHING**

- .1 The cost of cutting, patching and finishing is not included in this Division's Contract.
- .2 This Division shall advise the trade responsible for cutting, in advance of the time required, of the location and extent of cutting required, and any other pertinent information.
- .3 This Division shall advise the trade responsible for patching and finishing of any pertinent information such as, clearance requirements.
- .4 Refer also to item 25, Coordination, and item 12, Sleeves for other coordination requirements.
- .5 In case of costs arising to correct work, due to failure to provide coordination information on time, incorrect sizes or locations or other incorrect pertinent information, shall not be extra to Project.

#### **43 GUARANTEE**

- .1 This contractor shall guarantee all material and workmanship used in the work to be in strict accordance with the specifications, of best quality and type obtainable to give first-class construction and proper and efficient operation, and free from any defects. Any such defects which may appear in any of the work within one year after written acceptance of this work shall be repaired and replaced by this contractor without additional expense to the Owner. Where such defects occur, this contractor shall be held responsible for all costs incurred in making the defective work good.
- .2 This shall not obsolete any longer warranties on specific items of equipment.

- .3 All injuries to adjacent work particularly plaster, wood finishes or other materials, or damage to other equipment, caused by such defects of this contractor's work or by subsequent replacement and repairs, shall be made good at the expense of this contractor. All repair work shall be done by trades responsible for the original work.

- .4 Guarantee period begins upon acceptance of Substantial Completion.

#### **44 SPARE PARTS**

- .1 Furnish spare parts as specified in relevant sections.

#### **45 PROTECTION OF EQUIPMENT**

- .1 Temporarily protect all equipment and systems throughout construction from damage as required. Remove measures of protection at end of job.
- .2 Any damaged equipment shall be replaced by contractor at no cost to Owner.
- .3 Do not use equipment or systems as support platforms for work above, provide necessary work platforms as required.

#### **46 EXISTING SYSTEMS**

- .1 Connections into existing systems to be made outside normal hours of operation for building. Request approval of time when connections can be made.
- .2 Be responsible for damage to existing plant by this work.
- .3 Where connections are made to existing services, existing insulation shall be made good under this division.

#### **47 INTERRUPTION OF SERVICES**

- .1 Any interruption of mechanical services to any part of the building shall be scheduled with the Owner and General Contractor and shall be completed outside of normal hours of operation of the building. Make all necessary arrangements with those concerned and include for any overtime required to ensure that the interruption is held to a minimum.
- .2 All such overtime work shall be carried out without additional cost to the Project.

#### **48 DEMOLITION**

- .1 Division 20 contractor shall remove existing systems and equipment indicated on drawings. In order to determine the extent of the demolition of the existing system, the contractor, before quoting, shall examine the site and determine the extent of existing systems to be removed. The contractor shall be responsible for obtaining an understanding of the extent of the existing systems. No additional cost to the Project will be entertained due to failure of the contractor from reviewing on site the extent of the existing systems to be removed.
- .2 The demolition drawings showing existing mechanical systems may not represent "as-built" conditions and it shall be the responsibility of the contractor to verify on site the extent of the existing systems. Contractor shall visit site and confirm extent of existing equipment and system before submitting tender price to determine extent of systems to be demolished. No extras will be allowed for failure of the contractor in completing a

thorough review of the site prior to submitting tender price.

- .3 Provide temporary equipment and systems as indicated on the drawings and remove upon completion.
- .4 For exact details and total extent each service must be carefully checked on site. Before removing any service, follow the service through to its source to ensure other areas of the building are not adversely affected by the removal of this service. Open shafts, walls and ceilings as required to examine the service.
- .5 If there are no isolating valves readily available to isolate sections of pipe that requires removal, add valves as required. Install caps on all services. Add caps to all valves at the termination point of existing services.
- .6 Where valves are removed, remove valve tags, revise existing charts and hand tags over to Engineer.
- .7 Where services are to be removed as part of the demolition, obtain written consent from the owner before starting any work or removing any services.
- .8 Unless noted otherwise, removed equipment shall become the property of the contractor and disposed of off-site at an approved location.
- .9 Provide paperwork to indicate appropriate disposal of regulated materials.

#### **49 ABANDONED SERVICES**

- .1 Within the work areas of the existing building unknown abandoned services may be encountered. Obtain clarification from the owner regarding these services and remove any sections of services from the work areas as directed.

#### **50 CERTIFICATION**

- .1 All equipment and trim shall be certified for use in Ontario, by a qualified testing agency (e.g. CSA).

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Do the work in accordance with the following standards except where specified otherwise:
  - .1 ANSI/ASME B31.1: ASME Code for Pressure Piping and Power Piping.
  - .2 ANSI/ASME Boiler and Pressure Vessels Code:
    - .1 Section 1: Power Boilers.
    - .2 Section V: Non-destructive Examinations.
    - .3 Section IX: Welding and Brazing Qualifications.
  - .3 CSA W47.2 Aluminum welding qualification code.
  - .4 CSA W48 series Electrodes.
  - .5 CSA B51 Boiler, Pressure Vessel and Pressure Piping Code.
  - .6 CAN/CSA-W117.2, Code for safety in welding and cutting (Requirements for welding operators).
  - .7 CSA W178, Qualification code for welding inspection organizations.
  - .8 CSA W178.2, Certification of welding inspectors.
  - .9 AWS B3.0, Welding procedures and performance qualifications.
  - .10 AWS C1.1, Recommended practices for resistance welding.
  - .11 AWS W1, Welding inspection.
  - .12 Technical Standards and Safety Authority, Pressure Vessels Branch (T.S.S.A.).
  - .13 Boiler and Pressure Vessels Regulation (O.Reg. #220/01).

**1.2 WELDERS QUALIFICATIONS**

- .1 Welding qualifications to be in accordance with CSA B51 and T.S.S.A.
- .2 Use qualified and licensed welders possessing certificate for each procedure to be performed from T.S.S.A.
- .3 Furnish welder's qualifications to Consultant.
- .4 Each welder to possess identification stamp issued by T.S.S.A.

**1.3 INSPECTORS QUALIFICATIONS**

- .1 Inspectors to be qualified to CSA W178.2-14 and T.S.S.A.

**1.4 WELDING PROCEDURES**

- .1 Registration of welding procedures in accordance with CSA B51 and T.S.S.A.
- .2 Copy of welding procedures to be available for inspection at all times.
- .3 Safety in welding, cutting and allied processes to be in accordance with CAN/CSA-W117.2-12.

**Part 2 Products**

**2.1 ELECTRODES**

- .1 Electrodes: in accordance with CSA W48 series.
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**Part 3 Execution**

**3.1 WORKMANSHIP**

- .1 Welding to be in accordance with ANSI/ASME B31.1 and ANSI/ASME Boiler and Pressure Vessel Code, Sections I and IX, using procedures conforming to relevant AWS codes.
- .2 Welding to conform to standards governed by T.S.S.A. and Boiler and Pressure Vessels Regulation (O.Reg. #220/01).

**3.2 INSTALLATION REQUIREMENTS**

- .1 Identify each weld with welder's identification stamp.
- .2 Fittings:
  - .1 NPS 2 and smaller: install welding type sockets.
  - .2 Branch connections: install welding tees or forged branch outlet fittings.

**3.3 INSPECTION AND TESTS - GENERAL REQUIREMENTS**

- .1 Review all weld quality requirements and defect limits of applicable codes and standards with Consultant before any work is started.
- .2 Formulate "Inspection and Test Plan" in co-operation with Consultant.
- .3 Do not conceal welds until they have been inspected, tested and approved by inspector.
- .4 Provide for inspector to visually inspect all welds during early stages of welding procedures. Repair or replace all defects as required by codes and as specified herein.
- .5 Inspector shall be an independent agency qualified as per Section I of ASME Boiler and Pressure Vessel Code and T.S.S.A.. Contractor to pay cost of independent inspection agency to act on behalf of Owner.

**3.4 SPECIALIST EXAMINATIONS AND TESTS**

- .1 General:
  - .1 Perform examinations and tests at contractors' expense by specialist qualified in accordance with CSA W18 and W178.2 and approved by Consultant.
  - .2 To ANSI/ASME Boiler and Pressure Vessels Code, Section V, CSA B51 and requirements of authority having jurisdiction.
  - .3 As required by T.S.S.A.
- .2 Hydrostatically test all welds to requirements of ANSI/ASME B31.1, and ASME Boiler and Pressure Vessels Code.
- .3 Visual examinations: include entire circumference of weld externally and wherever possible internally.
- .4 Failure of visual examinations:
  - .1 Upon failure of any weld by visual examination, perform additional testing as directed by Consultant of a total of up to 10% of all welds, selected at random by Consultant by radiographic tests.

**3.5 DEFECTS CAUSING REJECTION**

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

### **3.6 REPAIR OF WELDS WHICH FAILED TESTS**

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

### **3.7 CLAIMS AGAINST OWNER FOR DELAYS**

- .1 Claims against Owner for delays in completion of project will not be entertained for reasons of failures of welds to pass examinations.

**END OF SECTION**

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**Part 1 General**

**1.1 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit descriptive data and shop drawings in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Descriptive Data
  - .1 Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
  - .2 Detailed schedules of flexibly and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.
- .3 Shop Drawings
  - .1 Submit fabrication details for equipment bases, including dimensions, structural member sizes, and support point locations.
  - .2 Provide all details of suspension and support for equipment hung from the ceiling.
  - .3 Where walls, floors, slabs, or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit, and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads, and seismic loads at all attachment and support points.
  - .4 Provide specific details of seismic restraints and anchors; include number, size, and locations for each piece of equipment.

**1.2 DESIGN REQUIREMENTS**

- .1 The contractor shall retain and pay for a specialty consultant or equipment manufacturer to develop and implement a seismic restraint system and perform seismic calculations in accordance with the Ontario Building Code and local codes and additional requirements specific in this section. Calculations, restraint selections, and installation details shall be done by a professional engineer experienced in seismic restraint design and installation and licensed in the Province of Ontario.
  - .2 The seismic restraint design, consisting of calculations, restraint selection, installation details, and other documentation, shall be submitted. This submittal shall be signed and sealed by a professional engineer, as stated above.
  - .3 The seismic restraint design shall clearly indicate the attachment points to the building structure and all design forces (in X, Y, and Z direction) at the attachment points. The seismic restraint engineer shall coordinate all attachments with the building's structural engineer of record, who shall verify the attachment methods and the ability of the building structure to accept the loads imposed. The seismic restraint design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from submittals or the manufacturers. The equipment manufacturer shall verify that the attachment points on the equipment can accept the combination of seismic, weight, and other loads imposed.
  - .4 Analysis should include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure. Analysis should detail anchoring methods, bolt diameter, embedment, and/or welded length. All seismic restraint devices should be designed to accept, without failure, the forces through the equipment or system's center of gravity.
  - .5 All seismic restraints and combination isolator/restraints should have verification of their
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seismic capabilities. Manufacturers may verify their capabilities by testing that is witnessed by an independent professional engineer.

- .6 Engineering Design Criteria
  - .1 Design system in accordance with Ontario Building Code for a building of "High" importance.
  - .2 Seismic design must be considered for machinery, equipment, ducts, tanks, and pipes.
- .7 The following companies that provide seismic systems are acceptable:
  - .1 HTS Engineering, Brian Gerow, 1646 Woodward Drive, Ottawa, Ontario, K2C 3R8 (613) 728-7400.
  - .2 Tecoustic Ltd., Ryan Belluz, 5036 South Service Road, Burlington, Ontario, L7L 5Y7, (905) 681-6077.
  - .3 E.H. Price, Carmelo Cambareri, 3236 Hawthorne Road, Ottawa, Ontario, K1G 3W9, (613) 725-2029.
  - .4 Capital Seismic & Engineering Ltd., Craig Andrews, Ottawa, Ontario, (613) 222-0141.

## **Part 2 Products**

### **2.1 ELASTOMERIC PADS DESIGNED FOR THE APPLICATION**

- .1 Pads may be either a single layer or two layers separated horizontally by a 1.6 mm (16 Ga.) galvanized shim. Load distribution plates shall be used as required. If bolting through the pad is required, type 4 bushings should be used.

### **2.2 NEOPRENE MOUNTINGS HAVING ALL-DIRECTIONAL SEISMIC CAPABILITY**

- .1 The mount should consist of a ductile iron casting or welded steel housing containing a molded neoprene element. The element should prevent the central threaded sleeve and attachment bolt from contacting the housing during normal operation. The neoprene should be compounded to bridge bearing specifications.

### **2.3 ONE-PIECE MOLDED BRIDGE BEARING NEOPRENE WASHER/BUSHING**

- .1 The bushing should surround the anchor bolt and have a flat washer face to avoid metal-to-metal contact.

### **2.4 SPRING MOUNTINGS**

- .1 As in the ASHRAE Handbook, Chapter 46, type 3, should be built into a ductile casting or welded steel housing to provide all-directional seismic snubbing. The snubber should be adjustable vertically and allow a maximum of 6 mm (1/4 in.) travel in all directions before contacting the resilient snubbing collars.

### **2.5 SEISMIC CABLE RESTRAINTS**

- .1 Should consist of steel cables sized to resist seismic loads with a minimum safety factor of 2 and arranged to provide all-directional restraint. Cables should be prestretched to achieve a certified minimum modulus of elasticity. Cable end connections should be steel assemblies that swivel to the final installation angle and utilize two clamping bolts to provide proper cable engagement. Alternatively, 45 degree bent steel plates, with holes for attachment to the structure and for steel cable loops with thimbles and wire rope clamps, are acceptable. A minimum of two wire rope clamps is required at each end of



the cable assembly.

## **2.6 SEISMIC SOLID BRACES**

- .1 Should consist of steel angles, channels, or strut channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all-directional restraint. Seismic solid brace end connectors should be steel assemblies that swivel to final installation angle and utilize two through-bolts to provide proper attachment.

## **2.7 STEEL ANGLES OR STRUT CHANNELS**

- .1 Sized to prevent buckling should be clamped to vertical support rods utilizing a minimum of two clamps at each restraint location when required. Clamp assemblies may be ductile casting or strut channels assemblies.

## **2.8 PIPE CLEVIS CROSS**

- .1 Bolt braces should be required at all restraint locations. They may be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt or pipe sections installed over the cross bolt with a minimum of 3 mm (1/8 in.) wall thickness.

## **2.9 SEISMIC SNUBBERS**

- .1 Should consist of interlocking steel members restrained by molded neoprene bushings or pads of bridge bearing neoprene. Bushings or pads should be replaceable and a minimum of 6 mm (1/4 in.) thick. A minimum air gap of 3 mm (1/8 in.) should be incorporated in the snubber design before contact is made between the rigid and resilient surfaces. Snubbers must have a minimum of two bolt holes for attachment to the structure.

## **2.10 ALL-DIRECTIONAL SEISMIC SNUBBERS**

- .1 Should consist of interlocking steel members restrained by shock absorbent neoprene material compounded of bridge bearing neoprene. Neoprene should be a minimum of 19 mm (3/4 in.) thick. Snubbers should be manufactured with an air gap between hard and resilient material of not less than 3 mm (1/8 in.) or more than 6 mm (1/4 in.). Snubbers should be installed with factory set clearances. Submittals should include the load deflection curves in the X, Y, and Z planes.

## **2.11 ALL-DIRECTIONAL ACOUSTICAL PIPE ANCHORS**

- .1 Consisting of two sizes of steel tubing, pipes, or plates should be separated by a minimum 3 mm (1/2 in.) thick neoprene. Vertical restraint should be provided by similar material arranged to prevent vertical travel in either direction. The design should be balanced for equal resistance in any direction.

## **2.12 PIPE GUIDES**

- .1 Should consist of an acoustically telescopic arrangement of two sizes of steel tubing or pipes separated by a minimum 13 mm (1/2 in.) thickness of neoprene. The guides should be preset with a device for the setting of the height to allow vertical motion due to pipe expansion or contraction. Guides should be capable of  $\pm 41$  mm ( $\pm 1\text{-}5/8$  in.) motion or to meet location requirements.

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**Part 3                      Execution**

**3.1                      GENERAL NOTES**

- .1 All seismic restraint systems should be installed in strict accordance with the manufacturer's written instructions and all certified submittal data.
  - .2 Installation of seismic restraints should not cause any change of position of equipment, piping, or ductwork, resulting in stresses or misalignment.
  - .3 No rigid connections between equipment and the building structure should be made that degrade the noise and vibration-isolation system specified.
  - .4 The contractor shall not install any equipment, piping, duct, or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs, and walls.
  - .5 Coordinate work with other trades to avoid rigid contact with the building.
  - .6 Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the consultant's attention prior to installation.
  - .7 Prior to installation, bring to the consultant's attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection.
  - .8 Overstressing of the building structure should not occur because of overhead support of equipment. Contractor should submit loads to the structural engineer of record for approval. Generally, bracing may occur from:
    - .1 flanges of structural beams,
    - .2 upper truss cords in bar joist construction, and
    - .3 concrete anchors.
  - .9 Type 6 cable restraints should be installed slightly slack to avoid short-circuiting the isolated suspended equipment, ductwork, piping, or conduit. When cables are installed slack a safety factor of 5 shall be used.
  - .10 Type 6 cable assemblies should be installed taut on non-isolated systems. Type 7 seismic solid braces may be used in place of cables on rigidly attached systems only.
  - .11 Cables should not be installed over sharp corners.
  - .12 At locations where type 6 or 7 restraints are located, the support rods should be braced when necessary to accept compressive loads with type 8 braces. Welding of compression braces to the vertical support rods is not acceptable.
  - .13 At all locations where type 6 or 7 restraints are attached to a pipe clevis, the clevis cross bolt should be reinforced with type 9 braces.
  - .14 The vibration-isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails should not be permitted.
  - .15 Post-installed concrete anchors should be as specified in Section 20 05 29 – Pipe Hangers and Supports.
-

- .16 When vertical pipe risers are flexibly supported to accommodate thermal motion and/or pipe vibration concerns, the pipe shall be guided with type 13 pipe guides, located to maintain pipe stability and provide horizontal seismic restraint. Where necessary, the riser shall also be anchored with type 12 pipe anchors, located to provide thermal control and vertical seismic restraint.
- .17 Seismic restraints should be mechanically attached to the system. It is not sufficient to loop restraints around the system.
- .18 Piping crossing building seismic joints, passing from building to building, or supported from different portions of the building shall be installed to allow differential support displacements without damaging the pipe, equipment connections, or support connections. Pipe offsets, loops, anchors, and guides shall be installed as shown on the plans or as required to provide required motion capability and limit motion of adjacent piping.
- .19 Water tanks should be secured to their saddles by welding or proper concrete attachment, and those saddles should be properly attached to the structure.
- .20 Do not brace a system to two different structures, such as a wall and a ceiling.

### **3.2 CERTIFICATION**

- .1 At the completion of the installation the seismic specialist shall visit the site and review that the installation of restraint for system is in accordance with their design. The specialist shall provide written and stamped certification that the systems have been correctly restrained.

**END OF SECTION**

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**Part 1                    General**

**1.1                    CODES AND REFERENCES**

- .1 Perform work and material to be in accordance with the following:
  - .1 ANSI/ASME B31.1, Power Piping, (SI Edition).
- .2 MSS-SP-58, Pipe Hangers and Supports - Materials, Design and Manufacturer.
- .3 MSS-SP-69, Pipe Hangers and Supports - Erection and Application.

**1.2                    SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Submit shop drawings and product data for following items:
  - .1 Upper attachment.
  - .2 Middle attachment.
  - .3 Pipe attachment.
  - .4 Riser clamps.
  - .5 Shields and saddles.

**1.3                    MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.

**1.4                    DESIGN REQUIREMENTS**

- .1 Construct pipe hanger and support to manufacturer's recommendations utilizing equipment manufacturer's regular production components, parts and assemblies.
- .2 Design hangers and supports to support systems under all conditions of operation, allow free expansion and contraction, prevent excessive stresses from being introduced into pipework or connected equipment.
- .3 Provide for vertical adjustments after erection and during commissioning.
- .4 Ensure that supports, guides, anchors do not transmit excessive quantities of stress or heat to building structure.
- .5 Base maximum load ratings on allowable stresses prescribed by ASME B31.1 or MSS-SP-58.

**Part 2                    General**

**2.1                    GENERAL**

- .1 Fabricate hangers, supports and sway braces in accordance with ANSI B31.1 and MSS-SP-58.
  - .2 Support from structural members, where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members. Do not suspend from metal deck.
-

- .3 All supplementary structural members and supports shall be hot dipped galvanized after fabrication. All steel hangers and rods shall be hot dipped galvanized. All supports beneath liquid levels in tanks shall type 304L stainless steel.
- .4 Provide seismic bracing of piping in accordance with Section 20 05 20 - Seismic Restraints.
- .5 Provide rubber hose over threaded rod on all pipe clamps.
- .6 Provide restraining clips on all c-clamps.
- .7 All steel hangers and rods shall be galvanized.

## 2.2 UPPER ATTACHMENTS

- .1 Upper Attachments:
  - .1 Concrete:
    - .1 Hollow core block concrete: Adhesive material applied with screen tube.
      - .1 Acceptable material: Hilti Hit Adhesive Anchors, HY 70.
    - .2 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.
    - .3 Submit anchor manufacturer's recommendations for anchoring to structural engineer prior to drilling for supports.
  - .2 Solid cast in place concrete or hollow core slabs: Adhesive material fastened into solid base.
    - .1 Acceptable material: Hilti Hit Adhesive Anchors, HY 200 (Safe Set).
    - .2 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.
    - .3 Scan hollow core slabs for locations to install attachments per the manufacturer's written installation instructions.
- .2 Steel beam (bottom flange):
  - .1 Cold piping NPS 2 and under: malleable iron C clamp to MSS-SP-58, type 23. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.86 or fig.92 c/w fig.89/89x in seismic applications).
  - .2 Cold piping NPS 2-1/2 and larger and all hot piping: malleable iron beam clamp to MSS-SP-58, type 28 or 29. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.228.
- .3 Steel beam (top):
  - .1 Cold piping NPS 2 and under: malleable iron "top of beam" C clamp to MSS-SP-58, type 19. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.94.
  - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP-58, type 25. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.227.
- .4 Steel joist:
  - .1 Cold piping NPS 2 and under: steel washer plate with double locking nuts.
    - .1 Standard of Acceptance: Anvil Int'l. fig.60.
  - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel washer plates with double locking nut, carbon steel clevis and malleable iron socket.
    - .1 Standard of Acceptance: Anvil Int'l.: washer plate fig.60; welded beam attachment fig.66; with weldless eye nut fig.290.

- .5 Steel channel or angle (bottom):
  - .1 Cold piping NPS 2 and under; malleable iron C clamp to MSS-SP-58, type 23. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.86 c/w fig.89 (89x in seismic applications)
  - .2 Cold piping NPS 2-1/2 and larger and all hot piping; universal channel clamp. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.94.
- .6 Steel channel or angle (top):
  - .1 Cold piping NPS 2 and under; malleable iron "top of beam" C clamp to MSS-SP-58, type 19. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.94.
  - .2 Cold piping NPS 2-1/2 and larger and all hot piping: steel jaw, hook rod with nut, spring washer and plain washer, to MSS-SP-58, type 25. ULC listed.
    - .1 Standard of Acceptance: Anvil Int'l. fig.227.

## **2.3 MIDDLE ATTACHMENT (ROD)**

- .1 Carbon steel threaded rod electro-galvanized finish.
  - .1 Standard of Acceptance: Anvil Int'l. fig.146.
- .2 Ensure that hanger rods are subject to tensile loading only.
- .3 Provide linkages where lateral or axial movement of pipework is anticipated.

## **2.4 PIPE ATTACHMENT**

- .1 Cold piping, steel or cast iron: hot piping steel, with less than 25 mm (1 in.) horizontal movement; adjustable clevis to MSS-SP-58, type 1. ULC listed. Electro galvanized finish.
  - .1 Standard of Acceptance: Anvil Int'l. fig.260.
- .2 Uninsulated cold copper piping; uninsulated hot copper piping with less than 25 mm (1 in.) horizontal movement; adjustable clevis to MSS-SP-58, type 1. Copper plated.
  - .1 Standard of Acceptance: Anvil Int'l. fig.CT-65.
- .3 Suspended hot piping, steel and copper, with horizontal movement in excess of 25 mm (1 in.); pipe roller to MSS-SP-58, type 43.
  - .1 Standard of Acceptance: Anvil Int'l. fig.171.
- .4 Bottom supported hot piping, steel and copper: pipe roller stand to MSS-SP-58, type 45.
  - .1 Standard of Acceptance: Anvil Int'l. fig.271.
- .5 Pipe hangers and supports on all cold pipework and hot pipework above NPS 1 must be oversized to accommodate thermal insulation and to avoid penetrating the vapour barrier.

## **2.5 RISER CLAMPS**

- .1 Steel or cast iron pipe: galvanized carbon steel to MSS-SP-58, type 42. ULC listed.
  - .1 Standard of Acceptance: Anvil Int'l. fig.261.
- .2 Copper pipe: carbon steel copper finished to MSS-SP-58, type 42.
  - .1 Standard of Acceptance: Anvil Int'l. fig. CT-121.

## **2.6 SADDLES AND SHIELDS**

- .1 Cold piping and hot copper piping NPS 1-1/4 and over: protection shield with high density insulation (maximum 25 mm (1 in.) thick polyisocyanurate) under shield with uninterrupted vapor barrier.
  - .1 Standard of Acceptance: Anvil Int'l. fig.167.
- .2 Hot piping steel NPS 1-1/4 and over: protective saddle with insulation under saddle.
  - .1 Standard of Acceptance: Anvil Int'l. fig.160 to 166A.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with:
  - .1 Manufacturer's instructions and recommendations.
- .2 Vibration Control Devices:
  - .1 Install on piping systems at pumps, boilers, chillers, cooling towers, elsewhere as indicated.
- .3 Clamps on riser piping:
  - .1 Support independent of connected horizontal pipework using riser clamps and riser clamp lugs welded to riser.
  - .2 Bolt-tightening torques to be to industry standards.
  - .3 Steel pipes: Install below coupling or shear lugs welded to pipe.
  - .4 Cast iron pipes: Install below joint.
- .4 Clevis plates:
  - .1 Attach to concrete with 4 minimum concrete inserts, one at each corner.
- .5 Provide supplementary structural steelwork where structural bearings do not exist or where concrete inserts are not in correct locations.
- .6 Use approved constant support type hangers where:
  - .1 Vertical movement of pipework is 13 mm (1/2 in.) or more, transfer of load to adjacent hangers or connected equipment is not permitted.
- .7 Use variable support spring hangers where:
  - .1 Transfer of load to adjacent piping or to connected equipment is not critical.
  - .2 Variation in supporting effect does not exceed 25% of total load.
- .8 Support plastic piping as per manufacturer recommendations.

### **3.2 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 Ontario Building Code, Part 7, or authority having jurisdiction.
  - .2 Gas piping: Gas Code.
  - .3 Copper piping: up to NPS 1/2: every 1.5 m (5 ft.).
  - .4 Flexible joint roll groove pipe: in accordance with table below, but not less than one hanger at joints.
  - .5 Within 300 mm (12 in.) of each horizontal elbow.

Pipe Size	Rod Diameter		Maximum Spacing Steel		Maximum Spacing Copper	
	Millimeters	Inches	Meters	Feet	Meters	Feet
Up to 1-1/4	9.5	3/8	2.1	6.9	1.8	5.9
1-1/2	9.5	3/8	2.7	8.9	2.4	7.8
2	9.5	3/8	3.0	9.8	2.7	8.9
2-1/2	9.5	3/8	3.6	11.8	2.7	8.9
3	9.5	3/8	3.6	11.8	3.0	9.8
3-1/2	9.5	3/8	3.9	12.8	3.0	9.8
4	15.9	5/8	4.2	13.7		
5	15.9	5/8	4.8	15.7		
6	22.2	7/8	5.1	16.7		

### 3.3 HANGER INSTALLATION

- .1 Install hanger so that rod is vertical under operating conditions.
- .2 Adjust hangers to equalize load.
- .3 Support from structural members. Where structural bearing does not exist or inserts are not in suitable locations, provide supplementary structural steel members.
- .4 Do not suspend from metal deck, wood roof deck or Siporex roof slab.
- .5 Anchoring of piping shall be as per manufacturers recommendations. Submit anchorage system for review before installation.
- .6 The use of perforated band, wire chain, or solid ring type hangers will not be accepted.

### 3.4 HORIZONTAL MOVEMENT

- .1 Angularity of rod hanger resulting from horizontal movement of pipework from cold to hot position not to exceed 4° from vertical.
- .2 Where horizontal pipe movement is less than 13 mm (1/2 in.), offset pipe hanger and support so that rod hanger is vertical in the hot position.

### 3.5 FINAL ADJUSTMENT

- .1 Adjust hangers and supports.
  - .1 Ensure that rod is vertical under operating conditions.
  - .2 Equalize loads.
- .2 Adjustable clevis.
  - .1 Tighten hanger load nut securely to ensure proper hanger performance.
  - .2 Tighten upper nut after adjustment.
- .3 C-clamps.
  - .1 Follow manufacturer's recommended written instructions and torque values when tightening C-clamps to bottom flange of beam. Provide restraining clips on all C-clamps.
- .4 Beam clamps:
  - .1 Hammer jaw firmly against underside of beam.



### **3.6 SEISMIC RESTRAINTS**

- .1 Provide bracing of piping and equipment in accordance with Section 20 05 20 – Seismic Restraints.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB).
  - .1 CAN/CGSB-24.3, Identification of Piping Systems.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Product data to include paint colour chips, all other products specified in this section.

**1.3 WASTE MANAGEMENT AND DISPOSAL**

- .1 Do not dispose of unused paint material into streams, lakes onto ground or in other locations where it will pose a health or environmental hazard.
- .2 Unused paint materials are to be returned to the paint depot or disposed at an official hazardous materials collection site.

**Part 2 Products**

**2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES**

- .1 All manufactured equipment to have factory install nameplates.
- .2 Information to include, as appropriate:
  - .1 Equipment: Manufacturer's name, model, size, serial number, capacity.
  - .2 Motor: voltage, Hz, phase, power factor, duty, frame size.

**2.2 SYSTEM NAMEPLATES**

- .1 Colours:
  - .1 Hazardous: red letters, white background.
  - .2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).
- .2 Construction:
  - .1 3 mm (1/8 in.) thick laminated plastic, matte finish, with square corners, letters accurately aligned, and machine engraved into core.
- .3 Sizes:
  - .1 9 mm (3/8 in.) to 12 mm (1/2 in.).
  - .2 Use maximum of 25 letters/numbers per line.
- .4 Locations:
  - .1 Terminal cabinets, control panels, disconnects, switches, equipment, pumps & control valves.

**2.3 EXISTING IDENTIFICATION SYSTEMS**

- .1 Apply new identification system to existing systems.
-

## 2.4 IDENTIFICATION OF PIPING SYSTEMS

- .1 Identify contents by background colour marking; direction of flow by arrows. To CAN/CGSB 24.3.
- .2 Pictograms:
  - .1 Where required, to Workplace Hazardous Materials Information System (WHMIS) regulations.
- .3 Legend:
  - .1 Block capitals to sizes and colours listed in CAN/CGSB-24.3.
- .4 Arrows showing direction of flow:
  - .1 Outside diameter of pipe or insulation less than 75 mm (3 in.): 100 mm (4 in.) long x 50 mm (2 in.) high.
  - .2 Outside diameter of pipe or insulation 75 mm (3 in.) and greater: 150 mm (6 in.) long x 50 mm (2 in.) high.
  - .3 Use double-headed arrows where flow is reversible.
- .5 Extent of background colour marking:
  - .1 To full circumference of pipe or insulation.
  - .2 Length to accommodate pictogram, full length of legend and arrows.
- .6 Materials for background colour marking, legend, arrows:
  - .1 Pipes and tubing 20 mm (3/4 in.) and smaller: Waterproof and heat-resistant pressure sensitive plastic marker tags.
  - .2 All other pipes: Pressure sensitive vinyl with protective overcoating, waterproof contact adhesive undercoating, suitable for ambient of 100% RH and continuous operating temperature of 150°C (300°F) and intermittent temperature of 200°C (400°F).
- .7 Colours and Legends:
  - .1 Where not listed, obtain direction from Consultant.
  - .2 Colours for legends, arrows: To following table:

Background Colour	Legend
Yellow	Black
Green	White
Red	White

- .3 Background colour marking and legends for piping systems:

Contents	Background Colour	Legend
Domestic Cold Water Supply	Green	DOM. CWS
Domestic Hot Water Supply	Green	DOM. HWS
Domestic Hot Water Recirculation	Green	DOM. HW RECIRC.
Condensate	Green	COND
Make-Up Water	Yellow	MAKE-UP WTR
Refrigerant Suction	Yellow	REF. SUCTION
Refrigerant Liquid	Yellow	REF. LIQUID
Heating Water Supply	Yellow	HEATING SUPPLY
Heating Water Return	Yellow	HEATING RETURN
Conduit for Low Voltage Control Wiring	To Section 23 09 36	

## **2.5 IDENTIFICATION DUCTWORK SYSTEMS**

- .1 50 mm (2 in.) high stencilled letters and directional arrows 150 mm (6 in.) long x 50 mm (2 in.) high.
- .2 Colours: Black, or co-ordinated with base colour to ensure strong contrast.
- .3 Stencil over final finish only.

## **2.6 CONTROLS COMPONENTS IDENTIFICATION**

- .1 Identify all systems, equipment, components, controls, sensors with system nameplates specified in this section.
- .2 Inscriptions to include function and (where appropriate) fail-safe position.

## **2.7 CONCEALED VALVE AND EQUIPMENT IDENTIFICATION**

- .1 Identify locations of concealed valves and equipment with 25 mm (1 in.) diameter coloured round labels with adhesive backing.

<b>Equipment or Valve Type</b>	<b>Round Label Colour</b>
Heating	Red
Cooling	Blue
Domestic Hot and Cold Water	Green
Fan Coils	Yellow
Fans	Brown
Fire Dampers	Orange
Coils	Black

## **2.8 LANGUAGE**

- .1 Identification to be in English.

## **Part 3 Execution**

### **3.1 TIMING**

- .1 Provide identification only after all painting specified Section 09 91 23 - Interior Painting has been completed.

### **3.2 INSTALLATION**

- .1 Perform work in accordance with CAN/CGSB-24.3 except as specified otherwise.

### **3.3 NAMEPLATES**

- .1 Locations:
  - .1 In conspicuous location to facilitate easy reading and identification from operating floor.
- .2 Standoffs:
  - .1 Provide for nameplates on hot and/or insulated surfaces.
- .3 Protection

- .1 Do not paint, insulate, or cover in any way.

### **3.4 LOCATION OF IDENTIFICATION ON PIPING AND DUCTWORK SYSTEMS**

- .1 On long straight runs in open areas. At not more than 17 m (50 ft.) intervals and more frequently if required to ensure that at least one is visible from any one viewpoint in operating areas and walking aisles.
- .2 Adjacent to each change in direction.
- .3 On both sides of separations such as walls, floors, partitions.
- .4 Where system is installed in pipe chases, ceiling spaces, other confined spaces, at entry and exit points, and at each access opening.
- .5 At beginning and end points of each run and at each piece of equipment in run.
- .6 At point immediately upstream of major manually operated or automatically controlled valves, etc. Where this is not possible, place identification as close as possible, preferably on upstream side.
- .7 Identification to be easily and accurately readable from usual operating areas and from access points.
  - .1 Position of identification to be approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury and reduced visibility over time due to dust and dirt.
- .8 Beside each duct access door.
- .9 On both sides of visual obstructions or where run is difficult to follow.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCES**

- .1      CAN/CGSB-51.10-92, Mineral Fibre Board Thermal Insulation.
- .2      CAN/CGSB-51.11-92, Mineral Fibre Thermal Insulation Blanket.
- .3      CAN/CGSB-51.12-M95, Cement, Thermal Insulating and Finishing.
- .4      CGSB 51-GP-52MA, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
- .5      American Society of Heating, Refrigeration and Air Conditioning Engineering (ASHRAE).
  - .1      ASHRAE Standard 90.1.
- .6      Manufacturer's Trade Associations.
  - .1      Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .7      ASTM C411-11, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- .8      CAN/ULC-S102-10, Surface Burning Characteristics of Building Materials and Assemblies.
- .9      ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .10     ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.

**1.2            SHOP DRAWINGS**

- .1      Submit shop drawings in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2      Submit for approval manufacturer's catalogue literature related to installation, fabrication for duct jointing recommendations.

**1.3            QUALIFICATIONS**

- .1      Installer to be specialist in performing work of this section and have at least 3 years successful experience in this size and type of project, qualified to standards of TIAC.

**1.4            DELIVERY, STORAGE AND HANDLING**

- .1      Deliver materials to site in original factory packaging, labelled with manufacturer's name, address.
- .2      Protect from weather and construction traffic.
- .3      Protect against damage from any source.
- .4      Store at temperature and conditions required by manufacturer.

**1.5            DEFINITIONS**

- .1      For purposes of this section:
-

- .1 "CONCEALED" - insulated mechanical services and equipment in suspended ceilings and non-accessible chases and furred-in spaces.
- .2 "EXPOSED" - will mean "not concealed" as defined herein, including mechanical and equipment rooms, etc...
- .3 Insulation systems - insulation material, fasteners, jackets, and other accessories.

## 1.6 SAMPLES

- .1 Provide sample installation of round and rectangular ductwork for review by Consultant. Samples shall be accepted prior to start of installations.

## Part 2 Products

### 2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### 2.2 INSULATION

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slab wool.
- .2 Thermal conductivity ("k" factor) not to exceed specified values at 24°C (75°F) mean temperature when tested in accordance with ASTM C 335.
- .3 Insulation is required on the following ductwork:
  - .1 All supply ductwork with the exception of supply ductwork exposed in space serviced by system.
  - .2 On ductwork systems where both thermal insulation is required and acoustic lining is indicated on the drawings, acoustic lining only shall be provided for the sections indicated and thermal insulation shall be provided for the remainder.
  - .3 All exterior ductwork.
  - .4 Thickness:
    - .1 Supply ducting: 38 mm (1-1/2 in.).
    - .2 Exhaust ducting: 38 mm (1-1/2 in.).
    - .3 Exterior ducting: 50 mm (2 in.).
    - .4 Outdoor and fresh air ducting: 75 mm (3 in.).
- .4 Mineral fiber blanket to CGSB-51.11 with vapour barrier to CGSB-51-GP-52MA.
  - .1 For use on all ductwork requiring insulation.
- .5 Rigid mineral fibre board to CAN/CGSB 51.10 with factory applied vapour retarder jacket to CGSB 51-GP-52ma for use on exterior ducting requiring insulation and combustion air ductwork.

### 2.3 JACKETS

- .1 Canvas:
  - .1 220 g/m<sup>2</sup> (6 oz./yd<sup>2</sup>) cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C 921.
  - .2 Apply in indoor exposed areas.
- .2 Lagging adhesive: Compatible with insulation.

- .3 Cover all exterior ductwork with prefabricated self-adhering, sheet type waterproofing membrane. Top of membrane to be stucco embossed, UV resistant aluminum weathering surface. Under aluminum to be double layer of tough, high density polyethylene reinforcement. Under polyethylene to be a uniform layer of aggressive rubberized asphalt adhesive that sticks directly to metal, insulation facers and most other clean, dry surfaces.
  - .1 Standard of Acceptance: Flex-Clad 400.

## **2.4 ACCESSORIES**

- .1 Vapour retarder lap adhesive:
  - .1 Water based, fire retardant type, compatible with insulation.
- .2 Indoor Vapour Retarder Finish:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
- .3 Insulating Cement: hydraulic setting on mineral wool, to ASTM C449.
- .4 ULC Listed Canvas Jacket:
  - .1 220 g/m<sup>2</sup> (6 oz/yd<sup>2</sup>) cotton, plain weave, treated with dilute fire-retardant lagging adhesive to ASTM C 921.
- .5 Outdoor Vapour Retarder Mastic:
  - .1 Vinyl emulsion type acrylic, compatible with insulation.
  - .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup> ( 9 oz./yd<sup>2</sup>).
- .6 Tape: self-adhesive, aluminum, reinforced, 75 mm (3 in.) wide minimum.
- .7 Contact adhesive: quick-setting.
- .8 Canvas adhesive: washable.
- .9 Tie wire: 1.5 mm (16 Ga.) stainless steel.
- .10 Banding: 19 mm (3/4 in.) wide, 0.5 mm (26 Ga.) thick stainless steel.
- .11 Facing: 25 mm (1 in.) galvanized steel hexagonal wire mesh stitched on one face of insulation.
- .12 Fasteners: 4 mm (0.157 in.) diameter pins with 38 mm (1-1/4 in.) square clips, length to suit thickness of insulation.

## **Part 3 Execution**

### **3.1 PRE- INSTALLATION REQUIREMENTS**

- .1 Pressure testing of ductwork systems to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

### **3.2 INSTALLATION**

- .1 Install in accordance with TIAC National Standards, NFPA 90A and NFPA 90B.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.



- .3 Maintain uninterrupted continuity and integrity of insulation and vapour retarder jacket and finishes.
  - .1 Hangers, supports, standing duct seams to be outside vapour retarder jacket.
  - .2 Insulation and vapour barrier to be without interruption at sleeves and supports.
- .4 Supports, hangers in accordance with Section 20 05 29 – Hangers and Supports for HVAC Piping and Equipment.
  - .1 Apply high compressive strength insulation where insulation may be compressed by weight of ductwork.
- .5 Mechanical fastenings:
  - .1 On rectangular ducts, use tie wires and weld pins at not more than 200 mm (8 in.) centres, but not less than 2 rows per side and bottom. Install in accordance with manufacturer's directions.
  - .2 On round ducts, install as per manufacturer's directions.
- .6 Use stand-offs for duct mounted control accessories, including balancing and control dampers.
- .7 Apply 1.0 mm (20 Ga.) thick galvanized sheet metal corners (nosings) to ductwork in mechanical rooms and exterior ducting.

**END OF SECTION**

---

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-51.2, Thermal Insulation, Calcium Silicate, for Exhaust Piping, Machinery and Boilers.
  - .2 CAN/CGSB-51.9, Mineral Fibre Thermal Insulation for Piping and Round Ducting.
  - .3 CAN/CGSB-51.12, Cement, Thermal Insulating and Finishing.
  - .4 CAN/CGSB-51.40, Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering.
  - .5 CGSB 51-GP-52Ma, Vapour Barrier Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.
  - .6 CGSB 51.53, Jacketing, Polyvinyl, Chloride Sheet, for Insulating Pipes, Vessels and Round Ducts.
- .2 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .3 Manufacturer's Trade Associations
  - .1 Thermal Insulation Association of Canada (TIAC): National Insulation Standards.
- .4 American Society of Testing Materials.
  - .1 ASTM A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
  - .2 ASTM C335, Test Method for Steady-State Heat Transfer Properties of Horizontal Pipe Insulations.
  - .3 ASTM C411, Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Submit for approval manufacturer's catalogue literature related to installation, fabrication for pipe, fittings, valves and jointing recommendations.

**1.3 QUALIFICATIONS**

- .1 Installer to be specialist in performing work of this section and have at least 3 years successful experience in this size and type of project. Installer to be qualified to standards of TIAC.

**1.4 DELIVERY, STORAGE AND HANDLING**

- .1 Delivery materials to site in original factory packaging, labelled with manufacturer's name, address.
  - .2 Protect from weather, construction traffic.
  - .3 Project against damage from any source.
  - .4 Store at temperatures and conditions required by manufacturer.
-

## 1.5 DEFINITIONS

- .1 For purposes of this section:
  - .1 "CONCEALED" - insulated mechanical services in suspended ceilings and non-accessible chases and furred-in spaces.
  - .2 "EXPOSED" - will mean "not concealed" as defined herein.

## 1.6 SAMPLES

- .1 Provide sample mock-up of each type of insulation including mock-up of insulation at pipe supports and valves. Samples shall be reviewed and accepted by Consultant prior to start of installations.

## Part 2 Products

### 2.1 FIRE AND SMOKE RATING

- .1 In accordance with CAN/ULC-S102:
  - .1 Maximum flame spread rating: 25.
  - .2 Maximum smoke developed rating: 50.

### 2.2 INSULATION

- .1 Mineral fibre as specified herein includes glass fibre, rock wool, slag wool.
- .2 Thermal conductivity ("k" factor) not to exceed 0.034 W/m °C at 24°C (75°F) mean temperature when tested in accordance with ASTM C 335.
- .3 Rigid moulded mineral fiber to CGSB-51.9 with factory applied vapour retarder jacket to CGSB-51-GP-52Ma, for use on:
  - .1 Domestic hot water piping and hot water recirc.
  - .2 Domestic cold water piping.
  - .3 Storm drainage piping.
  - .4 Sanitary piping to be insulated where indicated.
  - .5 Hydronic heating/cooling piping, including hybrid variable flow refrigerant water piping.
  - .6 Fan coil and cooling coils condensate drain piping.
  - .7 Valves and fittings for above piping systems.
  - .8 Thickness:
    - .1 Domestic hot water:
      - .1 up to NPS 1-1/4 = 25 mm (1 in.) thick.
      - .2 NPS 1-1/2 & up = 38 mm (1-1/2 in.) thick.
    - .2 Domestic cold water:
      - .1 up to NPS 1 = 25 mm (1 in.).
      - .2 NPS 1-1/4 & up = 38 mm (1-1/2 in.).
    - .3 Storm drainage piping:
      - .1 All sizes: 25 mm (1 in.) thick.
    - .4 Sanitary:
      - .1 All sizes: 25 mm (1 in.).
    - .5 Hydronic heating/cooling piping including glycol:
      - .1 up to NPS 1-1/4 = 38 mm (1-1/2 in.) thick.
      - .2 NPS 1-1/2 & up = 50 mm (2 in.) thick.
    - .6 Fan coil and cooling coil condensate drain piping:
      - .1 All sizes: 25 mm (1 in.).
- .4 Flexible unicellular tubular elastomer for use on:

- .1 Refrigeration suction and liquid lines.
- .2 Thickness:
  - .1 Suction lines all sizes: 25 mm (1 in.) thick.
  - .2 Liquid Lines:
    - .1 up to NPS 1: 25 mm (1 in.) thick.
    - .2 NPS 1-1/4 and over: 40 mm (1-1/2 in.) thick.
- .3 Exterior Piping Jacket: Flex-Clad 400 or Aluminum.
- .5 Insulation systems shall include all flanges, fittings, unions, and other equipment within piping systems. Insulation systems shall include all valves. Insulation for valves and other equipment requiring regular maintenance shall be easily removable and installed per TIAC standards.

### **2.3 INSULATION SECUREMENT**

- .1 Tape: Self-adhesive, aluminum, reinforced, 50 mm (2 in.) wide minimum.
- .2 Contact adhesive: Quick setting.
- .3 Canvas adhesive: Washable.
- .4 Tie wire: 1.5 mm (16 Ga.) diameter stainless steel.
- .5 Bands: Stainless steel, 19 mm (3/4 in.) wide, 0.5 mm (26 Ga.) thick.

### **2.4 VAPOUR RETARDER LAP ADHESIVE**

- .1 Water based, fire retardant type, compatible with insulation.

### **2.5 OUTDOOR VAPOUR RETARDER FINISH**

- .1 Vinyl emulsion type acrylic, compatible with insulation.
- .2 Reinforcing fabric: Fibrous glass, untreated 305 g/m<sup>2</sup>, (9 oz./yd<sup>2</sup>).

### **2.6 JACKETS**

- .1 Aluminum:
  - .1 To ASTM B 209.
  - .2 Thickness: 0.5 mm (14 Ga.) sheet. 1 mm thick jacket for piping.
  - .3 Finish: Stucco embossed.
  - .4 Joining: Longitudinal and circumferential slip joints with 50 mm (2 in.) laps, weatherproof "Z" type longitudinal joint.
  - .5 Fittings: 0.5 mm (14 Ga.) thick die-shaped fitting covers with factory-attached protective liner.
  - .6 Metal jacket banding and mechanical seals: stainless steel, 19 mm (3/4 in.) wide, 0.5 mm (26 Ga.) thick at 300 mm (12 in.) spacing.
- .2 Polyvinyl Chloride (PVC):
  - .1 One-piece moulded type to CGSB 51.53 with pre-formed shapes as required. One piece moulded preferred shapes to be used for all fitting types including mechanical grooved joint fittings and couplings.
  - .2 Colours: white.
  - .3 Minimum service temperatures: -20°C (-4°F).
  - .4 Maximum service temperature: 65°C (149°F).

- .5 Moisture vapour transmission: to ASTM E96.
- .6 Thickness: 0.75 mm (0.03 in.).
- .7 Fastenings:
  - .1 Use solvent weld adhesive compatible with insulation to seal laps and joints.
  - .2 Tacks.
  - .3 Pressure sensitive vinyl tape of matching colour.
- .8 Special requirements:
  - .1 Outdoor: UV rated material at least 0.5 mm (0.02 in.) thick.

## **2.7 WEATHERPROOF CAULKING FOR JACKETS INSTALLED OUTDOORS**

- .1 Non-shrink, permanently flexible, for applications with insulation systems.
- .2 Service temperature range: -73°C to 149°C (-100°F to 300°F).
- .3 Average non-volatile: 97% by weight.
- .4 Color: gray.

## **Part 3 Execution**

### **3.1 PRE- INSTALLATION REQUIREMENT**

- .1 Pressure testing of piping systems and adjacent equipment to be complete, witnessed and certified.
- .2 Surfaces to be clean, dry, free from foreign material.

### **3.2 INSTALLATION**

- .1 Install in accordance with TIAC National Standards.
- .2 Apply materials in accordance with manufacturer's instructions and this specification.
- .3 Use two layers with staggered joints when required nominal wall thickness exceeds 75 mm (3 in.).
- .4 Maintain uninterrupted continuity and integrity of vapour retarder jacket and finishes.
  - .1 Hangers and supports to be outside vapour retarder jacket.
- .5 Supports, Hangers:
  - .1 Apply high compressive strength insulation (maximum 25 mm (1 in.) thick polyisocyanurate), suitable for service, at oversized saddles and shoes where insulation saddles have not been provided.
- .6 Install in accordance with ANSI/NFPA 90A and ANSI/NFPA 90B.
- .7 Preformed: sectional up to NPS12, sectional or curved segmented above NPS 12.
- .8 Multi-layered: staggered butt joint construction.
- .9 Vertical pipe over NPS 3: insulation supports welded or bolted to pipe directly above lowest pipe fitting. Thereafter, locate on 5 m (15 ft.) centres.
- .10 Expansion joints in insulation: terminate single layer and each layer of multiple layers in

straight cut at intervals recommended by manufacturer. Leave void of 25 mm (1 in.) between terminations. Pack void lightly with flexible mineral insulation.

- .11 Seal and finish exposed ends and other terminations with aluminum jacket.
- .12 Expansion joints in piping: provide for adequate movement of expansion joint without damage to insulation or finishes.
- .13 Flanges and unions at equipment, expansion joints, valves, other components requiring regular maintenance: omit insulation and bevel away from studs and nuts to permit use of tools without damage to insulation, install insulation and finish to permit easy disassembly and replacement without damage to adjacent insulation and finishes.
- .14 Secure pipe insulation by tape at each end and centre of each section, but not greater than 900 mm (36 in.) on centres.
- .15 Apply thermal insulation on heat traced piping only after the heat tracing has been tested and accepted. Obtain written confirmation of heat trace acceptance.
- .16 Insulate underside of roof drain body with flexible elastomeric unicellular sheet pipe covering (CGSB-51.40) held in place with 100% coverage of adhesive.
- .17 Protect insulation from weather throughout installation and replace any insulation which has become wet.
- .18 Temporarily protect all equipment and systems when working above. Do not use equipment or systems as support during insulation work, provide necessary work platforms as required.

### **3.3 REMOVABLE PREFABRICATED, INSULATION AND ENCLOSURES**

- .1 Design: To permit movement of expansion joint and to permit periodic removal and replacement without damage to adjacent insulation.
- .2 Insulation:
  - .1 Insulation, fastenings, finishes and jackets same as system.
- .3 Removable covers for valves and pump heads shall be installed per TIAC National Standards.

### **3.4 PIPING INSULATION JACKET SCHEDULES**

- .1 Finishes:
  - .1 Outdoors: Water-proof Aluminum jacket.
  - .2 Exposed indoors: PVC jacket.
  - .3 Exposed in mechanical rooms: PVC jacket.
  - .4 Concealed, indoors: No further finish.

### **3.5 INSTALLATION OF ELASTOMERIC INSULATION**

- .1 Insulation to remain dry at all times. Overlaps to manufacturer's instructions. Ensure tight joints.
- .2 Provide vapour retarder as recommended by manufacturer.

**END OF SECTION**

---

**Part 1 General**

**1.1 REFERENCES**

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .2 CAN/ULC-S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .3 CGSB 51.10, Thermal Insulation, Mineral Fibre, Block or Board, for Ducting, Machinery and Boilers.
- .4 CGSB 51.11, Thermal Insulation, Mineral Fibre, Blanket, for Piping, Ducting, Machinery and Boilers.
- .5 ASTM C177, Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
- .6 NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .7 NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.

**1.3 SAMPLES**

- .1 Provide sample mock-up of rectangular duct section with acoustic insulation installed. Mock-up shall be reviewed and accepted by Consultant prior to start of installations.

**Part 2 Products**

**2.1 DUCT LINER**

- .1 General:
    - .1 Fibrous glass duct liner: air stream side faced with cleanable polymer air stream surface coating that withstands high air velocities to 20 m/s (4000 fpm), prevents infiltration by dust and dirt, and protects the coating from potential microbial growth. Cleanable interior coating to be formulated with an 1m mobilized, EPA-registered preservative agent to guard against potential microbiological contamination and growth of fungus and bacteria as tested in accordance with ASTM G21 and G22. Surface coating to be resistant to water not allowing standing water to pass through into fiber glass wool core.
    - .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50 when tested in accordance with CAN/ULC-S102.
  - .2 Rigid:
    - .1 Use on flat surfaces.
    - .2 25 mm (1 in.) thick, to CGSB 51.10, fibrous glass rigid board duct liner.
    - .3 Density: 33 kg/m<sup>3</sup> (2.25 lb/cu.ft.) minimum.
    - .4 Acceptable material: Johns Manville Permacote II Linacoustic R-300.
  - .3 Flexible:
    - .1 Use on round or oval surfaces.
    - .2 25 mm (1 in.) thick, to CGSB-51.11, fibrous glass blanket duct liner.
-

- .3 Density: 22 kg/m<sup>3</sup> (1.5 lb/cu.ft.).
- .4 Acceptable material: Johns Manville Permacote II Linacoustic Standard.

## **2.2 ADHESIVE**

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -29°C to 93°C (-20°F to 200°F).

## **2.3 FASTENERS**

- .1 Weld pins 2.0 mm (20 Ga.) diameter, length to suit thickness of insulation. Metal retaining clips, 32 mm (1-1/4 in.) square.

## **2.4 JOINT TAPE**

- .1 Poly-Vinyl treated open weave fiberglass membrane 50 mm (2") wide.

## **2.5 SEALER**

- .1 Meet requirements of NFPA 90A and NFPA 90B.
- .2 Flame spread rating shall not exceed 25. Smoke development rating shall not exceed 50. Temperature range -68°C to 93°C (-90°F to 200°F).

## **Part 3 Execution**

### **3.1 GENERAL**

- .1 Do work in accordance with recommendations of SMACNA duct liner standards as indicated in SMACNA HVAC Duct Construction Standards, Metal and Flexible, except as specified otherwise.
- .2 Line inside of ducts as follows:
  - .1 As indicated on drawings.
- .3 Duct dimensions, as indicated, are clear inside duct lining.
- .4 Protect insulation from weather throughout installation and replace any insulation which has become wet.

### **3.2 DUCT LINER**

- .1 Install in accordance with manufacturer's recommendations, and as follows:
  - .1 Fasten to interior sheet metal surface with 100% coverage of adhesive.
  - .2 In addition to adhesive, install weld pins not less than 2 rows per surface and not more than 425 mm (16 in.) on centres.

### **3.3 JOINTS**

- .1 Seal all butt joints, exposed edges, weld pin and clip penetrations and all damaged areas of liner with joint tape and sealer. Install joint tape in accordance with manufacturer's recommendations, and as follows:
  - .1 Bed tape in sealer.
  - .2 Apply 2 coats of sealer over tape.



- .2 Replace badly damaged areas of liner at discretion of Consultant.
- .3 Project leading and trailing edges of each duct section with sheet metal nosing having 19 mm (3/4 in.) overlap and fastened to duct.
- .4 Butter all leading and trailing edges with mastic to protect these from damage.

**END OF SECTION**

---

**Part 1            General**

**1.1            REFERENCES**

- .1    ANSI/ASME B16.15, Cast Copper Alloy Threaded Fittings: Classes 125 and 250.
- .2    ANSI B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
- .3    ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .4    ANSI/ASME B16.24, Copper Alloy Pipe Flanges and Fittings: Classes 150, 300, 600, 900, 1500 and 2500.
- .5    ASTM B88, Specification for Seamless Copper Water Tube (Metric).
- .6    CSA B242, Grooved and Shoulder Type Mechanical Pipe Couplings.
- .7    MSS-SP-67, Butterfly Valves.
- .8    MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.

**1.2            PRODUCT DATA**

- .1    Submit product data in accordance with Section 20 05 01 - Mechanical General Requirements.
- .2    Submit data for following:
  - .1    Valves

**1.3            MAINTENANCE DATA**

- .1    Provide maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.

**Part 2           Products**

**2.1            PIPING**

- .1    Domestic hot, cold and recirculation systems, within building.
  - .1    Above ground: copper tube, hard drawn, type L: to ASTM B88M.
  - .2    Buried or embedded: copper tube, soft annealed, type K: to ASTM B88M, in long lengths and with no buried joints.
  - .3    Tubing to be USA/Canada only.

**2.2            FITTINGS**

- .1    Copper alloy pipe flanges and flanged fittings, Class 150: to ANSI B16.24.
  - .2    Cast copper alloy threaded fittings, Class 125: to ANSI/ASME B16.15.
  - .3    Cast copper, solder type: to ANSI B16.18.
  - .4    Wrought copper and copper alloy, solder type: to ANSI/ASME B16.22.
  - .5    Fittings to be USA/Canada only.
-

## **2.3 JOINTS**

- .1 Rubber gaskets, 1.6mm (1/16 in.) thick: to ANSI/AWWA C111/A21.11.
- .2 Bolts, nuts, hex head and washers: to ASTM A307, heavy series.
- .3 Solder: lead free solder containing less than 0.2% lead in accordance with ASTM B32 "solder metal".
- .4 Teflon tape: for threaded joints.
- .5 Dielectric connections between dissimilar metals: dielectric fitting to ASTM F492, complete with thermoplastic liner.
- .6 The use of press-fit joints is not permitted.

## **2.4 VALVES GENERAL**

- .1 The following manufacturers are acceptable:
  - .1 Crane
  - .2 Jenkins
- .2 All other brands of valves installed under this Contract will be identified for removal and replacement with specified valves prior to issuing Substantial Performance.
- .3 Valves to be USA/Canada only.

## **2.5 SWING CHECK VALVES**

- .1 NPS 3 and under, soldered or threaded ends.
  - .1 To MSS SP-80, Class 150, 1304 kPa (150 psi) bronze body, bronze swing disc, screw in cap, regrindable seat.
  - .2 Standard of acceptance: Crane 1342.
- .2 NPS 4 and over, flanged:
  - .1 To MSS SP-71, Class 125, 860 kPa (125 psi), cast iron body, flat flange faces, regrind renewable seat, bronze disc, bolted cap.

## **2.6 BALL VALVES**

- .1 NPS 3 and under:
  - .1 2 piece standard port to MSS SP-80, Class 150, 2758 kPa (400 psi) WOG bronze body, stainless steel ball, PTFE Packing, PTFE seal, and steel lever handle, soldered or threaded ends.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with Ontario Building Code Part 7 Plumbing and local authority having jurisdiction.
- .2 Cut square, ream and clean tubing and tube ends, clean recessed of fittings and assemble without binding.
- .3 Assemble all piping using fittings manufactured to ANSI standards.

- .4 Install tubing close to building structure to minimize furring, conserve headroom and space. Group exposed piping and run parallel to walls.
- .5 Install CWS piping below and away from HWS and HWR and all other hot piping so as to maintain temperature of cold water as low as possible.
- .6 Connect to fixtures and equipment in accordance with manufacturer's instructions unless otherwise indicated.
- .7 Buried tubing:
  - .1 Lay in well compacted washed sand in accordance with AWWA Class B bedding.
  - .2 Bend tubing without crimping or constriction. Minimize use of fittings.
- .8 Piping installed through or within masonry walls shall be protected with polywrap so that the piping does not come in contact with concrete. This includes all insulated piping.

### **3.2 VALVES**

- .1 Isolate equipment, fixtures and branches with ball valves.

### **3.3 PRESSURE TESTS**

- .1 Conform to requirements of Section 20 05 01 – Mechanical General Requirements.
- .2 Test pressure: greater of 1½ times maximum system operating pressure or 860 kPa (125 psi).
- .3 Test in accordance with Ontario Building Code.

### **3.4 DISINFECTION**

- .1 Flush out, disinfect and rinse system to requirements of authority having jurisdiction.
- .2 Upon completion, provide laboratory test reports on water quality for Consultant review.
- .3 Provide necessary chemicals and equipment and disinfect system to requirements of the Ontario Building Code. Disinfection shall be in accordance with the procedures outlined in Appendix item A-7.6.2.8.(1) Flushing and Disinfecting Water Services Pipes, in the 2012 Ontario Building Code and supplemented as follows:
  - .1 All lines shall be disinfected, including distribution lines within building and including lines smaller than 100 mm (4 in.) in diameter.
  - .2 Free chlorine residual at ends of lines after disinfection to be greater than 0.05 mg/L.
  - .3 The Contractor shall carry out three consecutive tests of water samples (24 hours apart or greater) at all remote points of system for E-coli, total coliform, and heterotrophic plate count. Results shall show zero presence, and results shall be reviewed and accepted by Consultants.
  - .4 Contractor shall repeat the above disinfection procedures until satisfactory test results are received and accepted by the Consultant.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCES**

- .1 CAN/CSA-B181.2, PVC Drain, Waste and Vent Pipe and Pipe Fittings.
- .2 CAN/CSA-B182.1, Plastic Drain and Sewer Pipe and Pipe Fittings.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
  - .1 Piping.
  - .2 Couplings.
  - .3 Firestopping devices.

**MAINTENANCE DATA**

**1.3**

- .1 Provide maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.

**Part 2 Products**

**2.1 PIPING AND FITTINGS**

- .1 Plastic piping shall be used in the following applications:
  - .1 Buried applications for sanitary, storm and vent.
  - .2 Above ground applications for sanitary, storm and vent piping. Above ground plastic piping to be PVC DWV and listed by ULC to have a maximum flame spread no greater than 25, and a maximum smoke developed of no greater than 50 when tested in accordance with CAN/ULC S102. Provide certified firestopping devices where plastic piping penetrates fire separations. The firestopping devices shall be certified to the Standard CAN4-S115.
- .2 Materials to conform to:
  - .1 CAN/CSA-B181.2.
  - .2 CAN/CSA-B182.1.
- .3 Standard of Acceptance: IPEX System XFR.

**2.2 JOINTS**

- .1 Solvent weld for PVC: to CSA-B181.2.
- .2 Solvent weld for ABS: to CSA-B181.1.
- .3 The VOC content of adhesives and sealants used in the interior of the building envelope must be less than the VOC content limits of SCAQMD Rule #1168.
  - .1 Subcontractor to provide cut sheets, Material Safety Data Sheets, signed attestations or other official literature from manufacturers clearly identifying product emission rates. Documentation showing amount (in gallons) of each materials used should also be provided.

**2.3 FIRE STOP DEVICES FOR PVC PLASTIC PIPE**

- .1 On all PVC piping where piping passes through a fire rated wall or ceiling.
-

- .1 Certified to CAN4-S115.
- .2 Acceptable material: 3M fire barrier plastic pipe device.
- .3 Rated to maintain rating of penetrated wall – refer to architectural drawings for wall ratings.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install and test in accordance with Ontario Building Code Part 7 Plumbing and local authority having jurisdiction.
- .2 Install buried pipe on 150 mm (6 in.) bed of washed clean sand or granular 'A' shaped to accommodate fittings, to line and grade as indicated. Backfill with same material.
- .3 Support of piping to be in accordance with O.B.C. Part 7. Spacing of supports shall not exceed loading for structural systems.
- .4 Manufacturer's representative shall review installation prior to concealment and provide written certification that piping installation and firestopping is installed correctly and as per ULC listings.

**END OF SECTION**

---

**Part 1 General**

**1.1 REFERENCES**

- .1 ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
- .2 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .3 CAN/CSA-B79, Commercial and Residential Drains and Cleanouts.
- .4 Ontario Building Code Part 7.

**1.2 SUBMITTALS**

- .1 Submit shop drawings and product data in accordance with Section 20 05 01 - Mechanical General Requirements.
- .2 For shop drawings, indicate dimensions, construction details and materials for all materials specified in this section.
- .3 For product data, indicate dimensions, construction details and materials for all items specified herein.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in Section 20 05 01 - Mechanical General Requirements.
- .2 Data to include:
  - .1 Description of plumbing specialties and accessories, giving manufacturers name, type, model, year and capacity.
  - .2 Details of operation, servicing and maintenance.
  - .3 Recommended spare parts list.

**Part 2 Products**

**2.1 ROOF DRAINS**

- .1 RD-1: pan-formed copper drain body, deck flange and straight copper outlet with brass ferrule, stainless steel bolts welded to drain, brass stabilizer ring, cast aluminum under-deck clamping ring cast aluminum dome strainer, flow control accessory.
  - .1 Acceptable Material: Thaler RD-4C.

**2.2 PLUMBING ROOF FLASHINGS**

- .1 For all plumbing vents passing through the roof: Insulated vandal proof aluminum stack jack flashing with aluminum hood and perforated collar, thick pre-molded urethane insulation liner, EPDM base seal, and bituminous painted deck flange.
  - .1 Acceptable Material: Thaler SJ-31.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install and test in accordance with Ontario Building Code Part 7 Plumbing and local authority having jurisdiction.
-

- .2 Install in accordance with manufacturer's instructions and as specified.
- .3 Provide backflow preventors on domestic water connections to any non-potable systems and equipment.

### **3.2 START-UP**

- .1 Roof drains:
  - .1 Clean out baskets.
  - .2 Adjust flow control to value indicated on plan
- .2 Rectify start-up deficiencies.

### **3.7 COMMISSIONING**

- .1 After start-up, test, adjust and provide operation as indicated, to suit site conditions such as:
  - .1 Clean out strainers periodically until clear.

**END OF SECTION**



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**Part 1                    General**

**1.1                    TAB AGENCY**

- .1      General:
  - .1          All work described in this section to be performed by independent TAB Agency.
- .2      Certification:
  - .1          Submit documentation to confirm qualifications, experience of TAB Agency personnel.
- .3      Quality assurance:
  - .1          Perform TAB to standards of NEBB.
- .4      Co-ordination:
  - .1          Co-ordinate all work specified in this Section.
  - .2          Provide all facilities required by TAB Agency in order to carry out work of this Section.
- .5      Adequacy of work for TAB:
  - .1          TAB Agency to review contract documents before work is started and confirm in writing to Consultant adequacy of provisions for TAB and all other aspects of installation pertinent to TAB.
- .6      The following companies are acceptable:
  - .1          E.B. Balancing Inc.
  - .2          Kanata Air Balancing and Engineering.
  - .3          Data Air Testing and Balancing Ltd.
  - .4          Airwaso Ltd.
  - .5          Maxima Air Balancing.
  - .6          McKinley Air Balancing.
  - .7          TAB Inspecting Limited.

**1.2                    GENERAL**

- .1      TAB: means to test, adjust and balance all systems to perform in accordance with Contract Documents and to do all other work as specified in this section.
  - .2      Follow start-up procedures as recommended by manufacturer unless otherwise specified.
  - .3      Special start-up procedures may be specified elsewhere.
  - .4      Adjust and regulate equipment and systems so as to meet specified performance requirements and to achieve specified interaction with all other related systems under all normal and emergency loads and operating conditions.
  - .5      Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.
  - .6      Notify Consultant 7 days prior to start of TAB.
  - .7      Operate all systems to permit TAB to be performed.
  - .8      TAB to apply to systems, equipment and related controls specified in Division 23.
  - .9      Reference organization standards:
-

- .1 Do TAB over entire operating range in accordance with most stringent conditions of this specification and standard of following organization.
  - .1 AABC (Associated Air Balance Council).
  - .2 NEBB (National Environmental Balancing Bureau).
  - .3 SMACNA (Sheet Metal & Air Conditioning Contractors National Association).
  - .4 ASHRAE (American Society of Heating, Refrigerating and Air Conditioning Engineers).
- .10 Start TAB only when building is essentially completed, including:
  - .1 Installation of ceilings, doors, windows and other construction affecting TAB.
  - .2 Application of sealing, caulking and weatherstripping.
  - .3 All pressure, leakage and other tests specified elsewhere in Divisions 22 and 23 completed.
  - .4 All provisions for TAB are installed and operational.
  - .5 Start-up, verification for proper, safe and normal operation of mechanical and associated electrical and control systems affecting TAB including, but not limited to, the following:
    - .1 Proper thermal overload protection in place for electrical equipment.
    - .2 Air Systems:
      - .1 Filters in place and in clean conditions.
      - .2 Duct systems clean of debris.
      - .3 Air shafts, ceiling plenums are airtight to within specified tolerances.
      - .4 Correct fan rotation.
      - .5 Fire and volume dampers in place and open.
      - .6 Coil fins cleaned and combed.
      - .7 Access doors closed and duct end caps in place.
      - .8 All outlets installed and connected.
- .11 Accuracy tolerances:
  - .1 Do TAB to following tolerances of design values:
    - .1 HVAC systems:  $\pm 5\%$ .
  - .2 Measurements to be accurate to within plus or minus 2 % of actual values.
- .12 Instrument calibration: to be in accordance with TAB referenced organization standard, and completed within 3 months of commencement of TAB.
  - .1 Provide proof of calibration to Consultant upon request.
- .13 Submittals prior to commencement of TAB:
  - .1 Proposed methodology and procedures for performing TAB.
  - .2 Proposed check lists and report forms.
  - .3 List of instrumentation, including details and certificates of calibration.
- .14 Report:
  - .1 Format to be in accordance with TAB referenced organization standard, but using SI units.
  - .2 Report to include record full system schematics showing results of TAB.
  - .3 Submit, prior to formal submission of TAB reports, for checking and approval by Consultant, sample of rough TAB sheets. Include:
    - .1 Details of instruments used.
    - .2 Details of TAB procedures employed.
    - .3 Calculations procedures.
    - .4 Summaries.
  - .4 Submit 1 draft copy of TAB reports in PDF format (from digital source), complete with index tabs for verification and approval of Consultant.

- .5 Refer to attached sample TAB sheets for expected format.
- .6 Submit 1 hard copy and 1 PDF copy of approved TAB reports with O&M.
- .15 Verification:
  - .1 Reported measurements shall be subject to verification by Consultant. Provide instrumentation and manpower to verify results of up to 30 % of all reported measurements. Number and location of verified measurements to be at discretion of Consultant.
  - .2 Bear costs to repeat TAB, as required, to satisfaction of Consultant.
- .16 Settings: lock and permanently mark settings as required by reference standard.
- .17 Completion: TAB to be considered complete only when final reports are reviewed and accepted by Consultant.
- .18 The project will be considered incomplete until a TAB report is accepted by Consultant. Substantial completion will only be issued once the TAB report is accepted by Consultant.
- .19 TAB Contractor shall provide pulley and belt changes as required. Parts shall be provided by Division 20 Contractor.

### 1.3 AIR MOVING SYSTEMS

- .1 General: measurements as required by referenced organization standards, including, but not limited to, following:
  - .1 Measurements:
    - .1 Air velocity.
    - .2 Static pressure.
    - .3 Velocity pressure.
    - .4 Flow rate.
    - .5 Pressure drop.
    - .6 Temperature.
      - .1 Wet bulb.
      - .2 Dry bulb.
    - .7 Cross sectional area.
    - .8 RPM.
    - .9 Electrical power:
      - .1 Voltage.
      - .2 Current draw.
    - .10 Noise and vibration.
  - .2 Location of equipment measurements:
    - .1 Inlet and outlet of each:
      - .1 Fan.
      - .2 Coil.
      - .3 Filter.
      - .4 Damper.
      - .5 Other auxiliary equipment.
  - .3 Location of system measurements at:
    - .1 Main ducts.
    - .2 Main branch ducts.
    - .3 Sub-branch ducts.
    - .4 Each supply, exhaust and return air inlet and outlet.
    - .5 Other auxiliary equipment.
    - .6 All areas served by system.

### **1.3 HYDRONIC SYSTEMS**

- .1 Definitions: for purposes of this section, to include low pressure hydronic heating/cooling system.
- .2 Measurements: to include, but not limited to, following as appropriate for systems, equipment, components, controls: Flow rate, static pressure, pressure drop (or loss), temperature, RPM, electrical power voltage.
- .3 Locations of equipment measurements: To include, but not be limited to, following as appropriate:
  - .1 Inlet and outlet of each, boiler, chiller, coil, pump, PRV, control valve, other equipment causing changes in conditions.
  - .2 At each controller, controlled device.
- .4 Locations of systems measurements to include, but not be limited to, following as appropriate: Supply and return of each (main, main branch, branch, sub-branch of all hydronic systems, inlet connection of make-up water.

#### **Part 2 Products**

##### **2.1 NOT USED**

- .1 Not Used.

#### **Part 3 Execution**

##### **3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1 General**

**1.1 DESCRIPTION**

- .1 Purpose
  - .1 Verify operation and functional performance of HVAC and plumbing systems for compliance with design intent.
  - .2 Document HVAC and plumbing tests inspections.
  - .3 Verify application of operation and maintenance manuals, as-built (record) documents, spare parts listing, special tools listing, and other items as may be specified herein for support of HVAC and plumbing systems and equipment.
  - .4 Coordinate and direct training to personnel for operation and maintenance of equipment and systems.
- .2 General
  - .1 Furnish labor and material to accomplish complete HVAC and plumbing commissioning as specified herein. Complete interim commissioning of HVAC and plumbing systems during initial season operation and follow-up commissioning of required HVAC and plumbing systems during additional season operation.
  - .2 Refer to Division 22 specifications for plumbing system additional commissioning requirements.
- .3 Definitions
  - .1 Definition of terms used in this Guideline may be found in Terminology of Heating, Ventilation, Air-Conditioning, and Refrigeration, published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, Georgia 30329.
  - .2 Additional terms used in this Guideline not found in the terminology handbook are defined in this section.
  - .3 Acceptable performance: a component or system being able to meet specified design parameters under actual load.
  - .4 Commissioning Authority: the qualified person, company or agency that will plan and document the overall commissioning process. Division 20 shall retain the services of an independent commissioning agent/authority for this project and include all cost of these services in Division 20 tender amount.
  - .5 Commissioning Agent(s): The qualified person, company, agency or contractor that will carry out the overall commissioning process.
  - .6 Commissioning Plan: The overall document, prepared by the commissioning authority and/or agent, which outlines the organization, scheduling, allocation of resources, documentation, etc., pertaining to the overall commissioning process.
  - .7 Design professional: the Consultant responsible for the design and preparation of contract documents for the HVAC system.
  - .8 Functional performance testing: that full range of checks and test carried out to determine if all components, sub-systems, systems, and interfaces between systems function in accordance with the contract documents. In this context, "function" includes all modes and sequences of control operation, all interlocks and conditional control responses, and all specified responses to abnormal emergency conditions.

**1.2 QUALITY ASSURANCE**

- .1 Reference: ASHRAE Guideline 1.1-2007, HVAC & R Technical Requirements for the Commissioning Process.
- .2 Qualifications: The commissioning agent shall have a minimum of 10 years experience in

commissioning of systems.

### **1.3 DOCUMENTATION**

- .1 The HVAC Commissioning Agent shall obtain the following:
  - .1 Project plans and specification (contract documents), authorized revisions, HVAC shop drawings and submittals (approved), Test and Balance report, equipment start-up and certification reports, etc.
  - .2 Records of required code authority inspections, documentation sign-offs, etc.

### **1.4 SUBMITTALS**

- .1 HVAC Commissioning Agent will submit to Consultant for review and acceptance prior to starting the commissioning process.
  - .1 Commissioning Plan describing extent and delivery schedule.
  - .2 Training Plan (describe the extent of plan, expected duration of training, personnel involved, schedule, etc.).

### **1.5 RESPONSIBILITIES OF OTHERS**

- .1 Applicable specification sections may outline trade or manufacturer's responsibilities during the HVAC commissioning process.
  - .1 General Contractor
    - .1 General Contractor shall verify completeness of the building envelope, perimeter and interior items which effect proper operation and control of HVAC equipment and systems.
    - .2 The General Contractor will assure participation and cooperation of specialty contractors under his jurisdiction as required for the commissioning process.
  - .2 Owner/Operator
    - .1 Owner/Operator will schedule personnel to participate in HVAC commissioning process. This may include building security personnel, building engineer, HVAC operation and maintenance personnel. Personnel operating and maintaining equipment and systems will attend training sessions, factory schools, and educational institutions where indicated.
    - .2 Owner/Operator will advise HVAC Commissioning Agent regarding changes in building occupancy and/or usage.

## **1.6 ACCEPTABLE COMMISSIONING CONTRACTORS**

- .1 Acceptable Commissioning Contractors:
- .1 A CFMS Consulting Inc.  
40 Vogell Road, Unit 31  
Richmond Hill, ON L4B 3N6  
Phone: 905-787-9449 x 202  
E-mail: wcollins@cfms.ca  
Contact: Wendy Collins
  - .2 C.E.S. Engineering Ltd.  
709-2550 Victoria Park Avenue  
Toronto, ON M2J 5A9  
Phone: 416-226-4224 x 111  
E-mail: bratkovich@cesgroup.ca  
Contact: Boban Ratkovich
  - .3 Isotherm Commissioning Ottawa Ltd.  
111 Sherwood Drive, Suite 202  
Ottawa, ON K1Y 3V1  
Phone: 613-723-5182  
E-mail: m.lalonde@isothermcx.com  
Contact : Marc Lalonde
  - .4 Morrison Hershfield Ltd.  
2932 Baseline Road  
Ottawa, ON K2H 1B1  
Phone: 416-495-4294  
E-mail: rzan@morrisonhershfield.com  
Contact: Rino Zan
  - .5 Nova Commissioning Services Ltd.  
891 Island Road  
Akwesasne, ON K0C 1K0  
Phone: 613-830-6656  
E-mail: sales@novacommissioning.ca  
Contact: Matthew Van Gorp or Jeremiah Point
  - .6 Pact Engineering  
44 East Beaver Creek Road, Unit 5  
Richmond Hill, ON L4B 1G8  
Phone: 905-773-2442 x 301  
E-mail: r.ilkhani@pactengineers.com  
Contact: Reza Ilkhani
  - .7 WSP Canada Inc.  
2611 Queensview Drive, Suite 300  
Ottawa, ON K2B 8K2  
Phone: 613-690-3861  
E-mail: Sandy.Frazee@wsp.com  
Contact: Sandy Frazee

## **Part 2 Products**

### **2.1 INSTRUMENTATION**

- .1 Instrumentation will be provided by agency performing prior tests. Instruments will be operated by individual agency requested by the HVAC Commissioning Agent, as specified elsewhere herein.

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**Part 3            Execution**

**3.1               GENERAL**

- .1       HVAC Commissioning Agent will actively participate in construction phase of the project to assure compliance with HVAC Commissioning requirements.

**3.2               PROCEDURE**

- .1       Attend pre-construction meeting and establish requirements for HVAC commissioning authority process throughout construction phase.
- .2       Prepare and submit to Consultant, 6 weeks after contract award, HVAC Commissioning which shall outline:
  - .1       Responsibility of each trade affected by HVAC Commissioning, as required by appropriate section of this specification.
  - .2       Requirement for documentation as listed elsewhere herein.
  - .3       Requirements for documentation of HVAC tests and inspections required by code authorities.
  - .4       Requirements for the HVAC Commissioning program during specified operational seasons, part and full loads as further delineated in 3.3.
  - .5       Format for training program for operation and maintenance personnel.
- .3       Periodically attend construction and coordination meetings.

**3.3               HVAC COMMISSIONING**

- .1       Phase 1 - Pre-construction
  - .1       Introduction: The objective of this phase is to outline the scope of design requirements for the HVAC system constructed with a comprehensive commissioning process. The commissioning agent shall meet and review with the design Consultant the design intent and work with the design Consultant to develop the design criteria.
  - .2       Scope of the Phase 1: Phase 1 documents should include detailed requirements for HVAC commissioning as follows:
    - .1       Design criteria and assumptions
    - .2       Description of the HVAC system, intended operation and performance
    - .3       Commissioning plan
    - .4       Documentation requirements
    - .5       Verification procedures
    - .6       Commissioning documentation
    - .7       Operation and performance
  - .3       Design Criteria: Design criteria and assumptions should include design conditions for each space as follows:
    - .1       Indoor dry bulb temperature
    - .2       Indoor relative humidity
    - .3       Outdoor dry bulb-temperature
    - .4       Outdoor wet bulb temperature
    - .5       Occupancy, hours, and degree of activity
    - .6       Lighting and miscellaneous power
    - .7       Ventilation - recirculation and outside air
    - .8       Internal loads
    - .9       Special loads
    - .10      R values for roof, wall, glass, etc.
    - .11      Percentage of glass - fenestration
    - .12      Type of glass, including coatings and solar coefficients



- .13 Building pressurization and infiltration
- .14 Building mass
- .15 Code requirements and impact on criteria
- .16 Air quality design criteria, i.e., ASHRAE 62-1
- .17 Noise criteria
- .18 Fire and life safety
- .19 Energy-efficiency and cost
- .20 Maintainability
- .4 Description of HVAC System
  - .1 The description of the HVAC system and its intended operation and performance should include design intent, assumptions, noise criteria, and facility occupation and utilization.
  - .2 The description of the HVAC system should include basic system type, major components, interrelation of components, capacity and sizing criteria, automatic temperature control, and sequence of operation. If the system's complexity warrants, energy flow diagrams should be included for each mode of operation indicating valve and damper positions, highlighted piping and air ducts, pump, and fan status, etc.
  - .3 The operation and performance data should include equipment selection and redundancy criteria, intended operation under all seasonal loads, changeover procedures, part-load operational strategies for each season, occupied/unoccupied modes of operation, design set-points of control systems with permissible adjustments, operation of system components in life-safety modes, energy conservation procedures, and any other engineered operational mode of the system.
- .5 Commissioning Plan
  - .1 The HVAC commissioning plan should detail the implementation of the commissioning process. It should include the requirements that each party involved in the commissioning process will have to accomplish, including: sequence, scheduling, documentation requirements, verification procedures, staffing requirements, etc.
  - .2 The parties involved will include the owners, design professional, contractors, vendors, project managers, commissioning agent, manufacturers, and other parties as required.
  - .3 The needed staffing skills and qualifications shall be specified for the following:
    - .1 Commissioning team
    - .2 Operation and maintenance teams
- .6 Documentation Requirements
  - .1 The requirements for each party involved in the HVAC commissioning process shall detail the documentation that each must prepare to satisfy the commissioning plan requirements of the specification and submit for review. This documentation will be prepared and submitted after the prime HVAC contracts are issued and details of the equipment to be installed are available.
  - .2 The documents shall include the following:
    - .1 Detailed procedures for the test to be performed by each party in the commissioning process
    - .2 Detailed checklists for performance testing
    - .3 Report forms that will be used to submit test data and results
    - .4 Calibration data for test equipment
    - .5 Sequence and schedule of procedures.
- .7 Verification Procedures: The procedures for performance tests and verification include, but are not limited to, the following:
  - .1 Testing, adjusting and balancing performance
  - .2 Verification of all equipment performance

- .3 Verification of the performance of subsystems consisting of combinations of equipment (i.e., refrigeration cycle, pumps, chillers, cooling towers, and interconnecting piping)
- .4 Verification of the performance of the automatic controls in all seasonal modes
- .5 Verification of the performance of the HVAC system as a whole
- .6 Verification of the performance of all life safety devices and systems as the interface with the HVAC systems
- .8 Commissioning Documentation: HVAC commissioning documentation should be prepared and submitted by the commissioning agent at the completion of the commissioning process. This documentation should include readiness, start-up, and performance checklists of the commissioning plan with actual results achieved.
  - .1 Testing, adjusting, and balancing.
  - .2 Performance of all equipment.
  - .3 Control schematics, performance reports, and checklists for verification of the total HVAC system and HVAC subsystems.
  - .4 Operating data to include all necessary instructions to the owner's maintenance and operating staff in order to operate the system to specified standards.
  - .5 Maintenance data to include all necessary information required to maintain all equipment in continuous operation.
  - .6 As-built documents for the HVAC system to include all systems, equipment automatic controls, duct and piping systems.
- .9 Operation and Performance: The schedules for the participation of the operations and maintenance personnel during the construction phase and the subsequent phases of the commissioning process.
- .2 Phase 2 - Construction
  - .1 Introduction
    - .1 This section describes the HVAC commissioning process during the construction phase of the project. In this phase, the HVAC system is installed, tested, and put into operation. When construction is completed, the HVAC system is ready for functional performance testing.
    - .2 HVAC commissioning is an ongoing process. It continues through the installation of the HVAC system. In this phase, the commissioning agent shall witness all pressure tests of the piping and duct systems and shall also observe all start-up, testing, adjusting and balancing, and calibration activities.
    - .3 An important part of the commissioning process is the training of the operations and maintenance personnel. These people should be available at the site during construction to observe the installation of the HVAC system and to learn about its operation. The commissioning agent shall direct this training.
  - .2 Procedure
    - .1 This section describes the events and procedures that should occur during the construction phase in order to facilitate proper HVAC commissioning.
    - .2 The system operation description should be updated to incorporate design changes that occur prior to or during the construction phase. This information then should be combined with the equipment maintenance data and equipment submittals, including performance data, to form one complete operations and maintenance manual for training and subsequent use of the operations and maintenance staff.
  - .3 Operation: During the construction phase, the building operations and maintenance staff should be available at the site for the purpose of observing

- construction, especially equipment installations.
- .4 Submittals
- .1 Submittals should be reviewed prior to construction. In addition to shop drawings, equipment submittals, testing and balancing procedures, and forms, submittals should also include the commissioning plan and commissioning documentation format.
- .1 Equipment submittals should include complete performance data for each piece of equipment - capacity, flow rates, velocity, pressure losses, horsepower, rpm, electrical data, etc. After review of equipment submittals, the equipment operations and maintenance information (including parts lists, installation instructions, and special tool needs) should be submitted in accordance with specifications requirements.
- .2 Because of the importance of the control systems to the proper operation of the HVAC system, control submittals should be carefully reviewed to ensure it includes all information needed by the operations and maintenance staff to keep the control systems adjusted and calibrated. Information should include:
- .1 A fully labeled control piping or wiring schematic, which shows point-to-point piping and wiring and includes all performance parameters such as setpoints, throttling ranges, actions, spans, proportional bands, and other control component adjustment or setting data. Locations of pneumatic test ports and electronic system terminal strips should be indicated on the schematic drawings.
- .2 Fully labeled elementary electrical ladder diagrams.
- .3 Sequence of operation (narrative description of control system functions) cross-referenced to the control schematics and elementary electrical ladder diagrams.
- .4 Specifications sheets for each control components.
- .3 The commissioning plan should be prepared following the format described in the contract specifications. It should detail how the commissioning process will be organized, scheduled, and documented to include:
- .1 The organization of the commissioning team (commissioning authority; commissioning Agent; testing, balancing, and adjusting specialists; contractors, vendors, manufacturers; owner's operations and maintenance staff, etc.)
- .2 A list of activities required to commission the HVAC subsystems and systems and the functions of each member of the commissioning team.
- .3 A logical sequence schedule for each commissioning activity coordinated with all members of the commissioning team.
- .4 Commissioning plan documentation forms for all components and systems submitted.
- .2 The procedures for testing, balancing, and adjusting should be performed in accordance with one or any of the following standards:
- .1 NEBB Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, 2005.
- .2 Associated Air Balance Council National Standards, 2016.
- .3 ASHRAE Standard 111-2008.
- .4 Other recognized standards approved by the design professional.

- .5 Construction Phase Activities
  - .1 Testing, adjusting, and balancing work must be performed prior to commissioning. Operational tests should also be conducted on equipment, duct, pipe, and control systems to verify that pressures and flow rates meet design requirements.
  - .2 Controls testing and calibration should begin concurrent with, and be completed subsequent to, the testing, adjusting, and balancing work.
  - .3 The commissioning agent should observe and verify all start-up, testing and balancing, and calibration activities as part of the ongoing commissioning process.
  - .4 Controls testing should be accomplished on each control device. Actuators should be checked and adjusted for beginning and extent of travel. All relays and adapters should be checked for proper operation. Controllers should be checked for proper action. All system interlocks, interconnections, and safety devices should be checked for proper function.
  - .5 All control devices should be adjusted and calibrated. All control settings should be verified by comparing actual input and output values to calculated values.
  - .6 Testing, adjusting, and balancing work should be substantially complete with reports submitted prior to the verification and acceptance phase.
  - .7 Training, warranty, special tools, and spare parts should be taken into account under the construction phase.
  - .8 Contractor and equipment warranties shall be verified.
  - .9 Special tools and spare parts list shall be verified.

### 3.4 ACCEPTANCE PROCEDURES

- .1 Introduction: This section describes acceptance procedures for the HVAC commissioning process.
- .2 Pre-requisites to Functional Performance Tests:
  - .1 Prior to functional performance testing of each system, the commissioning agent should observe and verify that the physical installation of components and systems being tested is substantially installed in accordance with the contract documents.
  - .2 This should include: hydrostatic testing, flushing, cleaning, start-up or activation of equipment and systems, completion of testing, adjusting, and balancing, and calibration and test of automatic controls.
- .3 General:
  - .1 The functional performance test checklists contained in the approved HVAC commissioning plan should be used to document the results of the functional performance testing process.
  - .2 The functional performance testing process should be accomplished for all equipment, subsystems, systems, and system interfaces. There may be several similar pieces of equipment, systems, etc., on a project. All must be tested for acceptances, and there should be a separate checklist for each to ensure documentation specific to each is complete.
  - .3 Functional performance testing should progress from equipment or components through subsystems to complete systems. Functional performance testing will have to consider sequences of testing, starting with components and progressing towards complete systems. As a result, the causes of any functional problems should be easier to locate and correct.
  - .4 The specific tests, and the most efficient order of testing, will vary widely depending on the type of system, the number of systems, the sequence of

- construction, the relationship between building systems and specific tenant work, the degree of interaction between systems, the complexity of the controls sequence, the impact of system failures on health or safety, and other factors.
- .5 At the end of the process, every mode of systems operation, all system equipment, components and zones, and every item in the control sequence description should have been proved operational under all normal operational modes, including part and full load, and under abnormal or emergency conditions.
- .4 Equipment and Subsystem Functional Performance Tests:
- .1 Operate the equipment and subsystems through all specified modes of control and sequences of operation. Include full and part-load and emergency conditions.
- .5 Systems Functional Performance Test
- .1 Each system should be operated through all modes of system operation (for example, seasonal, occupied/unoccupied, warm-up/cool-down, etc., as applicable) including every individual interlock and conditional control logic, all control sequences, both full and part-load conditions, and simulation of all abnormal conditions for which there is a specified system or controls response.
- .2 Temporary upsets of systems, such as distribution fault, control loss, setpoint change, equilibrium upset, and component failure, should be imposed at different operating loads to determine system stability and recovery time.
- .6 Verification and Documentation:
- .1 As each individual check or test is accomplished, the commissioning agent should observe the physical responses of the system and compare them to the specified requirements to verify the test results. The actual physical responses of system components must be observed. Reliance on control signals or other indirect indicators is not adequate. The input and output signals for each control component also need to be observed to confirm they are correct for each physical condition.
- .2 Verification of the testing, adjusting, and balancing report should be an integral part of functional performance testing.
- .3 The commissioning agent should record the result of each individual check or test on the pre-approved test and report form from the commissioning plan.
- .7 Deferred Functional Performance Tests:
- .1 If any check or test cannot be accomplished for seasonal reasons, lack of occupancy, or for other reasons, this fact should be noted along with an indication of when the test will be scheduled.
- .2 If any check or test cannot be accomplished due to building structure or other building system deficiencies outside the scope of the HVAC systems work, these deficiencies should be resolved and corrected by the appropriate parties before completion of the HVAC commissioning process.
- .3 Every check or test for which acceptable performance was not achieved should be repeated after the necessary corrective measures have been completed. This re-testing process should be repeated until acceptable performance is achieved.
- .8 Corrective Measures:
- .1 If acceptable performance cannot be achieved, then the necessary corrective measures should be carried out. The design professional should issue appropriate directions in this regard.
- .9 Intersystem Functional Performance Tests:
- .1 When all individual systems' functional performance has been proved, the interface or coordinated responses between systems should be checked. The systems involved may be within the overall HVAC work, or they may involve other

- systems, such as emergency systems for life safety.
  - .2 The approach to intersystem performance testing should follow that previously described for systems.
- .10 Acceptance Documentation:
  - .1 A copy of the HVAC commissioning plan and functional performance test results should be included with each copy of the Operations and Maintenance Manuals. These manuals, along with testing and balancing reports, controls schematics, and any other documents required, should be submitted to the Consultant for review.
- .11 Operator Training:
  - .1 The building operator should be on site periodically during the construction phase, particularly during start-up of equipment, testing, adjusting, and balancing, and during the entire functional performance testing process.
  - .2 Operator training should provide a complete overview of all equipment, components, and systems with an emphasis on:
    - .1 Documentation in the final Operations and Maintenance Manuals
    - .2 How to use the Operations and Maintenance Manuals
    - .3 System operational procedures for all modes of operation, including warm-up, cool-down, occupied, unoccupied, etc.
    - .4 Acceptable tolerances for system adjustments in all operating modes
    - .5 Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.
- .12 Final Acceptance:
  - .1 When requirements of the commissioning plan have been completed and satisfactorily documented and required documentation has been completed, submitted to the design professional, and accepted, the commissioning agent should recommend final acceptance of the HVAC system.

**END OF SECTION**

**Part 1            General**

**1.1            GENERAL**

- .1      This General Requirements Section applies to all work performed under this section.
- 2      The "provide" in this Division shall be interpreted as "supply, install, connect, program and debug".
- .3      All work shall conform to Canadian Metric Practice Guide CSA CAN3-Z234.1-00, CAN/CSA-Z234.1-00(R2011).
- .4      Provide all required adapters between "Metric" and "Imperial" components.
- .5      Metric descriptions in this Division are nominal equivalents of Imperial values.
- .6      All equipment and material to be new, CSA certified, manufactured to minimum standard quoted including additional specified requirements.
- .7      Standards Compliance: Where materials or equipment are specified to conform to requirements of the standards of organizations, such as the Canadian Standard's Association (CSA) that use a label or listing as method of indicating compliance, proof of such conformance shall be submitted and approved, indexed and cross-referenced with the Government specification. The label or listing of the specified organization will be acceptable evidence. In lieu of the label or listing, the Contractor shall submit a certificate from a testing organization adequately equipped and competent to perform such services, and approved by the manufacturers/Engineer, stating that the item has been tested in accordance with the specified organization's test methods and that the item conforms to the specified organization's standard or code. For materials whose compliance with organizational standards or specifications is not regulated by an organization using its own listing or label as proof of compliance, a certificate from the manufacturer shall be furnished to the Consultant stating that the material complies with the applicable referenced standard or specified.
- .8      Where there is no alternative to supply equipment which is not CSA certified, submit such equipment to Inspection Authorities for special inspection and obtain approval before delivery of equipment to site.

**1.2            REFERENCES**

- .1      Canadian Standards Association (CSA)
  - .1      CAN/CSA-C22.2 No.0-10, Canadian Electrical Code, PartII, General Requirements.
  - .2      CAN/CSA-Z234.1-00, Canadian Metric Practice Guide.
- .2      American National Standards Institute (ANSI)
  - .1      ANSI/ISA 5.5-1985, Graphic Symbols for Process Displays.
  - .2      ANSI/IEEE 260-1978, Letter Symbols for SI and Certain Other Units of Measurements.
  - .3      CEMA2Y.1.

**1.3            PERMITS AND FEES**

- .1      Submit certificate of acceptance from authority having jurisdiction to Consultant & Owner. Obtain all permits required to perform the work listed in these specifications. Cost shall be the contractor's responsibility.
-

## **1.4 SCOPE OF WORK**

- .1 The work covered by this specification and related sections consists of providing submittals, shop drawings, equipment, labour, materials, engineering, programming, technical supervision, commissioning, site reviews, as-builts, and transportation as required to furnish and install a fully operational Energy Monitoring and Control System (EMCS) which provides the operation specified in strict accordance with these specifications and the contract drawings, and subject to the terms and conditions of the contract. The work in general consists of but is not limited to, the following:
  - .1 The preparation of submittals and provision of all related services.
  - .2 Provide and install data communication equipment necessary to affect an EMCS data transmission system including necessary interfaces, gateways, routers, and fiber optic transmission equipment.
  - .3 Provide Programmable Control Units, sensors, control devices, conduit and wiring, as required to provide the operation specified.
  - .4 Provide, load, program and debug all software required to implement a complete and operational EMCS.
  - .5 Provide all field equipment including control valves, control dampers, etc. as specified.
  - .6 Finetune all control loops and calibrate sensors & transmitters and adjust all control devices to perform to tolerances specified as required until approved final inspection and provide calibration services throughout warranty period.
  - .7 Provide complete operating and maintenance manuals as well as field training of operators, programmers, and maintenance personnel as outlined in these specifications.
  - .8 Perform acceptance tests and technical support during commissioning as indicated.
  - .9 Provide full documentation for all software and equipment in hard and soft copy.
- .2 (Programmable Control Units) to meet the intent of the specification and spare capacity requirements. The quantity and point content of the Programmable Controllers must be approved by the Consultant prior to installation.
- .3 Final location for all controllers to be approved by Owner and Consultant before mounting.
- .4 Division 23 09 36 controls contractor shall be responsible for extending power to all controllers and control devices. Refer to Division 26 (Electrical) drawings for controls power locations.
- .5 Provide all field equipment including control valves, control dampers, etc. as specified. Controls contractor shall provide all necessary relays for speed control of force flows, fan coils, unit ventilators, unit heaters and all other equipment as required.

## **1.5 METRIC REFERENCES**

- .1 Conform to CAN/CSA-Z234.1.
- .2 Provide all required adapters between Metric and Imperial components.

## **1.6 WORK BY OTHERS**

- .1 Division 23 shall be responsible for installing HVAC related equipment and components and Division 22 shall be responsible for installing plumbing equipment and components. Equipment includes wells, valves, taps, dampers, flow stations furnished by EMCS



manufacturer.

- .2 Division 26 (Electrical) shall be responsible for providing power. Power for controllers and devices shall be supplied to assigned general areas by Division 26 (Electrical) and shall be extended to controllers and devices by this Division.

## **1.7 ELECTRICAL WORK AND SAFETY REQUIREMENT**

- .1 Electrical work shall meet or exceed Canadian Electrical Code, Ontario Electrical Safety Code, Ontario Hydro Requirements, and Canada Labour Code Part IV. Electrical wiring, terminal blocks and other high voltage contacts shall be fully enclosed or properly guarded and marked to prevent accidental injury to personnel. Perform electrical work as per Division 26 (Electrical) specification and contract documents.

## **1.8 MANUFACTURER'S RECOMMENDATIONS**

- .1 Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Consultant with shop drawing submission. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations shall be cause for rejection of the material.

## **1.9 WIRING**

- .1 All wiring associated with and required by the EMCS shall be the responsibility of this contractor. The term "wiring" shall be construed to include furnishing of wire, transformers, conduit, miscellaneous material and labour as required to install a total working system. If departures from the contract drawings are deemed necessary by the contractor, details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the drawings to the Consultant for approval. Wiring to conform with Division 26 (Electrical) specifications and contract documents.
- .2 120V control power supplied by Division 26 (Electrical) to central distribution locations as shown on drawings, Division 23 Controls Contractor shall supply control transformers, wiring to controllers and devices serving miscellaneous equipment such as but not limited to motorized zone dampers, air flow sensors, etc...

## **1.10 PRODUCT AND SERVICE**

- .1 Materials and equipment shall be essentially the catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements. Where two units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of a single manufacturer. Each major component of equipment shall have the manufacturer's name and address and the model and serial number on a nameplate securely attached in a conspicuous place.
  - .2 Control equipment and installation shall be the product and service of one manufacturer unless otherwise specified.
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#### **1.11 ACCEPTABLE CONTROLS CONTRACTORS AND SYSTEM**

- .1 Acceptable controls contractors to be:
  - .1 Ainsworth (613) 702-0427
  - .2 Honeywell Ltd. (416) 758-2820
  - .3 AIRON (613) 747-7563
  - .4 Regulvar Canada (613) 565-2129
  - .5 Trane Canada (613) 820-8111, (613) 744-5396
  - .6 B. Lundy Mechanical (613) 342-7820

#### **1.12 QUALITY ASSURANCE**

- .1 The manufacturer shall provide full time, on site, experienced product manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the EMCS.
- .2 Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.
- .3 This system shall have a documented history of compatibility by design for a minimum of 10 years. Future compatibility shall be supported for no less than 20 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.
  - .1 Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

#### **1.13 VERIFICATION OF DIMENSIONS**

- .1 The Contractor shall visit the premises to thoroughly familiarize himself with all details of the work and working conditions and verify all information in the field, and shall advise the Consultant of any discrepancy before performing any work. The Contractor shall be specifically responsible for the coordination and proper relation of his work to the building structure and to the work of all trades.

#### **1.14 PRELIMINARY DESIGN REVIEW MEETING**

- .1 The contractor shall convene before programming is to start, a review of sequence of operations to insure a meeting of the minds between the Consultant and Owner and the contractor's programmer. Note that contractor's programmer must be at the meeting and that the Consultant has the right to revise any sequence or subsequent CDL to his satisfaction at any time prior to software finalization without cost to the Owner or Consultant. Note: final draft to be approved by the Owner's representative before return of shop drawings.

#### **1.15 SHOP DRAWINGS**

- .1 Provide shop drawings in accordance with Section 01 33 00 - Submittals and Section 20 05 01 – Mechanical General Requirements.
  - .2 Before start of construction and as stated in Division 20 specifications, provide shop drawings consisting of:
    - .1 Wiring and piping diagrams. Show conduit size and spare capacity. Provide interface wiring diagrams complete with termination connections for existing
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- .2 equipment and equipment supplied by others. Indicate signal levels.  
Shop drawing for each input/output point showing all information associated with each particular point including:
  - .1 Sensing element type and location.
  - .2 Transmitter type and range.
  - .3 Details of associated field wiring schematics, schedules and terminations.
  - .4 Pneumatic schematics and schedules.
  - .5 Point address.
  - .6 Setpoints, curves, graphs, alarm limits (H + L, 4 types) and signal range.
  - .7 Manufacturer's recommended installation instructions and procedures for each type of sensor and/or transmitter.
- .3 Control schematics with Narrative Description and Control Description Logic fully showing and describing operation and/or manual procedures available to achieve proper operation of the building.
- .4 Complete system CDL's including companion English language explanations on the same sheet (use different fonts and italics). CDL's must contain the energy optimization programs specified elsewhere.
- .5 A listing and example of all reports.
- .6 A listing of all time schedules.
- .7 Provide valve schedule indicating valve selection, valve application, calculated Cv, calculations used indicating pressure drop used, and explanation for each valve indicating appropriateness of selection and differential pressure in relation to maximum close-off of each valve in relation to associated pump pressure.

#### **1.16 SYSTEM DESIGN RESPONSIBILITY**

- .1 Design and provide all wiring linking all elements of system, including future capability.
- .2 Supply sufficient programmable controllers of all types to meet project requirements. Quantity and points contents to be approved by Consultant/Owner prior to installation.
- .3 Location of controllers to be approved by Consultant/Owner prior to installation.

#### **1.17 TESTING**

- .1 This work shall include the testing and verification of all major subsystems of the complete EMCS including all field components and an on-site field operational test.
- .2 The Contractor shall provide all test equipment including 2 way radios.
- .3 All test equipment such as but not limited to digital thermometers, humidistats, velometers and milliamp and volt meters shall be certified as accurate by an independent testing laboratory no later than 2 months prior to the tests. Test equipment used shall be of equal or better accuracies then these specified for the devices.
- .4 Notify the Consultant in writing at least 14 working days before testing is to take place.
- .5 Provide all necessary personnel and coordinate with other trades.
- .6 Perform tests in presence of Consultant.
- .7 Demonstrate the proper operation of each component.
- .8 Correct any deficiencies and re-test until designated part of the system performs satisfactorily.

- .9 Acceptance of tests by the Consultant shall not relieve the Contractor of responsibility for the complete system meeting the requirements of these specifications after installation.

## **1.18 COMMISSIONING**

- .1 General
- .1.1 Commissioning to be carried out under general direction of Controls Contractor.
- .2 Approvals
- .2.1 Obtain approval to start commissioning from Consultant in writing at least 14 days prior to start. Information to include:
- .2.2 Systems to be commissioned.
- .2.3 Procedures, anticipated results.
- .2.4 Names of commissioning personnel.
- .3 Purpose Commissioning shall ensure that facility is fully commissioned and includes assurance that systems meet design criteria, and specification requirements.
- .4 Co-ordination
- .4.1 Co-ordinate commissioning procedures with disciplines and trades involved.
- .5 Timing
- .5.1 Commissioning to commence only after satisfactory completion of start-up, and verification of performance.
- .6 Instrumentation
- .6.1 Provide sufficient permanent and temporary instrumentation. Verify locations, access, illumination for readings.
- .6.2 Instrumentation shall have accuracy tolerances of higher order of magnitude than equipment, system, etc. being tested.
- .6.3 Locations to be approved, readily accessible and readable.
- .6.4 Application: shall conform to normal industry standards.
- .7 Operation of Systems
- .7.1 Operate systems for as long as necessary to commission entire project.
- .8 Supervision and Monitoring
- .8.1 Commissioning to be carefully supervised by qualified supervisory personnel.
- .8.2 Monitor progress. Keep detailed records of activities, results.
- .9 Documentation & Training
- .9.1 Documentation, O & M Manuals, training of O & M personnel to be completed to satisfaction of Owner and Consultant prior to starting and commissioning.
- .10 Use of O & M Personnel
- .10.1 O & M personnel to assist in commissioning procedures as part of training.
- .11 Procedures
- .11.1 Test each system independently and then in unison with all other related systems.
- .11.2 Test weather-sensitive systems twice - once at near winter design conditions and again under near summer design conditions.
- .11.3 Commission integrated system in co-operation with 3rd party manufacturer.
- .11.4 Debug systems.
- .11.5 Optimize operation, performance of each system.
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- .6 Test full scale emergency evacuation procedures including operation and integrity of smoke management systems.
- .12 Demonstrations
  - .1 Demonstrate to Owner, User, Project Manager, Consultant, the operation of each system including sequence of operations in regular and emergency modes, under all normal and emergency conditions, start-up, shut-down, interlocks, lock-outs.
- .13 Final Settings
  - .1 Upon completion of commissioning to satisfaction of Consultant, set and lock all devices in final position, permanently mark all settings.
- .14 Final Report
  - .1 Submit report to Consultant. Report to:
    - .1 Include all measurements, final settings, certified test results.
    - .2 Bear signature of commissioning technician and supervisor.
    - .3 Be subject to verification by Consultant.
- .15 Commissioning Activities during EMCS Warranty Period
  - .1 Continue system debugging and optimization.
    - .1 Perform two (2) checks of environmental conditions. Submit written report to Consultant.
  - .2 Rectify deficiencies revealed by maintenance inspections and environmental checks.
  - .3 Revise "As-built" documentation, commissioning reports to reflect changes, adjustments, modifications to EMCS as set during commissioning.
  - .4 Review effectiveness of training provided to O&M personnel.
  - .5 Provide additional training as deemed necessary by Consultant.
  - .6 Recommend additional changes, modifications deemed advisable in order to improve performance, environmental conditions, energy consumption.
- .16 Maintenance Activities During EMCS Warranty Period
  - .1 Provide services, materials, equipment and maintain EMCS for warranty period specified in Section 23 09 36 - EMCS: General Requirements.
  - .2 Perform one minor inspection per quarter (more often if required by manufacturer) and two major inspections per year. Provide fully detailed schedule indicating inspection and maintenance dates and provide detailed report in writing to Consultant and to Owner.
  - .3 Major inspections to include, but not limited to:
    - .1 Minor inspection.
    - .2 Clean OWS, all peripheral equipment, PCU's, all interface and other panels, micro-processor interior and exterior surfaces.
    - .3 Check signal, voltage and system isolation of all PCU's, peripherals, all interface and other panels.
    - .4 Provide mechanical adjustments, new ribbons/ink cartridges, necessary maintenance on printers.
    - .5 Check and/or calibrate each field input/output device. Provide dated, all-point log to Owner as proof of executed point-to-point system check. Log to indicate binary input
    - .6 Run system software diagnostics as required.
  - .4 Minor inspections to include, but not limited to:
    - .1 Perform visual, operational checks to all PCU's, peripheral equipment, interface and other panels, FID's.
    - .2 Check fan, change filters of all PCU's, peripheral equipment, as required.

- .3 Perform regular service calls during regular working hours, 0800 to 1630 h, Monday through Friday, excluding legal holidays.
- .5 Emergency service:
  - .1 Emergency service shall be valid 24 hours day, 7 days per week for one full year of service.
  - .2 Service calls will be initiated when there is indication that EMCS is not functioning correctly. Have qualified control personnel available during contract period to provide service to "CRITICAL" components whenever required at no extra cost. Furnish Owner with telephone number where service personnel may be reached at any time. Service personnel to be on site ready to service EMCS within 3 hours after receiving request for service. Perform work continuously until EMCS restored to reliable operating condition.
- .6 Operation:
  - .1 Foregoing and all other servicing to provide proper sequencing of equipment and satisfactory operation of EMCS based on original design conditions and to be as recommended by manufacturer.
- .7 Records and logs:
  - .1 Maintain records and logs of each maintenance task. Organize cumulative records for each major component and for entire EMCS chronologically. Complete forms and submit monthly, by 10th day of succeeding month, indicating that planned and systematic maintenance has been accomplished.
- .8 Work requests:
  - .1 Record each service call request, when received separately on approved form. Form to include serial number identifying component involved, its location, date and time call received, nature of trouble, names of personnel assigned, instructions of work to be done, amount and nature of materials used, time and date work started, time and date of completion.
- .9 System modifications:
  - .1 Provide in writing. No system modification, including operating parameters and control settings, to be made without prior written approval of Owner.
- .10 Software:
  - .1 Implement all software maintenance updates. To be accomplished as required. Maintain co-ordination with EMCS supervisory personnel.
- .11 Controls contractor shall perform summer and winter system start-ups and shutdowns during warranty service period.
- .17 Service Contracts
  - .1 Provide in-depth technical expertise and assistance to Owner in preparation and implementation of service contracts and in-house preventive maintenance procedures.
  - .2 Service Contracts to include:
    - .1 Annual verification of field points for operation and calibration.
    - .2 # visits per year.
    - .3 # responses to emergency calls during day, per year.
    - .4 # responses to emergency calls during silent hours per year.
    - .5 Silent hours.
- .18 Completion of Commissioning
  - .1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved to full satisfaction of Consultant and Owner.

- .1 Conform to this section as well as to Section 20 05 01 – Mechanical General Requirements and 01 33 00 - Submittals.
- .2 Final Control Diagrams
  - .1 Provide before acceptance in both hard and soft copy.
  - .2 Show:
    - .1 All changes to contract documents as well as all addenda and contract extras.
    - .2 All changes to interface wiring.
    - .3 Major routing of conduit and control air lines.
    - .4 All signal levels, setpoints, reset curves, schedules.
  - .3 Where possible, bind with Operating and Maintenance Manuals specified herein.
  - .4 Provide listing of alarm messages.
  - .5 Provide soft copy of all updated drawings on system and soft copy back-up AutoCAD 2018 format.
- .3 Language
  - .1 To be in English.
- .4 O & M Manuals
  - .1 O & M Manuals (both hard and soft copy) to be custom designed and contain material pertinent to this project only, and to provide full and complete coverage of all subjects referred to in this section.
  - .2 Provide three (3) soft copies and one (1) hard copy in hard-back, 50 mm (2 in.) 3 ring, D-ring binders.
    - .1 Binders to be 2/3 maximum full.
    - .2 Provide index to full volume in each binder.
    - .3 Identify contents of each manual on cover and spine.
    - .4 Include names, addresses, telephone numbers of each sub-contractor having installed equipment, local representative for each item of equipment, each system.
    - .5 Provide Table of Contents in each manual. Assemble each manual to conform thereto, with tab sheets placed before instructions covering subject.
  - .3 Furnish one (1) complete set of hard and soft copy to system or equipment tests. Furnish remainder upon acceptance.
  - .4 Include complete coverage in concise language readily understood by operating personnel using common terminology of all functional and operational requirements of system. Do not presume knowledge of computers, electronics, or in-depth control theory.
  - .5 Functional description to include:
    - .1 Functional description of theory of operation.
    - .2 Design philosophy.
    - .3 Specific functions of design philosophy and system.
    - .4 Full details of data communications, including data types and formats, data processing and disposition data link components, interfaces and operator tests or self-test of data link integrity.
    - .5 Explicit description of hardware and software functions, interfaces, requirements for all components in all functions and operating modes.
    - .6 Description of person-machine interactions required to supplement system description, all known or established constraints on system operation, operating procedures currently implemented for implementation in automatic mode.
  - .6 System operation to include:
    - .1 Complete step-by-step procedures for operation of system including

- required actions at each OWS.
- .2 Operation of computer peripherals, input and output formats.
- .3 Emergency, alarm and failure recovery.
- .4 Step-by-step instructions for start-up, back-up equipment operation, execution of all systems functions and operating modes.
- .7 Software to include:
  - .1 Documentation of theory, design, interface requirements, functions, including test and verification procedures.
  - .2 Detailed descriptions of program requirements and capabilities.
  - .3 All data necessary to permit modification, relocation, reprogramming and to permit new and existing software modules to respond to changing system functional requirements without disrupting normal operation.
  - .4 All software modules, fully annotated source code listings, error free object code files ready for loading via peripheral device.
  - .5 Complete program cross reference plus any linking requirements, data exchange requirements, necessary subroutine lists, data file requirements, other information necessary for proper loading, integration, interfacing, program execution.
  - .6 All software for each PCU and single section referencing all PCU common parameters and functions.
- .8 Maintenance: document all maintenance procedures including inspection, periodic preventive maintenance, fault diagnosis, repair or replacement of defective components, including calibration, maintenance, repair of sensors, transmitters, transducers, FID's plus diagnostics and repair/replacement of system hardware.
- .9 Test procedures and reports: record implementation, description of test procedures. Provide for measurement or observation of results.
- .10 System configuration document:
  - .1 Basic system design and configuration.
  - .2 Provisions and procedures for planning, implementing, recording hardware and software modifications required during installation, test and operating lifetime of system.
  - .3 Information to ensure co-ordination of hardware and software changes, data link or message format/content changes, sensor or control changes in event that system modifications are required.
  - .4 Full documentation of new system configurations.
- .11 PROM programmer and test equipment manual: include full documentation on all PROM's including as minimum PROM locations in system, stock number, Programmer/PROM unique considerations.
- .12 Programmer control panel documentation: provide where panels are independently interfaced with EMCS, including interfacing schematics, signal identification, timing diagrams, fully commented source listing of applicable driver/handler.

## 1.20 TRAINING

- .1 Training Proposal
  - .1 At least 30 days prior to anticipated date of commencement of training, provide complete hour-by-hour schedule complete with brief overview of content of each segment.
  - .2 Submittal to list name of person conducting each session, visual and audio aids to be used.
  - .3 Indicate how training schedule to be co-ordinated with other training programs in mechanical and electrical systems connected to EMCS.
- .2 Instructors



- .1 To be bilingual competent, thoroughly familiar with all aspects of EMCS installed in this facility.
- .2 Consultant reserves right to approve instructors, based on qualifications.
- .3 Instruction
  - .1 Provide instruction to designated personnel in adjustment, operation, maintenance, pertinent safety requirements of EMCS installed.
  - .2 Training to be project-specific.
- .4 Number of 8 h person-days of instruction to be as specified in this section (one person-day = 8 h including two 15 min breaks and excluding lunch time).
- .5 Training Materials
  - .1 Provide all equipment, visual and audio aids, and materials for classroom training.
  - .2 Provide manual for each trainee, describing in detail data included in each training program.
- .6 Training Program
  - .1 To be in 2 phases over month period:
    - .1 Phase 1: Provide 1/2 day training before commissioning at time mutually agreeable to Owner, Contractor and Consultant. Train O & M personnel in functional operations and procedures to be employed for system operation. Supplement with continuous on-the-job training during installation and commissioning. To include overview of system architecture, communications, operation of computer, software, peripherals and report generation; detailed training on operator interface functions for control of mechanical systems, CDL's for each system, and elementary preventive maintenance.
    - .2 Phase 2: Provide 1/2 day of additional on-site training for operators programmers, 8 weeks after acceptance. Include the following: General equipment layout, trouble shooting and preventative maintenance of EMCS components, maintenance and calibration of sensors and controls.
- .7 Monitoring of Training
  - .1 Consultant retain the right to monitor training program and to modify schedule and content.

## **1.21 WARRANTY**

- .1 Provide all services, materials and equipment necessary for the successful operation of the entire EMCS system for a period of one year after issue of Substantial Completion.
- .2 The adjustment, required testing, and repair of the system includes all computer software and equipment, transmission equipment and all sensors and control devices.
- .3 The EMCS contractor shall dispatch the appropriate personnel to the job site to resolve the problem within 3 hours of the time that the problem is reported.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 The energy management system shall consist of a primary workstation complete with colour graphics, remote system dial-in dial-out capabilities, and alarm paging for the

purpose of Monitoring, Controlling and Alarming.

- .2 The building automation system shall be integrated to the board offices building enterprise management system using a Tridium JACE 8000 N4 based network controller complete with software revisions for integration into existing controls network platform and to permit remote operator capabilities to monitor control, perform programming changes, and archive alarms and trend through the use of a web browser using I.P. addressing.
- .3 The primary workstation shall be located in the custodian office. Final locations are to be determined on site by the Owner and Consultant and shall come at no extra cost to the Owner.
- .4 EMCS control system shall be a wired system. No wireless shall be accepted.

## **2.2 REFERENCES**

- .1 Institute of Electrical and Electronics Consultants.
  - .1 IEE C37-90.1 "Standard for Surge Withstand Capability (SWC) Test for Relays and Relay Systems Associated with Electric Power Apparatus"
  - .2 IEEE C62.41 - Recommended Practice on Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
  - .3 IEEE C57.13, Requirements for Instrument Transformers.
- .2 Canadian Standards Association
  - .1 CSA C22.2no.205, Signal Equipment.
- .3 National Electrical Manufacturer's Association (NEMA)
  - .1 NEMA1
  - .2 EEMAC3
- .4 Canadian Standards Association (CSA)
  - .1 CAN/CSA C22.3 No.1, Overhead Systems.
  - .2 CSA Standard C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations and with Ontario amendments.
- .5 American National Standards Institute (ANSI)
  - .1 ANSI C2, National Electrical Safety Code.
  - .2 CSA Standard C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations and with Ontario amendments.

## **2.3 ELECTRICAL WIRING**

- .1 Wiring to conform to Division 26 (Electrical) specifications and to manufacturers written requirements, installed in conduit as indicated in these specifications. Wiring type and literature to be submitted to consultant prior to installation.
- .2 All controllers shall be powered through the uninterruptable power supplies (UPS) provided by the EMCS contractor. EMCS contractor to coordinate power distribution layout/arrangement and UPS requirements with electrical contractor at time of tender.

## **2.4 EMCS ARCHITECTURE**

- .1 The design of the EMCS communications Network consists of two layers. The management level network layer shall be based on standard LAN protocols for TCP/IP communications over the Ethernet and shall provide full colour interactive Graphical User
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Interface (GUI) operator facilities based on standard Web Browser arrangements. This layer shall consist of the primary workstation, operator workstations, remote workstations, network interfaces and JACE Universal Network controllers with web option and revised software for existing integration into existing client platform. The controller level network layer (or layers) shall consist of modular equipment controllers, standard programmable equipment controllers, and application specific controllers.

- .1 All communications shall be via twisted pairs wires, shielded where required.
- .2 EMCS microprocessor failures shall not cause loss of communications of the remainder of any network.
- .3 All networks shall be peer-to-peer supporting sensor sharing, global application programs and bus to bus communications.
- .4 Provide an EMCS incorporating full Open Database Connectivity (ODBC) facilities via Microsoft Structured Query Language (SQL), or approved equal, ready for interactions with other potential software applications and for primary EMCS database storage on the local server.
- .5 A 10/100 MB Ethernet infrastructure within the building will be provided for use by the EMCS and for the support and connection of EMCS Network Area Controllers, Network Servers, and other EMCS network node equipment.  
**Contractor to provide network cable drop and cable from the EMCS control data network to the UCDSB network router for connection by UCDSB IT staff.**
- .6 The EMCS use of the Owner's network will be provide in conformance with:
  - .1 IEEE Ethernet Standard 802.3.
  - .2 ANSI/ASHARE BACnet Standard 135, Annex J with support for Internet Protocol (IP) Addressing and common routers.
- .7 The Owner's network infrastructure will be comprised primarily of Category 5, 10 Base-T, UTP-8 shielded cabling.

## 2.5 MANAGEMENT LEVEL NETWORK

- .1 Operating System
  - .1 The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. EMCS software shall run on a Windows 10 operating system. These Windows applications shall run simultaneously with the EMCS software. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, with optional capability of annunciating on-line EMCS alarms and monitoring information.
- .2 Owner will provide the Primary Operator Workstation and printer. Controls contractor to provide and install software and devices necessary to communicate with the field control panels and devices.
- .3 Web Browser Interface
  - .1 The EMCS shall be designed and provided so as to be theoretically capable of supporting an unlimited number of Client Workstations with operator access via standard Web Browsers such as Internet Explorer and Netscape Navigator. No additional software on the Client should be required to enable Browsers to properly access and manage the EMCS.
  - .2 The Web Browser shall provide viewing "windows" into the EMCS including current information and status, trends, graphics, schedules, calendars, logs, etc.
  - .3 The Web Browser Client shall, at minimum, support the following security functions:
    - .1 User log-on identification and password Operator access control enabled. If an unauthorized user attempts access, a blank web page shall be displayed.

- .2 Security using password, authentication and encryption techniques to prevent unauthorized access.
  - .4 Storage of the graphical screen database shall be in the Network Area Controller or Network Server without specifically requiring any graphics to be stored on the Client workstations.
  - .5 Real-time values displayed on a Web page shall update automatically without requiring a manual "refresh" of the Web page.
  - .6 Each User shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform, at minimum, the following:
    - .1 Modify common application objects, such as schedules, calendars and set points in a graphical manner.
      - .1 Schedule times will be adjusted using a graphical slider, or similar tool, not requiring significant key entry.
      - .2 Using a graphical calendar, or similar tool, not requiring significant keyboard manual entry, shall set holidays.
    - .2 Stop/Start binary commands and analog point commands and other common commands shall use graphical icons or symbols and not require significant keyboard entry.
  - .7 The EMCS shall incorporate the capability to implement customized multiple User's Home Pages. Provide the ability to limit a specific User to their defined Home Page. From the Home Page, provide links to other views, or pages in the EMCS as governed by the System Administrator.
  - .8 Provide for graphic screens on the Web Browser Client, to support links to other locations on the Internet or on Intranet sites by specifying the Internet Uniform Resource Locator (URL) address for the desired link.
- .4 Workstation Software
- .1 Workstation Control Software
    - .1 Enable non-programmer operator to easily perform tasks which form part of daily routine.
    - .2 Must perform the following functions, facilitate keyboard visual displays; keyboard, disk, or network entry of information into system; display and logging of system information and following tasks:
      - .1 Automatic logging of digital alarms and change of status messages.
      - .2 Automatic logging of analog alarms.
      - .3 System changes (such as alarm limits, set-points, alarm lockouts).
      - .4 Display specific point values, states as selected.
      - .5 Provide reports as requested and on scheduled basis when so required.
      - .6 Display graphics as requested. i.e. Floor plans/graphics that show overridden values in purple and alarms in red.
      - .7 Display error messages library.
      - .8 Floor plans graphics displaying units fed from and links to unit's graphics.
      - .9 Floor plans graphics that show controller locations
      - .10 Display list of points within system.
      - .11 Display list of systems within building.
      - .12 Provide trend logs as required.
      - .13 Provide manual control of DO and AO as required.
      - .14 Direct output of information to selected device.
      - .15 On-line changes:
        - .1 Setpoints.
        - .2 Control and change of state changes.

- .3 Schedule changes.
- .2 Error Messages
  - .1 Inform operator of all errors in data, errors in entry instructions, failure of equipment to respond to requests or commands, failure of communications between components of EMCS.
  - .2 Error messages to be comprehensive and communicate clearly to operator precise nature of problem.
- .3 Password Protection
  - .1 Minimum 5 levels of password access protection to limit control, display, data base manipulation capabilities as follows:
  - .2 User-definable, automatic log-off timers to prevent operators leaving devices on-line inadvertently.
  - .3 Ability to perform override on digital outputs at controllers.
- .4 Alarms
  - .1 All alarms to be classified as "critical", "warning", "maintenance". Personnel having required password level to designated alarms and alarm classifications.
  - .2 Presentation of alarms to include features identified under applicable report definitions of report program paragraph.
  - .3 Alarm reports to include:
    - .1 Summary of all points in critical alarm. Include at least point name, point description, alarm type, current value, limit exceeded.
    - .2 Summary of all points in maintenance alarm. Include at least point name, point description, alarm type, current value.
    - .3 Analog alarm limit summary: include point acronym, alarm limits.
    - .4 Summary of all alarm messages: include associated point name, description, alarm description.
  - .4 Software to notify operator of occurrence of alarm conditions at operator workstation and through dial-out to the building maintenance personnel's alphanumeric pager. Each point to have its own alarm message.
  - .5 EMCS to notify operator of occurrence of alarms within following time period of detection:
    - .1 Critical - 2 seconds.
    - .2 Warning - 8 seconds.
    - .3 Maintenance - upon operator's request.
  - .6 Display alarm messages in English.
  - .7 Primary alarm message to include as minimum: location of alarm, time of occurrence, type of alarm.
  - .8 System reaction to alarms: Acknowledgement of alarm to change visual indicator from flashing to steady state and to silence audible device. Steady state to remain until alarm condition is corrected but must not impede reporting of new alarm conditions. Notification of any type of alarm not to impede notification of other alarms or operation of controllers or system network. Acknowledgement of one alarm not to be considered as acknowledgement of any other alarms.
  - .9 Controller network alarms: system supervision of controllers and communications lines to provide following alarms as minimum.
    - .1 Controller not responding - where possible delineate between controller and communication line failure.
    - .2 Controller responding - return to normal.
    - .3 Controller communication normal - return to normal.
  - .10 Digital/alarm status to be interrogated every 2 seconds as minimum or be direct interrupting non-polling type. Annunciate each non-expected status with alarm message.
- .5 Scheduling

- .1 Provide a graphical format for simplification of time-of-day scheduling and overrides of building operations. Provide the following graphic schedules as a minimum: - Weekly schedules - Zone schedules - Monthly schedules
- .6 Report Programs
  - .1 General:
    - .1 The OWS to support all special reports for energy management programs, function totalization, analog/pulse totalization and event totalization features available at the Controller level.
    - .2 All reports to include time, day, month, year, report title, operator's initials.
    - .3 Software to provide capability to create, generate and format graphic display of report for printing or temporary/permanent storage. To be able to select and assign points used in such reports. Sort output by Area, System, as minimum, provide for user options for report presentation.
  - .2 Message control:
    - .1 Message and alarm buffering to prevent loss of information.
    - .2 Error detection correction and retransmission to guarantee data integrity.
    - .3 Default device definition to prevent loss of alarms or date, ensure alarms are reported as quickly as possible in event that operator device does not respond.
    - .4 Synchronization of real-time clocks in all control panels.
  - .3 Periodic/automatic report:
    - .1 To generate specified report(s) automatically including options of start time and date, interval between reports (hourly, daily, weekly, monthly), output device. Software to permit modifying periodic/automatic reporting profile at any time.
    - .2 Reports to include:
      - .1 Night cycle summary.
      - .2 Disabled "Locked-out" point summary: include point name, description, whether disabled by system or by operator.
      - .3 Run time summary: summary of accumulated running time of selected equipment. Include point acronym, description, run time to date, alarm limit setting. Run time to accumulate until reset individually by operator.
      - .4 Summary of start/stop schedules: include start/stop times and days, point acronym, description.
      - .5 Motor status summary.
  - .4 Report types:
    - .1 Summary report: printout or display of any database value selected by operator. To indicate status at time of request.
- .7 Trend Data
  - .1 Includes historical, archival, trend points, control loop plots.
  - .2 Make separate from reports.
  - .3 Trend reports: to trend continuously points selected by operator, including at least present value of DI, DO, AI, AO, set points, and calculated values. To trend concurrently at least 40 selectable points per MEC, SEC, ASC at operator-selectable rate 05 seconds to 3600 seconds, individually selected for each point. To permit display or printout of any point individually or in selectable groups. Store trends on 24h basis in temporary storage until point removed from trend program by operator. Provide ability to specify report type, point name, output device, add trend point, delete trend point. Display trend plots on OWS.

- To plot up to 4 selectable points concurrently. Trend data to be available in disk form for use in third party PC applications.
  - .4 Historical data collection: collect concurrently at least 40 operator selectable real or calculated points per controller at operator selectable rate 30-480 minutes, which is individually selectable for each point. Data collection to be continuous, stored in temporary storage until point is removed from program by operator. Temporary storage to have at least 24h capacity. All reports to include time, day, month, year, report title, operator's initials.
- .5 Network Interface Controller (NIC)
- .1 System Description
    - .1 Provide sufficient number of NIC to fully meet all requirements of this specification plus specified spare point capacity.
    - .2 NIC to be stand-alone intelligent controller. NIC panel to:
      - .1 Be microprocessor based, multi-tasking, multi-user, real-time digital control processors capable of supervising other lower level programmable controllers through secondary network.
      - .2 Provide LAN interface for peer-to-peer communication between NIC and at least 2 RS-232C serial data communication ports to support simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, PC workstations and NIC-mounted or portable OTs.
      - .3 Allow temporary use of portable devices without interrupting normal operation of permanently connected modems, printers, OTs.
      - .4 Dial-up Communications:
        - .1 Auto-dial/auto-answer communications to allow NIC to communicate with remote OWS on continuous basis via telephone lines.
        - .2 To analyze and set priorities for all alarms to minimize number of calls. Non-critical alarms to be buffered in memory and reported as group or until operator manually requests upload of alarms.
    - .3 Provide LAN port for local control network if different from NIC-to-NIC LAN.
  - .2 Basic Functional Requirements
    - .1 To include scanning of digital and analog inputs, digital change of state (alarm) monitoring, analog input (alarm) monitoring, on-off digital control with programmable logic (including PID) with adjustable dead bands and deviation alarms, control of HVAC systems as required to meet design intent.
    - .2 Optimization functions such as scheduled start-stop, optimal start, timed setpoint reset must reside at Equipment Controller Level.
  - .3 Graphics
    - .1 Graphics software to permit User to create, modify, delete, file, and recall all graphics as required to provide full graphic interactive interface plus 100% expansion for future capability. This includes multiple layered diagrams for site and building interactions. To permit operator to monitor inputs, start and stop equipment, change setpoints, modify alarm limits, override system functions and points form graphic displays through mouse or similar pointing device.
    - .2 Display particular graphics: provide for manual and/or automatic activation. To include capability to call up and cancel display of graphic picture.
    - .3 Provide library of pre-engineered screens and symbols depicting

- standard air handling components (such as fans, coils, filters, dampers, force flows), complete mechanical system components (such as chillers, boilers, pumps), electrical symbols.
- .4 Graphic development, creation, modification package to use mouse and drawing program to permit user to:
  - .1 Modify portion of graphic picture/schematic background.
  - .2 Delete graphic picture.
  - .3 Call up and cancel display of graphic picture.
  - .4 Define symbols.
  - .5 Position and size symbols.
  - .6 Define background screens.
  - .7 Define connecting lines, curves.
  - .8 Locate, orient, size descriptive text.
  - .9 Define, display colours of all elements.
  - .10 Establish co-relation between symbols or test and associated system points or other graphic displays.
- .5 User to be able to build graphic displays showing on-line point data from multiple control panels. Graphic displays to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, other logical grouping of points which aids operator in analysis of facility. Data to be upgrade every 5 seconds.
- .6 Dynamic data (such as, but not limited to, temperature, humidity, flow, status) to be shown in actual schematical locations, be automatically updated to show current values without operator intervention.
- .7 Windowing environment to allow user to view several graphics simultaneously to permit analysis of building operation, system performance, display of graphic associated with alarm to be viewed without interrupting work in progress.
- .8 Utilize graphics package to building and generate schematic diagrams for building systems and as directed by consultant. Graphics to include but not limited to:
  - .1 Floor plans/graphics that show overridden values in purple and alarms in red.
  - .2 Floor plans graphics displaying units fed from and links to unit's graphics.
  - .3 Floor plans graphics that show controller locations
- .9 Complete directory of system functions, schematics list, other pertinent information. Utilize mouse to "point and click" to activate selected function.
- .4 Environmental Conditions
  - .1 NIC and associated hardware to operate in conditions of 0°C to 44°C and 10% to 90% non-condensing RH.
- .5 Central Processor Unit (CPU)
  - .1 Processor to consist of minimum 16 bit microprocessor capable of supporting all software to meet specified requirements.
  - .2 Minimum addressable memory to be at manufacturer's discretion but to support at least all performance and technical specifications. Memory to include:
    - .1 Non-volatile EPROM to contain all operating system, executive, application, sub-routine, other configurations definition software. Tape media not acceptable.
    - .2 Battery backed RAM 72h or EPROM to eliminate operating data reload in event of power failure RAM to contain all CDLs, application functions, operating data or software that is required to be modifiable from operational standpoint such as schedules,



setpoints, alarm limits, PID constants and CDL and hence modifiable on-line through operator panel or remote operator's interface. RAM to be downline loadable from OWS, or locally installed CD or flash drive.

## 2.6 CONTROLLER LEVEL NETWORK

- .1 Standard Equipment Controller
  - .1 SEC shall be a minimum 10-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
  - .2 Each SEC shall have sufficient memory to support its own operating system and databases, including:
    - .1 Control processes
    - .2 Energy management applications
    - .3 Alarm management applications including custom alarm messages for each level alarm for each point in the system
    - .4 Historical/trend data for points specified
    - .5 Maintenance support applications
    - .6 Custom processes
    - .7 Operator I/O
    - .8 Dial-up communications
  - .3 Each SEC shall support firmware upgrades without the need to replace hardware.
  - .4 SEC shall provide an RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
  - .5 SEC shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
  - .6 SEC shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The SEC shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
  - .7 Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
    - .1 RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6-) at 3V.
    - .2 Electro Static Discharge (ESD) Immunity per EN 61000-4-2(IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
    - .3 Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power.
    - .4 Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)  
Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:
      - .1 IEEE Standard 587-1980.
      - .2 UL 864 Supply Line Transients.
      - .3 Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11).
  - .8 In the event of the loss of normal power, there shall be orderly shutdown of all SEC to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
    - .1 Upon restoration of normal power, the SEC shall automatically resume full operation without manual intervention.
    - .2 Should SEC memory be lost for any reason, the user shall have the

- capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
- .3 Provide a separate SEC for each AHU or other HVAC system. It is intended that each unique system be provided with its own point resident DDC Controller.
- .9 Controller shall communicate schedules, measurable variables, command values and be capable of time clock synchronization all using the BACNET protocol.
- .2 Application Specific Controllers (ASC)
  - .1 Each DDC Controller shall be able to extend its performance and capacity through the use of application specific controllers (ASCs).
  - .2 Each ASC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
    - .1 Controllers shall include all point inputs and outputs necessary to perform the specified control sequences.
    - .2 Each controller shall support its own real-time operating system.
    - .3 All programs shall be customizable to meet the user's exact control strategy requirements. Controllers utilizing canned programs shall be acceptable. Provided it meet the specified sequence of operation in full.
    - .4 Programming of controllers shall utilize the same language and code as used by MEC Controllers to maximize system flexibility and ease of use.
    - .5 Each controller shall have connection provisions for a portable operator's terminal. This tool shall allow the user to display, generate or modify all point databases and operating programs.
  - .3 Application Specific Controllers shall be capable of control of the following equipment, but not limited to, the following:
    - .1 Fan coils
    - .2 Constant Air Volume (CAV) boxes
    - .3 Dual Duct Terminal Boxes
    - .4 Unit Conditioners
    - .5 Heat Pumps
    - .6 Unit Ventilators
    - .7 Room Pressurization
    - .8 Variable Refrigerant Flow Systems
  - .4 Controllers shall include all points inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10V, allowing for interface to a variety of modulating actuators.
  - .5 All controller sequences and operation shall provide closed loop control of the intended application.
  - .6 Acceptable material: Controller shall communicate schedules. Measured variables. Command values and capable of time clock synchronization all using the BACNET protocol.

## 2.7 EMCS: FIELD CONTROL DEVICES

- .1 General
  - .1 Control devices of each category to be of same type of manufacturer.
  - .2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight, shockproof, vibration-proof, heat resistant assembly.
  - .3 Operating conditions: 0-44°C with 10-90% RH (non-condensing) for indoor equipment and -40 to +60°C with 10-90% RH non-condensing for outdoor equipment unless otherwise specified.

- .4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.
- .5 Transmitters to be unaffected by external transmitters (e.g. walkie talkies).
- .6 Account for hysteresis, relaxation time, maximum and minimum limits in all applications of sensors and controls.
- .2 Temperature Sensors
  - .1 General: except for space temperature sensors, temperature sensors are to be resistance or thermocouple type to following requirements:
    - .1 Thermocouples: to be limited to temperature range of 200°C and over.
    - .2 RTD's: 1000 ohm at 0°C (plus or minus 0.2 ohms) platinum element with strain minimizing construction, 3 integral anchored leadwires. Coefficient of resistivity: 0.00385 ohms/ohm C.
    - .3 Sensing element: hermetically sealed.
    - .4 Stem and tip construction: copper or type 304 stainless steel.
    - .5 Time constant response: less than 3 seconds to temperature change of 10°C.
    - .6 Immersion wells: NPS 3/4, stainless steel spring loaded construction, with heat transfer compound compatible with sensor. Insertion length to equal 1/3 of the pipe diameter.
  - .2 Sensors:
    - .1 Room Type Temperature:
      - .1 Wall mounted, white ABS plastic covers, with guard where indicated on drawings. Provide digital display, occupancy override push button and setpoint adjustment on temperature sensors. Locations as noted in drawings and documents. Sensors to be equipped with plug in connection for access to the DDC network by the portable operator terminal. (Plug-in connection not to be wired). Sensor to have software limitation of setpoint capability.
      - .2 Temperature Operating Range: 5°C to 40°C.
      - .3 Temperature Sensing Element: 10KΩ NTC Thermistor.
      - .4 Temperature Accuracy: ±0.5°C.
      - .5 Temperature Resolution: 0.1°C.
      - .6 Daisy-Chaining capability.
      - .7 Standard of Acceptance: Distech Controls Allure EC-Smart-View-Sensor.
      - .8 Corridors, washrooms, and vestibules shall be flat plate type temperature sensor.
        - .1 Standard of Acceptance: Greystone TE200AS7.
      - .9 Gymnasium shall be flat plate type temperature sensor c/w pushbutton.
        - .1 Standard of Acceptance: Greystone TE200AS7GB.
    - .2 General purpose duct type: suitable for insertion into ducts at any angle, insertion length to be 2/3 of duct width.
      - .1 Standard of Acceptance: T.A.C. Balco model TS-8201.
    - .3 Averaging duct type: continuous filament with minimum immersion length 6000 mm. Bend probe at field installation time to 100 mm radius at any point along probe without degradation of performance.
    - .4 Outside air type: Combination outdoor temperature and humidity sensor complete with solar radiation shield. Mount device in easily accessible location for maintenance and well away from any exhaust openings. Acceptable Material: Vaisala model HMS112.
- .3 Temperature Transmitters
  - .1 To following requirements:

- .1 Input circuit: to accept 3-lead, 100ohm at 0°C, platinum resistance detectors type sensors.
  - .2 Power supply: 575 ohms at 24V DC into load of 575 ohms. Power supply effect less than 0.01°C per volt change.
  - .3 Output signal: 4-20 mA into 500 ohm maximum load.
  - .4 Input and output short circuit and open circuit protection.
  - .5 Output variation: less than 0.2% of full scale for supply voltage variation of plus or minus 10%.
  - .6 Combined non-linearity, repeatability, hysteresis effects: not to exceed plus or minus 0.5% of full scale output.
  - .7 Maximum current to 100 ohm RTD sensor: not to exceed 25 mA.
  - .8 Integral zero and span adjustments.
  - .9 Temperature effects: not to exceed plus or minus 1.0% of full scale/50°C.
  - .10 Long term output drift: not to exceed 0.25% of full scale/6 months.
  - .11 Transmitter ranges: Select narrowest range to suit application from following:
    - .1 Minus 50°C to plus 50°C, plus or minus 0.5°C.
    - .2 0 to 100°C, plus or minus 0.5°C.
    - .3 0 to 50°C, plus or minus 0.25°C.
    - .4 0 to 25°C, plus or minus 0.1°C.
    - .5 10 to 35°C, plus or minus 0.25°C.
- .4 Temperature Switches
- .1 To following requirements:
    - .1 Range: To suit system requirements.
    - .2 Temperature sensor: liquid, vapour or bimetallic type. Operate automatically. Reset automatically, except as follows:
      - .1 Freeze protection: manual reset. Optional if software does not auto restart.
      - .2 Fire detection: manual reset. Optional if software does not auto restart.
    - .3 Adjustable setpoint and differential.
    - .4 Accuracy: plus or minus 1°C.
    - .5 Snap action rating: 120V, 15 amps or 24V DC as required.
    - .6 Type as follows:
      - .1 Duct, general purpose: insertion length = 460mm.
      - .2 Thermowell: stainless steel, with compression fitting for NPS 3/4 thermowell. Immersion length: 100mm.
      - .3 Freeze detection: continuous element with 6000mm insertion length, duct mounting, to detect coldest temperature in any 30mm length.
      - .4 Strap-on: with helical screw stainless steel clamp.
- .5 Differential Pressure Transmitters
- .1 To following requirements:
    - .1 Internal materials: suitable for continuous contact with ventilation air, water, glycol as applicable.
    - .2 Output signal: 4-20mA into 500 ohm maximum load.
    - .3 Output variations: less than 0.2% full scale for supply voltage variations of plus or minus 10%.
    - .4 Combined non-linearity, repeatability, and hysteresis effects: not to exceed plus or minus 0.5% of full scale output over entire range.
    - .5 Integral zero and span adjustment.
    - .6 Temperature effects: not to exceed plus or minus 1.5% full scale/50°C.
    - .7 Over-pressure input protection to at least twice rated input pressure.
    - .8 Output short circuit and open circuit protection.

- .9 Pressure ranges: to meet system requirements.
- .6 Pressure and Differential Pressure Sensors and Switches:
  - .1 General:
    - .1 Range: to suit system requirements.
      - .1 Pressure sensing elements: bourdon tube, bellows or diaphragm type.
      - .2 Switches to following requirements:
      - .3 Adjustable setpoint and differential.
        - .1 Switch: snap action type, rated to suit electrical equipment.
        - .2 Sensor assembly: to operate automatically and reset automatically when conditions return to normal.
      - .4 Sensor pressure and accuracy ratings:
        - .1 Chilled and condenser water: 860 kPa.
        - .2 Hot water: 860 kPa. Accuracy: plus or minus 14 kPa.
        - .3 High temperature water: 2700 kPa. Range: 0-2700 kPa. Accuracy: plus or minus 25 kPa.
        - .4 For fan operation: Range: 0 to 3000 Pa. Adjustable differential: 10 to 300 Pa.
      - .5 Provide sensors with isolation valve and snubber between sensor and pressure source.
      - .6 Sensors on steam and high temperature hot water service: provide pigtail syphon.
- .7 Combination Temperature, Humidity, and CO2 Sensor:
  - .1 Temperature Operating Range: 5°C to 40°C.
  - .2 Temperature Sensing Element: 10KΩ NTC Thermistor.
  - .3 Temperature Accuracy: ±0.5°C.
  - .4 Temperature Resolution: 0.1°C.
  - .5 CO2 Measurement Range: 0 to 2000 ppm.
  - .6 CO2 Accuracy: 400-1250 ppm ± 30 ppm or 3% of reading, whichever is greater.
  - .7 CO2 Sensing Method: Non-dispersive infrared (DNIR) absorption gold plated optics.
  - .8 CO2 Sensor Stability: <2% of FS over life of sensor.
  - .9 Humidity Accuracy: +/- 3%
  - .10 Humidity Resolution: 1%
  - .11 Daisy-Chaining capability.
  - .12 Standard of Acceptance: Distech-Controls Allure EC-Smart-Vue-CH Sensor.
- .8 Combination Temperature, and CO2 Sensor:
  - .1 Temperature Operating Range: 5°C to 40°C.
  - .2 Temperature Sensing Element: 10KΩ NTC Thermistor.
  - .3 Temperature Accuracy: ±0.5°C.
  - .4 Temperature Resolution: 0.1°C.
  - .5 CO2 Measurement Range: 0 to 2000 ppm.
  - .6 CO2 Accuracy: 400-1250 ppm ± 30 ppm or 3% of reading, whichever is greater.
  - .7 CO2 Sensing Method: Non-dispersive infrared (DNIR) absorption gold plated optics.
  - .8 CO2 Sensor Stability: <2% of FS over life of sensor.
  - .9 Daisy-Chaining capability.
  - .10 Standard of Acceptance: Distech-Controls Allure EC-Smart-Vue-C Sensor.
- .9 CO2 duct mount sensor:
  - .1 Measurement Range: 0-2000 PPM factory calibrated.
  - .2 Duct Air Velocity: 0 to 1500 ft/min (0 to 450 meter/min.).

- .3 Temp Dependence: 0.2% of full scale per °C.
- .4 Stability: <2% of full scale over the life of the sensor (15 years typical).
- .5 Accuracy: ±40 ppm +3% of reading @ 22°C (72°F) when compared with a factory certified reference.
- .6 Non-linearity: <1% of full scale @ 22°C (72°F).
- .7 Pressure Dependence: 0.13% of reading per mm of mercury.
- .8 Sampling Rate: Every two seconds, 25% duty cycle.
- .9 Warm-up Time: <two minutes (operational); 10 minutes to achieve maximum accuracy.
- .10 Operating Conditions:
  - .1 Temperature: 0°C to 50°C (32°F to 122°F).
  - .2 Humidity: 0 to 95% relative humidity, non-condensing.
- .11 Storage Conditions: -20°C to 70°C (-40°F to 158°F).
- .12 Output: Analog 0 to 10 VDC (100 ohm output impedance).
- .13 Power Supply Requirements: 18 to 30 VAC RMS, 50/60 Hz or 18 to 42 VDC, polarity protected.
- .14 Power Consumption: Typical values (1.65 watts peak, 0.65 watts avg. @ 42 VDC).
- .15 Acceptable material: TelAir Duct Probe Sensor transmitter model T8041.
- .10 Electrical Relays
  - .1 To following requirements:
  - .2 Double voltage, DPDT, plug-in type with termination base.
  - .3 Coils: rated for 120V AC or 24V AC as dictated by electrical control diagrams. Other voltage: provide transformer.
  - .4 Contacts: rated at 5 amps at 120V AC.
- .11 Endswitch
  - .1 Operating temperature: -40°C to 100°C.
  - .2 Switch & contacts electrically rated to handle equipment connecting to it. Coordinate with equipment supplier.
- .12 Electronic Control Damper Operators
  - .1 To following requirements:
    - .1 Direct Coupled or push pull as required.
    - .2 Spring return for "fail-safe" in Normally Open or Normally Closed position as indicated.
    - .3 Operator: size so as to control dampers against maximum pressure or dynamic closing pressure (whichever is greater).
    - .4 Power requirements: 5VA maximum at 120 VAC.
    - .5 Acceptable materials: Belimo Direct coupled, Brushless, sensorless DC motor type c/w endswitch.
- .13 Panels
  - .1 Either free-standing or wall mounted enamelled steel cabinets with hinged and key-locked front door.
  - .2 To be modular multiple panels as required indicated to handle all requirements with space to accommodate additional capacity (to be approved by Consultant without adding additional cabinets).
  - .3 All panels to be lockable and keyed alike.
  - .4 Mount on 1½" x 1½" 12 gauge c-channel framing brackets where required and where shown on drawing.
  - .5 Where panels locations are not against a wall-construct a c-channel support framing member from floor to ceiling, and securely fasten framing members and panels to support structure.
- .14 Sensor & thermostat guard: Wall sensors to use wire guards model STI9620 from Safety

Technology International, where larger guards are required use white Rodgers model F29-0198. Sensor & thermostat guards to have tamper resist tumbler lock and 2 keys. All locks to be keyed alike for this project.

- .15 Current transducer:
  - .1 Provide current sensing transducer for status monitoring of all fans and pumps as required in these drawings and specifications.
  - .2 Current sensors shall be as follows:
    - .1 Selectable Range: 1-200 Amps.
    - .2 Temp. Range: -15° to 60°C.
    - .3 Humidity Range: 10-90% RH non-condensing.
    - .4 0-5 VDC output.
- .16 Metal pushbutton switch:
  - .1 Standards Reference: IEC EN 60947\_5\_1, CSA C22-2 n.14.
  - .2 Enclosure Material: Zn + Al + Mg alloy, chromium plated.
  - .3 Contacts Material: Silver.
  - .4 Mechanical Life: Pushbuttons, switches: 1,000,000 operations.
  - .5 Electrical:
    - .1 Rated Insulation Voltage: Ui 660V according to CEI EN 60947-5-1, 300V according to CSA C22-2 n.14 and UL 508.
    - .2 Dielectric Strength: 3KV (1 second).
    - .3 Insulation Resistance: 2Mohm min. (500V DC).
    - .4 Connections: Single screw with non-loosening plate clamp, 14AWG max.
    - .5 Contacts Operation: Self-cleaning types EN01 (N.C.) EN 10 (N.O.) slow action, positive opening.
    - .6 Operation Frequency: 3600 operations per hour max.
- .17 Pulse Water Meter:
  - .1 Provide as shown on the drawing for ¾ to 2" pipe size, a pulse water meter using the multi jet principle complete with gear train, register totalizer dials and pulse output sensor. Sensor to be a reed switch. Meter to read in US gallons.
    - .1 Temperature: 105°F (40°C) max.
    - .2 Pressure: 150 psi operating.
    - .3 Materials:
      - .1 Body: Cast bronze.
      - .2 Internals: Engineered thermoplastic.
      - .3 Magnet: Alnico.
    - .4 Accuracy: ±1.5% of reading.
    - .5 Pulse sensor:
      - .1 Sensor MJNR, Reed switch.
      - .2 Maximum Current 20 mA.
      - .3 Maximum Voltage 24 Vdc or Vac.
    - .6 Cable Length: 12' (4m) standard (2000' maximum run).
    - .7 Flow Rates (GPM): up to 2" Pulse meter (Potable water System)
      - .1 Minimum 1.98.
      - .2 Maximum 132.
    - .8 Acceptable Material: Seametrics model MJNR NSF 61 listed. Size to suit existing line size 4 pulse/gal preferred.
- .18 Power Phase Monitoring:
  - .1 Power phase monitor provided by Div. 26. (Electrical), EMCS to connect via BACnet and monitor the following: Voltage, Amperage, kilowatt hours.
- .19 Flush valve solenoid: Asco solenoid valve 8210G094LF controlled by EMCS to be:
  - .1 Body: Lead-Free Brass.

- .2 Seals and discs: PTFE.
- .3 Disc-holder: PA.
- .4 Core tube: 305 stainless steel.
- .5 Core and plugnut: 430F stainless steel.
- .6 Springs: 302 stainless steel.
- .7 Shading Coil: Copper.
- .8 Voltage: 24VAC.

## 2.8 SEC RESIDENT SOFTWARE FEATURES

- .1 General:
  - .1 The software programs specified in this Section shall be provided as an integral part of SEC and shall not be dependent upon any higher level computer for execution.
  - .2 All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
  - .3 All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)).
- .2 Control Software Description:
  - .1 The SEC shall have the ability to perform the following pre-tested control algorithms:
    - .1 Two-position control
    - .2 Proportional control
    - .3 Proportional plus integral control
    - .4 Automatic tuning of control loops
- .3 SEC shall provide where indicated the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.
  - .1 Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy.
    - .1 The SSTO program shall operate in both the heating and cooling seasons.
      - .1 It shall be possible to apply the SSTO program to individual fan systems.
      - .2 The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
    - .2 The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.
  - .2 Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
    - .1 It shall be possible to individually command a point or group of points.
    - .2 For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
    - .3 The operator shall be able to define the following information:
      - .1 Time, day
      - .2 Commands such as on, off, auto, and so forth
      - .3 Time delays between successive commands
      - .4 There shall be provisions for manual overriding of each schedule by an appropriate operator



- .4 It shall be possible to schedule events up to one year in advance.
  - .1 Scheduling shall be calendar based.
  - .2 Holidays shall allow for different schedules. A
- .3 Enthalpy switchover (economizer). The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
- .4 Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
- .5 Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.
- .4 SEC shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
  - .1 A single process shall be able to incorporate measured or calculated data from any and all other SEC Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other SEC on the network. Database shall support 30 character, English language point names, structured for searching and logs.
  - .2 Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
  - .3 SEC shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
  - .4 SEC shall be capable of comment lines for sequence of operation explanation.
- .5 Alarm management shall be provided to monitor and direct alarm information to operator devices. Each SEC shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the SEC ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
  - .1 All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
  - .2 The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each SEC shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
  - .3 Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hours destinations) or based on priority.
  - .4 In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator sequence.
  - .5 In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.
- .6 A variety of historical data collection utilities shall be provided to manually or

automatically sample, store and display system data for points as specified in the I/O summary.

- .1 Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each SEC point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each SEC shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 2000 data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
- .2 SEC shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
  - .1 Loop tuning shall be capable of being initiated either locally at the SEC, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.
- .7 SEC shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
- .8 The peer to peer network shall allow the SEC to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.

## **Part 3 Execution**

### **3.1 GENERAL**

- .1 Install systems and related controls using factory trained specialist in accordance with manufacturer's instructions and/or as indicated.
- .2 Install all equipment, components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.
- .3 Install all special supports as required and as indicated.

### **3.2 REFERENCES**

- .1 CSA C22.1 Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

### **3.3 PROJECT MANAGEMENT**

- .1 Provide a designated project manager who will be responsible for the following:
  - .1 Construct and maintain project schedule
  - .2 On-site coordination with all applicable trades and subcontractors
  - .3 Authorized to accept and execute orders or instructions from owner/consultant
  - .4 Attend project meetings as necessary to avoid conflicts and delays
  - .5 Make necessary field decisions relating to this scope of work

- .6 Coordination/Single point of contact

### 3.4 INSTALLATION

- .1 General
- .1 Install all field control devices in accordance with manufacturers recommended methods, procedures and instructions.
- .2 Temperature transmitters, humidity transmitters, transducers solenoid air valves, controllers, relays: install in NEMA 1 enclosure or as required for specific applications. Provide for electrolytic isolation in all cases when dissimilar metals make contact.
- .3 Support field-mounted transmitters, control panels sensors on channel brackets.
- .4 Install all wall mounted devices on plywood panel properly attached to wall.
- .5 Provide identification for all control items.
- .6 Submit for approval samples of nameplates, identification tags and list of proposed wording.
- .7 Nameplates for Panels
- .1 Identify faces with laminated plastic nameplates.
- .2 Sizes: 25 x 67mm minimum.
- .3 Lettering: 7mm minimum high, black.
- .4 Inscriptions: machine engraved to identify function and, where applicable, fail-safe position.
- .5 Nameplates: plastic laminate, 3mm thick Melamine, matt white finish, black core, square corners, lettering accurately aligned and engraved into core.
- .8 Field Devices
- .1 Identify by plastic encased cards attached by chain.
- .2 Sizes: 50 x 100mm minimum.
- .3 Lettering: 5mm minimum high produced from laser printer in black.
- .4 Data to include: point name, schematic designation number, model, probe/capillary length, size, range, set point, other pertinent data, function, fail-safe position.
- .5 Companion cabinet: identify interior components using plastic enclosed cards.
- .9 Room Sensors
- .1 Interior: identify by stick-on labels.
- .2 Sizes: to suit.
- .3 Lettering: to suit. Clearly legible.
- .10 Warning Signs
- .1 Equipment (e.g. motors, starters) under remote automatic control, provide orange coloured signs warning of automatic starting under control of EMCS (e.g. "Caution: This equipment is under automatic remote control of EMCS").
- .11 Wiring
- .1 Numbered tape markings with label indicating panel & point name where applicable on all wiring at panels, junction boxes, splitters, cabinets, outlet boxes and devices.
- .2 Colour coding: use colour coded wiring. **Controls wire jacketing to be orange in colour.**
- .3 Power wiring: identify at each panel.
- .4 **All wiring within hallways to be run in the cable tray system where available. Wiring to extend from wall tray to devices shall be neatly bundled and secured. In hallways with no available cable tray system, provide j-hooks at intervals not greater than 1.5 meters. J-Hooks to be secured off open web steel joists or building structure. DO NOT SECURE TO ROOF SLAB OR STEEL DECK. Do**

- not fasten to t-bar pencil rod. Wiring to be installed in conduit when passing through walls to devices.**
- .5 Cables to be grouped together using Velcro straps, no zip ties
  - .12 Conduit
    - .1 **Colour code all EMCS conduit.** Refer to Division 26 (Electrical) for conduit, boxes, connectors, wiring & colour coding.
    - .2 Locate coding on all conduits, exposed and concealed in all locations including removable suspended ceilings, tunnels, shafts, on both sides of walls, floors, etc, and at 15m intervals.
    - .3 All exposed wiring within finished spaces and all wiring within block or concrete walls shall be in conduit. Conduit to be installed in walls where devices are to be located.
  - .13 Manufacturer's Nameplates, CSA Labels
    - .1 To be visible and legible at all times.
  - .14 Equipment and device locations shall be selected to permit access to entire assembly.
  - .2 Temperature and Humidity Sensors
    - .1 Stabilize to ensure minimum field adjustments or calibrations.
    - .2 To be readily accessible and adaptable to each type of application so as to allow for quick easy replacement and servicing without special tools or skills.
    - .3 Outdoor installation:
      - .1 Protect from solar radiation and wind effects and student access by stainless steel shields.
      - .2 Install in EEMAC3 enclosures.
    - .4 Duct installations:
      - .1 Do not mount in dead air space.
      - .2 Location to be within sensor vibration and velocity limits.
      - .3 Securely mount extended surface sensor used to sense average temperature.
      - .4 Thermally isolate elements from brackets and supports so as to respond to air temperature only.
      - .5 Support sensor element separately from coils, filter racks.
    - .5 Averaging duct type temperature sensors:
      - .1 Sensor length to be not less than 1000mm for each square metre of duct cross-sectional area.
      - .2 Use multiple sensors where single sensor does not meet minimum length ratio. Wire multiple sensors in parallel for freeze protection applications.
      - .3 Wire multiple sensors separately for temperature measurement.
      - .4 Use either software averaging algorithm to derive overall average for control purposes or separate inputs, based on site requirements.
    - .6 Thermowells: install for all piping installations. Where pipe diameter is less than well insertion length, locate well in elbow. Thermowell to restrict flow by less than 30%.
    - .7 Room sensors shall not be located behind doors, shelving, above photocopiers or heat producing equipment and shall be placed on a diagonal to diffusers within loft. Where there is conflict contractor shall consult with Engineer and Owner before installation.
  - .3 Panels
    - .1 Arrange for conduit and tubing entry from bottom or either side.
    - .2 Use modular multiple panels if necessary to handle all requirements, with space for additional 25% DDC Controllers or Field Devices if applicable without adding additional panels. Space to accommodate maximum capacity of associated controller.

- .3 Wiring within panels: locate in trays or individually clipped to back of panel.
- .4 Identify all wiring and conduit clearly.
- .4 Magnehelic Pressure Indicators
  - .1 Install adjacent to each fan system static pressure sensor and duct system velocity pressure sensors (as approved by the Consultant).
  - .2 Locations to be as indicated or specified.
- .5 Pressure and Differential Pressure Switches
  - .1 Install isolation valve and snubber on all sensors between and pressure source. In addition, protect sensing elements on steam and high temperature hot water service with pigtail syphon between valve and sensor.
- .6 Field Mounted Transmitters and Sensors
  - .1 Support properly on channel brackets.
  - .2 Install wall mounted devices on plywood panel attached properly to wall.
- .7 Identification
  - .1 Identify all field devices properly.
  - .2 Refer to Identification.
- .8 Air Flow Measuring Stations
  - .1 Cap manifold until cleaning of ducts is completed. Install as per manufacturer's recommendations.
- .9 Electrical General
  - .1 Do complete installation in accordance with requirements of:
    - .1 Division 26 (Electrical), this specification.
    - .2 Electrical safety Code of Province having jurisdiction.
    - .3 ANSI/NFPA 70.
    - .4 ANSI C2.
  - .2 Fully enclose or properly guard electrical wiring, terminal blocks, all high voltage above 70V contacts and mark to prevent accidental injury.
  - .3 Do underground installation to CAN/CSA C22.3 No.1, except where otherwise specified.
  - .4 Conform to all manufacturer's recommendations for storage, handling and installation.
  - .5 Check all factory connections and joints. Tighten where necessary to ensure continuity.
  - .6 Install electrical equipment between 1000 and 2000mm above finished floor wherever possible and adjacent to related equipment.
  - .7 Protect exposed live equipment such as panel, mains, outlet wiring during construction for personnel safety.
  - .8 Shield and mark all live parts "LIVE 120 VOLTS" or other appropriate voltage.
  - .9 Install conduits, sleeves, etc. prior to pouring of concrete.
  - .10 Holes through exterior wall and roofs: flash and make weatherproof.
  - .11 Make all necessary arrangements for cutting of chases, drilling holes and other structural work required to install electrical conduit, cable, pull boxes, outlet boxes.
  - .12 Install all cables, conduits and fittings which are to be embedded or plastered over, neatly and closely to building structure to minimize furring.
- .10 Conduit System
  - .1 All exposed wiring within finished spaces and all wiring within block or concrete walls shall be in conduit.
  - .2 Conduit sizes to suit wiring requirements and to allow for **25%** future expansion

- capabilities. Drawings do not show conduits.
- .3 Install conduits parallel or perpendicular to building lines, to conserve headroom and to minimize interference.
- .4 Do not run exposed conduits in normally occupied spaces unless otherwise indicated or unless impossible to do otherwise. Obtain approval from Consultant and Owner before starting such work. Conduit size to match conductors plus future expansion capabilities as specified. Total not to exceed 40% fill.
- .5 Locate conduits at least 150mm from parallel steam or hot water pipes and at least 50mm at crossovers.
- .6 Bend all conduit so that diameter is reduced by less than 1/10th original diameter.
- .7 Field thread on rigid conduit to be of sufficient length to draw conduits up tight.
- .8 Limit conduit length between pull boxes to less than 30m.
- .9 Use conduit outlet boxes for conduit up to 32mm diameter and pull boxes for larger sizes.
- .10 Fastenings and supports for conduits, cables, equipment, etc:
  - .1 Provide metal brackets, frames, hangers, clamps and related types of support structures as indicated and as required to support cable and conduit runs.
  - .2 Provide adequate support for raceways and cables, sloped vertically to equipment.
  - .3 Use supports or equipment installed by other trades for conduit, cable and raceway supports only after written approval from Consultant/Consultant.
- .11 Install polypropylene fish cord in empty conduits for future use.
- .12 Where conduits become blocked, remove and replace blocked sections.
- .13 Pre-paint all coupling, pull and junction boxes orange prior to installation.
- .14 Pass conduits through structural members only after receipt of written approval.
- .15 Conduits may be run in flanged portion of structural steel.
- .16 Group conduits wherever possible on suspended or surface channels.
- .17 Pull boxes:
  - .1 Install in inconspicuous but accessible locations.
  - .2 Support boxes independently of connecting conduits.
  - .3 Fill boxes with paper or foam to prevent entry of construction material.
  - .4 Provide correct size of openings. Reducing washers not permitted.
  - .5 Mark location of pull boxes on record drawings.
- .18 Install terminal blocks or strips indicated in cabinets to Section 26.
- .11 Wiring
  - .1 Do not install in ducts.
  - .2 Do not pull spliced wiring inside conduits or ducts.
  - .3 Use CSA certified lubricants of type compatible with insulation to reduce pulling tension.
  - .4 Tests: use only qualified personnel. Demonstrate that:
    - .1 All circuits are continuous, free from shorts, unspecified grounds.
    - .2 Resistance to ground of all circuits is greater than 50 Megohms.
  - .5 Provide Owner/Consultant with test results showing locations, circuits, results of tests.
  - .6 Remove insulation carefully from ends of conductors and install to manufacturer's recommendations. Accommodate all strands in lugs. Where insulation is stripped in excess, neatly tape so that only lug remains exposed.
  - .7 Wiring in main junction boxes and pull boxes to terminate on terminal blocks only, clearly and permanently identified. Junctions or splices not permitted for sensing or control signal covering wiring.
  - .8 Do not allow wiring to come into direct physical contact with compression screw.
  - .9 Install ALL strands of conductor in lugs of components. Strip insulation only to

- extent necessary for installation.
- .10 All wiring entering motor starters or contactors, etc..., to current sensing relays or other status inputs as well as output for stops or start sequencing to be rated at least equal to the operating voltage of the electrical equipment.
- .11 Cables to be grouped together using Velcro straps, no zip ties.
- .12 Wiring Devices, Cover Plates
  - .1 Receptacles within control panels:
    - .1 Install vertically in gang type outlet box when more than one receptacle is required in one location.
  - .2 Coverplates:
    - .1 Install suitable common coverplate where wiring devices are grouped.
    - .2 Use flush type coverplates only on flush type outlet boxes.
- .13 Starters, Control Devices
  - .1 Install and make power and control connections as indicated.
  - .2 Install correct over-current devices.
  - .3 Identify each wire, terminal for external connections with permanent number marking identical to diagram.
  - .4 Performance Verification:
    - .1 Operate switches and controls to verify functioning.
    - .2 Perform start and stop sequences of contactors and relays.
    - .3 Check that interlock sequences, with other separate related starters, equipment and auxiliary control devices, operate as specified.
- .14 Grounding
  - .1 Install complete, permanent, continuous grounding system for equipment, including conductors, connectors and accessories.
  - .2 Install all separate grounding conductors in conduit within building.
  - .3 Install ground wire in all PVC ducts and in all tunnel conduit systems.
  - .4 Tests: perform ground continuity and resistance tests, using approved method appropriate to site conditions.

### 3.5 EMCS: START-UP AND CHECK-OUT

- .1 Definitions
  - .1 AEL: ratio between total test period less any system downtime accumulate within that period and test period.
  - .2 Downtime: results whenever EMCS is unable to fulfill all required functions due to malfunction. Downtime measured by intervals in test period between time that Contractor is notified of failure and time system is restored to proper operating condition. Downtime not to include following:
    - .1 Outage of main power supply in excess of back-up power sources, provided that:
      - .1 Automatic initiation of back-up was accomplished.
      - .2 Automatic shut-down and re-start of components was as specified.
    - .2 Failure of communications link, provided that:
      - .1 Controller automatically and correctly operated in stand-alone mode.
      - .2 Failure was not due to failure of any specified EMCS equipment.
      - .3 Failure of existing equipment.
      - .4 Functional failure resulting from individual sensor or controller provided that:
        - .1 System recorded said fault.

- .2 Equipment defaulted to fail-safe mode.
- .3 AEL of total of all sensors and controllers is at least 99% during test period.

.2 Acronyms

.1 Acronyms used in this section include:

AI	Analog Input
AO	Analog Output
AEL	Average Effectiveness Level
CDL	Control Description Logic
DI	Digital Input
DO	Digital Output
DP	Differential Pressure
EMCS	Energy Monitoring & Control System
MEC	Modular Equipment Controller
OWS	Operator's Work Station
PCU	Programmable Control Unit
SEC	Standard Equipment Controller
SP	Static Pressure
VAV	Variable Air Volume

.3 General

.1 Work includes:

- .1 Start-up testing and verification of all systems.
- .2 Check out demonstration of proper operation of all components.
- .3 On-site operational tests.
- .2 Perform work under direction of, and in presence of, Consultant/Consultant and EMCS Commissioning Contractor.
- .3 Provide all test equipment, two-way radios.
- .4 Independent testing laboratory to certify all test equipment as accurate to within approved tolerances no later than 2 months prior to tests.
- .5 Inform, and obtain approval from, Consultant/Consultant in writing at least 14 days prior to each test. Indicate:
  - .1 Location and part of system to be tested.
  - .2 Testing procedures, anticipated results.
  - .3 Names of testing personnel.
- .6 Co-ordinate with all other trades.
- .7 Correct deficiencies, re-test in presence of Consultant/Consultant until satisfactory performance is obtained.
- .8 Acceptance of tests will not relieve Contractor from responsibility for ensuring that complete systems meet every requirement of Contract.
- .9 Load system with project software.
- .10 Perform tests as required.
- .11 When installation of the system is complete, calibrate equipment and verify transmission media operation before the system is placed on-line. All testing, calibrating, adjusting and final field tests shall be completed by the manufacturer. Verify that all system are operable from local controls in the specified failure mode upon panel failure or loss of power.
- .12 Provide any recommendation for system modification in writing to consultant. Do not make any system modification, including operating parameters and control settings, without prior approval of consultant.
- .13 Install and debug software packages.

.4 Completion Tests

- .1 General: test after installation of each part of system and after completion of mechanical and electrical hook-ups, to verify correct installation and functioning.



- .2 Include following activities:
    - .1 Test and calibrate all field hardware including stand-alone capability of each controller.
    - .2 Verify each A-to-D convertor.
    - .3 Test and calibrate each AI using calibrated digital instruments.
    - .4 Test each DI to ensure proper settings and switching contacts.
    - .5 Test each DO to ensure proper operation and lag time.
    - .6 Test each AO to ensure proper operation of controlled devices. Verify tight closure and signals.
    - .7 Test all operating software.
    - .8 Test all application software. Provide samples of all logs and commands.
    - .9 Verify each CDL including energy optimization programs.
    - .10 Debug all software.
    - .11 Blow out flow measuring and static pressure stations with high pressure air at 700 kPa.
  - .5 Final Startup/Check-out Tests
    - .1 Upon satisfactory completion of all tests, perform point-by-point test of entire system under direction of EMCS Commissioning Contractor.
    - .2 Detailed daily schedule showing items to be tested and personnel available.
    - .3 Key document for recording all procedures to be listing of system database, including keyname, English description, point type and address, engineering units, low and high limits. Include space on listing for remarks and signatures of commissioning technician.
  - .6 Final Operational Acceptance Tests
    - .1 Purpose: to demonstrate that EMCS functions in accordance with all contract requirements.
    - .2 Test to last at least 30 consecutive 24 hour days.
    - .3 Tests to include:
      - .1 Demonstration of correct operation of all monitored and controlled points.
      - .2 Operation and capabilities of all sequences, reports, special control algorithms, diagnostics, software.
    - .4 System is accepted if:
      - .1 Equipment operates at AEL of at least 99% for test period.
      - .2 All other requirements of Contract have been met.
    - .5 In event of failure to attain specified AEL during test period, extend test period on day-to-day basis until specified AEL is attained for test period.
    - .6 Correct all defects when they occur and before resuming tests.
  - .7 Commissioning
    - .1 In accordance with this section.
-

### 3.6 COMMISSIONING, TESTING AND ACCEPTANCE

- .1 Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets which shall be submitted prior to acceptance testing. Commissioning work which requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required. The commissioning must be coordinated with the owner and construction manager to ensure systems are available when needed. Notify the operating personnel in writing of the testing schedule so that authorized personnel from the owner and construction manager are present throughout the commissioning procedure.
  - .1 Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning to include, but not be limited to:
    - .1 Sensor accuracy at 10, 50 and 90% of range.
    - .2 Sensor range.
    - .3 Verify analog limit and binary alarm reporting.
    - .4 Point value reporting.
    - .5 Binary alarm and switch settings.
    - .6 Actuator ranges.
    - .7 Fail safe operation on loss of control signal, electric power, network communications.
- .2 After control devices have been commissioned (i.e. calibrated, tested and signed off), each EMCS program shall be put on line and commissioned. The contractor shall, in the presence of the Owners and Consultant, demonstrate each programmed sequence of operation and compare the results in writing. In addition, each control loop shall be tested to verify proper response and stable control, within specified accuracies. System program test results shall be recorded on commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified and retested.
- .3 After all EMCS programs have been commissioned, the contractor shall verify the overall system performance as specified. Tests shall include, but not be limited to:
  - .1 Data communication, both normal and failure modes.
  - .2 Fully loaded system response time.
  - .3 Impact of component failures on system performance and system operation.
  - .4 Time/Date changes.
  - .5 End of month/end of year operation.
  - .6 Season changeover.
  - .7 Global application programs and point sharing.
  - .8 System backup and reloading.
  - .9 System status displays.
  - .10 Diagnostic functions.
  - .11 Power failure routines.
  - .12 Battery backup.
  - .13 Smoke Control, stair pressurization, stair, vents, in concert with Fire Alarm System testing.
  - .14 Testing of all electrical and HVAC systems with other division of work.
- .4 Submit for approval, a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracies and the system performance does not degrade over time.

- .5 Using the commissioning test data sheets, the contractor shall demonstrate each point. The contractor shall also demonstrate all system functions. The contractor shall demonstrate all points and system functions until all devices and functions meet specification.

**END OF SECTION**

## **Part 1 General**

### **1.1 REFERENCES**

- .1 Canadian Standards Association (CSA).
  - .1 CSA B242, Groove and Shoulder Type Mechanical Pipe Couplings.
  - .2 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
  - .3 CSA W47.1S1, Supplement No.1-M1989 to W47.1-09, Certification of Companies for Fusion Welding of Steel Structures.
- .2 American National Standards Institute (ANSI).
  - .1 ANSI/ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125 and 250.
  - .2 ANSI/ASME B16.3, Malleable-Iron Threaded Fittings, Classes 150 and 300.
  - .3 ANSI/ASME B16.5, Pipe Flanges and Flanged Fittings NPS ½ through NPS 24 Metric/Inch Standard.
  - .4 ANSI/ASME B16.9, Factory-Made Wrought Buttwelding Fittings.
  - .5 ANSI/ASME B18.2.1, Square and Hex Bolts and Screws.
  - .6 ANSI/ASME B18.2.2, Square and Hex Nuts.
  - .7 ANSI/AWWA C111/A21.11, Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
- .3 American Society for Testing and Materials (ASTM).
  - .1 ASTM A47M, Specification for Ferritic Malleable Iron Castings.
  - .2 ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
  - .3 ASTM A536, Specification for Ductile Iron Castings.
  - .4 ASTM B61, Specification for Steam or Valve Bronze Castings.
  - .5 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
  - .6 ASTM E202, Test Method for Analysis of Ethylene Glycols and Propylene Glycols.
- .4 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS).
  - .1 MSS-SP-67, Butterfly Valves.
  - .2 MSS-SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.
  - .3 MSS-SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
  - .4 MSS-SP-80, Bronze Gate, Globe, Angle and Check Valves.
  - .5 MSS-SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.

### **1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate on manufacturers catalogue literature the following:
  - .1 Valves.

### **1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.

## **Part 2 Products**

### **2.1 PIPE**

- .1 Steel pipe: to ASTM A53, Grade B, as follows:

- .1 To NPS 6, Schedule 40.
- .2 NPS 8 and over, Schedule 30.

- .2 Pipe to be USA/Canada only.

## **2.2 PIPE JOINTS**

- .1 NPS 2 and under: screwed fittings with teflon tape or pulverized lead paste.
- .2 NPS 2-1/2 and over: welding fittings and flanges to CSA W47.1 and CSA W47.1S1 or coupling mechanical rolled groove rigid.
- .3 Flanges: plain, slip on.
- .4 Flange gaskets: to ANSI/AWWA C111/A21.11.
- .5 Pipe thread: taper.
- .6 Bolts and nuts: to ANSI B18.2.1 and ANSI/ASME B18.2.2.

## **2.3 FITTINGS**

- .1 Screwed fittings: malleable iron, to ANSI/ASME B16.3, Class 150.
- .2 Pipe flanges and flanged fittings:
  - .1 Cast iron: to ANSI/ASME B16.1, Class 125.
  - .2 Steel: to ANSI/ASME B16.5.
- .3 Butt-welding fittings: steel, to ANSI/ASME B16.9.
- .4 Unions: malleable iron, to ASTM A47M and ANSI/ASME B16.3.
- .5 Fittings to be USA/Canada only.

## **2.4 VALVES GENERAL**

- .1 The following manufacturers are acceptable:
  - .1 Crane
  - .2 Victaulic
  - .3 Jenkins
- .2 Ball valves; NPS 3 and under:
  - .1 2 piece standard port to MSS SP-80, Class 150, 2758 kPa (400 psi) WOG bronze body, stainless steel ball, PTFE Packing, PTFE seal, and steel lever handle, threaded or grooved ends.
- .3 Butterfly valves; NPS 2½ and over:
  - .1 Lug design to MSS SP-67, Class 200, cast iron body, ductile iron chrome plated disc, stainless steel stem, EPT liner and steel lever handle for NPS 8 and under.
  - .2 Valves above 1.8m (6 ft.) to have chain operators.
- .4 Globe valves; NPS 3 and under:
  - .1 Threaded ends to MSS SP-80, Class 125, 1380 kPa (200) WOG, bronze body, renewable disc, screwed over bonnet, and steel lever handle.
- .5 Swing check valves; NPS 3 and under:
  - .1 Threaded ends with union down stream to MSS-SP-80 Class 125 1379 kPa (200

psi) WOG, bronze body, bronze disc screw in cap.

- .6 Circuit balancing valves:
  - .1 NPS 2 and under: Manual externally adjustable bronze copper alloy body globe style balancing valve with shut-off, nylon handle wheel and protective cap, PTFE seat, stuffing box gasket and flow measuring ports. Solder, threaded.
    - .1 GPM Range.
    - .2 Pressure Range.
    - .3 Acceptable Manufacturer:
      - .1 Armstrong CBV.
  - .2 NPS 2½ and over: manual cast iron body globe style balancing valve with shut-off, hand wheel, grooved ends and P/T test ports.
    - .1 GPM range.
    - .2 Pressure range.
    - .3 Acceptable Manufacturer:
      - .1 Armstrong CBV.
  - .3 Contractor to have manufacturer size valves for flow rate indicated. Do not assume valves are line size. Circuit balancing valve to be selected near midpoint range of adjustment and pressure drop at selection point not to exceed 5 ft. of head unless approved by Engineer. Provide reducer/enlarger before and after valve as required.
  - .4 Provide manufacturer's prefabricated and formed removable insulation covers complete with vapour barrier and PVC jacket.
- .7 Valves to be manufactured in USA/Canada.

### **Part 3 Execution**

#### **3.1 PIPING INSTALLATION**

- .1 Connect to equipment in accordance with manufacturer's instruction unless otherwise indicated.
- .2 Install concealed pipes close to building structure to keep furring space to minimum. Install to conserve headroom and space. Run exposed piping parallel to walls. Group piping wherever practical.
- .3 Slope piping in direction of drainage and for positive venting.
- .4 Use eccentric reducers at pipe size change installed to provide positive drainage or positive venting.
- .5 Provide clearance for installation of insulation and access for maintenance of equipment, valves and fittings.
- .6 Ream pipes, clean scale and dirt, inside and outside, before and after assembly.
- .7 Assemble piping using fittings manufactured to ANSI standards.
- .8 Saddle type branch fittings may be used on mains if branch line is no larger than half the size of main. Hole saw or drill and ream main to maintain full inside diameter of branch line prior to welding saddle.

#### **3.2 VALVE INSTALLATION**

- .1 Install rising stem valves in upright position with stem above horizontal.

- .2 Install butterfly valves on chilled water and condenser water lines only.
- .3 Install ball valves at branch take-offs and to isolate each piece of equipment, and as indicated.
- .4 Install globe valves in by-pass around control valves as indicated.
- .5 Provide swing check valves in horizontal lines on discharge of pumps and as indicated.
- .6 Install chain operators on valves NPS 2 1/2 and over where installed more than 2500 mm (8 ft) above floor in Mechanical Equipment Rooms.

### **3.3 CIRCUIT BALANCING VALVES**

- .1 Install flow balancing valves as indicated.
- .2 Tape joints in prefabricated insulation on valves installed in chilled water mains.

### **3.4 FLUSHING AND CLEANING**

- .1 Flush and clean in presence of Consultant.
- .2 Refer also to section on water treatment.
- .3 Flushing water should be potable water and should be from a municipal system that treats water with chlorination or some other appropriate means to kill bacteria. Flush water shall contain a corrosion inhibitor and a biocide at levels sufficient to passivate system preventing corrosion and to kill any bacteria in system.
- .4 Flush after pressure test for a minimum of 4 h.
- .5 Fill with solution of water and non-foaming, phosphate-free detergent 3% solution by weight. Circulate for minimum of 8 h.
- .6 Refill system with clean water. Circulate for at least 4 hours. Clean out strainer screens/baskets regularly. Then drain.
- .7 Refill system with clean water. Circulate for at least 2 hours. Clean out strainer screens/baskets regularly. Then drain.
- .8 Drainage to include drain valves, dirt pockets, strainers, every low point in system.
- .9 Re-install strainer screens/baskets only after obtaining Consultant's approval.

### **3.5 FILLING OF SYSTEM**

- .1 Refill system with clean water adding water treatment as specified.
- .2 For glycol hot water system refill system with 50% by volume ethylene glycol to ASTM E202, inhibited and for use in building systems.

### **3.6 TESTING**

- .1 Test system in accordance with Section 20 05 01 - Mechanical General Requirements.

### **3.7 BALANCING**

- .1 Balance water systems to within  $\pm 5\%$  of design output.
- .2 Refer to Section 20 05 93 - Testing Adjusting and Balancing for applicable procedures.

**END OF SECTION**



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**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA).
  - .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code.
- .2 American Society for Testing and Materials (ASTM).
  - .1 ASTM A47M, Specification for Ferritic Malleable Iron Castings Metric.
  - .2 ASTM A278M, Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures up to 345°C Metric.
  - .3 ASTM A516/A516M, Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower - Temperature Service.
  - .4 ASTM A536, Specification for Ductile Iron Castings.
  - .5 ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
- .3 American Society of Mechanical Engineers (ASME).
  - .1 ANSI/ASME, Boiler and Pressure Vessels Code (BPVC), Section VIII.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 20 05 01 – Mechanical General Requirements.
  - .1 Automatic air vents.

**Part 2 Products**

**2.1 AUTOMATIC AIR VENT**

- .1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa, (100 psi), working pressure.
  - .1 High points in system.
  - .2 Standard of Acceptance: Honeywell, Braukman model EA122A1002.

**Part 3 Execution**

**3.1 GENERAL**

- .1 Install as indicated and to manufacturer's recommendations.
- .2 Run drain lines and blow off connections to terminate above nearest drain.
- .3 Maintain proper clearance to permit service and maintenance.

**3.2 AIR VENTS**

- .1 Install at locations shown and at all high points of systems, except for glycol systems.
  - .2 Install isolating ball valve on automatic air vent inlet.
  - .3 Install screwdriver vents on wall fin radiation requirement.
  - .4 On air separator air vent, pipe discharge to drain.
  - .5 Install manual air vent consisting of ball valve with plugged end at high points of glycol systems.
-

**END OF SECTION**

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**Part 1            General**

**1.1            CODES AND REFERENCE**

- .1 All work and material to be in accordance with following:
  - .1 ANSI B16.22, Wrought Copper and Copper Alloy Solder - Joint Pressure Fittings.
  - .2 ANSI B16.24, Bronze Pipe Flanges and Flanged Fittings, Class 150 and 300.
  - .3 ANSI B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
  - .4 ANSI/ASME B31.5, Refrigeration Piping.
  - .5 ASTM B88M, Specification for Seamless Copper Water Tube.
  - .6 ASTM B280, Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
  - .7 CSA B52, Mechanical Refrigeration Code.
  - .8 EPS 1/RA/1, Code of Practice for the Reduction of CFC's (Environment Canada).
  - .9 References shall be the latest update version.

**Part 2            Products**

**2.1            TUBING**

- .1 Provide processed tubing for refrigeration installation, deoxidized, dehydrated, and sealed.
- .2 Hard copper tube, type ACR, or L to ASTM B88M.
- .3 Annealed copper tube to ASTM B280, with minimum wall thickness as per CSA B52 and ASME B31.5.
- .4 Tubing to be USA/Canada only.

**2.2            FITTINGS**

- .1 Service: design pressure 2070 kPa (300 psig) and temperature 121°C (250°F).
- .2 Brazed: wrought copper to ANSI B16.22.
- .3 Flanged: bronze or brass, Class 150 and Class 300 to ANSI B16.24.
- .4 Flare: Bronze or brass, for refrigeration, to ANSI B16.26.
- .5 Fittings to be USA/Canada only.

**2.3            JOINTS**

- .1 Brazing: silver solder, 45% Ag-15% Cu or copper-phosphorous, 95% Cu-5%P.
- .2 Gaskets: non-metallic to ANSI B16.21.
- .3 The use of press-fit joints is not permitted.

**2.4            ACCESSORIES**

- .1 Provide check valves, sight glasses, filter driers, mufflers as recommended by the equipment supplier.
-

## **2.5 VALVES**

- .1 NPS 3/4 and under: Class 500, 3.5 MPa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moistureproof seal for below freezing applications, brazed connections.
- .2 Over NPS 3/4: Class 375, 2.5 MPa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and bonnet, moistureproof seal for below freezing applications, brazed connections.

## **Part 3 Execution**

### **3.1 GENERAL**

- .1 Install and test in accordance with CSA B52.
- .2 EPS 1/RA/1 and ASME B31.5.
- .3 Do work in accordance with manufacturers recommendations.
- .4 Pipe between computer room air conditioning units and air cooled condensing units. Piping layout and sizes to be verified by equipment supplier.
- .5 Connect to equipment with isolating valves and unions.
- .6 Provide space for servicing, disassembly and removal of equipment and components all as recommended by manufacturer.
- .7 Protect all openings in piping against entry of foreign material.

### **3.2 BRAZING PROCEDURES**

- .1 Bleed inert gas into pipe during brazing.
- .2 Remove valve internal parts, solenoid valve coils, sight glass.
- .3 Do not apply heat near expansion valve and bulb.

### **3.3 PIPING INSTALLATION**

- .1 General:
  - .1 Soft annealed copper tubing: bend without crimping or constriction. Hard drawn copper tubing: do not bend. Minimize use of fittings.
- .2 Hot gas lines:
  - .1 Pitch at least 1:240 down in direction of flow to prevent oil return to compressor during operation.
  - .2 Provide trap at base of risers greater than 2400 mm (8 ft.) high and at each 7600 mm (25 ft.) thereafter.
  - .3 Provide inverted deep trap at top of each riser.
  - .4 Provide double risers for compressors having capacity modulation.
    - .1 Large riser: install traps as specified above.
    - .2 Small riser: size for 5.1 m/s (16.7 ft./s) at minimum load. Connect of traps

on large riser.

### **3.4 PRESSURE AND LEAK TESTING**

- .1 Close valves on factory charged equipment and other equipment not designed for test pressures.
- .2 Leak test to CSA B52 before evacuation to 2 MPa and 1 MPa on high and low sides respectively.
- .3 Test Procedure: Build pressure up to 35 kPa (5 psig) with refrigerant gas on high and low sides. Supplement with nitrogen to required test pressure. Test for leaks with electronic or halide detector. Repair leaks and repeat tests.

### **3.5 DEHYDRATION AND CHARGING**

- .1 Close service valves on factory charged equipment.
- .2 Ambient temperatures to be at least 13°C (55°F) for at least 12 h before and during dehydration.
- .3 Use copper lines of largest practical size to reduce evacuation time.
- .4 Use 2-stage vacuum pump with gas ballast on 2nd stage capable of pulling 5 Pa absolute and filled with dehydrated oil.
- .5 Measure system pressure with vacuum gauge. Take readings with valve between vacuum pump and system closed.
- .6 Triple evacuate all system components containing gases other than correct refrigerant or having lost holding charge as follows:
  - .1 Twice to 14 Pa absolute and hold for 4 h.
  - .2 Break vacuum with refrigerant to 14 kPa.
  - .3 Final to 5 Pa absolute and hold for at least 12 h.
  - .4 Isolate pump from system, record vacuum and time readings until stabilization of vacuum.
  - .5 Submit all test results to Consultant.
- .7 Charging:
  - .1 Charge system through filter-drier and charging valve on high side. Low side charging not permitted.
  - .2 With compressors off, charge only amount necessary for proper operation of system. If system pressures equalize before system is fully charged, close charging valve and start up. With unit operating, add remainder of charge to system.
  - .3 Re-purge charging line if refrigerant container is changed during charging process.
- .8 Checks:
  - .1 Make all checks and measurements as per manufacturer's operation and maintenance instructions.
  - .2 Record and report all measurements to Consultant.

### **3.6 INSTRUCTIONS**

- .1 Post instructions in frame with glass cover in accordance CSA B52.

**3.7                    REGISTRATION AND INSPECTION**

- .1      Register refrigeration system with Technical Standards and Safety Authority when required by CSA B52 and Technical Standard and Safety Act 2000. Apply, pay for and have T.S.S.A. inspect refrigeration system when required by CSA B52 or Technical Standards and Safety Act 2000.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.
- .2 SMACNA HVAC Duct Leakage Test Manual.
- .3 CSA B228.1, Pipe Ducts and Fittings for Residential Type Air Conditioning Systems.
- .4 ASTM A480/A480M, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .5 ASTM A525M, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process. (Metric).
- .6 ASTM A621/A621M, Specification for Steel Sheet and Strip, Carbon, Hot-Rolled, Drawing Quality.
- .7 ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .8 ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .9 All reference standards shall be the latest editions.

**1.2 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate the following:
  - .1 Sealants

**1.3 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2 Products**

**2.1 SEAL CLASSIFICATION**

- .1 Classification as follows:

Maximum Pressure	SMACNA Seal Class
Pa (in. w.c.)	--
up to 500 (2)	A

- .2 Seal classification:
  - .1 Class A: All transverse joints, longitudinal seams, and duct wall penetrations.

**2.2 SEALANT**

- .1 Sealant: oil resistant, polymer type, water based, flame resistant duct sealant. Temperature range of minus 37°C (19°F) to plus 93°C (200°F).
  - .1 Standard of Acceptance: Bakor Duckseal.

## **2.3            FITTINGS**

- .1      Fabrication: to SMACNA.
- .2      Radiused elbows:
  - .1      Rectangular: standard radius and/or short radius with single thickness turning vanes, centreline radius: 1.5 times width of duct. Provide single thickness turning vanes in standard radius elbows where indicated on the drawings.
  - .2      Round: smooth radius, 4 piece. Centreline radius: 1.0 times diameter.
- .3      Mitred elbows, rectangular:
  - .1      To 900 mm (36 in.): single thickness turning vanes.
  - .2      Over 900 mm (36 in.): single thickness turning vanes, supported at 900 mm (36 in.) maximum centres.
- .4      Branches:
  - .1      Rectangular main and branch: 45° entry on branch.
  - .2      Round main and branch: enter main duct at 90° with conical connection.
  - .3      Provide volume control damper in branch duct near connection to main duct.
- .5      Transitions:
  - .1      Diverging: 20° maximum included angle.
  - .2      Converging: 30° maximum included angle.
- .6      Offsets:
  - .1      Full radiused elbows.
- .7      Obstruction deflectors: maintain full cross-sectional area. Maximum included angles: as for transitions.

## **2.4            FIRESTOPPING**

- .1      Retaining angles all around duct, on both sides of fire separation.
- .2      Firestopping material and installation must not distort duct.
- .3      Provide firestopping material according to Section 07 84 00 – Firestopping and Smoke Seals.

## **2.5            GALVANIZED STEEL**

- .1      Lock forming quality: to ASTM A525M, Z90 zinc coating.
- .2      Thickness, fabrication and reinforcement: to ASHRAE and SMACNA.
- .3      Joints: to ASHRAE and SMACNA.
- .4      All round duct to be spiral wound rigid duct.

## **2.6            HANGERS AND SUPPORTS**

- .1      Hanger configuration: to ASHRAE and SMACNA.
  - .2      Hangers: prime painted steel angle with black steel rods to the more stringent requirement of SMACNA or the following table:
-



Duct Size		Angle Size		Rod Size	
mm	in.	mm	in.	mm	in.
Up to 1050	Up to 42	40 x 40 x 3	1-½ x 1-½ x 1/8	6	1/4
1051 to 1500	43 to 60	40 x 40 x 3	1-½ x 1-½ x 1/8	10	3/8
1501 to 2100	61 to 84	50 x 50 x 3	2 x 2 x 1/8	10	3/8
2101 to 2400	85 to 96	50 x 50 x 6	2 x 2 x 1/4	10	3/8
2400 and over	96 and over	50 x 50 x 6	2 x 2 x 1/4	10	3/8

- .3 Upper hanger attachments:
  - .1 Concrete:
    - .1 Hollow core block concrete: Adhesive material applied with screen tube.
      - .1 Acceptable material: Hilti Hit Adhesive Anchors, HY 70.
      - .2 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.
      - .3 Submit anchor manufacturer's recommendations for anchoring to structural engineer prior to drilling for supports.
    - .2 Solid cast in place concrete or hollow core slabs: Adhesive material fastened into solid base.
      - .1 Acceptable material: Hilti Hit Adhesive Anchors, HY 200 (Safe Set).
      - .2 Coordinate minimum embedment of adhesive anchors with anchor manufacturer.
      - .3 Scan hollow core slabs for locations to install attachments per the manufacturer's written installation instructions.
  - .2 For steel joist: manufactured joist clamp or steel plate washer.
    - .1 Standard of Acceptance: Anvil Int'l. fig.86 for joist clamps, Anvil Int'l. fig.60 for plate washer.
  - .3 For steel beams: manufactured beam clamps.
    - .1 Standard of Acceptance: Anvil Int'l. fig.94.

## 2.8 SEISMIC RESTRAINTS

- .1 Provide bracing of ducts in accordance with Section 20 05 20 - Seismic Restraints.

## Part 3 Execution

### 3.1 GENERAL

- .1 Do work in accordance with ANSI/NFPA 90A, ASHRAE, CSA B228.1 and SMACNA.
- .2 Do not break continuity of insulation vapour barrier with hangers or rods. Insulate strap hangers 100 mm (4 in.) beyond insulated duct.
- .3 Support risers in accordance with ASHRAE and SMACNA.
- .4 Install breakaway joints in ductwork on each side of fire separation.
- .5 Install proprietary manufactured flanged duct joints in accordance with manufacturer's instructions.
- .6 Manufacture duct in lengths to accommodate installation of acoustic duct lining.
- .7 All open ducts shall be sealed during construction.
- .8 Do not suspend from metal deck, wood roof deck or Siporex roof slab.

### **3.2            HANGERS**

- .1      Strap hangers: install in accordance with SMACNA.
- .2      Angle hangers: complete with locking nuts and washers.
- .3      Hanger spacing: in accordance with SMACNA.
- .4      Rectangular risers shall be supported by angles or channels secured to the sides of the ducts with welds, bolts, sheet metal screws or blind rivets. For ducts over 762 mm (30 in.) wide, fasteners shall allow for expansion of the sheet due to internal pressure. Maximum spacing of risers supports shall be every 3.6 m (11.8 ft.) steel angles and channels shall be of adequate size to support the weight of the duct, given the spans of supports and a safety factor of 4 applied.

### **3.3            WATERTIGHT DUCT**

- .1      Provide watertight duct for:
  - .1          Fresh air intake.
  - .2          As indicated.
- .2      Form of horizontal duct without longitudinal seams. Solder or weld joints of bottom and side sheets. Seal all other joints with duct sealer.
- .3      Slope horizontal branch ductwork down towards hoods served. Slope header ducts down toward risers.
- .4      Fit base of riser with 150 mm (6 in.) deep drain sump and 32 mm (1-¼ in.) drain connected, with deep seal trap discharging to open funnel drain.

### **3.4            SEALING**

- .1      Apply sealant to outside of joint to manufacturer's recommendations.

### **3.5            DUCT CLEANING**

- .1      All ducts shall be thoroughly vacuumed.

### **3.6            SEISMIC RESTRAINTS**

- .1      Provide bracing of ductwork in accordance with Section 20 05 20 – Seismic Restraints.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCES**

- .1 CSA B228.1, pipes, ducts and fittings for residential type air conditioning.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate the following:
  - .1 Flexible connections.
  - .2 Duct access doors.

**1.3 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2 Products**

**2.1 FLEXIBLE CONNECTIONS**

- .1 Frame: galvanized sheet metal frame with fabric clenched by means of double locked seams.
- .2 Material: neoprene.
  - .1 Fire resistant, self-extinguishing, neoprene coated glass fabric, temperature rated at -40°C (-40 °F) to 90°C (194°F), density of 1.3 kg/m<sup>2</sup> (38 oz./yd<sup>2</sup>).

**2.2 ACCESS DOORS IN DUCTS**

- .1 Non-insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm (24 Ga.) thick complete with sheet metal angle frame.
- .2 Insulated ducts: sandwich construction of same material as duct, one sheet metal thickness heavier, minimum 0.6 mm (24 Ga.) thick complete with sheet metal angle frame and 25 mm (1 in.) thick rigid glass fibre insulation.
- .3 Gaskets: neoprene.
- .4 Hardware:
  - .1 Up to 300 X 300 mm (12 in. x12 in.): 2 sash locks
  - .2 301 to 450 mm (12 in. x 18 in.): 4 sash locks
  - .3 451 to 1000 mm (18 in. to 40 in.): piano hinge and minimum 2 sash locks.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Flexible connections.
    - .1 Install in following locations:
      - .1 Inlets and outlets of supply air, transfer, exhaust and return air fans.
-

- .2 As indicated.
- .2 Length of connection: 150 mm (6 in.).
- .3 Minimum distance between metal parts when system in operation: 75 mm (3 in.).
- .4 Install in accordance with recommendations of SMACNA.
- .2 Access doors:
  - .1 Location:
    - .1 At fire dampers.
    - .2 At smoke dampers.
    - .3 At control dampers.
    - .4 At devices requiring maintenance.
    - .5 At locations required by code.
    - .6 Elsewhere as indicated.
    - .7 Before and after turning vanes.
    - .8 Before and after hydronic and electric coils.

**END OF SECTION**

---

**Part 1 General**

**1.1 REFERENCES**

- .1 SMACNA HVAC Duct Construction Standards, Metal and Flexible.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate the following:
  - .1 Single Blade Dampers.
  - .2 Multi-Blade Dampers.

**Part 2 Products**

**2.1 GENERAL**

- .1 Manufacture to SMACNA standards.

**2.2 SINGLE BLADE DAMPERS**

- .1 Of same material as duct, but one sheet metal thickness heavier. V-groove stiffened.
- .2 Size and configuration to recommendations of SMACNA, except maximum height 300 mm (12 in.).
- .3 Locking quadrant, with shaft extension to accommodate insulation thickness.
- .4 Channel frame of same material as adjacent duct, complete with angle stop.
- .5 Provide shaft extension and standoff for insulated ducts.
- .6 Standard of Acceptance: Nailor Industries model 1870-HLQ-SB for rectangular ductwork and model 1890-HLQ-SB for round ductwork.

**2.3 MULTI-BLADED DAMPERS**

- .1 Factory manufactured of material compatible with duct.
  - .2 Opposed blade: configuration, metal thickness and construction to recommendations of SMACNA.
  - .3 Maximum blade height: 100 mm (4 in.).
  - .4 Bearings: pin in bronze bushings.
  - .5 Linkage: shaft extension with locking quadrant.
  - .6 Channel frame of same material as adjacent duct, complete with angle stop.
  - .7 Provide shaft extension and stand off for insulated ducts.
  - .8 Standard of Acceptance: Nailor Industries model 1820-BO-HL2. Frame and transitions as required.
-

**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Install where indicated.
- .2        Install in accordance with recommendations of SMACNA and in accordance with manufacturer's instructions.
- .3        For supply, return and exhaust systems, balancing dampers are to be located in each branch duct.
- .4        Runouts to registers and diffusers: install single blade damper located as close as possible to main ducts.
- .5        All dampers to be vibration free.
- .6        Ensure damper operators are observable and accessible.

**END OF SECTION**

---

**Part 1 General**

**1.1 REFERENCES**

- .1 ASTM A525M, Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate the following:
  - .1 Performance data.

**1.3 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.

**1.4 CERTIFICATION OF RATINGS**

- .1 Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency.

**Part 2 Products**

**2.1 MULTI-LEAF DAMPERS**

- .1 Provide where indicated.
- .2 Opposed blade type.
- .3 Extruded, interlocking blades, complete with extruded silicone seals, spring stainless steel side seals, extruded aluminum frame. Low leakage thermally broken face type.
- .4 Pressure fit self-lubricated bronze bearings.
- .5 Linkage: plated steel tie rods, brass pivots and plated steel brackets, complete with plated steel control rod.
- .6 Operator: Refer to Section 23 09 36 – Energy Monitoring Control Systems (EMCS).
- .7 Insulated aluminum dampers:
  - .1 Frames: thermally broken insulated with extruded polystyrene foam with R factor of 5.0.
  - .2 Blades: thermally broken constructed from aluminum extrusions with internal hollows insulated with polyurethane or polystyrene foam, R factor of 5.0.
- .8 Standard of Acceptance: Tamco 9000BF Series.

**2.2 BACK DRAFT DAMPERS**

- .1 Automatic gravity operated, multi leaf, steel construction with nylon bearings, spring assisted. Provide on all exhaust fans except where noted otherwise and in other locations where indicated.
-

- .2 Standard of Acceptance: Tamco Series 7000.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install where indicated.
- .2 Install in accordance with recommendations of SMACNA and manufacturer's instructions.
- .3 Seal multiple damper modules with silicon sealant.
- .4 Install access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories.
- .5 Install damper operator and accessories.

**END OF SECTION**



---

**Part 1            General**

**1.1            REFERENCES**

- .1    ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .2    CAN4-S112, Fire Test of Fire Damper Assemblies.
- .3    ULC-S505, Fusible Links for Fire Protection Service.
- .4    Reference standards to be latest editions.

**1.2            PRODUCT DATA**

- .1    Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2    Indicate the following:
  - .1    Fire Dampers.
  - .2    Smoke Dampers.
  - .3    Fire and Smoke Dampers.
  - .4    Operators.

**1.3            MAINTENANCE DATA**

- .1    Provide maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.

**1.4            MAINTENANCE MATERIALS**

- .1    Provide maintenance materials in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2    Provide following:
  - .1    6 fusible links of each type.

**1.5            CERTIFICATION OF RATINGS**

- .1    Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or those ordered by him from independent testing agency signifying adherence to codes and standards.

**Part 2           Products**

**2.1            FIRE DAMPERS**

- .1    Fire dampers: listed and bear label of ULC meet requirements of provincial fire authority, ANSI/NFPA 90A and authorities having jurisdiction. Fire damper assemblies to be fire tested in accordance with CAN4-S112.
  - .2    Mild steel, factory fabricated for fire rating requirement to maintain integrity of fire wall and/or fire separation.
  - .3    Steel hi-hat section, interlocking type; sized to maintain full duct cross section.
  - .4    Fusible link actuated, weighted to close and lock in closed position when released or
-

having negator-spring-closing operator for multi-leaf type or roll door type in horizontal position with vertical air flow.

- .5 Retaining angle iron frame, on full perimeter of fire damper, on both sides of fire separation being pierced.
- .6 Fire damper to be dynamic type designed to close against continuous airflow and pressure in duct system.
- .7 Standard of Acceptance: Nailor model D0120 type B, dynamic type.

## **2.2 SMOKE DAMPERS**

- .1 Smoke dampers: listed and bear label of ULC.
- .2 Motorized: folding airfoil blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled. Ultra-low leakage, low pressure drop model.
- .3 Motorized Round: round single blade type, normally open with power on. When power is interrupted damper shall close automatically. Both damper and damper operator shall be ULC listed and labelled. Ultra-low leakage model.
- .4 Smoke damper to be designed to close against continuous airflow and pressure in duct system.
- .5 Standard of Acceptance: Nailor model 1210 type A for rectangular, Nailor model 1290S for round.

## **2.3 COMBINATION FIRE AND SMOKE DAMPERS**

- .1 Fire and Smoke dampers: similar to smoke dampers specified above.
- .2 Combined actuator: electrical control system actuated from smoke sensor or smoke detection system and from fusible link.
- .3 Standard of Acceptance: Nailor model 1222 type B for rectangular, Nailor model 1290FS for round.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with ANSI/NFPA 90A and in accordance with conditions of ULC listing.
- .2 Maintain integrity of fire separation.
- .3 After completion and prior to concealment obtain approvals of complete installation from authority having jurisdiction.
- .4 Install access door adjacent to each damper. See Section 23 33 00 – Air Duct Accessories.
- .5 Coordinate with installer of firestopping.

- .6 Ensure access doors/panels, fusible links, and damper operators are easily observed and accessible.
- .7 Install break-away joints of approved design on each side of fire separation.
- .8 Do random drop test on six fire dampers to ensure proper installation. Reset damper upon completion of test.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCES**

- .1        CAN/ULC-S110, Fire Tests for Air Ducts.
- .2        UL 181, Factory Made Air Ducts and Connectors.
- .3        ANSI/NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
- .4        ANSI/NFPA 90B, Installation of Warm Air Heating and Air Conditioning Systems.
- .5        SMACNA HVAC Duct Construction Standards - Metal and Flexible.

**1.2            PRODUCT DATA**

- .1        Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.

**1.3            CERTIFICATION OF RATINGS**

- .1        Catalogue or published ratings shall be those obtained from tests carried out by manufacturer or independent testing agency signifying adherence to codes and standards.

**Part 2           Products**

**2.1            GENERAL**

- .1        Factory fabricated to CAN/ULC S110.
- .2        Pressure drop coefficients listed below are based on relative sheet metal duct pressure drop coefficient of 1.00.
- .3        Flame spread rating not to exceed 25. Smoke developed rating not to exceed 50.

**2.2            METALLIC - UNINSULATED**

- .1        Spiral wound flexible aluminum.
- .2        Performance:
  - .1        Factory tested to 2.5 kPa (10 in. w.c.) without leakage.
  - .2        Maximum relative pressure drop coefficient: 3.
- .3        Standard of Acceptance: Flexmaster T/L.

**2.3            METALLIC - INSULATED**

- .1        Spiral wound flexible aluminum with factory applied 25 mm (1 in.) thick flexible glass fibre thermal insulation with vapour barrier and vinyl jacket.
  - .2        Performance:
    - .1        Factory tested to 2.5 kPa (10 in. w.c.) without leakage.
    - .2        Maximum relative pressure drop coefficient: 3.
  - .3        Standard of Acceptance: Flexmaster T/L-M.
-

**Part 3 Execution**

**3.1 DUCT INSTALLATION**

- .1 Install in accordance with: SMACNA, CAN/ULC-S110 and NFPA 90A.
- .2 Maximum length of flexible duct: 1.5 m (5 ft.). Support flexible duct to prevent deforming or restricted air flows. All ductwork to diffusers including the elbow shall be rigid ductwork. Flexible duct to be used only for vertical drop to diffuser beyond rigid elbow in order to center diffuser in ceilings.
- .3 Hanger or saddle material in contact with the flexible duct shall be of sufficient width to prevent any restriction of internal diameter of duct when the weight of the supported section rests on the hanger or saddle material. In no case will the material contacting the flexible duct be less than 25 mm (1 in.) wide and cover one half the circumference of the outside diameter of the flexible duct.
- .4 Transverse duct joints at connections to rigid ductwork and equipment shall be sealed in accordance with Section 23 31 14 – Ductwork-Low-Pressure-Metal to 500 Pa (2 in.).
- .5 The ends of ducts shall be trimmed squarely prior to installation.
- .6 Collars to which flexible duct is attached shall be a minimum of 50 mm (2 in.) in length.
- .7 Collars and sleeves shall be inserted into flexible ducts a minimum of 25 mm (1 in.) before fastening.
- .8 Metallic flexible duct shall be attached using a minimum of three #8 sheet metal screws equally spaced around the duct's circumference; ducts larger than 300 mm (12 in.) diameter shall have a minimum of five #8 sheet metal screws. Screws shall be located at least 12 mm (1/2 in.) from the duct end.
- .9 Insulation and vapour barriers shall be fitted over the core connection and shall be supplementally secured with a draw band.
- .10 Insulated metallic flexible ductwork shall be provided where ductwork is identified to be insulated under Section 20 07 13 – Thermal Insulation for Ducting.

**END OF SECTION**

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**Part 1 General**

**1.1 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate following:
  - .1 Fan Curves showing point of operation and sound rating data.
  - .2 Dimensions.
  - .3 Voltage and amperage.

**1.2 MAINTENANCE DATA**

- .1 Provide maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.

**1.3 MAINTENANCE MATERIALS**

- .1 Provide maintenance materials in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Furnish list of individual manufacturer's recommended spare parts for equipment such as bearings and seals, and addresses of suppliers, together with list of specialized tools necessary for adjusting, repairing, or replacing, for placement into operating manual.

**1.4 CERTIFICATION OF RATINGS**

- .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.

**Part 2 Products**

**2.1 FANS GENERAL**

- .1 Standard of rating: AMCA 201 for Fan Application. AMCA 303 for application of Sound Power Ratings for ducted air moving devices. Performance of fans to AMCA 210 and ANSI/ASHRAE 51. Unit to bear AMCA certified seal. Pwl ratings to comply with AMCA 301, tested to AMCA 300 Unit to bear AMCA certified sound rating seal.
- .2 Maximum loudness: 6 sones.
- .3 Capacity, total static pressure, revolutions per minute, power, model, size and sound power levels: as indicated. Refer to drawings for schedule.

**2.2 CENTRIFUGAL INLINE FANS**

- .1 Fan wheels:
    - .1 Welded steel or aluminum construction.
    - .2 Maximum operating speed of centrifugal fans not more than 50% of first critical speed.
  - .2 Bearings: heavy duty grease lubricated ball or roller self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 h in accordance with (Anti-Friction Bearing Manufacturers Association) AFBMA L-10 life standard. Bearings to
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be rated and selected in accordance with AFBMA 9 and AFBMA 11.

- .3 Housings:
  - .1 Volute with inlet cones: fabricated steel for wheels 300 mm (12 in.) or greater, steel, aluminum, for smaller wheels, braced, and with welded supports.
  - .2 Provide latched airtight access doors with handles.
- .4 Motors:
  - .1 Externally mounted with adjustable drive pulleys.
  - .2 Cabinet mounted factory wired disconnect switch.

## **2.3 CEILING FANS**

- .1 Centrifugal wheels complete with backdraft damper, inlet grille disconnect switch.

## **2.4 SIDEWALL FANS**

- .1 Fan wheels:
  - .1 Aluminum propeller construction.
  - .2 Direct drive, maximum operating speed within manufacturer's recommended limits.
- .2 Bearings: heavy duty grease lubricated ball self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 h in accordance with (Anti-Friction Bearing Manufacturers Association) AFBMA L-10 life standard. Bearings to be rated and selected in accordance with AFBMA 9 and AFBMA 11.
- .3 Housings:
  - .1 Galvanized steel panel and drive frame, with optional wall housing.
  - .2 Provide wall housing with integral aluminum control damper, complete with Belimo actuator.
  - .3 Provide inlet louver as standard.
  - .4 All components to be braced and supported as required for secure wall mounting.
- .4 Motors:
  - .1 Direct drive, motor located in airstream.
  - .2 Cabinet mounted factory wired disconnect switch.
- .5 Accessories:
  - .1 Aluminum control damper with Belimo actuator.
  - .2 Wall housing for exterior installation.
  - .3 All mounting hardware and electrical connections required for complete installation.

## **Part 3 Execution**

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

- .1 Install as per manufacturer's instructions.
- .2 Provide sheaves and belts for final air balance.
- .3 Provide rubber in shear vibration isolation hanging kits for hung fans.
- .4 Provide flexible duct connection on inlet and outlet of fans.

- .5 Provide seismic cable restraint system designed to section 20 05 20 – Seismic Restraints for all suspended fans.

**END OF SECTION**



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**Part 1            General**

**1.1            REFERENCES**

- .1    AMCA 99, Standards Handbook.
- .2    ANSI/AMCA 210, Laboratory Methods of Testing Fans for Rating.
- .3    AMCA 300, Reverberant Room Method for Sound Testing of Fans.
- .4    AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- .5    ANSI/ASHRAE 51, Laboratory Methods of Testing Fans for Rating.

**1.2            SHOP DRAWINGS AND PRODUCT DATA**

- .1    Submit shop drawings and product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2    Product data to include fan curves and sound rating data.

**1.3            OPERATION AND MAINTENANCE DATA**

- .1    Provide operation and maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.

**1.4            CERTIFICATION OF RATINGS**

- .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 in force.
- .2    Provide confirmation of testing.

**Part 2           Products**

**2.1            FANS GENERAL**

- .1    Capacity: as indicated on fan schedule.
- .2    Sound ratings: comply with AMCA 301, tested to AMCA 300.
- .3    Statically and dynamically balanced. Constructed in conformity with AMCA 99.
- .4    Ratings: based on tests performed in accordance with ANSI/AMCA 210, and ANSI/ASHRAE 51.
- .5    Bearings: sealed lifetime of self aligning type with oil retaining, dust excluding seals and a certified minimum rated life of 100,000 h in accordance with AFBMA L10 life standard. Bearings to be rated and selected in accordance with AFBMA 9 and AFBMA 11.
- .6    Provide self-flash roof curbs for all roof mounted fans.
- .7    Refer to fan schedule for additional description and options.

**2.2            ROOF EXHAUSTERS**

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- .1 Centrifugal V belt or direct driven as indicated.
  - .1 Housings: spun aluminum housing and complete with resilient mounted motor and fan.
  - .2 Impeller: non-overloading.
  - .3 12 mm (1/2 in.) mesh 2.0 mm (12 Ga.) dia. aluminum birdscreen.
  - .4 Gasketed aluminum backdraft dampers.
  - .5 Weatherproof disconnect switch on fan housing.
  - .6 Continuous curb gaskets, cadmium plated securing bolts and screws.
  - .7 Adjustable motor sheave.
  - .8 Gravity backdraft damper c/w seals and spring assistance.
- .2 Standard of Acceptance: Greenheck model indicated in schedule on drawings.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Size anchor bolts for exhaust fan base to withstand seismic acceleration and velocity forces for building location.

**END OF SECTION**

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**Part 1            General**

**1.1            PRODUCT DATA**

- .1        Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2        Indicate the following:
  - .1            Capacity.
  - .2            Throws.
  - .3            Noise criteria.
  - .4            Finish.
  - .5            Fastening details.

**1.2            MAINTENANCE MATERIALS**

- .1        Provide maintenance materials in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2        Include:
  - .1            Keys for volume control adjustment.
  - .2            Keys for air flow pattern adjustment.

**1.3            MANUFACTURED ITEMS**

- .1        Grilles, registers and diffusers shall be product of one manufacturer for generic type.

**1.4            CERTIFICATION OF RATINGS**

- .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.

**Part 2            Products**

**2.1            GENERAL**

- .1        Standard product to meet capacity, throw, noise level, throat and outlet velocity as indicated.
- .2        Frames:
  - .1            Full perimeter gaskets.
  - .2            Plaster frames where set into plaster or gypsum board.
  - .3            Concealed fasteners.
  - .4            Dimensions to suit T-bar ceiling where applicable.
- .3        Concealed operators.
- .4        Colour: as directed by Consultant.

**2.2            DIFFUSERS, GRILLES & REGISTERS**

- .1        Sizes and types as indicated on drawings.
  - .2        Standard of acceptance: E.H. Price, Titus, Nailor Hart, Krueger, Metalaire.
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**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Install in accordance with manufacturer's instructions.
- .2        Install with oval head stainless cadmium plated screws in countersunk holes where fastenings are visible.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCES**

- .1 ASTM E90, Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.

**1.2 PRODUCT DATA**

- .1 Submit product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate the following:
  - .1 Pressure drop.
  - .2 Face area.
  - .3 Free area.

**1.3 CERTIFICATION OF RATINGS**

- .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.

**1.4 TEST REPORTS**

- .1 Submit certified data from independent laboratory substantiating acoustic and aerodynamic performance to ASTM E90.

**Part 2 Products**

**2.1 FIXED LOUVERS - ALUMINUM**

- .1 Locations as indicated on drawings.
  - .1 Material: extruded aluminum alloy 6063-T5.
  - .2 Blade: stormproof pattern with centre watershed in blade, reinforcing bosses and maximum blade length of 1500 mm (5 ft.).
  - .3 Frame, head, sill and jamb: 100 mm (4 in.) deep one piece extruded aluminum, minimum 2 mm (0.08 in.) thick with approved caulking slot, integral to unit.
  - .4 Mullions: at 1500 mm (5 ft.) maximum centres.
  - .5 Fastenings: stainless steel nuts and resilient neoprene washers between aluminum and head of bolt, or between nut, S/S washer and aluminum body.
  - .6 Screen: 12 mm (1/2 in.) exhaust 19 mm (3/4 in.) intake mesh, 2 mm (12 Ga.) diameter wire aluminum bird screen on inside face of louvers in formed U-frame.
  - .7 Finish: factory applied primer and baked enamel or anodized finish.  
Colour: to Consultant's approval.
  - .8 Standard of Acceptance: E.H. Price Model JE443.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 In accordance with manufacturers and SMACNA recommendations.
- .2 Anchor securely into opening. Seal with caulking all around to ensure weather tightness.

**END OF SECTION**

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**Part 1 General**

**1.1 SHOP DRAWINGS AND PRODUCT DATA**

- .1 Submit shop drawings and product data in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Product data to include fan curves and sound rating data.

**1.2 OPERATION AND MAINTENANCE DATA**

- .1 Provide operation and maintenance data for incorporation into maintenance manual specified in Section 20 05 01 – Mechanical General Requirements.

**1.3 MANUFACTURED ITEMS**

- .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 in force.
- .2 Provide confirmation of testing.

**Part 2 Products**

**2.1 GENERAL**

- .1 Units shall be UL listed and bear the UL label. Energy transfer ratings shall be ARI Certified. Ventilators shall bear the AMCA Certified Rating Seals for air performance. Performance shall be as scheduled on plans. Outdoor air shall not mix with exhaust air in a common plenum. Exhaust discharge and outside air intake shall not be located on the same side on roof top units.
- .2 Unit must conform to regulations set out in the Canadian Energy Efficiency Act for large air conditioners (condensing units). Packaged units shall be tested to CSA Standard C746-98 and must bear an EEV (energy efficiency verification) label provided by CSA. "Where specified as factory packaged air conditioning unit, factory assembled split systems do not conform to the Canadian Energy Efficiency Act and will not be considered."

**2.2 UNIT CASING AND FRAMES**

- .1 Unit shall be of internal frame type construction of galvanized steel. Frame and panels shall be G90 galvanized steel. All panels exposed to the weather shall be a minimum of 18 gauge galvanized steel. Where top panels are joined there shall be a standing seam to insure positive weather protection. All metal-to-metal seams shall be sealed, requiring no caulking at job site. Permatector exterior finish. Unit base to be designed for curb mounting. Unit base shall over hang the curb for a positive seal against water run-off.

**2.3 WEATHERHOODS**

- .1 Weatherhoods shall be of the same finish as the unit. Outdoor air weatherhood shall incorporate a louvered design and moisture eliminator. Weatherhoods shall be tested in accordance with AMCA Standard 500-L to prevent water penetration up to 3 in/hr at 29 mph. Moisture eliminator shall be aluminum, consisting of corrugated mesh to eliminate water penetration into unit.
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## **2.4 INSULATION**

- .1 Unit casing to be insulated with 1" - 3 lb. fiberglass with Foil-Scrim-Kraft facing. Insulation shall be in accordance with NFPA 90A and tested to meet UL 181 erosion requirements and secured to unit with water proof adhesive and permanent mechanical fasteners.

## **2.5 ENERGY RECOVERY WHEEL**

- .1 Wheel shall be of the enthalpy type for both sensible and latent heat recovery and be designed to insure laminar flow. Energy transfer ratings must be ARI Certified to Standard 1060. Ratings "in accordance with 1060" without certification are not acceptable. Desiccant shall be silica gel for maximum latent energy transfer. Wheel shall be constructed of lightweight polymer media to minimize shaft and bearing loads. Polymer media shall be mounted in a stainless steel rotor for corrosion resistance.
- .2 Wheel design shall consist of removable segments (for wheels greater than 26 in. diameter) for ease of service and/or cleaning. Silica gel desiccant shall be permanently bonded to wheel media to retain latent heat recovery after cleaning. Wheels with sprayed on desiccant coatings are not acceptable. Wheels with desiccant applied after wheel formation are not acceptable. Energy recovery device shall transfer moisture entirely in the vapor phase.

## **2.6 ACCESS DOORS**

- .1 All components shall be easily accessible through removable doors for exhaust, supply, filter, and damper compartments. Energy recovery wheels (smaller than 54 inches) shall be mounted in a slide-out track for ease of inspection, removal, and cleaning.

## **2.7 FAN SECTIONS**

- .1 Centrifugal fans to be double width, double inlet, single fan forward curved type. All blower wheels shall be statically and dynamically balanced. Ground and polished steel fan shafts shall be mounted in permanently lubricated, sealed ball bearing pillow blocks. Bearings shall be selected for a minimum (L10) life in excess of 100,000 hours at maximum catalogued operating speeds. Separate motors for exhaust and supply blowers shall be provided. Adjustable sheaves on belt-driven fans with motors less than 10 hp shall allow independent balancing of exhaust and supply airflows. Fan and motor assemblies are to be mounted to unit base with neoprene isolators as standard. Fans shall be located in draw-through position in reference to the energy recovery wheel.

## **2.8 MOTORS AND DRIVES**

- .1 Motors shall be energy efficient, complying with EPACT standards, for single speed ODP and TE enclosures. Motors shall be permanently lubricated, heavy-duty type, matched to the fan load and furnished at the specified voltage, phase, and enclosure. Belt drive motors shall be factory mounted to an adjustable motor plate having two heavy duty adjusting bolts for alignment and belt tension. Drives shall be sized for a minimum of 150% of driven horsepower. Pulleys shall be of the fully machined cast type, keyed and securely attached to the fan wheel and motor shafts; 10 horsepower and less shall be supplied with an adjustable drive pulley. Energy wheel motors and direct drive motors shall have integral overload protection.

## **2.9 FILTERS**

- .1 Supply and exhaust air filters shall be 50mm (2 in.) thick pleated fiberglass, MERV 13 and tested to meet UL Class 2. Filter racks shall be die formed galvanized steel. Provide

one set of spare filters.

## **2.10 DAMPERS**

- .1 Unit to be equipped with insulated motorized damper on fresh air and exhaust.

## **2.11 ELECTRICAL**

- .1 All internal electrical components shall be factory wired for single point power connection. All electrical components shall be CSA Listed, Approved or Classified where applicable and wired in compliance with C22.1-02 c/w Ontario Amendments.
- .2 Weatherproof, integral door interlocking disconnect switch and terminal strip shall be supplied as standard components in the control center. Optional features include motor contactors, 24 VAC control circuit, and fusing.
- .3 Provide manufacturer's BACnet control interface to communicate with the EMCS.

## **2.12 TIMED EXHAUST FROST CONTROL**

- .1 Unit to come complete with timed exhaust frost control which turns the supply blower power off and on using field adjustable timer settings when outdoor temperature falls below the frost threshold and wheel differential pressure is above setpoint. The temperature and differential set points are to be field adjustable with a factory supplied thermostat and differential pressure switch. Time period between fan on/off cycle to also be field adjustable.

## **2.13 ECONOMIZER CONTROL**

- .1 Unit to be set up for shut down of wheel through signal from EMCS for economizer operation.

## **2.14 CURBS**

- .1 Provide 600 mm (24 in.) high manufacturer's seismic curb for each ERV unit.

## **2.15 MATERIAL**

- .1 Standard of Acceptance: Greenheck model as indicated in Schedule on drawings.
- .2 **Acceptable Alternates: Engineered Air, Trane.**
  - .1 **Alternates must meet or exceed the technical performance requirements of this Specification Section and the schedules on the drawings.**

## **Part 3 Execution**

- .1 Install units as per manufacturer's instructions.

**END OF SECTION**



**Part 1 General**

**1.1 REFERENCES**

- .1 ANSI/ARI 210/240-2017, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- .2 CSA B52-2023, Mechanical Refrigeration Code.
- .3 ANSI/UL 465-1984, Air Conditioners, Central Cooling.

**1.2 SHOP DRAWINGS**

- .1 Submit shop drawings in accordance with Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate:
  - .1 Equipment, piping, and connections, together with valves, strainers, control assemblies, thermostatic controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired, and piped ready for final connection to building system, its size and recommended bypass connections.
  - .2 Piping, valves, fitting shipped loose showing final location in assembly.
  - .3 Control equipment shipped loose, showing final location in assembly.
  - .4 Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
  - .5 Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories, controllers.
  - .6 Pump and fan performance curves.
  - .7 Details of vibration isolation.
  - .8 Estimate of sound levels to be expected across each individual octave band in dB referred to A rating.
  - .9 Type of refrigerant used.

**1.3 CLOSEOUT SUBMITTALS**

- .1 Provide maintenance data for incorporation into manual specified in Section 20 05 01 – Mechanical General Requirements.
- .2 Indicate:
  - .1 Brief description of unit, indexed, with details of function, operation, control, and service for each component.
- .3 Manufacturer's installation instructions shall govern and unless otherwise noted, operation, maintenance and service of items. Include names and addresses of spare part suppliers.
- .4 Include following:
  - .1 Provide for each unit, manufacturer's name, type, year, number of units, and capacity.

## **1.4 WARRANTY**

- .1 Provide a full parts warranty for 5 years from start-up on all refrigeration compressors.

## **Part 2 Products**

### **2.2 GENERAL**

- .1 Roof mounted, self-contained single zone unit with electric heat and DX refrigeration and bear label of CSA, CGA.
- .2 Units to consist of cabinet and frame, supply fan, heat exchanger, heater control, air filter, refrigerant cooling coil, compressor, condenser coil and fans, motorized outside air damper, return damper, and other accessories as noted in schedule.
- .3 Prefabricated roof curb to conform to requirements of National Roofing Contractors Association (NRCA), height 600 mm (24 in.).
- .4 Units to meet ASHRAE 90.1-2013 energy efficiency requirements.

### **2.3 CONSTANT VOLUME UNITS**

- .1 Complete factory package tested, charged, and wired.
  - .1 Dual circuit cooling with independent scroll compressors.
  - .2 Hermetically sealed, direct-drive scroll compressors with internal overload protection.
  - .3 Variable speed direct drive plenum supply fan (backward-curved, high efficiency).
  - .4 Symbio 700 advanced controls with BACnet BAS compatibility.
  - .5 Multi-stage electric heat (54 kW, 2 stages).
  - .6 Non-fused disconnect switch, through-the-base electrical provisions.
  - .7 Microchannel all-aluminum condenser coils with factory-installed hail guards
  - .8 Foil-faced insulation, removable single side maintenance access panels.
  - .9 Permanently lubricated, thermally protected motors
  - .10 24 volt control circuit with compressor lockout protection.
  - .11 High pressure, low pressure, and freeze stat controls.
  - .12 Liquid line filter driers.
  - .13 Compressor anti-recycle protection.
  - .14 Copper tube/aluminum fin coils.
  - .15 Single point power connection.
  - .16 CSA approval on all units.
  - .17 Ultra low leak enthalpy economizer with barometric relief, fully modulating 0–100% dampers, dry bulb control.
  - .18 Weatherproof non-fused disconnect switch.
  - .19 Filters: MERV 13, throwaway.
  - .20 Refrigerant: R-454B.
  - .21 Humidi-Mizer Adaptive Dehumidification System.
  - .22 Return air CO2 sensor, factory mounted and wired.
  - .23 Return air humidity sensor, factory mounted and wired.
  - .24 Phase monitor control.
  - .25 Horizontal supply and return air connections as required per layout drawings. Field convertible units are acceptable.
- .2 Factory warranty: one (1) year on the complete unit parts and labour and four (4) additional years on the compressors.

- .3 Accessories as noted in schedule.
- .4 Standard of Acceptance: as noted in schedule.
- .5 Acceptable Alternates: Carrier, Lennox, Trane, York.
  - .1 Alternates must meet or exceed the technical performance requirements of this Specification Section and the schedules on the drawings.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install as per manufacturers' instructions on above the roof support frame provided by structural.
- .2 Manufacturer to certify installation, supervise start-up and commission unit. This is a requirement for Substantial Completion.
- .3 Run drain line from cooling coil condensate drain pan to discharge over roof drain.
- .4 Reinforce roof curbs, when provided, for seismic forces in accordance with Section 20 05 20 – Seismic Restraints.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Air-Conditioning, Heating and Refrigeration Institute (AHRI):
  - .1 ANSI/AHRI Standard 530 (SI), Rating of Sound and Vibration for Positive Displacement Refrigerant Compressors.
  - .2 AHRI Standard 551/591-SI, Performance Rating of Water Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle.
  - .3 AHRI 1230 (I-P), Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air-conditioning and Heat Pump Equipment.
- .2 American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
  - .1 ANSI/ASHRAE Standard 15, Safety Standard for Refrigeration Systems.
  - .2 ANSI/ASHRAE Standard 34, Designation and Safety Classification of Refrigerants.
  - .3 ANSI/ASHRAE/IES Standard 90.1-2013, Energy Standard for Buildings Except Low-Rise Residential Buildings.
  - .4 ANSI/ASHRAE Standard 147, Reducing the Release of Halogenated Refrigerants from Refrigerating and Air-Conditioning Equipment and Systems.
- .3 CSA Group (CSA):
  - .1 CSA B52, Mechanical Refrigeration Code.
  - .2 CSA C22.2 No. 236, Heating and cooling equipment (Bi-national standard with UL 1995).
- .4 U.S. General Services Administration - Federal Standards (FED-STD):
  - .1 FED-STD-141D/GEN, Paint, Varnish, Lacquer And Related Materials: Methods Of Inspection, Sampling And Testing.
- .5 Government of Canada:
  - .1 Environment Canada En14-207, Environmental Code of Practice for Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.
- .6 Underwriters Laboratories (UL):
  - .1 ANSI/UL 508, Standard for Industrial Control Equipment.
  - .2 UL 1995, Heating and Cooling Equipment
- .7 Underwriters Laboratories of Canada (ULC):
  - .1 CAN/ULC-S102, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

**1.02 SUBMITTALS**

- .1 Product Data:
  - .1 Submit shop drawings/product data sheets, complete with control components, and piping and wiring schematics.

- .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Submit a start-up and certification letter from equipment supplier as specified in Part 3 of this Section.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
  - .2 Indicate:
    - .1 Equipment including connections, piping and fittings, valves, strainers, control assemblies and ancillaries, identifying factory and field assembled.
    - .2 Dimensional data including dry and operation weights, openings required, service space and clearance requirements, and location and sizes of field connections.
    - .3 Electrical data and wiring as assembled and schematics.
    - .4 Construction details, recommended installation and support, mounting bolt hole sizes and locations and point loads.
    - .5 Details that include loadings and type of frames, brackets, stanchions, guides, anchors or other supports.
    - .6 Refrigerant piping system plans.
    - .7 Type and quantity of refrigerant used, including safety group and Global Warming Potential (GWP) and ozone depleting potential (ODP). Provide documentation demonstrating compliance with AHJ required codes and noted Project LEED requirements.
    - .8 Performance data for heating operation, cooling operation and simultaneous heating/cooling operation including correction for glycol type. Include peak and part load performance.
    - .9 Pressure relief piping or venting requirements.
    - .10 Sound performance data.
    - .11 Sequence of operations.
  - .3 VRF manufacturer data to include as applicable:
    - .1 Selection Procedures:
      - .1 Indoor and outdoor units.
      - .2 Branch selector units.
      - .3 Piping material and fittings.
      - .4 Refrigerant mass for system.
      - .5 Refrigerant classification.
      - .6 Controls.
    - .2 System Efficiency Curves/Data including:
      - .1 Efficiency correlated with outside air temperature.
      - .2 At least five data points covering full range of operation.
      - .3 Minimum and maximum values over operational range.
      - .4 Efficiency at standard AHRI conditions.
    - .3 Installation check lists, startup procedures and commissioning procedures.
- .3 Delegated Design:
  - .1 Engage system manufacturer Professional Engineer experienced in variable refrigerant flow (VRF) systems work to prepare, design, and sign and seal system engineered delegated design submittals including:
    - .1 Layout design drawings consisting of detail working drawings of system layout identifying:

- .1 Items listed above for shop drawings.
  - .2 System equipment and ratings.
  - .3 Controls and devices.
  - .4 Refrigerant type.
  - .5 Equipment piping schematic, pipe routing and sizing.
  - .6 Zones.
  - .7 Data essential for proper installation of each system.
  - .8 Equipment layouts, details, plan view, elevations, and sections of systems supply and piping.
  - .9 Piping schematic of systems supply, devices, valves, pipe, and fittings.
  - .10 Electrical point-to-point wiring diagrams.
  - .11 Integrated systems and equipment.
  - .12 Design Data Identifying:
    - .1 Calculations of system design listing design data used in preparing calculations, system layout, zoning and sizing.
    - .2 Type and design of each system.
  - .13 Certification that each system has performed in manner intended.
  - .14 List of standards, codes and regulations that preparation of design was based.
- .4 Submit manufacturer check list of field start-up tests, signed by start-up technician certifying satisfactory for operation.
  - .5 Submit certified factory inspection and testing reports, including sound testing.
  - .6 Submit compliance certificates and onsite testing and verification reports.

### **1.03 QUALITY ASSURANCE**

- .1 Provide equipment and installation work in accordance with:
  - .1 AHRI Standard 551/591.
  - .2 ANSI/ASHRAE Standard 15.
  - .3 ANSI/ASHRAE Standard 34.
  - .4 ANSI/ASHRAE/IES Standard 90.1.
  - .5 ANSI/ASHRAE Standard 147.
  - .6 ANSI/UL 508.
  - .7 CSA B52.
  - .8 CSA C22.2 No. 236.
  - .9 Environment Canada En14-207.
  - .10 AHJ energy efficiency regulations.
- .2 Complete system units to be listed by ETL (Engineering Testing Laboratory), be evaluated in accordance with UL 1995, be listed in AHRI directory and tested in accordance with AHRI 1230.
- .3 VRF unit manufacturer to be represented in locale of Project by experienced, factory trained service vendor with fully stocked parts department and personnel available seven days a week. Submit name of vendor with shop drawings/product data.
- .4 Factory sound test each unit by independent agency with preparation of certified factory testing reports.

#### **1.04 SPARE PARTS**

- .1 Supply following spare parts:

- .1 .

### **PART 2 PRODUCTS**

#### **1.05 GENERAL**

- .1 Complete variable refrigerant flow (VRF) systems to be supplied from single supplier that is system manufacturer authorized regional representative.
- .2 VRF systems generally consist of following as detailed on drawings/schedules:
  - .1 Cooling Types:
    - .1 Air cooled: Condenser units placed outdoors.
  - .2 Outdoor units: Single or multiple units of various types and capacities.
  - .3 Indoor units: Single or multiple units of various types and capacities.
  - .4 Piping: Two pipe piping systems.
  - .5 Controls: Various controls allowing for customizing operations suiting specific applications and environment in which system is installed.
  - .6 Flow Selector Boxes: Single or multiple, connected to each indoor units as required to enable individual heating and cooling selection year-round.
  - .7 Ventilation Units:
    - .1 Indoor units with controls, all connected by fully insulated refrigerant lines utilizing factory-supplied, fully insulated branching kits.
    - .2 Indoor units connected to condensate piping that terminates to nearest drain point.
- .3 Equipment Performance Capacities and Electrical Ratings: Refer to drawings/schedules.
- .4 Equipment Withstand Ratings:
  - .1 Unless otherwise noted:
  - .2 Coordinate with Work of Division 26 in determining required short circuit current rating for equipment.
- .5 Refrigerant:
  - .1 Designed to operate with refrigerants in accordance with CSA B52, other applicable codes and requirements of AHJ.
  - .2 Designed for use with type of refrigerant eliminating fluorocarbon emissions in accordance with Environment Canada En14-207 and in accordance with equipment manufacturer recommendations.
  - .3 System field charged with field supplied refrigerant.
- .6 Maximum Sound Pressure Ratings:
  - .1 Single modules: Not exceed 62 dBA sound pressure in cooling and 63 dBA in heating.
  - .2 Twinned systems: Not exceed 65 dBA in cooling and 66 dBA in heating.
  - .3 3-modules systems: Not exceed 68 dBA in cooling and 70 dBA in heating.

- .4 Sound pressure ratings are measured at a distance of 910 mm out and 1370 mm up from side of outdoor unit.
- .7 Maximum number of connected indoor units: Not exceed selected unit manufacturer specifications.
- .8 Total connected indoor unit capacity range: In accordance with unit manufacturer range of outdoor unit capacity based on indoor unit type and size selected.
- .9 System automatically restarts normal operation after power failure of any duration without reprogramming or manual assistance.
- .10 Insulate, fully enclose, guard, or fit with other types of safety devices:
  - .1 Exposed moving parts.
  - .2 Parts that produce high operating temperature.
  - .3 Parts which may be electrically energized.
  - .4 Parts that may be hazard to operating personnel.
- .11 Manufacturer Technician Services:
  - .1 Provide instructions on installation: 1 day per unit.
  - .2 Perform onsite after installation inspection, start-up, commissioning, testing and certification of equipment and installation, including:
    - .1 Start-up: 1 day per unit.
    - .2 Commissioning: 1 day per unit.
    - .3 Functional Testing: 1 day function (heating, cooling, simultaneous).
  - .3 Provide certified copies of certification reports.
  - .4 O & M training: Unless otherwise noted, minimum two days training.

## **1.06 OUTDOOR UNITS**

- .1 Heat Recovery Types:
  - .1 Factory-assembled, single-piece units.
  - .2 Contained within unit enclosure are factory wiring, piping, controls, and multiple inverter-driven compressors.
  - .3 2-pipe system provides simultaneous heating and cooling as requested by individual indoor zones that can consist of single or multiple indoor units.
  - .4 Units include oversized accumulator and liquid tank for proper heating performance while allowing indoor unit PMV (pulse modulating valve) metering device to shut off completely when a zone is satisfied.
  - .5 Units protected by high-pressure switches, high-pressure sensors, low-pressure sensors, fusible plugs, PC boards, and inverter overload protectors.
  - .6 Units capable of operating in cooling mode down to minus 10°C ambient air temperature and down to minus 20°C wet bulb ambient air temperature in heating. For simultaneous heating and cooling, unit capable of operating between minus 10°C and 16°C ambient air temperature.
  - .7 Defrost operations melt accumulated frost, snow and ice from outdoor units.
- .2 Unit Cabinets:
  - .1 Constructed of pre-coated steel, finished on both inside and outside.



- .2 Access panels removable with minimal screws providing full access to compressors, fan, and control components.
  - .3 Compressors isolated in compartment and with acoustic wrap material for noise reduction.
  - .4 Control panel includes sliding window to access adjustable controls and LED display for setup and diagnostics.
  - .5 Capable of withstanding minimum 500-hour salt spray test in accordance with FED-STD-141D/GEN (method 6061).
  - .6 Hail Guard Panels: Provide protection to condenser coils while enabling optimal airflow.
  - .7 Snow/Wind Kits: Provide protection of heat exchanger coils from snow build-up and wind.
- .3 Fans:
- .1 Fans discharge air and be driven by DC inverter variable speed motor with multiple steps that is capable of running down to 60 rpm.
  - .2 Fan Motors:
    - .1 ECM.
    - .2 In accordance with Section 26 05 80 – Fractional Horsepower Motors.
    - .3 Protected by internal thermal overload protection.
    - .4 Blades of non-metallic construction and statically and dynamically balanced.
    - .5 Controlled by variable frequency drives or starters of types in accordance with system manufacturer to provide high efficiency and harmonic mitigation.
  - .3 Protected by raised non-metallic corrosion resistant protective grille.
- .4 Compressors:
- .1 Types:
    - .1 Hermetic scroll.
  - .2 Number:
    - .1 Single variable speed compressor.
    - .2 Variable speed compressor plus fixed-speed compressor.
    - .3 Multiple variable speed compressors.
  - .3 Totally enclosed in machine compartment.
  - .4 Equipped with factory mounted crankcase heaters and internal overloads protecting compressor from over-temperature operation.
  - .5 Motor suitable for operation in specified supplied refrigerant atmosphere.
  - .6 Compressor assembly installed on rubber vibration isolators.
  - .7 To maximize compressor reliability, multiple compressors within a module started and operated in variable patterns to ensure equal run time on all compressors.
  - .8 To ensure maximum efficiency throughout system operation range, no compressor is required to run at maximum speed under any condition.
  - .9 Total oil management system that balances oil between compressors within a module, replenishes compressor oil to compressors in a module from oil separator if required, and allows oil and refrigerant to move between module units if required, even if one of units is not running.
- .5 Heat Exchangers and Coils:
- .1 Coils constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
  - .2 Coil configuration: 4-sided and fully separated from machine compartment for more effective heat transfer and sound isolation.

- .3 Coil fins finish: Factory-applied corrosion resistant and salt-resistant blue-fin finish.
- .6 Controls and Safeties:
  - .1 Operating Controls and Safeties:
    - .2 Factory selected, assembled, and tested.
    - .3 Microprocessor control in outdoor units, heat recovery units and indoor units communicate between units using same protocol.
    - .4 Human interface capability that provides visual code that reports systems operation status. If any malfunction occurs, or system is operating with unstable refrigerant, cycle sensors report malfunction to visual display.
    - .5 Individual or central indoor unit controls with on/off temperature settings.
    - .6 System capable of performing continuous operation when individual or several indoor units are being serviced, or when communication wire cut or power to indoor unit is disconnected.
    - .7 Unit microprocessors capable of reporting malfunction and diagnostic codes to remote control devices such as central controllers, zone controllers and building automation systems.
  - .8 LED/LCD Display:
    - .1 Illuminated digital colour multi-character and multi-line display.
    - .2 Displays current temperature, temperature setpoint, fans status, occupancy status and conditioning mode at same time.
    - .3 Temperature setpoint adjustment in one-degree increments.
  - .9 Controls:
    - .1 Compressor speed to match refrigerant flow and capacity with system requirements.
    - .2 Fan motor speed for higher efficiency and lower sound.
    - .3 Oil control for improved system reliability and comfort.
    - .4 Pulse modulating valve control for precise control of refrigerant distribution and accurate capacity management to avoid starving any units.
    - .5 Control of compressor staging for maximizing reliability and minimum run time on all compressors.
    - .6 Module control of compressor operation, compressor speed, and outdoor heat exchanger surface to maximize efficiency and sound level and reliability across entire operating range of system.
    - .7 Control of heat exchanger surface (main vs sub-heat exchangers) for maximum efficiency and comfort.
  - .10 Safeties (Condensing Units):
    - .1 High-pressure switches.
    - .2 Fuses.
    - .3 Crankcase heaters.
    - .4 Fusible plugs
    - .5 Overcurrent relays for compressors.
    - .6 Thermal protectors for compressors and fan motors.
    - .7 Compressor time delays.
    - .8 Oil recovery systems.
    - .9 Oil level sensors.
    - .10 Overcurrent sensors.
    - .11 Compressor suction and discharge temperature sensors.
    - .12 Compressor suction and discharge pressure sensors.
  - .11 Communications:
    - .1 Digital communications compatible to Division 25 BMS/BAS systems.
    - .2 BACnet communication protocol.

- .3 Wi-Fi: Allows service or maintenance personal access to complete operating system, without need of tools other than smart phone or tablet.
- .7 Electrical Requirements:
  - .1 Field power supplies of ratings as noted.
  - .2 Modular systems: Separate field power supply to each module.
  - .3 Two-core, standard, shielded low voltage cable for communication between outdoor and indoor unit.
- .8 Refrigerant Systems:
  - .1 Single refrigeration circuit using code and AHJ approved refrigerant.
  - .2 Factory-installed components:
    - .1 Refrigerant strainer, oil separator and accumulator.
    - .2 Check valves, hot gas bypass valve, four-way reversing valve, electronic controlled expansion valve (EEV) and service valves.
    - .3 High and low side charging ports, high pressure safety switch and interconnecting piping.
    - .4 Integral sub-cooler assembly consisting of double spiral tube-type subcooling heat exchanger and EEV providing refrigerant subcooling modulation.
- .9 Refrigerant Piping and Line Lengths:
  - .1 Piping Connections:
    - .1 From front or bottom of units.
    - .2 Units capable of operating with maximum connected refrigerant line lengths in accordance with unit manufacturer specifications.
  - .2 Units capable of operating with maximum height of 69 m (225 ft.) between outdoor and lowest indoor unit.
  - .3 Maximum distance outdoor unit and furthest fan coil not to exceed unit manufacturer specifications. No line size changes or oil traps shall be required.
  - .4 System capable of operating when height difference between upper and lower fan coil is 39 m (125 ft.).
- .10 Auxiliary Refrigerant Components:
  - .1 Field-supplied copper tubing connecting outdoor unit to indoor unit: Use of factory-supplied branching kits consisting of either Y joints or headers to ensure even refrigerant flow.
  - .2 To ensure piping flexibility, system to allow having Y joints or headers downstream of another header.
  - .3 For modular systems, in order to maximize efficiency and comfort, provide 9.5 mm (3/8") oil balance line to allow flow oil and refrigerant between modular units, even when one of units is not running.
  - .4 Flow Selector Boxes:
    - .1 Regulate flow of high-pressure hot gas or high-pressure liquid to fan coil requiring heating or cooling.
    - .2 Up to 8 fan coils, all requiring same duty cycle, may be connected to a single flow selector box.
    - .3 Fan coil that runs in cooling only is not required to connect to flow selector box.
    - .4 Can be installed up to 15 m (50 ft.) from indoor units.
    - .5 Wired from indoor unit using factory-supplied power and control wire harness.
    - .6 Not require drain connection.

- .7 Include galvanized steel enclosure, full interior insulation, and be tested prior to shipment.
- .11 Insulation:
  - .1 Refrigerant pipe, y-branches, elbows and valves: Individually insulated with no air gaps.
  - .2 Insulation heat transfer resistance: Not less than minimum in accordance with AHJ, codes or system manufacture installation requirements.
  - .3 Do not install insulation in compressed state at any point in system.
  - .4 Insulation located indoors and which are located in air plenum spaces:
    - .1 Unless otherwise noted, materials in accordance with CAN/ULC-S102.
    - .2 Have Maximum Flame Spread Rating: 25.
    - .3 Have Maximum Smoke Developed Rating: 50.
  - .5 Glue and seal joints in accordance with insulation manufacturer instructions to make a vapor tight assembly.

## **1.07 INDOOR UNITS**

- .1 Flush In-Ceiling Units:
  - .1 Indoor, direct-expansion, low profile, compact in-ceiling fan coil unit with:
    - .1 Coil, fan driven by DC inverter motor, PMV (pulse modulating valve) and piping connectors.
    - .2 Electrical controls, microprocessor control system and integral temperature sensing.
    - .3 Condensate pump.
    - .4 Hanging brackets and installation hardware.
  - .2 Unit Cabinets:
    - .1 Constructed of zinc-coated steel.
    - .2 Fully insulated discharge and inlet grilles attractively styled and constructed of high-impact non-metallic material.
    - .3 Inlet grille equipped with hinges and can be opened to obtain access to cleanable filters and fan motor.
    - .4 Ceiling panel grille suiting specific installations.
  - .3 Fans:
    - .1 Centrifugal direct-drive blower type with air intake in center of unit and discharge at perimeter.
    - .2 Automatic, motor-driven vertical air louver, adjustable for 2, 3 or 4-way airflow cassette discharge as noted.
    - .3 Air louver operation provides three user selectable modes.
  - .4 Coils:
    - .1 Copper tube with aluminum fins and galvanized steel tube sheets.
    - .2 Fins bonded to tubes by mechanical expansion and specially coated for enhanced wettability.
    - .3 Drip pan under coil with factory-installed condensate lift mechanism having lift capacity of minimum 7.5 m (25 ft.) and drain connection for hose attachment to remove condensate.
  - .5 Motors:
    - .1 NEMA Premium, totally enclosed with permanently lubricated bearings.
    - .2 In accordance with Section 26 05 80 – Fractional Horsepower Motors.
    - .3 Protected by internal thermal overload protection.
    - .4 Inverter controlled variable speed.
  - .6 Filters:

- .1 Factory-supplied resin net (cleanable) type filters.
- .2 Return air filter material:
  - .1 Odorless.
  - .2 Temperature resistant to 85°C (185°F).
  - .3 Humidity resistant up to 95% RH.
- .7 Controls:
  - .1 System microprocessor controlled to maintain precise room temperature and minimum power consumption.
  - .2 Controls system employ genetic algorithm for temperature control.
  - .3 Refer to article - Controllers for Indoor Units, in this Section, for additional controller options.
- .8 Operations:
  - .1 Selectable automatic restart: After power failure system restarts at same operating conditions as before failure.
  - .2 Temperature-sensing controls: Sense return air temperature at unit or at remote control.
  - .3 Indoor coil freeze protection: In both cooling and heating (reversing valve failure) modes.
  - .4 Automatic air sweep control: Provides multiple operating modes of air sweep louvers.
  - .5 Dehumidification (Dry) mode: Provides increased latent removal through total system modulation.
  - .6 Fan-only operation: Provides room air circulation when no cooling is required.
  - .7 Fan speed control: User-selectable of high, medium, low, or microprocessor determined (Auto) based on differential between room temperature and set point during all modes of operations.
  - .8 Indoor coil high temperature protection: Provides detection of excessive indoor discharge temperature in heating.
  - .9 Cold blow prevention in heating.
  - .10 Adjustable compensation for air stratification in heating.
- .2 In-Ceiling-Concealed Ducted Units:
  - .1 Factory assembled, wired and run tested.
  - .2 Suitable for use in plenums.
  - .3 Mounts above ceiling with 2-position, field adjustable return and fixed horizontal discharge supply.
  - .4 Contained within units:
    - .1 Factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor.
    - .2 Self-diagnostic function, 3-minute time delay mechanism, and auto restart function.
    - .3 Refrigerant pipes charged with dehydrated air before shipment from factory.
  - .5 Unit Cabinets:
    - .1 Ceiling-concealed, ducted.
    - .2 Cabinet panel includes provisions for field installed filtered outside air intake.
    - .3 Mounting brackets and installation hardware.
  - .6 Fans:
    - .1 Assembly with one or two equivalent to Sirocco type fans direct driven by single motor.
    - .2 177 mm blades, gimbaled design for 360° directional airflow.
    - .3 Statically and dynamically balanced and run on low power draw motor with permanently lubricated bearings.
    - .4 Three speeds, High, Mid, and Low plus Auto-Fan function.

- .5 12/24V auto-sensing capability.
- .6 Ducted air outlet system and ducted return air system.
- .7 Filters:
  - .1 Return air filtered by means of standard factory installed return air filter.
  - .2 Return filter box (rear or bottom placement) with high-efficiency filter.
- .8 Coil:
  - .1 Nonferrous construction with smooth plate fins on copper tubing.
  - .2 Tubing with inner grooves for high efficiency heat exchange.
  - .3 Tube joints brazed with phos-copper or silver alloy.
  - .4 Pressure tested at factory.
  - .5 Condensate pan and drain provided under coil.
  - .6 Condensate gravity drained from fan coil.
  - .7 Both refrigerant lines to indoor units insulated.
  - .8 The unit shall have the following functions as a minimum:
- .9 Controls:
  - .1 Units compensate for higher temperature sensed by return air sensor compared to temperature at level of occupant when in HEAT mode. Disabling of compensation possible for individual units to accommodate instances when compensation is not required.
  - .2 Control board include contacts for control of external heat source. External heat may be energized as second stage with adjustable deadband from set point.
  - .3 Include no less than four digital inputs capable of being used for customizable control strategies.
  - .4 Include no less than three digital outputs capable of being used for customizable control strategies.
  - .5 Room temperature/CO2 sensors have strengthened glass coloured touchscreen user interface to display setpoint, room temperature, relative humidity and CO2 level with BACnet-MS/TP interface or other compatible protocol to Division 25 BMS/BAS system.
  - .6 Digital communications compatible to Division 25 building automation systems, including BACnet.
  - .7 Remote Controllers:
    - .1 Microprocessor controlled, backlit display.
    - .2 Controls for ON/OFF, mode (cool, heat, auto, dry, setback and fan, temperature setting, fan speed setting and airflow direction.
    - .3 Display of temperatures and limit set temperature range.
    - .4 Provide weekly, special day and operational scheduling feature.
    - .5 During schedule operation, user can set power status (ON/OFF), operation mode, temperature setup, and remote-control operation, restricted / allowed, return back and ventilation operation.
    - .6 Provide web interface for remote monitoring, control, and scheduling.
    - .7 Monitoring energy consumption for each tenant and generate monthly KW usage reports.
    - .8 Night setback control with upper and lower set temperature settings.
    - .9 Display of four-digit error code in event of system abnormality/error.
    - .10 Control of minimum 16 multiple indoor units.
    - .11 Require no addressing.
    - .12 Digital I/O interface to provide alarm, fire and locking signals.
- .3 Standard Wall-Mounted Units:
  - .1 General:
    - .1 Low-profile units designed to mount on vertical surface with mounting guide and separate hanging bracket.

- .2 Enclosure manufactured with coated metal.
- .3 Cold surfaces covered with coated polystyrene insulating material.
- .4 Case finish manufactured using ABS polymeric resin with final pearl white finish.
- .2 Fan Assemblies and Control:
  - .1 Fans: Single, direct-drive, crossflow tangential equivalent to Sirocco type fans made of high strength polymeric resin.
  - .2 Fan Motors:
    - .1 Brushless digitally controlled design with permanently lubricated and sealed ball bearings.
    - .2 Thermal, overcurrent and low RPM protection.
    - .3 Assembly mounted on vibration attenuating rubber grommets.
    - .4 Fan impeller statically and dynamically balanced.
    - .5 Fan speed controlled using microprocessor-based direct digital control algorithm that provides high fan speed in cooling thermal ON and low fan speed in cooling thermal OFF, high fan speed in heating thermal ON and fan off in heating thermal OFF.
    - .6 Fan speeds field adjusted between low, medium, and high speeds.
    - .7 Fan speed algorithm provides field-selectable fixed-speed or auto-speed setting that changes fan speed to simulate natural airflow.
- .3 Air Filters:
  - .1 Return air filtered with removable, washable filter with anti-fungal treatment.
  - .2 Filter access from front of unit without use of tools.
- .4 Airflow Guide Vanes: Motorized guide vanes that automatically changes direction of airflow.
- .5 Coils: Constructed with grooved design copper tubes with slit coil fins, two rows, eighteen fins per inch.
- .6 Controls:
  - .1 Integrated Microprocessor Controllers:
    - .1 Perform functions necessary to operate system without use of wall-mounted controller. Functions include:
      - .1 Auto addressing, self-diagnostics, auto restart following power restoration and test run.
    - .2 Operate unit using one of five operation modes:
      - .1 Auto Changeover (Heat Recovery only).
      - .2 Heating.
      - .3 Cooling.
      - .4 Dry.
      - .5 Fan Only.
  - .2 Temperature thermistor factory mounted in return air stream.
  - .3 Unit operation parameters, excluding operating schedule, are stored in non-volatile memory resident on unit microprocessor.
  - .4 Operating schedules stored in select models of wall-mounted, local or central controllers.
  - .5 Heat Recovery Systems: Auto Changeover setting automatically switches control of unit between Cooling and Heating modes based on space temperature conditions.
  - .6 Heat Pump Systems: Heated or cooled air delivery is dependent upon outdoor unit operating mode.
  - .7 Cooling or heating mode test cycle operates unit for 18 minutes without regard to space temperature.
- .2 Controls Features:
  - .1 Auto changeover (Heat Recovery only).
  - .2 Auto operation.
  - .3 Auto clean (coil dry; requires wireless controller).

- .4 External ON/OFF control.
- .5 Dual thermistor control.
- .6 Dual set-point control.
- .7 Filter life display.
- .8 Group control.
- .9 Forced operation.
- .10 Hot start.
- .11 Self-diagnostics.
- .12 Timer (ON/OFF).
- .13 Weekly schedule.
- .14 Auto direction/swing (up/down).
- .15 Fan speed control.
- .16 Jet cool (fast cooling).
- .17 Wi-Fi.
- .18 Auto Fan.
- .19 Leak detection.
- .3 Remote Controllers:
  - .1 Refer to article - Controllers for Indoor Units, in this Section, for additional controller options.
- .7 Condensate:
  - .1 Unit designed for gravity draining of condensate.
  - .2 Factory insulated flexible drain hose.
  - .3 Condensate drain pan constructed of expandable polystyrene resin.

#### **1.08 VRF SYSTEM MAIN CONTROL SYSTEMS**

- .1 Features:
  - .1 Consist of low voltage communication network of unitary built-in controllers with on-board communications and web-based operator interface.
  - .2 Web controller with network interface card gathers data from system and generates web pages accessible through conventional web browser on each PC connected to network.
  - .3 Operators perform normal operator functions through web browser interface.
  - .4 Furnish energy conservation features such as optimal start, night setback, request-based logic, and demand level adjustment of overall system capacity as specified in sequence.
  - .5 Provide direct and reverse-acting on and off algorithms based on input condition or group conditions to cycle binary output or multiple binary outputs.
  - .6 Provide capability for future system expansion to include monitoring and use of occupant card access, lighting control and general equipment control.
  - .7 Email generation for remote alarm annunciation.
  - .8 Unit operating time monitoring with notification of when maintenance such as for filters is required.
  - .9 Control System Startup performed by system manufacturer authorized and factory trained technician.

#### **1.09 CONTROLLERS FOR INDOOR UNITS**

- .1 Controllers to be provided by same manufacturer as VRF system manufacturers.
- .2 Wired Programmable Remote Controllers:



- .1 Operate as primary or secondary controller when two remote controllers are connected to single indoor unit or group.
- .2 Wall-mounted thermostat that maintains room temperature by controlling system operation.
- .3 Features:
  - .1 Backlight LCD display.
  - .2 Mode settings: Cool, heat, dry, fan, and auto.
  - .3 Room temperature display.
  - .4 Fan speed setting.
  - .5 Louver swing setting.
  - .6 Programmable weekly scheduling
  - .7 ON / OFF.
  - .8 Clock and timer setting.
  - .9 Dual set-point control.
  - .10 Error display.
  - .11 Group Control.
  - .12 Touch Buttons.
  - .13 Clock.
  - .14 Addressing capability.
- .3 Touchscreen Wired Controllers:
  - .1 Low voltage wall-mounted controller that maintains room temperature by controlling system operation.
  - .2 Features:
    - .1 Touchscreen.
    - .2 Group control.
    - .3 Dual setpoint control.
    - .4 Programmable weekly scheduling.
    - .5 Mode Setting: Fan Speed, Swing.
    - .6 Room temperature display.
    - .7 Addressing capability
    - .8 Error code display
- .4 Touchscreen Central Controllers:
  - .1 Low voltage, wall-mounted controller that provides site-level control of multiple systems.
  - .2 Controlling multiple indoor units individually with capability to program multiple schedules.
  - .3 Allows central management of mode, setpoint and scheduling of indoor units.
  - .4 Features:
    - .1 Touchscreen.
    - .2 Three levels of account management for up to 20 users.
    - .3 Remote access to system.
    - .4 Alarm notification via email.
    - .5 Dual setpoint control.
    - .6 Programmable weekly scheduling.
    - .7 Settings: Mode, fan speed, swing, temperature range and dual setpoint control.
    - .8 Digital input and digital output.
    - .9 Controls up to minimum 100 indoor units.
    - .10 Recognize units automatically.
    - .11 Error code display.

.5 BMS/BAS System Control:

- .1 System controlled by BACnet protocol of BMS/BAS either directly or through external gateway.
- .2 Controlling:
  - .1 ON / OFF.
  - .2 Operation mode.
  - .3 Fan speed.
  - .4 Louvers
  - .5 Set temperature.
  - .6 Permit / prohibit local operation.
- .3 Monitoring:
  - .1 ON / OFF.
  - .2 Operation mode.
  - .3 Fan speed.
  - .4 Louvers
  - .5 Set temperature.
  - .6 Permit / prohibit local operation.
  - .7 Room temperature.
  - .8 Error status.
  - .9 Error code.

**1.10 REFRIGERANT LEAK DETECTORS**

- .1 Provide refrigerant leak detectors in accordance with:
  - .1 Codes and AHJ requirements.
  - .2 ANSI/ASHRAE Standard 15 and ANSI/ASHRAE Standard 34.
  - .3 CSA B52.
- .2 Operations:
  - .1 Detectors sense refrigerant and activates alarm and initiates room ventilation system.
  - .2 Alarms consist of energized light on or near detector as well as second light installed on outside wall next to room entrance.
  - .3 Exterior light provided with sign that warns personnel entering mechanical room of refrigerant release and that self-contained breathing apparatus is required to enter.
- .3 Detectors:
  - .1 Continuously-operating, halogen-specific type refrigerant leak detectors appropriate for type of refrigerant in use.
  - .2 Specifically designed for area monitoring and include sampling points installed where indicated.
  - .3 Design and construction compatible with temperature, humidity, barometric pressure and voltage fluctuations of operating area.
  - .4 Adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm).
  - .5 Supplied factory-calibrated for appropriate refrigerant.
  - .6 Alarm relay outputs which energize when detector detects refrigerant level at or above toxicity measurement consistent therewith for refrigerant in use.
  - .7 Factory set high alarm levels and pre-alarm levels.
  - .8 Visual indication: Multicolor status LED indication.
  - .9 Audible alarm: Integral alarm device sounding at 85dB @ 3 m.

- .10 Relays capable of initiating corresponding alarms and ventilation system as noted.
  - .11 Failure relay output that energizes when monitor detects a fault in its operation.
  - .12 Power supply.
  - .13 Compatible with integrated communications with Division 25 building automation system, allowing for generating electronic log of refrigerant level in operating area, monitoring for detector malfunctions and monitoring for any refrigerant alarm conditions.
- .4 Remote Alarm Lamp and Audio Device:
- .1 Minimum 25 mm diameter red LED lamp and audible horn device mounted on single gang stainless steel faceplate.
  - .2 Integral reset switch deactivates alarms and resets.
  - .3 Circuitry for connection to detector relays to illuminate lamp and audible device upon detector activation.
  - .4 Approved for specific applications.
  - .5 Engraved identification nameplate.

#### **1.11 SIGNAGE**

- .1 Refrigerant Signs:
- .1 In accordance with codes and AHJ requirements.
  - .2 Medium-weight aluminum type with baked enamel finish
  - .3 Corrosion resistant.
  - .4 Unless otherwise directed, white background with red letters not less than 13 mm in height.
  - .5 Identification of:
    - .1 Installing Contractor name.
    - .2 Refrigerant number and amount of refrigerant.
    - .3 Lubricant identity and amount.
    - .4 Field test pressure applied.
    - .5 Other requirements of AHJ.

#### **1.12 MANUFACTURER PRE-DELIVERY FACTORY INSPECTION AND TESTING**

- .1 At factory, inspect and pressure test each unit. Test components.
- .2 Certify test results and forward copies of certified test results to Consultant.
- .3 Allow Consultant option to factory witness testing units. Schedule testing at times reviewed with and recommended by Consultant.
- .4 Where unit fails to meet specified requirements, rectify and perform re-testing described above. Consultant to have option to witness retesting.
- .5 Do not ship units until such time as testing is proven to meet specified requirements and is recommended for acceptance by Consultant.

#### **1.13 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 VRF HVAC Systems:
- .1 Mitsubishi.

- .2 Daikin.
- .3 Carrier/Toshiba.
- .4 LG.

.2 Refrigerant Leak Detectors:

- .1 Bacharach (MSA Safety).
- .2 Emerson.

## **2 EXECUTION**

### **2.01 INSTALLATION OF VRF SYSTEMS**

- .1 Verify refrigerant type being utilized and provide proper system units from manufacturer.
- .2 Obtain installation instructions and detailed drawings specific to each unit, from unit manufacturers.
- .3 Provide units in locations. Assemble and install units level and plumb with neoprene isolation pads on concrete pads as noted. Install in accordance with CSA B52.
- .4 Anchor units in accordance with seismic restraint requirements and in accordance with requirements of AHJ and building codes. Provide flexible connections in piping connections to units.
- .5 Coordinate exterior roof top work with general trades and roofing work.
- .6 Coordinate connection of water and drain piping to units with plumbing trade. Provide drainage piping trapped.
- .7 Install components shipped loose with units. Calibrate control components requiring field calibration.
- .8 Install piping in accordance with requirements of AHJ, system manufacturer and Section 23 23 10 - Refrigerant Piping, Valves and Accessories. Prepare and flush piping prior to connection to units.
- .9 Provide pressure gauges in readily accessible locations.
- .10 Coordinate installation of each unit with other trades making connections to unit. Provide electrical power connections as coordinated with electrical work of Division 26. Provide connections to BMS/BAS control connections, as coordinated with requirements of work of Division 25. Perform required wiring and piping to interconnect units, and other control wiring.
- .11 Install indoor units suiting intended applications suiting type of units. Coordinate units installed within and to ceiling structures with structural trades. Install units in locations not obstructing air circulation in accordance with manufacturer guidelines. Submit structural support details with shop drawings.
- .12 Electrical Connections: Coordinate with electrical work of Division 26 in providing:
  - .1 Electrical power, disconnect switches, circuit breakers, electrical protection devices, conduits and wiring.

- .2 Connections to units, controls and auxiliary equipment.
- .3 Integration of system controls with other building systems and equipment.
- .13 Install controllers in locations as noted. Install wall-mounted controllers in flush mounted boxes unless otherwise noted.
- .14 Programme units and controller suiting sequence of operations reviewed with Consultant and approved by Owner. Submit proposed sequence of operations for review prior to start of Work.

## **2.02 INSTALLATION OF REFRIGERANT LEAK DETECTORS**

- .1 Verify refrigerant type being utilized and provide proper refrigerant sensor from manufacturer.
- .2 Provide refrigerant leak detectors, locate as noted and connect complete.
- .3 Mount detectors/sensors at proper height in accordance with manufacturer installation instructions.
- .4 Install and connect to provide sequence of operation and communications as confirmed with Owner and reviewed with Consultant.
- .5 Provide wiring and interconnections to ventilation equipment when alarm condition occurs. Interconnect detector relays to remote alarm lamp units. Perform alarm wiring in accordance with manufacturer certified wiring diagrams and Division 26 electrical work wiring requirements.

## **2.03 IDENTIFICATION AND SIGNAGE**

- .1 Provide product with engraved lamicoid nameplates.
  - .1 Provide identification nameplates on equipment enclosures identifying equipment and performance ratings.
- .2 Provide identification nameplates and tags and labelling on valves and controls.
- .3 Main Nameplates: Size No. 4 unless otherwise noted, and engraved as noted.
- .4 Install refrigerant warning signs where noted and as required by AHJ.
- .5 Review signage nomenclature with Consultant prior to ordering.

## **2.04 FIELD QUALITY CONTROL**

- .1 Manufacturer Technician Field Services:
  - .1 Performing initial examination and certification of installation.
  - .2 Performing start-up and basic commissioning procedures.
  - .3 Submitting compliance certificates verifying installation and operations of equipment.
- .2 Piping Systems:
  - .1 Perform inspection and testing of piping systems.

- .2 Provide record of pressure check process recorded and tagged at the outdoor unit.
- .3 Tag to identify:
  - .1 Date and time of pressure check start.
  - .2 Fill pressure.
  - .3 Outdoor temperature at start and stop.
  - .4 Date and time of pressure check completion.
  - .5 Test technician name and company information completing pressure check.
- .3 Inspection, Start-up, Testing, Commissioning and Verification:
  - .1 Perform inspection and start-up procedures, and programming as recommended by manufacturer. Confirm installation checklist items are completed.
  - .2 Verify that equipment is secured to supports, and that piping and electrical connections are complete.
  - .3 Verify that cleaning and adjusting is complete.
  - .4 When installation is complete start-up each system, set and adjust controls and safeties, check operating controls.
  - .5 Adjust systems in accordance with requirements of AHJ and user defined system performance measures.
  - .6 Check for safe and proper operation.
  - .7 Verify for proper installation, adjustment, fine tuning and system initiation.
  - .8 Test and adjust controls and safeties.
  - .9 Verify control and monitoring control panels.
- .4 Arrange for manufacturer technician to inspect installations and issue compliance certificates to include with reports.
- .5 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.
- .6 Where delegated design, include for delegated design Professional Engineer to witness testing and also sign reports.
- .7 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system manufacturer certification requirements.
- .8 Refer to Section entitled Basic Mechanical Materials and Methods for equipment/system start-up requirements.
- .9 Include for half day (4 hours) of on-site operation demonstration and training session. Training is to be a full review of all components including, but not limited to, a full operation and maintenance demonstration, with control set-up and abnormal events.

**END OF SECTION**

**DIVISION 26**

**ELECTRICAL**

Section 26 00 10	Electrical Work General Instructions
Section 26 05 00	Common Work Results for Electrical
Section 26 05 05	Selective Demolition for Electrical
Section 26 05 19	Low Voltage Electrical Power Conductors and Cables
Section 26 05 20	Wire and Box Connectors (0-1000V)
Section 26 05 26	Grounding and Bonding for Electrical Systems
Section 26 05 29	Hangers and Supports for Electrical Systems
Section 26 05 31	Splitters and Electrical Boxes
Section 26 05 32	Outlet Boxes Conduit Boxes and Fittings
Section 26 05 34	Conduits, Conduit Fastenings and Fittings
Section 26 05 43	Installation of Cables in Trenches and in Ducts
Section 26 05 45	Concrete Products for Electrical
Section 26 05 48	Vibration and Seismic Controls
Section 26 05 52	Direct Buried Underground Cable Ducts
Section 26 05 90	Hazardous Materials
Section 26 22 13	Low Voltage Distribution Transformers
Section 26 23 00	Low Voltage Switchgear and Switchboards
Section 26 24 16	Panelboards
Section 26 27 26	Wiring Devices
Section 26 28 13	Fuses - Low Voltage
Section 26 28 17	Low Voltage Breakers
Section 26 28 28	Ground Fault Protection Equipment
Section 26 28 23	Disconnect Switches - Fused and Non-Fused
Section 26 32 13.16	Solar Photovoltaics
Section 26 43 00	Surge Protective Devices

**DIVISION 28**

**ELECTRONIC SAFETY AND SECURITY**

Section 28 46 02	Existing Fire Alarm System Work
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**DIVISION 33**

**UTILITIES**

Section 33 65 73	Concrete Encased Duct Banks and Manholes
Section 33 65 76	Direct Buried Underground Cable Ducts
Section 33 71 75	Underground Electrical Services

**END OF DOCUMENT**

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**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1 Unless otherwise noted, this Section is common to each Section of Division 26, Division 27 and Division 28, and supplements each Section and read accordingly.
- .2 Division 00 and Division 01.
- .3 Where requirements of this Section contradict requirements of Divisions 00 or 01, conditions of Division 00 or 01 to take precedence, as confirmed with Owner and reviewed with Consultant prior to Bid submission.
- .4 Advise product manufacturer and vendors, and trades of each Section, of requirements of this Section. Product manufacturers and vendors are responsible for complying with specified product requirements.

**1.2            REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.1-24, Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C235-19, Preferred Voltage Levels for AC Systems up to 50 000 V.
- .2 Institute of Electrical and Electronics (IEEE):
  - .1 IEEE Standards Dictionary.
- .3 National Research Council Canada (NRC):
  - .1 NBC-2020, National Building Code of Canada.
- .4 Ontario Building Code (OBC), 2012 with amendments to 2024.

**1.3            DEFINITIONS**

- .1 Electrical and electronic terms, unless otherwise defined in Specifications or on Drawings, are those defined by IEEE Standards Dictionary.
  - .2 AHJ: Authority Having Jurisdiction.
  - .3 As noted: Directs reader to refer to schedules, drawings (layouts, riser diagrams, schematics, details) and Specification for additional information.
  - .4 BAS: Building Automation System. Equivalent terms include Building Management System (BMS), Energy Management and Control System (EMCS) or Facility Management System (FMS). Typically, generically referenced in Divisions other than Division 25. Refer to Division 25 for final terminology used and system requirements.
  - .5 Compliance Certificates: Approval documentation of products or installation work issued by AHJ or product manufacturers, as specified.
  - .6 Concealed: Hidden from normal sight in furred spaces, shafts, ceiling spaces, walls and partitions.
  - .7 Delete or Remove (and tenses of delete or remove): Disconnect, make safe, and remove obsolete materials in planned deconstruction and disassembly of electrical items from existing construction including removal of conduit, junction boxes, cabling and wiring from electrical component to panel, taking care not to damage adjacent assemblies designated to remain. Legally dispose of deleted items off site. Patch and repair/finish surfaces to match adjoining similar construction. Re-program systems to suit deletions. Revise documentation identifications to suit deletions. Retain items indicated as removed and salvaged. Retain items indicated as removed and reinstalled.
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- .8 Demolish: Delete or remove, and detach items from existing construction and if not indicated as retained or salvaged, legally dispose of items off site. Retain items indicated as removed and salvaged, or removed and reinstalled.
- .9 Electrical Divisions: Typically, refers to Divisions 26, 27, 28 and other Divisions as specifically noted and which work as defined in Specifications or on drawings is responsibility of Electrical Contractor, unless otherwise noted.
- .10 Existing to Remain: Existing items of construction that are not removed and that are not otherwise indicated as being removed and salvaged, or removed and reinstalled.
- .11 Exposed: Work normally visible, including work in equipment rooms, service tunnels, and similar spaces.
- .12 Finished: When in description of area or part of area or product which receives finish such as paint, or in case of product may be factory finished.
- .13 Install (and tenses of install): Secure in position, connect, test, adjust, verify and certify complete, ready for its intended use.
- .14 Local: In context to authorities or codes or standards, means of place of Work, unless otherwise noted.
- .15 Mechanical Divisions: Typically, refers to Divisions 21, 22, 23, 25 and other Divisions as specifically noted and which work as defined in Specifications or on drawings is responsibility of Mechanical Contractor, unless otherwise noted.
- .16 Professional Engineer: Individuals registered or licensed in Place of Work, by respective provincial or territorial associations that regulate practice of engineering in Canada.
- .17 Provision or provide (and tenses of provide): In context of products, means supply, install and test complete, ready for its intended use.
- .18 Remove and Reinstall: Detach items from existing construction, prepare them for reuse, check for proper working condition and reinstall them where indicated.
- .19 Remove and Salvage: Detach items from existing construction and deliver them ready for reuse, to onsite storage areas, as reviewed with Consultant.
- .20 Supply: Procure, arrange for delivery to site, inspect, accept delivery and administer supply of products. Distribute to areas and provide manufacturer assistance for required onsite testing, initial start-up, programming, basic commissioning and verification work.
- .21 Wherever words "indicated", "shown", "noted", "listed", "scheduled" or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean product referred to is "indicated", "shown", "listed", "noted" or "scheduled" in Contract Documents. When such references are used and do not identify exactly where in Contract Documents to refer to, examine issued Contract Documents and if unable to locate, submit request for information to Consultant.
- .22 Wherever words "reviewed", "satisfactory", "as directed", "submit", or similar words or phrases are used in Contract Documents they are understood, unless otherwise defined, to mean that work or product referred to is "reviewed by", "to satisfaction of", or "submitted to" Consultant.

#### **1.4 CONTRACT DOCUMENTS**

- .1 Specification is typically generally arranged in coordination with guidelines of Construction Specifications Institute/Canadian Specifications Canada (CSI/CSC) 50 Division MasterFormat.
- .2 Drawings and Specifications are portions of Contract Documents and identify labour, products and services necessary for performance of Work and form a basis for determining pricing. They are intended as complementary. Perform Work that is shown,

- specified, noted or reasonably implied on drawings but not mentioned in Specification, or vice-versa, as though fully covered by both.
- .3 Sections of Specifications generally designate a basic unit of work, and Sections are read as whole.
  - .4 Except where specifically noted, Specification does not typically indicate specific number of items or quantities of material required. Specification is intended to provide product data and installation requirements. Refer to schedules, Drawings (layouts, riser diagrams, schematics, details) and Specification to provide correct quantities. Singular may be read as plural and vice versa.
  - .5 Drawings are performance drawings, diagrammatic, and show approximate locations of equipment and materials. Take accurate measurement of building on site. Do not scale Drawings, and do not use Drawings for prefabrication work.
  - .6 Drawings convey scope of work and do not show architectural and structural details. Provide fittings, offsets, transformations and similar items required as a result of obstructions and other architectural or structural details not shown on Drawings.
  - .7 Locations of equipment and materials shown may be altered, when reviewed by Consultant, to meet requirements of equipment or materials, other equipment or systems being installed, and of building, at no additional cost to Contract.
  - .8 Starter/motor control centre (MCC)/variable frequency drive (VFD) schedule drawings are both mechanical and electrical and apply to work of Mechanical Divisions and Electrical Divisions. Review starter, MCC, VFD, and motor specification requirements of both Electrical and Mechanical Divisions specifications and drawings, prior to Bid submission. Review and coordinate exact scope of work and responsibility of work between Mechanical Divisions and Electrical Divisions.
  - .9 If there is conflict or discrepancy between, among or within any provisions of Contract Documents, provisions establishing higher quality, manner or method of performing the Work, using more stringent standards, prevails, with intent that provisions which produce higher quality with higher levels of safety, reliability, durability, performance and service prevails.
  - .10 Upon finding discrepancies in, or omissions from Contract Documents, or having doubt as to their meaning or intent, notify Consultant.
  - .11 Language within Specification is in many cases written in imperative mode for brevity. Clauses containing instructions or directions are directed to Contractor.
  - .12 Drawings and Specifications are prepared solely for use by party with whom Consultant has entered into a contract and there are no representations of any kind made by Consultant to any other party.

## **1.5 METRIC AND IMPERIAL MEASUREMENTS**

- .1 Generally, metric units of measurement (typically SI) are given in Sections of Specification. Measurement conversions may be generally "soft" and rounded off from imperial units. Industry common standard units also are specified. Confirm exact measurements based on application. Where measurements are related to installation and onsite applications, confirm issued document measurements with applicable governing code requirements, and as applicable, make accurate measurements onsite. Where significant discrepancies are found, notify Consultant for direction.
- .2 Some units are specified in imperial units with use based on common trade terms.

## **1.6 EXAMINATION OF DOCUMENTS AND SITE**

- .1 Carefully examine Documents and visit site to determine and review existing site conditions that will or may affect work and include for such conditions in Bid Price.
- .2 Report to Consultant, prior to Bid Submittal, existing site conditions that will or may affect performance of Work in accordance with Documents. Failure to do so will not be grounds for additional costs.

## **1.7 SUBMITTALS**

- .1 Submit electronic copies of submittals, unless otherwise noted.
- .2 Submit product data and shop drawings as specified in Sections.
- .3 Where required by AHJ, provide submittals to such authorities for review and approval. Obtain submission requirements from AHJ. Before making changes requested by AHJ, review with Consultant. Where required for permit approvals, submit plans before commencement of work.
- .4 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .5 Shop Drawings:
  - .1 Where specifically specified for products or work, submit shop drawings stamped and signed by Professional Engineer.
  - .2 At start-up meeting, review with Consultant, products for including in shop drawing submission. Prepare and submit list of products to Consultant for review.
  - .3 Properly identify each shop drawing or product data sheet, with project name and product drawing or specification reference. Shop drawing or product data sheet dimensions are to match dimension type on drawings.
  - .4 Limit shop drawing submissions specifically to product (not family of products), without extraneous materials such as manufacturer brochures and sales materials.
  - .5 Submit each system and each major component as separate shop drawing submissions. Submit together, shop drawings for common devices such as devices of each system.
  - .6 Obtain shop drawings for submission from product manufacturer authorized representatives and supplemented with additional items specified herein.
  - .7 Do not order product until respective shop drawing review process has been properly reviewed with Consultant.
  - .8 Where extended warranties are specified for equipment items, submit specified extended warranty with shop drawing submittal.
  - .9 Ensure proposed products meet each requirement of Project. Endorse each shop drawing copy "CERTIFIED TO BE IN ACCORDANCE WITH ALL REQUIREMENTS". Include company name, submittal date, and sign each copy. Shop drawings that are received and are not endorsed, dated and signed will be returned for resubmitted.
  - .10 Consultant to review shop drawings and indicate review status by stamping shop drawing copies as follows:
    - .1 "REVIEWED" or "REVIEWED AS NOTED" (appropriately marked) - When Consultant review of shop drawing is final, Consultant to stamp shop drawing as respectively stated.

- .2 "REVISE & RESUBMIT" - When Consultant review of shop drawing is not final, Consultant to stamp shop drawing as stated, mark submission with comments, and return submission. Revise shop drawing in accordance with Consultant notations and resubmit.
- .11 Submit for review, shop drawings showing in detail design, construction, and performance of equipment and materials as requested in Specification. Prior to ordering and delivery of product to site, submit shop drawings for Consultant review and recommendations for acceptance. Prepare and submit following as applicable to respective product submissions:
  - .1 Product data, types and ratings (including short circuit withstand ratings on major equipment).
  - .2 Operating instructions and sequence of operations.
  - .3 Equipment dimension drawings including required clearances and service access requirements.
  - .4 Mounting arrangements.
  - .5 Equipment loads (self-weight, operating weight).
  - .6 System block diagrams.
  - .7 Connection wiring schematic diagrams.
  - .8 Functionality with integrated systems.
  - .9 Manufacturer certification of current model production.
  - .10 Certification of compliance to applicable codes.
  - .11 Spare parts.
  - .12 Maintenance schedules.
  - .13 Other items as listed in Specifications.
- .12 Identify with products, types of finishes and colours of final finishes. Submit colour samples/swatches.
- .13 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories and other items shown to verify coordinated installation.
- .14 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .15 Indicate on drawings, clearances for operation, maintenance, and replacement of equipment devices.
- .16 Supply opening sizes and locations to allow verification of their effect on design, and for inclusion on structural drawings where appropriate.
- .17 Submit product data of field applied glues, adhesives, solvent cements, paints, caulking, sealants, firestopping coatings and other similar materials, for Consultant review of VOC limits and chemical component limitations.
- .18 Indicate products having requirements for installation and energizing onsite soon after delivery to maintain manufacturer warranty and service life.
- .19 Submit detailed matrix identifying responsibilities related to door hardware and security devices.
- .20 Submit manufacturer documentation on start-up and operating procedures.
- .21 Submit manufacturer recommended maintenance schedules and procedures.
- .22 Submit manufacturer recommended spare parts and maintenance materials and tools.
- .6 Other Submittals:
  - .1 Electrical distribution system single line riser drawings.

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- .2 Fire alarm system riser drawings.
  - .3 Interference drawings.
  - .4 Layout drawings of equipment and access doors.
  - .5 Copies of reflected ceiling plan drawings and wall elevation drawings showing proposed access door locations.
  - .6 Sleeving drawings: Dimensioned location drawings indicating required sleeves and formed openings in structural poured concrete or precast concrete construction or in roofing, and locations of cutting or drilling required for work.
  - .7 Detailed section drawings of ceiling spaces.
  - .8 Backboard drawings.
  - .9 Drawing details of:
    - .1 Housekeeping pads (concrete pads).
    - .2 Inertia pads.
    - .3 Bases, supports, and anchor bolts.
    - .4 Seismic restraints as required.
  - .10 Permits and Fees:
    - .1 Determine appropriate respective AHJ for Work.
    - .2 Prior to start of construction, make application for approvals from AHJ, and obtain permits.
    - .3 Prior to start of Work, submit copy of permit or notification form and notification number issued by AHJ.
  - .11 Sustainability: Submit in accordance with Division 01 requirements.
  - .12 Samples:
    - .1 Submit samples for products as noted.
    - .2 Unless otherwise noted, do not use samples for construction of Work.
    - .3 Include:
      - .1 Product finishes: Colour swatches/chits.
      - .4 Other items as noted herein this Section and in other Sections.
  - .13 Manufacturer procedures and recommendations for product onsite testing and verification.
  - .14 Field Quality Control Reports:
    - .1 Manufacturer Field Reports: Submit, manufacturer certified report, verifying compliance of Work.
    - .2 Testing and Verification Reports: Submit testing and verification reports signed by testing technician for products as specified.
    - .3 Power System Studies: Submit studies as specified including final power system studies performed, documented and recommended for acceptance.
    - .4 Fire alarm system testing and verification report of each component of work. Provide devices certified working and in proper order.
  - .15 Compliance Certificates:
    - .1 Upon completion field quality control work, submit compliance certificates verifying installation and performance of installed systems and equipment.
    - .2 Upon completion of the Work submit certificate of acceptance from AHJ.
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## 1.8 AS-BUILT DRAWINGS

- .1 As work progresses at site, clearly mark in red in neat and legible manner on set of bound white prints of Contract drawings, changes and deviations from routing of services and locations of equipment shown on drawings, on daily basis, as required for Work. Use notes marked in red. Maintain white print red line as-built set at site for exclusive use of recording as-built conditions, keep set up-to-date, and available for periodic review. Mark changes as work progresses and as changes occur. Include following with as-built set:
  - .1 Dimensioned location of inaccessible concealed work.
  - .2 Locations of control devices with identification for each.
  - .3 Location and identification of devices in concealed locations such as accessible ceiling spaces and raised floors.
  - .4 For underground ducts, record dimensions, invert elevations, offsets, fittings, cathodic protection and accessories, as applicable, and locate and identify dimensions from benchmarks.
  - .5 Location of concealed services terminated for future extension and work concealed within building in inaccessible locations.
  - .6 Location and identification of main junction boxes and main pull boxes.
  - .7 Location of fire alarm devices and addresses of devices. Identify fire alarm zones.
  - .8 Identify routing and location of concealed conduits/ducts of diameter 50 mm and greater.
  - .9 Where applicable, changes to existing electrical systems, control systems and low voltage control wiring.
  - .10 Other items noted on drawings.
  - .11 Other items noted within Specifications.
- .2 Identify each drawing in lower right-hand corner in letters at least 12 mm high as follows: "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW ELECTRICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).
- .3 Submit copies to Consultant for review and comments, and make corrections as recommended by Consultant.
- .4 System Riser Displays:
  - .1 Prepare and submit for review "as-built" PDF drawings as follows:
    - .1 Electrical distribution riser diagram record of entire electrical distribution system up to and including line side connections to panelboards.
    - .2 Fire alarm system riser diagram record of entire system.
  - .2 Revise drawings incorporating any Consultant comments and obtain Consultant recommendations acceptance.
  - .3 Size diagrams same size as issued full size drawings. Mount final reviewed by Consultant, riser diagrams on 10 mm thick foam core with plexiglass cover, and hardware suitable for wall mounting.
  - .4 Mount and locate final version of electrical distribution system riser diagram in areas as follows:
    - .1 Main electrical room.
    - .2 Sub-electrical rooms as noted.
  - .5 Mount and locate final version of fire alarm system riser diagram in locations as specified in Section 28 46 00 - Multiplex Fire Alarm and Voice Communications Systems.

- .5 Unless otherwise noted in Divisions 00 or 01, failure to maintain accurate record drawings will incur additional 5% holdback on progress claims until drawings are brought up to date to approval of Owner and reviewed with and recommended for acceptance by Consultant.
- .6 For projects with phased turnover of project (refer to Division 01), review with Consultant completeness of as-built drawings prior to turnover of an area. Make copies of hand drawn interim as-built drawings available to Owner maintenance personnel.
- .7 Prepare and submit for review with record drawings, a neat, clear, properly identified, "as-built" electrical distribution riser diagram record drawing of entire electrical distribution system up to and including line side connections to panelboards. Make building and room outlines reflecting "as-built" outlines. Include in diagrams for feeder types and sizes, conduit sizes, breaker, switchboard and distribution panel ratings, and other electrical equipment ratings. Submit sample version to Consultant for review and comments prior to final manufacturer. Size diagrams same size as issued full size Drawings. Mount riser diagrams on minimum 10 mm thick foam core complete with mylar finish cover, and hardware suitable for wall mounting in main electrical room.
- .8 Include on single lines, panelboard locations identified by room numbers below panel. When specific identified location is not available, identify nearest available room number followed by triangle ( $\Delta$ ) flagging approximate location. Encircle various loads by Building Wings (where applicable) for ease of identification. Group lighting loads on panelboards on top of panel. Identify fuse sizing including existing equipment where there is no difficulty in obtaining information. Review exact requirements with Consultant prior to commencing work.
- .9 Replace existing posted single line electrical distribution drawings with revised drawings reflecting renovations and revisions to electrical distribution equipment. Provide drawings of type matching existing as confirmed with Owner and reviewed with Consultant. Supply electronic files of format confirmed with Owner and reviewed with Consultant for following:
  - .1 Fire alarm system test report devices and addresses.
- .10 Submit electronic version of completed reproducible as-built drawings with Operating and Maintenance (O & M) Manuals.

## **1.9 OPERATION AND MAINTENANCE (O & M) MANUALS**

- .1 Prepare and submit project specific, indexed copies of equipment manufacturer O & M instruction data manuals. Consolidate each copy of data in identified hard cover three "D" ring binder.
- .2 Operating and maintenance instructions relate to job specific equipment supplied under this project and relate to project building. Language used in manuals contain simple practical operating terms and language easy for in-house maintenance staff to understand how to operate and maintain each system/equipment.
- .3 Supply manuals in English language.
- .4 Include electronic PDF version saved on USB type flash drives.
- .5 Prepare O & M manuals for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
- .6 For each system and equipment identify manufacturer name, type, model year, ratings (performance, capacity, electrical data as applicable) and serial number.
- .7 O & M Data: Obtain operation and maintenance data for products for incorporation into manuals. Include following:

- .1 Front Cover Clearly Labelled: Project name label; wording - "Electrical Systems Operating and Maintenance Manual"; with specific system/equipment name highlighted, and date.
- .2 Introduction sheet listing Subcontractor and trades names, street addresses, telephone number and e-mail addresses.
- .3 Equipment manufacturers authorized distributor, telephone number, e-mail and company website.
- .4 Table of Contents sheet, and corresponding index tab sheets.
- .5 Copy of each reviewed shop drawing. Limit shop drawing documentation to specific product requirements as specified for Shop Drawings.
- .6 Product manufacturer name, type, model year, capacity and serial number.
- .7 Description of systems and their controls. Include systems architecture and operating data.
- .8 Parts lists with catalogue numbers.
- .9 Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
- .10 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
- .11 Colour-coding charts.
- .12 Safety precautions.
- .13 Maintenance and Operating:
  - .1 Servicing, maintenance, operation and trouble-shooting instructions for each item of equipment.
  - .2 Schedules of tasks, frequency, tools required and task time.
  - .3 Recommended spare parts and maintenance materials for systems and equipment.
  - .4 Contact names and addresses of servicing companies and locations where to obtain replacement parts.
- .14 Performance Data:
  - .1 Equipment manufacturer certified factory test reports.
  - .2 Equipment manufacturer certified performance datasheets with point of operation as left after commissioning is complete.
  - .3 Equipment performance certified verification test results.
  - .4 Special performance data as specified.
- .15 Procedures in event of equipment failure.
- .16 Copies of inspection reports or certificates issued by AHJ.
- .17 Copies of panelboard typed directories of circuit breakers and circuits.
- .18 Copies of warranties.
- .19 Other items of instruction as recommended by manufacturer of each system or item of equipment.
- .20 Other items noted within Specifications.
- .8 Provide operating instructions on signage for specific equipment/systems as noted.
- .9 Submit copies of draft O & M manuals to Consultant in format reviewed with and recommended for acceptance by Consultant. Combine material as specified and not as individual submissions.
- .10 Make changes as reviewed by and recommended by Consultant and re-submit.
- .11 Additional Data: Prepare and insert into O & M manual additional data when need for it becomes apparent during specified demonstrations and instructions.



- .12 Prepare and submit final reviewed with Consultant O & M manuals, with Consultant comments incorporated. Submit as directed in Division 01.

#### **1.10 CLOSEOUT SUBMITTALS**

- .1 Prior to application for Substantial Performance of the Work, submit items and documentation noted, including following:
  - .1 O & M Manuals.
  - .2 As-built record drawings and associated data.
  - .3 Emergency battery unit lighting test letter.
  - .4 Seismic review letter, stamped by a seismic engineer, indicating the drawings and restraints, and installations have been reviewed on site and are in conformance with the requirements of the OBC.
  - .5 Final fire alarm verification report, free of deficiencies.
  - .6 Final ESA inspection report.
  - .7 Meggering results.
  - .8 Extended warranties for equipment as noted.
  - .9 Operating test certificates.
  - .10 Final commissioning reports.
  - .11 Identified keys for equipment and/or panels for which keys are required, and other items required to be submitted.
  - .12 Other data or items as noted.

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

- .1 Deliver, store and handle materials as specified, in accordance with Division 01 and manufacturer instructions.
- .2 Delivery and Acceptance Requirements:
  - .1 Deliver materials to site in original factory packaging, labeled with manufacturers name and address.
  - .2 Review and coordinate equipment deliveries with manufacturers and suppliers, and Consultant so equipment is delivered to site when it is required, or so it can be stored.
- .3 Storage and Handling Requirements:
  - .1 Store materials indoors in accordance with manufacturers recommendations in clean, dry, and well-ventilated area onsite, as confirmed with Owner and as reviewed with Consultant.
  - .2 Store and protect products from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new. Remove rejected material and equipment site.
  - .4 Touch up damage to factory finishes. Use finishes to match factory finishes. Do not paint over nameplates or labels.
  - .5 Hoisting and Transporting:
    - .1 Hoist and transport materials and equipment as required.
    - .2 Coordinate with Prime Contractor or General Contractor.
    - .3 Review procedures with Consultant.
    - .4 Review use of elevators and Owner permissions with Consultant. Review limitations of dimensions and loading of elevators that are permitted for use. Where such elevators are permitted for use, prepare schedule of

use, detailing date and time frame, materials and equipment being transported and loads. Submit copy for Consultant review and recommendations for acceptance.

- .5 Refer to requirements of Division 01.
- .4 Develop Construction Waste Management Plan in accordance Division 01.
- .5 Packaging Waste Management: Remove for reuse as specified in Division 01.

## **1.12 QUALITY ASSURANCE**

- .1 Pre-Installation Meeting: Convene pre-installation meeting minimum one week prior to beginning onsite installations as reviewed with Consultant to:
  - .1 Verify project requirements.
  - .2 Review installation and substrate conditions.
  - .3 Co-ordinate with other building subtrades.
  - .4 Review manufacturer installation instructions and warranty requirements.
- .2 Submit following as specifically referenced for products in respective Sections, and as reviewed with Consultant:
  - .1 Factory inspection and test report for equipment. Include copy of each report with operating and maintenance manual project close-out data.
  - .2 Manufacturer/supplier installation compliance certificates.
  - .3 Onsite post installation test reports.

## **1.13 QUALITY OF WORK**

- .1 Perform work so that items are and remain plumb, square and straight. Provide materials and equipment that are free from warping, twisting and other defects.
- .2 Install products in accordance with manufacturer instructions and recommended usage, unless otherwise noted and suiting intended installation requirements. Obtain instructions from manufacturer representative on special installation procedures.
- .3 Perform work in accordance with requirements of AHJ.
- .4 Where installation procedures conflict, review with Consultant prior to proceeding with installation and obtain direction.
- .5 Run exposed conduit and duct runs including runs in ceiling spaces, parallel to building lines unless otherwise noted. Mount panels, boxes, covers, and such other products in similar manner.
- .6 Replace bolts and nuts in "stripped" condition. Replace bolts and nuts in "cross threaded" condition.
- .7 Avoid connection between dissimilar metals. Where such applications cannot be avoided, provide compound or other means recommended for such applications to prevent effects of contact between dissimilar materials.
- .8 Avoid use of material that corrodes when exposed to moisture, in wet locations or damp locations.
- .9 Conceal rough-in work in areas except where surface installations are specifically indicated. Where this becomes impossible and before proceeding with work, review with Consultant, to determine what adjustments to make.
- .10 Maintain superintendent onsite at times when work is being performed.

## **1.14 REGULATORY REQUIREMENTS**

- .1 Comply with requirements of:
  - .1 Governing Ministry of Labour.
  - .2 Workplace Hazardous Materials Information System (WHMIS).
  - .3 Occupational Health and Safety Act.
  - .4 AHJ governing codes, regulations and standards.
- .2 Where code, regulation, bylaw, standard, contract form, manual, printed instruction, and installation and application instruction is quoted it means, latest published edition adopted by and enforced by AHJ, unless edition date is specified. Comply with revisions, bulletins, supplementary standards or amendments issued by AHJ. Comply with federal and provincial codes and standards. Prior to start of Work, confirm edition dates being enforced for Project.
- .3 Where regulatory codes, standards and regulations are at variance with each other, or with Drawings or Specification, more stringent requirement applies. In doubt, review with Consultant.
- .4 Comply with requirements for barrier free access.
- .5 Perform Work in accordance with requirements of CSA C22.1 and provincial electrical code.
- .6 Perform Work in accordance with requirements of NBC and provincial building code, and codes and standards listed throughout Specification.
- .7 Work is to be performed by journeyperson who perform only work that their certificates permit, or by apprentices under direct onsite supervision of experienced journeyperson, in accordance with requirements of AHJ and local rules and regulations.
- .8 Journeypersons are to have copy of valid trade certificates available at site for review by Consultant.
- .9 Engage Professional Engineers to provide delegated design work of respective Sections, to prepare, design, and sign and seal engineered delegated design submittals.
- .10 Qualifications of Professional Engineers retained by Contractors to perform consulting services and provide engineered delegated designs with regard to Project work, such as seismic engineer, fire protection engineer or structural engineer:
  - .1 Legally qualified to practice professional engineering in Place of the Work.
  - .2 Experienced in work of respective Sections as noted.
  - .3 Carry and pay for errors and omissions professional liability insurance in compliance with requirements of AHJ in Place of the Work.
- .11 Retained engineers professional liability insurance protects Contractor consultants and their respective servants, agents, and employees against any loss or damage resulting from professional services rendered by aforementioned consultants and their respective servants, agents, and employees in regard to the Work of this Contract.
- .12 Unless otherwise specified in Divisions 00 and 01, liability insurance requirements are as follows:
  - .1 Coverage of minimum of \$1,000,000.00 CDN inclusive of any one occurrence.
  - .2 Insurance policy cannot be cancelled or changed in any way without insurer giving Owner minimum thirty days written notice.
  - .3 Liability insurance obtained from insurer registered and licensed to underwrite such insurance in Place of the Work.

- .4 Retained consultants are to ascertain that sub-consultants employed by them carry insurance in form and limits specified above.
- .5 Evidence of required liability insurance in such form as may be required is issued to Owner, Owner Consultant, and AHJ as required prior to commencement of aforementioned consultant services.
- .13 Engineered delegated design submittals include, but not be limited to following:
  - .1 REVIT/CAD layout design drawings consisting of minimum 760 mm by 1050 mm detail working drawings of system layout and identifying as applicable:
    - .1 Head-end equipment.
    - .2 Devices.
    - .3 Applicable conduit/piping/ductwork layout and sizing.
    - .4 Applicable electrical point-to-point wiring diagrams.
    - .5 Data essential for proper installation of system.
    - .6 Details, plan view, elevations, and sections of system.
    - .7 Seismic restraints as required.
  - .2 Design data identifying:
    - .1 Calculations of system design listing design data used in preparing calculations, system layout, zoning and sizing, as applicable.
    - .2 Type and design of system.
    - .3 Certification that system has performed in manner intended.
    - .4 List of standards, codes and regulations that preparation of design was based.
  - .3 Manufacturer test data indicating results of factory tests on equipment prior to shipment.
  - .4 Items as noted in other Sections.
- .14 Responsibilities of Retained Engineers:
  - .1 Design, prepare, seal and sign engineered submittals.
  - .2 Perform periodic field reviews, including review of associated mock-ups where applicable, at locations wherever work as described by engineered submittal is in progress, during fabrication and installation of such work.
  - .3 Perform field reviews at intervals as necessary to progress of work.
  - .4 Determine if work is proceeding in general conformity with Contract Documents including reviewed shop drawings and design calculations.
  - .5 Submit field review report after each visit.
  - .6 Submit field review reports to Consultant and AHJ as required.
  - .7 Certifying that work has been supplied and installed in accordance with requirements of Contract Documents, AHJ and engineered submittal.

#### **1.15 DESIGNATED SUBSTANCES**

- .1 Hazardous substances removal by hazardous abatement specialist is not included as part of scope of this Project.
- .2 Hazardous substances are as defined in Hazardous Products Act.
- .3 Immediately notify Consultant when materials suspected of containing hazardous substances are encountered and perform following:
  - .1 Stop work in area of suspected hazardous substances.

- .2 Take preventative measures to limit user and worker exposure, provide barriers and other safety devices and do not disturb materials.
- .3 Proceed with work only after written instructions have been received from Consultant.

#### **1.16 PERMITS, CERTIFICATES, APPROVALS AND FEES**

- .1 Contact and confirm with AHJ including utility providers, requirements for approvals from such authorities.
- .2 Obtain and pay for permits, inspections and compliance certificates. Give required notices. Submit required applications, shop drawings
- .3 Provide electrical distribution system protection device coordination studies, short circuit calculation study, arc flash study and other information requested by AHJ.
- .4 Notify Consultant of proposed changes to documents requested by AHJ and obtain Consultant recommendations prior to making changes.
- .5 Provide notification as requested by AHJ, for AHJ to perform onsite inspection of work. Allow sufficient lead time to correct deficiencies in manner not impeding schedule of completion of Work. Where defect, deficiency or non-compliance is found in work by inspection, provide for such inspection including related expenses, making good and return to site, until work is accepted by AHJ.
- .6 Coordinate work inspection reviews and approvals with AHJ ensuring construction schedule is not delayed. Promptly notify deficiencies to Consultant and submit reports and certificates to Consultant.
- .7 Obtain and submit to Consultant, compliance certificates issued by AHJ that verifies Work as installed is in accordance with rules and regulations of AHJ and are acceptable by AHJ.
- .8 Include in each copy of operating and maintenance instruction manuals, copies of compliance certificates issued by AHJ.
- .9 Where electromagnetic locks are installed, ensure required certificates of work with regards to such electromagnetic lock work are obtained.

#### **1.17 ACCEPTABLE PRODUCT MANUFACTURERS AND VENDORS**

- .1 Products and services may generally be specified:
  - .1 With listing of acceptable manufacturers, vendors or service companies.
  - .2 With manufacturer model or series numbers listed.
  - .3 Base specified with manufacturer and model or series number.
- .2 Base Bid pricing on products supplied by base specified or listed acceptable companies. Unless otherwise noted, base pricing on model or series where listed. If only base specified company is specified with no other acceptable manufacturers listed, base pricing on base specified product.
- .3 Listing acceptable manufacturers/vendors does not imply automatic acceptance by Consultant or Owner. Ensure that any price quotations received, and submittals made are for products or services that meet or exceed specifications included herein. Ensure that acceptable products are equivalent in performance and operating characteristics (including energy consumption if applicable) to base specified products. It is understood that any additional costs (i.e. for larger starters, larger feeders, additional spaces), and changes to associated or adjacent work resulting from provision of product supplied by manufacturer other than base specified manufacturer, is included in Bid Price. In addition, in spaces where product named as acceptable is used in lieu of base specified product and dimensions of such product differs from base specified product, prepare and submit

for review accurately dimensioned layouts of rooms/ceiling plans affected, identifying architectural and structural elements, systems and equipment to prove that product in space will fit and perform properly meeting design intent. There will be no increase in Contract Price for revisions.

- .4 Where products are listed as “equal to” or equivalent to” or “approved equal”, other manufacturers may be proposed for review of acceptability by Consultant. Submit RFI with proposed manufacturer and model with detailed product specifications to Consultant during Bidding period. Acceptance is at sole discretion of Consultant and acceptance documented in addendum. Unless acceptance is given, do not include such products in Bid pricing.
- .5 When issued with Documents or requested by Consultant, complete and submit as directed, List of Proposed Acceptable Manufacturers and Vendors, or when directed by Consultant submit separate list of proposed manufacturers and vendors.
- .6 Changes to list of proposed manufacturers and vendors, initiated by Contractor after award of Contract may be considered by Consultant at Consultant discretion. Additional costs for such changes if approved by Owner and reviewed with and recommended for acceptance by Consultant, and costs for review, to be borne by Contractor.

#### **1.18 MATERIALS AND EQUIPMENT**

- .1 Provide material and equipment (products). Where products are indicated, scheduled or specified, they establish performance and quality standard, and in some instances, dimensional standard.
- .2 Ensure that selected products meet design intent and specified quality standards, performance criteria and operating characteristics. Ensure that product dimensions, weight and special conditions can be accommodated in spaces designated for installations. Where selected product installation requires changes to base design of architectural or structural nature, or changes to interconnected electrical or mechanical components, costs of such changes is borne by Contractor.
- .3 Product Certifications:
  - .1 Canadian Standards Association (CSA) certifications or Underwriters Laboratories of Canada (ULC) listings markings.
  - .2 References to UL listings of products to include requirements that products are also Underwriters Laboratories of Canada ULC / cUL listed for use in Canada.
  - .3 Other certification organizations accredited by Standards Council of Canada to approve electrical equipment may be acceptable subject to approval from electrical AHJ and review with and recommended for acceptance by Consultant.
  - .4 Certifications of standards as listed in trade Sections.
- .4 Provide systems and equipment that are most recent and up to date series/version of product available at time of shop drawing review process. Provide software of latest version available and with updates available at time of shop drawing review process. Provide software that is backwards compatible and such that future upgrades do not require hardware replacements or additions to utilize latest software.
- .5 Operating Voltages: In accordance with CSA C235.
- .6 Equipment located in extreme operating conditions: Provide to operate in extreme operating conditions in accordance with CSA C235 without damage to equipment.
- .7 Provide control devices and equipment rated for electrical utility connected line voltage operation, or where required low voltage, and operate at 60 Hz within normal operating limits established by above standard.

- .8 Determine short circuit current ratings at various levels of electrical distribution system and advise mechanical equipment vendors of rating requirements for equipment.
- .9 Factory assemble control panels and component assemblies.
- .10 Products (including associated installation and supporting hardware) located in non-climate controlled environments: Features for corrosion-resistant, weather-resistant, able to withstand various climatic conditions including hot and cold temperatures.
- .11 Products located in public spaces and which are located within hands reach: Features for tamper-proof and impact-resistant.
- .12 Supply inserts, anchors, bolts, sleeves, ferrules and other items built into work of other Divisions, complete with necessary templates, instructions and assistance for locating and installing.
- .13 Utilize materials of same manufacturer for similar aspects of work, where practical. Utilize same common manufacturer for wiring devices, such as switches and receptacles, whether installed loose or in pre-manufactured component. Coordinate with each supplier and ensure conformance with this requirement. Identify deviations to Consultant and obtain Owner approval of change prior to proceeding with work.
- .14 Systems that are of technology that changes rapidly and are forever evolving and changing, may result in systems or equipment that may be outdated by time of installation. Include provisions allowing Owner option to select most updated technology. During shop drawing submission period include provisions for minimum 15 working days review time for Owner to review degree of technology of each system/equipment and determine acceptance and give Owner right to substitute more advanced technology subject to negotiated pricing and time constraints of project.

#### **1.19 PRODUCT SUBSTITUTIONS**

- .1 Other manufacturers of products may be proposed as substitutions to Consultant for review and consideration for acceptance, listing in each case a corresponding credit for each substitution proposed. However, base Bid Price on products named as acceptable.
- .2 Certify in writing that proposed substitution meets space, power, design, energy consumption, and other requirements of listed acceptable product.
- .3 There will be no increase in Contract Price or Contract time by reason of any changes to associated equipment, mechanically, electrically, structurally or architecturally, required by acceptance of proposed substitution.
- .4 Consultant has sole discretion in accepting any such proposed substitution of product.
- .5 Do not order such products until they are approved by Owner and reviewed with Consultant.
- .6 Unless otherwise noted, substitutions will not be considered by Consultant during Bid period unless permitted by Owner and directions and submission areas are provided on Bid Form.
- .7 At Consultant discretion, Consultant may consider substitutions if formally requested in writing minimum of 10 working days prior to Bid closing date.
- .8 Documents have been prepared based on product available at time of Project Bidding. If, after award of Contract, and if successful manufacturer can no longer supply product that meets base specifications, notify Consultant immediately. Obtain other manufacturers product that complies with base specified performance and criteria and meets project timelines. Proposed products are subject to review and consideration by Consultant and are considered as substitutions subject to credit to Contract. In addition, if such products require modifications to room spaces, mechanical systems, electrical systems and other construction elements, include required revisions. Submit such revisions in detail to

Consultant for review and consideration for acceptance. There will be no increase in Contract Price for revisions.

## **1.20 CHANGES IN THE WORK**

- .1 Whenever Consultant proposes in writing to make a change or revision to design, arrangement, quantity, or type of any work from that required by Contract Documents, prepare and submit to Consultant for review, a quotation detailing proposed cost for executing change or revision.
- .2 Submit quotation as detailed and itemized estimate of product, labour, and equipment costs associated with change or revision, plus overhead and profit percentages and applicable taxes and duties.
- .3 When overhead and profit percentages are not specified in Division 00 or 01, and allowable under Contract as reviewed with Consultant prior to contract signing, then allowable maximum percentages for overhead and profit are 5% for overhead and 5% for profit.
- .4 Unless otherwise noted in Divisions 00 or 01, following additional requirements apply to quotations submitted:
  - .1 When change or revision involves deleted work as well as additional work, cost of deleted work (less overhead and profit percentages but including taxes and duties) is subtracted from cost of additional work before overhead and profit percentages are applied to additional work.
  - .2 Material costs are not to exceed those published in local estimating price guides. For mechanical work material costs, refer to additional requirements of Section 23 00 10 - Mechanical Work General Instructions.
  - .3 Costs for journey person and apprentice labour to not exceed prevailing rates at time of execution of Contract and to reflect actual personnel performing work.
  - .4 Cost for site superintendent to not exceed 12% of total hours of labour estimated for change or revision, and change or revision includes site superintendent involvement.
  - .5 Costs for rental tools or equipment to not exceed local rental costs.
  - .6 Overhead percentage deemed to cover quotation costs other than actual site labour and materials, and rentals.
  - .7 Quotations, including those for deleted work, include required change to Contract time.
- .5 Quotations submitted that are not in accordance with requirements specified above will be rejected and returned for re-submittal. Failure to submit proper quotation enabling Consultant to expeditiously process quotation and issue Change Order will not be grounds for any additional change to Contract time.
- .6 Make requests for changes or revisions to work in writing to Consultant and, when accepted by Owner, Notice of Change to be issued.
- .7 Do not execute any change or revision until written authorization for change or revision has been obtained from Owner and reviewed with Consultant.

## **1.21 PROGRESS PAYMENT BREAKDOWN**

- .1 Prior to submittal of first progress payment draw, submit detailed breakdown of work cost to assist Consultant in reviewing and recommending for acceptance progress payment claims.
- .2 Payment breakdown is subject to Owner approval and Consultant review and recommendations. Progress payments will not be processed until approved breakdown is



in place. Breakdown to include one-time claim items such as mobilization and demobilization, insurance, bonds (if applicable), shop drawings and product data sheets, commissioning including system testing and verification, and project closeout submittals.

- .3 Indicate equipment, material and labour costs for site services (if applicable) and indicate work of each trade in same manner as they will be indicated on progress draw.

## **1.22 WARRANTY**

- .1 Except where otherwise specified in Divisions 00 and 01, warrant work to be in accordance with Contract Documents and free from defects for a period of 1 year from date of issue of Certificate of Substantial Performance of the Work.
- .2 Where equipment includes extended warranty period, first year of warranty period is governed by terms and conditions of warranty in Contract Documents, and remaining years of warranty are direct from equipment manufacturer or supplier to Owner. Submit signed and dated copies of extended warranties with shop drawings and O & M manuals.
- .3 Warranty includes parts, labour, travel costs and living expenses incurred by manufacturer authorized technician to provide factory authorized onsite service.
- .4 Repair and/or replace defects that appear in Work within warranty period without additional expense to Owner. Be responsible for costs incurred in making defective work good, including repair or replacement of building finishes, other materials, and damage to other equipment. Ordinary wear and tear and damage caused wilfully or due to carelessness of Owner staff or agents is exempted.
- .5 Do not include Owner deductible amounts in warranties.
- .6 Warranties commence from time of Substantial Performance of the Work, regardless of what is noted within following Sections of Specification. Provide "bridging" or additional extended warranty period required from time that material is purchased until time of Substantial Performance of the Work.
- .7 Visit building during warranty period with Owner representatives. Owner organizes these visits. At these meetings, Owner representatives review performance of systems. When performance is satisfactory, then no further action is required. When unsatisfactory, then correct deficiencies. These site visits to occur:
  - .1 Once during first month of building operation.
  - .2 Once during third month of building operation.
  - .3 Once between fourth and tenth month in a season opposite to first and third month visits.

## **1.23 REQUEST FOR INFORMATION (RFI)**

- .1 Review contract documents for information prior to issuance of RFI during performance of Work. Where it is determined, at discretion of Owner and review with Consultant, that information requested in RFI was readily identifiable as part of Contract Documents, respective trades Contractor to be back-charged against their contract amount for time spent by Consultant and Owner in preparing response to RFI. Minimum amount of \$150 CDN to be back charged against contract amount for any response to readily identifiable RFI.

**Part 2            Products (Not Used)**

**Part 3            Execution (Not Used)**

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED REQUIREMENTS**

- .1    Section 26 00 10 - Electrical Work General Instructions.
- .2    Unless otherwise noted, this Section is common to each Section of Division 26, Division 27 and Division 28, and supplements each Section and read accordingly.
- .3    Advise product manufacturer and vendors, and trades of each Section, of requirements of this Section. Product manufacturers and vendors are responsible for complying with specified product requirements.

**1.2            REFERENCE STANDARDS**

- .1    American National Standards Institute/Telecommunications Industries Association (ANSI/TIA):
  - .1    ANSI/TIA-569-E-2019, Telecommunications Pathways and Spaces.
- .2    ASTM International (ASTM):
  - .1    ASTM C679-15(2022), Standard Test Method for Tack-Free Time of Elastomeric Sealants.
- .3    CSA Group (CSA):
  - .1    CSA A23.1-19/CSA A23.2-19, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
  - .2    CSA C22.1-24, Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
  - .3    CSA C22.1-24, Ontario Electrical Safety Code (OESC), (29th Edition).
  - .4    CSA C22.3 No. 1-2020, Overhead Systems.
  - .5    CSA C22.3 No. 7-20, Underground Systems.
- .4    International Organization for Standardization (ISO):
  - .1    ISO 10664:2014, Hexalobular Internal Driving Feature for Bolts and Screws.
- .5    Underwriters Laboratories of Canada (ULC):
  - .1    CAN/ULC-S115-2023, Standard Method of Fire Tests of Firestop Systems.
  - .2    CAN/ULC-S524-2019, Standard for the Installation of Fire Alarm Systems.
  - .3    CAN/ULC-S1001-2023, Integrated Systems Testing of Fire Protection and Life Safety Systems.

**1.3            SUBMITTALS**

- .1    Product Data:
    - .1    Submit manufacturer product literature, specifications, installation instructions and datasheets.
    - .2    Include product characteristics, performance criteria, physical size, weight, service clearance requirements, finish and limitations.
  - .2    Shop Drawings:
    - .1    Submit shop drawings for products of this Section.
    - .2    Where specifically specified for products or work, submit shop drawings stamped and signed by Professional Engineer.
    - .3    Include:
-

- .1 Access Doors: Sample of each proposed type of access door where supplied under work of this Division, as well as electronic copies of reflected ceiling plan drawings and wall elevation drawings showing proposed access door locations.
  - .2 Equipment Nameplate and Signage: With proposed nomenclature, print type, symbols, sizing and colours.
  - .3 Firestopping and Smoke Seal Materials: With installation drawings and specific ULC certifications.
- .3 Submit compliance certificates, and testing and verification reports, as noted.

## **Part 2 Products**

### **2.1 SUSTAINABILITY REQUIREMENTS**

- .1 Refer to and comply with sustainability requirements of Division 01.
- .2 Provide materials with applicable volatile organic compounds (VOC) requirements. Materials include but not limited to:
  - .1 Sealants.
  - .2 Air filters.
  - .3 Paints, primers and coatings.
  - .4 Adhesives.
  - .5 Insulations.
  - .6 Wood or composite wood products.
  - .7 Other materials as noted in Sections.

### **2.2 FINISHES**

- .1 Factory finish metal enclosure surfaces by application of rust-resistant primer inside and outside, and at least two-coats of finish enamel, with colour finish. Before manufacturing, review finishes with Consultant during shop drawing submission.
- .2 Paint outdoor electrical distribution equipment in weather-resistant, corrosion-resistant finish of equipment manufacturer standard ANSI green finish colour, unless otherwise noted.
- .3 Paint indoor switchgear and electrical distribution equipment enclosures in equipment manufacturer standard ANSI gray finish colour, unless otherwise noted.
- .4 Refer to trade sections for additional painting requirements.
- .5 Submit sample paint colour chits or swatches.
- .6 Include touch-up paint matching finishes for each major equipment.

### **2.3 EQUIPMENT ENCLOSURE DRIP SHIELDS AND WATER INGRESS PROTECTION**

- .1 Provide drip shields for protection of surface-mounted equipment enclosures located in climate-controlled areas, from water spray and dripping of liquids. Features of shields:
  - .1 Factory constructed by respective equipment manufacturers.
  - .2 Constructed from non-combustible materials (sheet steel).
  - .3 Enamel painted to match equipment.
  - .4 Prior to painting, surfaces and edges filed or sanded smooth.

- .5 Where not integrated with top side of enclosure, mechanically supported from equipment with structural steel rods or metal framing or other similar means by equipment manufacturer.
- .6 Structural support finish painted to match shield.
- .2 Include with equipment shop drawings, detailed dimensions of drip shields, and methods of supporting as applicable.
- .3 Provide equipment with cable or conduit entries sealed with gasketing or waterproof sealant, preventing water from entering enclosure. Unless otherwise noted, do not penetrate drip shields or tops of enclosures with cable or conduit entries.
- .4 Provide enclosure ventilation louvers designed protecting live components from exposure to water spray and dripping liquids.
- .5 Above requirements are additional minimum "sprinkler protection" standards for equipment noted as NEMA 1, NEMA 2 or NEMA 12.
- .6 Provide NEMA 4 rated enclosures in non-climate controlled non-hazardous classified areas unless otherwise noted.
- .7 Obtain CSA certification where required by AHJ.

## **2.4 SLEEVES**

- .1 Poured Concrete Construction:
  - .1 Galvanized sheet steel: Minimum No. 16 gauge galvanized steel with integral flange at one end to secure sleeve to formwork construction.
  - .2 Polyethylene: Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses. Use where permitted by AHJ.
  - .3 Waterproof sleeves in new poured concrete construction: Schedule 40 waterproof mild galvanized steel pipe with welded-on square steel anchor and water stop plate at sleeve midpoint.
- .2 Masonry and Drywall Construction:
  - .1 Schedule 40 mild galvanized steel pipe.
  - .2 Class 4000 cast iron pipe.
- .3 Interlocking Link Type Mechanical Seals:
  - .1 Synthetic rubber construction.
  - .2 Provides sealing rated of annular space between conduits and sleeves.
  - .3 Protects from galvanic corrosion.
  - .4 Absorbs shocks, sound and vibration.
- .4 Refer to requirements of Division 03.

## **2.5 FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Refer to Division 07, for requirements for firestopping and smoke seal materials.
- .2 Coordinate responsibilities for materials and work with general trades.

## **2.6 FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Asbestos-free, elastomeric materials and intumescent materials, for installation in ULC designated firestopping and smoke seal systems. Tested, listed and labeled by ULC in accordance with following:
  - .1 ASTM C679.

- .2 ASTM D6904.
- .3 ASTM G21.
- .4 CAN/ULC-S101.
- .5 CAN/ULC-S102.
- .6 CAN/ULC-S115.
- .2 System assemblies and materials provide positive fire, water and smoke seal, and fire-resistance rating (flame, hose stream and temperature) no less than fire-rating for surrounding construction.
- .3 Assembly Rating: As determined by CAN/ULC-S115 which is equal to time rating of construction joint assembly.
- .4 Mold Resistance: Provide penetration firestopping with mold and mildew resistance rating of 0 as determined by ASTM G21.
- .5 Exterior exposure applications rain and water resistance: Provide perimeter joint sealant tested in accordance with ASTM D6904 with less than 1 hour tack free time as tested in accordance with ASTM C679.
- .6 Materials are specifically ULC certified with designated reference number for its specific installation. As part of shop drawing submission, submit copies of firestopping drawings with ULC certificate and system number for each specific installation.
- .7 Materials are compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with firestopping manufacturer's recommendations and ULC tested assembly. Coordinate material requirements with trades supplying abutting areas of materials.
- .8 Provide pre-formed firestop devices for use with non-combustible and combustible raceways, conduit or cable bundles penetrating concrete floors or gypsum walls.
- .9 Provide sealants or caulking materials for use with non-combustible items including rigid steel conduit and electrical metallic tubing.
- .10 For typical standard indoor applications for conduit and cable installations to seal openings up to 25 mm, pre-formed firestopping cable discs with features as follows:
  - .1 Approximate Density: 1.6 g/cm<sup>3</sup>.
  - .2 Mold and mildew resistant.
  - .3 Surface Burning Characteristics: Flame Spread: 0 and Smoke development: 5.
  - .4 Application Temperature: 0 to 40°C.
  - .5 Percent Fill: Up to 100% per tested system.
  - .6 Sound Transmission Classification: 62 (Relates to specific construction).
- .11 For typical standard indoor applications to seal openings up to 1800 mm x 900 mm, ready-to-use, intumescent flexible block as follows:
  - .1 For sealing single or multiple penetrations of openings.
  - .2 For temporary or permanent sealing of cables and cable tray penetrations.
  - .3 For temporary or permanent sealing of conduit penetrations.
  - .4 Halogen, asbestos, solvent free and smoke resistant.
  - .5 Operational immediately after installation.
  - .6 Application Temperature: 5°C to 40°C.
  - .7 Temperature Resistance: Minus 15°C to 60°C.
  - .8 Intumescent Activation: Approximately 200°C.
  - .9 Expansion Ratio (unrestricted): Up to 1:3.

- .10 Surface Burning Characteristics: Flame Spread Index: 10 and Smoke Development Index: 15.
- .11 Sound Transmission Classification: STC Rating: 52.
- .12 Suitable for wet areas when applied with additional silicone coating in accordance with manufacturer directions.
- .12 Applications where fire-rated firestopping cable pathway system is special structurally reinforced, reusable and require no or minimal alterations to firestop component when cables are either added or removed, provide sleeve assembly with features as follows:
  - .1 Re-penetrable cable management device for electrical and telecom cables.
  - .2 Smoke gaskets.
  - .3 50 mm or 100 mm diameter opening models suiting intended applications.
  - .4 Total Length: Approximately 315 mm.
  - .5 Temperature Resistance: Minus 6°C to 100°C.
  - .6 Intumescent Activation: Approximately 160°C.
  - .7 Expansion Ratio (unrestricted): 1:40.
  - .8 Construction: Metal steel with zinc coating, plastic ABS and fabric glass-fibre.
  - .9 Structure: Sturdy enough to stand up to constant modification and use, but maintain its ULC firestopping rating.
- .13 Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- .14 Supply products of a single manufacturer for use on work of this Division.
- .15 Installer is manufacturer trained and certified on specific product. Submit copy of certificate with shop drawings.
- .16 Manufacturer authorized technician services:
  - .1 Onsite inspect and verify each installation and application.
  - .2 Submit test report signed and verified by system installer authorized representative and manufacturer representative.
  - .3 Prepare, sign and submit test report that lists each installation with test results and respective ULC certification and number.
- .17 Acceptable certification also includes certification by Underwriters Laboratories of Northbrook IL, using tests in accordance with CAN/ULC-S115 and given cUL listing published by UL in their "Products Certified for Canada (cUL) Directory".

## **2.7 ACCESS DOORS**

- .1 Refer to Division 08, for access doors requirements.
- .2 Coordinate responsibilities for doors and work with general trades.
- .3 Coordinate location of outlet boxes, junction boxes, pull boxes, and other concealed equipment requiring access, to minimize need for access doors. Determine size, quantity and location of access doors, for ease of access to installation.
- .4 Size access door to suit concealed work for which they are supplied and wherever possible they are to be of standard size for each application, but in any case, of minimum 300 mm x 300 mm for hand entry and 600 mm x 600 mm for body entry.
- .5 Access doors in fire rated ceilings, walls, partitions, and structures, are ULC listed and labelled and of rating to maintain fire separation integrity.
- .6 Identify on reflected ceiling plans and wall elevation drawings, coordinated locations of proposed access door locations and submit to Consultant.

## **2.8 ACCESS DOORS**

- .1 Coordinate consistency of look and finish of access doors on project with each Division of Work. Coordinate exact requirements with General Trades Contractor.
- .2 Access doors are rust resistant steel door panels, with concealed hinges and positive locking and self-opening screwdriver operated lock. Wall type frames are suitable for wall installation and have integral keys for plaster walls. Doors in tile wall are stainless steel and in ceilings are suitable for plaster covering with only frame joint showing. Other doors are prime painted steel.
- .3 Size access door to suit concealed work for which they are supplied, and wherever possible are of standard size for all applications, but in any case, are minimum 300 mm x 300 mm for hand entry and 600 mm x 600 mm for body entry.
- .4 Lay-in type tiles, properly marked, may serve as access panels. Coordinate marking of ceiling tiles with Consultant. Panels in glazed tile walls are 12 gauge, 304 alloy stainless steel, No. 4 finish, with recessed frame secured with stainless steel counter-sunk flush head screws.
- .5 Panels in plaster surfaces include dish-shaped door and welded metal lath, ready-to-take plaster. Provide plastic grommet for door key access.
- .6 Other access doors are welded 12 gauge steel, flush type with concealed hinges, lock and anchor straps, complete with factory prime coat. Submit to Consultant, details of non-standard door construction details.
- .7 Access doors in fire-rated ceilings, walls, partitions, or structures, are ULC listed and labelled and of rating to maintain fire separation integrity.
- .8 Where access doors are located in surfaces where special finishes are required, they are recessed door type capable of accepting finish in which they are installed so as to maintain final building surface appearance throughout.

## **2.9 EQUIPMENT BACKBOARDS**

- .1 Refer to Division 06 for rough carpentry and Division 09 for painting and provide equipment backboards as specified.
- .2 Coordinate responsibilities and work with general trades.

## **2.10 EQUIPMENT BACKBOARDS**

- .1 FSC (Forest Stewardship Council), G1S (good one side) construction grade fir plywood.
- .2 Containing no added urea formaldehyde.
- .3 Flame retardant prime coat painted on exposed surfaces.
- .4 Minimum 20 mm thick, and as sized on drawings.
- .5 Flame spread rating:
  - .1 In accordance with building code requirements.
  - .2 Typically, maximum flame spread 25, maximum smoke developed 25.

## **2.11 ANCHOR BOLTS, LIFTING EYES AND HOOKS**

- .1 Provide and set anchor bolts, sleeves, washers, nuts and provide templates to locate positions of bolts. Set sleeves flush with or slightly above top surface or rough concrete. Provide anchor bolts with right-angles bends or hooks, or with square plate washers, threads and nuts for anchoring. Do not use expansion shields or similar devices for anchoring equipment to concrete bases.



- .2 Provide steel lifting eyes and hooks on equipment of type and lifting capacity to accommodate weight of equipment. Provide galvanized steel types or other corrosion-resistant finish for products located in non-climate-controlled areas.

## **2.12 MAINTENANCE MATERIALS AND SPARE PARTS**

- .1 Supply maintenance materials and spare parts as specified in respective Sections.
- .2 Generally, include:
  - .1 One set of spare parts required to service equipment as recommended by respective equipment/system manufacturers.
  - .2 One set of special tools required to service equipment as recommended by respective equipment/system manufacturers.
  - .3 Other items noted within respective Sections.

## **2.13 ACCEPTABLE PRODUCT MANUFACTURERS/VENDORS**

- .1 Firestopping and Smoke Seal Materials:
  - .1 Hilti Canada.
  - .2 Specified Technologies.
  - .3 3M Canada.
  - .4 Tremco.
  - .5 A/D Fire Protection Systems.
  - .6 Nelson.
- .2 Access Doors:
  - .1 Acudor.
  - .2 BAUCO
  - .3 SMS.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of Conditions:
  - .1 Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for respective product installation in accordance with manufacturer written instructions.
  - .2 Verify that conditions are acceptable for product installation in accordance with manufacturer written instructions and for work of respective Sections.
  - .3 Field verify building and site dimensions prior to fabrication and installation of equipment or materials.
- .2 Inspect conditions visually onsite. When requested by Consultant, inspect in presence with Consultant.
- .3 Report to Consultant, conditions that hinder or obstruct installation work beyond intent of issued Documents.
- .4 Proceed with installation only after these conditions have been remedied, and reviewed with Consultant.

### **3.2 TEMPORARY SERVICES**

- .1 Coordinate with Prime Contractor, requirements for temporary services including but not limited to:
  - .1 Temporary electrical power.
  - .2 Lighting.
  - .3 Heating.
  - .4 Water.
  - .5 Exit pathways.
- .2 Confirm locations of exit pathways are as decided at discretion of Prime Contractor and be illuminated complete with emergency lighting and provided with exit signage and fire alarm devices.
- .3 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems.
- .4 Provide services in accordance with requirements of building codes and AHJ.

### **3.3 PHASING AND SCHEDULING OF WORK**

- .1 Include for scheduling, co-ordination, and construction phasing suiting project as specified in Division 01, or as noted. Prior to start of Work, review phasing requirements with Consultant.
- .2 Perform phasing and scheduling of Work to maintain existing building operations.
- .3 Perform work within occupied spaces and work affecting surfaces adjacent to occupied spaces during and after regular business hours, as coordinated with Owner and reviewed with Consultant. For areas where spaces are used by Owner on a 24-hours basis or over various hours, coordinate hours of work with Owner on a regular basis, suiting Owner schedule. Execute work at times approved by Owner and reviewed with Consultant, so as not to inconvenience Owner occupation or in any way hinder Owner use of building.
- .4 Provide project partial occupancy permits as required throughout project. Provide for each partial permit, compliance certificates for systems.

### **3.4 LAYOUT AND COORDINATION OF WORK**

- .1 Cooperate and coordinate with other Divisions as required for completion of the Work and avoiding interference with work by other Sections. Coordinate locations of conduits, raceways, junction and pull boxes, with other Divisions and other trades.
- .2 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings. Lay out work for execution of work.
- .3 Examine drawings verifying work can be performed without changes to building as noted on plans.
- .4 Plan, coordinate, and establish exact locations and routing of services with affected trades prior to installation such that services clear each other as well as other obstructions.
- .5 Do not use Contract Drawing measurements for prefabrication and layout of piping, sheet metal work and such other work. Locations and routing are to generally be in accordance with Contract Drawings, however, prepare layout drawings for such work. Use established bench marks for both horizontal and vertical measurements. Confirm inverts, coordinate with and make allowances for work of other trades. Accurately layout work, and be entirely responsible for work installed in accordance with layout drawings. Prior to

- proceeding with Work, notify Consultant where any invert, grade, or size is at variance with Contract Drawings.
- .6 Prepare plan and interference drawings of work for coordination with each trade. Prepare detailed section drawings of ceiling spaces, areas of shafts, rooms and ceilings which are highly congested and for which site workers could not solve construction coordination issues. Indicate on section drawings lateral and elevation dimensions of major services within spaces. These drawings propose solutions for trades affected.
  - .7 Prepare and submit drawings showing sleeving, recessed and formed holes required in concrete for work. Prepare drawings in conjunction with other trades. Prepare drawings to scale sufficient showing necessary details. Submit for review using same procedures as specified for shop drawings.
  - .8 Dimension sleeves, recesses and openings with respect to building elevations and established grid lines.
  - .9 Coordinate structural work for support of products with requirements of Division 13 and Structural Consultant as applicable.
  - .10 Do not install conduits in flutes of metal roof deck.
  - .11 Provide concrete topping at electrical service trenches for protection.
  - .12 Coordinate concrete work such as housekeeping pads, sumps and bases, required for work, and including required dimensions, operating weight of equipment and location.
  - .13 Coordinate depth and routing of excavation required for work, and requirements for bedding and backfill, in accordance with requirements of Division 31 as applicable.
  - .14 Coordinate with, instruct and supervise those Divisions doing related work.
  - .15 Supply measurements of equipment to other Divisions allowing for necessary openings in their work.
  - .16 Locate equipment maximizing usable space. Install raceways, fittings, pull boxes, junction boxes, concealed wiring and cables, close to building structure in order that furring is as small as possible.
  - .17 Prior to commencing work, review relevant shop drawings and product data of other Divisions where they affect work of this Section.
  - .18 Refer to mechanical drawings when coordinating locations of starters, variable frequency drives, motors, panels, and connected equipment.
  - .19 Coordinate various low voltage systems. Perform following:
    - .1 Coordinate with trades of various systems which are interfaced with, monitored by, and integrated to electrical work.
    - .2 Prepare systems coordination drawings detailing related system coordination and integration points.
    - .3 Coordinate wiring work required for equipment and systems but not specified to be done as part of work of other Divisions, including termination points, wiring type and size, and controls.
    - .4 Coordinate security system requirements with successful door hardware supplier and prepare detailed coordination drawings of component installations, sequence of operations, wiring and conduit layouts and division of responsibility between various trades.
    - .5 Review systems requirements for power supplies, communication interface protocols, component back boxes and conduits.
    - .6 Provide onsite technical assistance during testing and commissioning functions of each system.
-

- .7 Document coordination and integration requirements and maintain records for submission as part of shop drawings.
- .20 Carry out alterations in arrangement of work that has been installed without proper coordination, study, and review, even if in accordance with Contract Documents, in order to conceal work behind finishes, or to allow installation of other work, without additional cost. In addition, make necessary alterations in other work required by such alterations, without additional cost.
- .21 Where drawings indicate that acoustic tile ceiling is being suspended below structural ceiling, coordinate design of framework used to support suspended ceiling, luminaires, and other components that are mounted within or through ceiling. Unless otherwise noted, do not mount devices to suspended ceiling. Secure and mount to ceiling slab above. Seal ceiling openings to maintain required fire-rating.
- .22 Order products in timely manner meeting project-scheduling timelines. Failure to order products to allow manufacturers sufficient production or delivery time to meet project-scheduling timelines is unacceptable reason to request for use of other suppliers or substitutions.

### 3.5

#### **INTERRUPTION TO AND SHUT-DOWN OF ELECTRICAL SERVICES AND SYSTEMS**

- .1 Coordinate shut-down and interruption to existing electrical services or systems with Owner. Generally, shut-downs may be performed only between hours of 8:00pm Friday until 6:00 a.m. Monday morning. Include for costs of premium time to perform work during nights, weekends or other times outside of normal working hours, which may be necessary to comply with stipulations specified herein. Services for operation of existing non-renovated areas of building are to be maintained.
- .2 Upon award of Contract, submit list of anticipated shut-down times and their maximum duration.
- .3 Prior to each shut-down or interruption, inform Owner and Consultant in writing minimum 7 working days in advance of proposed shut-down or interruption and obtain written consent to proceed. Do not shut-down or interrupt any service or system without such written consent. Shutdowns of some essential services may require additional advance notification time.
- .4 Perform work associated with shut-downs and interruptions as continuous operations to minimize shut-down time and to reinstate systems as soon as possible, and, prior to any shut-down, ensure materials and labour required to complete work for which shut-down is required are available at site.
- .5 Prior to start of work, confirm methods of procedures with Owner and review with Consultant.
- .6 Where working in close proximity to "live parts" or inside energized panels or energized cubicles of switchboards/substations, provide protection "boots" over bussing and insulating mats to cover areas of exposed live parts.
- .7 Review with Consultant if any feeder (conductor) is designated for special considerations and if designated as such and is to be interrupted, ensure that at least following preparations are met:
  - .1 Provide schedule of proposed feeders being interrupted. Propose one feeder at a time to be worked on per scheduled shutdown.
  - .2 Provide method of procedure for work.
  - .3 At least 10 working days prior to date of each proposed work, prepare above documentation and submit for Owner approval and Consultant review.

- .4 On day/night of proposed feeder work, advise Consultant of which feeder is being worked on. Review with Consultant requirements for witnessing work.
- .5 De-energize feeders and perform work in accordance with Owner approved and Consultant reviewed and recommended for acceptance schedule.
- .6 After feeders are re-routed, inspect and megger test each feeder.
- .8 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of codes and AHJ.

### **3.6 GENERAL INSTALLATION REQUIREMENTS**

- .1 Unless otherwise noted, comply with manufacturer instructions and recommendations, including product technical bulletins, data sheets and handling, storage and installation instructions. Conform also to Contract Documents and accepted shop drawings.
- .2 Prior to roughing-in of devices and equipment, review final installation locations with Consultant.
- .3 Provide operational equipment and systems in accordance with specified requirements, CSA C22.1, provincial electrical code and product manufacturer instructions, unless otherwise noted.
- .4 Install underground systems in accordance with CSA C22.3 No. 7. and as noted.
- .5 Base installation layout, design, terminations, and supply of accessories, on Contract Documents with specific coordination with reviewed shop drawings.
- .6 Refer to drawings, details and schedules for additional requirements.
- .7 Install conduits and raceways generally in locations and routes noted, close to building structure. Install minimizing furring requirements and interference with other services or free space. Remove and replace equipment not installed in accordance with Specifications, Drawings or manufacturer recommendations. Install conduits and raceways in concealed spaces, unless otherwise noted.
- .8 Unless otherwise noted, conceal work in finished areas, and conceal work in partially finished and/or unfinished areas to extent made possible by area construction. Install services as high as possible to conserve headroom or ceiling space. Prior to installation of Work, notify Consultant where headroom or ceiling space appears to be inadequate.
- .9 Provide additional material for modifications as required to correct minor job conflicts.
- .10 Refer to Architectural drawings for construction details, with regards to roof supports, penetrations through walls, roof and other building construction.
- .11 Unless otherwise noted, connect branch lighting and power circuits to panelboards so as to balance actual loads (wattage) within 5%. If required, transpose branch circuits when work is complete to meet this requirement.
- .12 Consultant reserves right to relocate electrical components such as receptacles, switches, communication system, outlets, hard wired outlet boxes and luminaries from original designed location, but prior to surfaces installations and component installations, without additional cost, and relocation per component does not exceed 3 m from original location.
- .13 For cutting, patching and core drilling work, refer to Section 26 05 05 - Selective Demolition for Electrical.

### **3.7 SERVICE AND MAINTENANCE ACCOMMODATION**

- .1 Install equipment with access and service clearances around equipment, and with space for future equipment removal and replacement. Provide access and service space provisions around equipment in accordance with requirements of AHJ.

- .2 Install equipment and controls, in manner facilitating proper maintenance and ease of repair or replacement.
- .3 Provide adequate clear space for equipment designated as supplied by others and provide connections for such equipment. Prior to commencing work, prepare and submit detailed layouts for review with Consultant.
- .4 Leave clear, spaces reserved for equipment noted as future on drawings, allowing for future connections.

### **3.8 EQUIPMENT LOADS**

- .1 Supply equipment loads (self-weight, operating weight, concrete pad, and inertia pads) to Consultant, via shop drawing submissions, prior to construction.
- .2 Where given choice of specific equipment, actual weight, location and method of support of equipment may differ from those assumed by Consultant for base design. Back-check equipment loads, location, and supports, and include necessary accommodations.
- .3 Where supporting structure consists of structural steel framing, confirm equipment loads, location, and method of support prior to fabrication of structural steel. Prior to construction, review locations of equipment with Consultant.

### **3.9 OPENINGS**

- .1 Supply opening sizes and locations to Consultant, allowing verification of their effect on design, and for inclusion on structural drawings, where appropriate.
- .2 No openings are permitted through completed structure without written approval from Owner and review with Consultant. Show required openings on a copy of structural drawings. Identify exact locations, elevations, and size of proposed openings and submit to Consultant for review, well in advance of doing work.
- .3 Prior to leaving site at end of each day, walk through areas of work and check for any openings, penetrations, holes, or voids created under scope of work of project, and verify that openings created under scope of work have been closed off, firestopped and smoke-sealed. Unless otherwise directed by Owner and reviewed with Consultant, do not leave any openings unprotected or unfinished overnight.

### **3.10 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 Locate light switches on latch side of doors unless otherwise noted.
- .4 Locate disconnect devices in mechanical and elevator machine rooms on latch side of doors.

### **3.11 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment or indicated otherwise.
- .2 Before proceeding with installation, where mounting height of equipment is not noted, review with Consultant.
- .3 Install electrical products at following heights unless otherwise noted in accordance with accessibility requirements reviewed with Consultant:

- .1 Local Switches: 1000 mm (unless otherwise to be in accordance with accessibility requirements of building code).
- .2 Wall Receptacles:
  - .1 General: 450 mm.
  - .2 Above top of continuous baseboard heater: 200 mm.
  - .3 Above top of counters or counter splash backs: 175 mm.
  - .4 In Mechanical Rooms: 1400 mm.
- .3 Panelboards: As noted, unless otherwise required by AHJ.
- .4 Telephone and Interphone Outlets: 450 mm.
- .5 Wall-mounted telephone and interphone outlets: 1000 mm.
- .6 Fire Alarm Manual Stations: 1150 mm above floor measured to centre of manual station (unless otherwise to be in accordance with accessibility requirements of building code).
- .7 Wall Mounted Fire Alarm Strobes: to be mounted such that the entire lens is to be not less than 2000mm or greater than 2400mm
- .8 Wall Mounted Fire Alarm Horn/Strobes: to be mounted such that the top of the device shall not be less than 2300mm above the finished floor, and the entire lens be mounted not greater than 2400mm.
- .9 Wall-Mounted Fire Alarm Horns: Where ceiling heights allow, audible signal devices shall be installed so that the top of the device will not be less than 2300 mm above the finished floor level.
- .4 Fire alarm device mounting heights: Also, in accordance with CAN/ULC-S524.
- .5 Barrier free access installation: Refer to drawings for barrier free areas. Install devices at following heights.
- .6 Above mounting heights are typical. Prior to start of Work, review mounting heights with Consultant.

### **3.12 INSTALLATION OF SLEEVES**

- .1 Where conduits, round ducts and conductors pass through structural poured concrete or masonry surfaces, provide sleeves as noted and of type suiting intended applications.
- .2 Prior to pouring of concrete, install sleeves.
- .3 Size sleeves for free passage of conduit, and protruding 50 mm.
- .4 Do not use plastic sleeves in fire-rated walls or floors.
- .5 Submit to concrete reinforcement detailer at proper time, drawings indicating required sleeves, recesses and formed openings in poured concrete work or masonry work. Dimension such drawings and relate sleeves, recesses and formed openings to suitable grid lines and elevation datum.
- .6 Size sleeves to leave 13 mm clearance around conduit, duct, conductor, and other material passing through openings. Pack and seal void between sleeves and conduit, duct, conductors and other material passing through opening, for length of sleeves with specified firestopping and sealing materials, and including.
  - .1 Firestopping and smoke seal materials: Fire-rated construction.
  - .2 Fire-retardant, waterproof non-hardening mastic: Foundation walls and below grade floors.
  - .3 Waterstop plate and synthetic rubber interlocking link type mechanical seals: Waterproof slabs or walls.
  - .4 Acoustic seals for openings: Partitions and floor slabs.

- .5 Water-tight seals: Exterior walls, or walls in contact with moisture.
- .6 Synthetic rubber interlocking link type mechanical seals: Sealing pipes through other walls, floors and casings.
- .7 Supply sleeves of water protecting type in following locations:
  - .1 Mechanical and fan room floor slabs, except where on grade.
  - .2 Slabs over mechanical, fan, electrical and telephone equipment rooms or closets.
  - .3 Floors equipped with waterproof membranes.
  - .4 Roof slabs.
  - .5 Waterproof walls.
- .8 Do not provide "Gang" type sleeving.
- .9 Sleeves for exposed work: Terminate both ends of sleeves flush with building surface. Install escutcheon plate to cover sleeve completely, except for sleeves in waterproof floors which are to terminate 100 mm above finished floor.
- .10 Where sleeves are provided in non-fire rated construction for future conduits and ducts, cap and seal both ends of sleeved opening.
- .11 Where conduits or duct are removed from existing sleeves, cap and seal both ends of sleeved opening.
- .12 Coordinate below grade penetrations with waterproofing systems or with damp proofing systems.

### **3.13 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Where work penetrates or punctures fire-rated construction, coordinate provision of ULC certified, listed and labeled firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and providing continuity and integrity of fire separation is maintained.
- .2 Refer to Division 07 for additional installation requirements. Coordinate responsibilities of work with general trades.

### **3.14 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Where work penetrates or punctures fire rated construction, provide firestopping and smoke sealing packing material systems to seal openings and voids around and within raceway and to provide continuity and integrity of fire separation is maintained.
- .2 Install firestopping and smoke seal materials for each installation in accordance with specific ULC certification number and manufacturer instructions. Comply with building code requirements and obtain approvals from AHJ. Verify that openings through fire separations do not exceed maximum size wall opening, and maximum and minimum dimensions in accordance with respective ULC listings.
- .3 Verify that continuity and integrity of fire separation is maintained and conform to respective ULC listings.
- .4 Perform work as follows:
  - .1 In accordance with manufacturer installation instructions for each specific application.
  - .2 Clean areas and surfaces before materials are installed.
  - .3 Examine substrates, openings, voids, adjoining construction and conditions under which firestop and smoke seal system is installed. Verify compatibility of surfaces.



- .4 Verify penetrating items are securely fixed and properly located with proper space allowance between penetrations and surfaces of openings.
- .5 Prior to commencement of work, report unsuitable or unsatisfactory conditions to Consultant. Commencement of work means acceptance of conditions and surfaces.
- .6 Mask where necessary avoiding spillage and over-coating onto adjoining surfaces. Remove stains on adjacent surfaces.
- .7 Prime substrates.
- .8 Provide temporary forming and remove only after materials have gained sufficient strength and after initial curing.
- .9 Tool or trowel exposed surfaces neat, smooth, and with consistent finish.
- .10 Remove excess compound promptly as work progresses and upon completion.
- .5 When work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies, notify Consultant. Prior to concealing or enclosing work, arrange for final inspection of work by AHJ. Make corrections.
- .6 On completion of firestopping and smoke sealing installation, submit manufacturer technician compliance certificate certifying firestopping and smoke sealing installation has been carried out to service penetrations and that installation has been performed in accordance with requirements of AHJ, ULC requirements and manufacturer instructions.
- .7 Where work requires removal of existing firestopping materials and replacement of firestopping materials after cabling changes have been made, verify that replacement material is same material and manufacturer of existing if any remains in place, or verify that existing material is removed before installation of replacement material.

### **3.15 INSTALLATION OF BACKBOARDS**

- .1 Provide backboards for systems and equipment.
- .2 Securely wall mount each backboard with proper fasteners, suiting wall construction.
- .3 Size backboards to sufficiently provide adequate terminal space for each system, plus 20% space for future additions. Provide back boards of dimensions where identified.
- .4 Coordinate installation of backboards for systems and equipment with work of Section 06 10 00 - Rough Carpentry and Section 09 23 51 - Interior Painting.

### **3.16 CONCRETE REQUIRED FOR ELECTRICAL INSTALLATION**

- .1 Coordinate provision of concrete required for electrical work with Work of Division 03. Coordinate requirements (type, dimensions, re-enforcing, locations).
- .2 Layout and mark out Work as required for installation of concrete necessary for duct banks, equipment pads, bollards, pole bases, and other Work as indicated on drawings.
- .3 Locate pads at site and be present during concrete pour to ensure anchor bolts, inserts, plates and similar hardware are not damaged or dislodged.
- .4 Coordinate pad installations with concrete trade and ensure pads are keyed into structure to meet seismic restraint requirements.
- .5 Provide concrete topping at electrical service trenches for protection.

### **3.17 CONCRETE WORK FOR ELECTRICAL EQUIPMENT PADS**

- .1 Provide poured concrete work, including reinforcing and formwork, required for electrical equipment pads.

- .2 Perform concrete work in accordance with requirements of Division 03. Coordinate work with General Trades Contractor.
- .3 Concrete: Minimum 20,700 kPa ready-mix concrete in accordance with CSA A23.1/CSA A23.2 and building code.
- .4 Submit for review, dimensioned shop drawings, prepared and stamped by Structural Professional Engineer registered in jurisdiction of the Work, for concrete pads for support of large heavy equipment. Indicate on shop drawings total weight of pad as well as equipment it is provided for, and concrete reinforcing.
- .5 Verify that pads are keyed into structure in accordance with seismic restraint requirements.

### **3.18 EQUIPMENT BASES AND SUPPORTS**

- .1 Provide equipment bases (pads) and supports. Coordinate concrete pour for pads, luminaire poles bases and bollards with work of Division 03.
- .2 Submit dimensioned shop drawings of structurally designed bases for support of large, heavy equipment. Indicate on shop drawings:
  - .1 Total weight of base, reinforcement, and equipment for which it is required.
  - .2 Templates and anchor bolts for proper setting of equipment on pads.
- .3 Unless otherwise noted, submit detailed design of concrete pads.
- .4 Unless otherwise noted, secure floor-mounted equipment in place on concrete pads as follows:
  - .1 Pads not less than 100 mm high and not less than 100 mm wider and longer than equipment base dimensions.
  - .2 Secure equipment to pads with mounting hardware. Place anchor bolts during concrete pour and level, align and grout equipment.
  - .3 As minimum, use wire mesh reinforcement, however, for pads for large heavy equipment such as gensets and main power transformers, use reinforcement in accordance with structural drawing details.
  - .4 Chamfer edges of pads.
  - .5 In accordance with equipment manufacturer recommendations and special construction requirements when specified by Structural Professional Engineer.
  - .6 With vibration isolation and seismic controls in accordance with respective product Sections or Section 26 05 48 - Vibration and Seismic Control.
- .5 Perform work within formwork Subcontractor schedule.
- .6 Unless otherwise noted, support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods. Submit details with shop drawing submissions.
- .7 For equipment not designed for concrete base mounting and except those for small equipment, where required provide welded, cleaned and prime coat painted structural steel stands or supports in accordance with following:
  - .1 Designed by Structural Professional Engineer registered in jurisdiction of the Work.
  - .2 Submit stamped and signed design drawings with calculations as shop drawings for review.
  - .3 Provide flange bolt steel stands to concrete pads.
  - .4 Seismically restrained in accordance with AHJ and building code requirements.

**3.19 EXCAVATION AND BACKFILL WORK**

- .1 Excavation and backfill work required for electrical work is under work of Division 31, except for final hand grading work and backfill to 450 mm above service which is responsibility of Division 26.
- .2 Mark out location and routing of excavation required for work as well as required depth. Verify bedding is graded, providing proper drainage for ducts as reviewed with Consultant.
- .3 Where inverts and locations of existing site services are site surveyed and locations are indicated, such locations are approximate. Confirm that various utility providers have performed locates and marking out. Prior to commencement of work, verify inverts and locations are correct. Where discrepancies are found, immediately inform Consultant, and await direction.
- .4 Allow Consultant and AHJ to inspect work before covering and backfilling.

**3.20 EXCAVATION AND BACKFILL WORK**

- .1 Before commencement of excavation for work, determine in consultation with Consultant, Owner, Municipality and utilities, presence, if any, of existing underground services at site. Engage utilities to locate and mark out such services. Ensure trades concerned are aware of their presence.
- .2 Be responsible for any damage done to underground services caused by neglect to determine and mark out location of such services prior to excavation work commences.
- .3 Where Work falls under jurisdiction of utility, confirm requirements and comply with utility requirements.
- .4 Provide excavation, backfill and related work required for electrical work. Perform such work in accordance with requirements of Division 31, except as modified by this Article. Obtain copy of soil test report if available from Consultant. Excavate to depths in accordance with AHJ requirements and local standard practices to compensate for local frost levels of Place of the Work.
- .5 Inverts and locations of existing site services may have been site surveyed and approximate location may be identified on drawings. Prior to commencing excavation, confirm inverts and locations are correct, and contact Utilities to accurately locate their services. Where discrepancies are found, immediately inform Consultant, and await direction. Grade bottom of trench excavations as required.
- .6 Grade bottom of excavation. In firm, undisturbed soil, lay services directly on soil. Backfill excess excavation with 13,790 kPa concrete. Grade bottom such that ducts are installed to drain as reviewed with Consultant.
- .7 Prepare new bedding under service in unstable soil, in fill, and in cases where bedding has been removed in earlier excavation, particularly near perimeter walls of buildings, and at manholes and catch basins, compact to maximum possible density and support service by means of 200 mm thick concrete cradles spanning full length between firm supports. Refer to detail on drawings.
- .8 Where excavation is necessary in proximity to and below level of any footing, backfill with 13,790 kPa concrete to level of highest adjacent footing. Proximity is determined by angle of repose as reviewed with Consultant.
- .9 Do not open trenches ahead of installation of services and backfilling more than weather permits. Break up rocks and boulders and remove by drilling and wedging. Do not use blasting unless specifically permitted by Owner and reviewed with Consultant.
- .10 Before backfilling, arrange for inspection of work by AHJ and Consultant. Do not backfill work unless reviewed with and recommended for acceptance by Consultant. Failure to do

- so prior to backfilling will require re-excavating work and re-backfilling at no additional cost to Owner.
- .11 Unless otherwise noted, backfill trenches within building with clean sharp sand in individual layers of maximum 150 mm thickness compacted to density of 100% Standard Proctor. Hand compact first layers up to compacted level of minimum 300 mm above top of service. Hand or machine compact balance up to grade.
  - .12 Unless otherwise noted, backfill trenches outside building (not under roads, parking lots or traffic areas), up to compacted level of 450 mm thick above service with Granular "A" material, hand compacted to density of 95% Standard Proctor. Backfill balance in 150 mm layers with approved excavated material, compacted to 95% Standard Proctor density using approved equipment.
  - .13 Unless otherwise specified, backfill trenches outside building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm thickness, compacted to 100% Standard Proctor density up to grade level.
  - .14 Unless otherwise directed in Division 31, store and dispose of excavated materials as follows:
    - .1 During progress of Contract, place material as directed in such manner to minimize damage or disfigurement of ground and which in no way impedes progress of Work.
    - .2 Separately place surplus topsoil and subsoil as directed and leave site clean and unencumbered.
  - .15 Perform pumping as required to keep excavations free of water.
  - .16 Fill depressions to correct grade level with appropriate material, after adequate period has passed to reveal any settlement. Use maximum possible compaction. Pay costs required to make good damages caused by settlement.
  - .17 Engage services of independent soils testing agency to test final backfill compaction density of each backfilled location. Compact backfill to satisfaction of testing agency and in accordance with Specification. Submit copy of testing agency report to Consultant.
  - .18 Coordinate requirements for final surface toppings (concrete, asphalt, pavers, grass sod, and other such materials) with General Trades Contractor.

### **3.21 ELECTRIC MOTORS, MOTOR CONTROLLERS, CONTROLS AND ELECTRICAL CONNECTIONS**

- .1 Coordinate responsibilities related to supply, installation, testing and verification of motors, motor control equipment (starters, motor control centres, variable frequency drives) and controls.
- .2 Control Wiring and Conduit: In accordance with Section 26 05 21 - Low Voltage Conductors and Cables, except for wiring and connections below 50 V which are related to control systems specified in Division 25.
- .3 Provide electrical connections to equipment including equipment supplied by other Divisions. Review shop drawings and coordinate with each equipment vendor, requirements for power feeds, control and communication interconnections, and provide these requirements to complete installations work.
- .4 Review drawings and schedules. Provide wired and empty conduit systems with fish cord, junction boxes, pull boxes, outlet boxes, faceplates and sleeves. Provide interconnect wiring between remote operator devices, controllers, and equipment being controlled by operator devices. Where equipment is of split-unit design and line voltage is required to both units, provide feeders to each unit as coordinated with equipment manufacturer.

- .5 Provide complete wired and empty conduit systems with fish cord, junction boxes, pull boxes, outlet boxes, faceplates, sleeves and ancillary devices. Provide disconnect switches, receptacles and other wiring and connection accessories. Coordinate work with respective Consultants and suppliers of equipment to be provided with electrical connections.
- .6 Provide lugs, terminals, and screws used for termination of wiring that are suitable for type of conductors and equipment connected.
- .7 Refer to Divisions 10 and 11 and include for coordination and interconnections of Divisions 10 and 11 requirements and equipment schedules.
- .8 Coordinate alarm connections of equipment with Mechanical Divisions BAS Contractor. Refer to drawings of both Electrical Divisions and Mechanical Divisions for BAS points to be connected. Include for wiring in conduit, contacts, termination/junction boxes and ancillary devices as required for interconnection.
- .9 Coordinate with Mechanical Division 23, supply and installation of motor control centres (MCCs), motor starters, variable frequency drives (VFDs) (also known as variable speed drives –VSDs) and harmonic filters for motorized equipment supplied by Mechanical Divisions. Motor starters, MCCs and VFDs are generally as scheduled and in accordance with respective product Sections. Generally, starters are supplied in following manner:
  - .1 Loose starters for mounting adjacent to apparatus or on motor starter panels.
  - .2 Mounted starters in factory assembled and pre-wired motor control centres.
  - .3 Mounted starters on factory assembled and pre-wired packaged equipment.
- .10 Provide following work as coordinated with Mechanical Division work:
  - .1 Mount loose starters and provide line and load power connections.
  - .2 Mount motor starter panels with conduit work at motor starter panels installed level, plumb and aligned with building surfaces. Plan installation to avoid crossovers.
  - .3 Make line side power connections to motor control equipment and load side connections to motors or other apparatus supplied power from motor control equipment.
  - .4 Make line side power connections to starters on packaged equipment.
  - .5 Install disconnect switches in accordance with Section 26 28 23 - Disconnect Switches – Fused and Unfused.
  - .6 Make connections to thermistors and provision of additional relays as required for connections to starters.
  - .7 Perform motor starter interlocking in accordance with motor control equipment and starter schedules. Coordinate interlocking requirements with work of Division 23.
  - .8 In coordination with work of Division 23, provide 120 VAC power feeds to receptacles and luminaires integral with mechanical equipment including air handling units.
  - .9 Provide identification nameplate on each motor control equipment, VFD, motor starter or disconnect. Nameplates identify equipment identification number and electrical ratings.
  - .10 Connect VFDs and harmonic filters with power, control and monitoring conductors in accordance with manufacturer instructions and electrical code. Make interlock connections between disconnect switch and VFD to signal VFD to turn off when disconnect switch is opened. Provide manufacturer recommended conductors and connectors suiting respective connected equipment. Provide required upstream fused disconnects or breakers and overload protection. Maintain separation of power and control conductors in accordance with

manufacturer requirements to minimize effects of electromagnetic interference.  
Ground and bond equipment.

- .11 Perform other items as noted.

### **3.22 PROVISIONS FOR BUILDING AUTOMATION SYSTEMS**

- .1 Display points and functions of electrical distribution system equipment and other systems on BAS as specified and as scheduled. Provide digital type and analogue communications points, as noted and suiting intended applications.
- .2 Provide wiring, conduit and connections from respective equipment and extend to load side of terminal cabinet. Provide line side wiring, conduit and connections of terminal cabinet and extend to BAS connection points and panels, as coordinated with BAS vendor.
- .3 For potential indications, provide fused disconnect and potential transformer, rated 600/120 V, connected to centre phase.
- .4 Terminal Cabinet:
  - .1 NEMA 1 unless otherwise noted, CSA certified.
  - .2 Surface mounted with hinged door and drip shield.
  - .3 Screw type indexed terminals.
  - .4 Suitable size and labeled with lamaroid nameplate, identifying use, equipment designated number and electrical characteristics.
  - .5 Factory finished painted.
  - .6 Nameplate nomenclature and finishes: Reviewed with Consultant.
- .5 Analogue indications: Provide two minimum #12 AWG conductor and #12 AWG ground conductor in 21 mm conduit for each function to respective terminal cabinet.
- .6 Digital functions: Provide communications and control wiring of type reviewed with respective connected equipment vendors and run in 21 mm conduit for each function to respective terminal cabinet.
- .7 Install terminal cabinets with tops not to exceed 1800 mm above finished floor. Determine quantity of cabinets based on BAS circuits in common areas located in same cabinet.
- .8 Coordinate requirements with BAS vendor. Refer to Division 25 for additional requirements.

### **3.23 PATHWAYS FOR VARIOUS SYSTEMS**

- .1 Provide systems of conduits, raceways, electrical boxes and pull wires, for systems.
- .2 Provide following basic electrical components accommodating installation of various miscellaneous systems:
  - .1 Conduit:
    - .1 Diameters as sized on drawings with non-metallic fish wires or pull cords and suitable bushings for conduit terminations.
    - .2 In accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Fittings, and respective system trade Sections.
    - .3 Labelling at each end to clearly identify each conduit run with respect to system and path.
  - .2 Outlet Boxes:
    - .1 Size and type suiting intended applications.
    - .2 Complete with faceplates or coverplates.

- .3 In accordance with Section 26 05 32 - Outlet Boxes, Conduit Boxes and Fittings and respective system trade Sections.
- .3 Pull Boxes, Junction Boxes and Back Boxes:
  - .1 Size and type suiting intended applications.
  - .2 Complete with coverplates.
  - .3 In accordance with Section 26 05 31 - Splitters and Electrical Boxes and respective system trade Sections.
- .4 Sleeves:
  - .1 Size and type suiting intended applications.
  - .2 Refer to sleeve requirements of this Section.
- .3 Miscellaneous systems are noted on drawings. Provide dedicated conduit runs for each system. Coordinate sizes of boxes with respective system vendors, providing sizing accommodating components and wiring-bending radii. Review conduit and box requirements with system vendors.
- .4 Provide pull boxes in conduit runs longer than 30 m or having more than two 90° bends. Size pull box in accordance with respective system standards, but no shorter in length of at least 8 times diameter of entering conduit.
- .5 Leave conduits free and clear of obstructions and terminate. Equip terminations with bushings and clearly identify each run. Provide fish wires in empty conduits. Run telecommunications conduits with separation from sources of electromagnetic radiation in accordance with ANSI/TIA-569-E. Site bend telecommunications conduit elbows in accordance with system conduit bending radii requirements.
- .6 Prior to roughing-in, review requirements and locations of equipment with Consultant and respective system installers.
- .7 Refer to system riser diagrams on drawings.
- .8 Determine quantities for outlets in accordance with floor plan drawings and not riser diagrams.

### **3.24 PRODUCT REQUIREMENTS IN SPECIAL AREAS**

- .1 Special areas include such areas as:
  - .1 Children care.
  - .2 Public vehicle parking.
  - .3 Non-climate controlled public.
- .2 Provide special areas with provisions such that intended users of area are not exposed to or subject to hazards from supplied products. Provide products manufactured for use in such environments.
- .3 Power receptacles, switches and communication devices features:
  - .1 Resistance to tampering: Tamperproof screws.
  - .2 Resistance to vandalism and impact:
    - .1 Heavy duty construction.
    - .2 Polycarbonate covers or wire guards.
  - .3 Non-climate-controlled areas: Weather-resistant provisions such as gasketed covers, corrosion resistant hardware and weather-resistant finishes. Devices operate in extreme temperatures.

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**3.25 CLEANING**

- .1 Progress Cleaning: Leave Work area clean at end of each day.
- .2 Final Cleaning:
  - .1 Work performed in electrical equipment rooms, electrical closets and communication closets, perform following:
    - .1 Prior to energization, HEPA vacuum and clean interiors and buswork of switchgear, switchboards, panels, cabinets and other electrical equipment, of construction debris and dust.
    - .2 HEPA vacuum top of switchgear, switchboards, panels, cabinets, bus ducts, cable trays and conduits in room, followed by thorough HEPA vacuuming of floors.
    - .3 Prior to final turn over: Coordinate laying of permanent floor matting in electrical rooms after rooms are re-cleaned, and floors wet mopped and dried.
    - .4 Clean luminaire reflectors, lenses, and other luminary surfaces that have been exposed to construction dust and dirt, including top surface, whether it is exposed or in ceiling space.
    - .5 Clean switches, receptacles, communications outlets, cover plates, and exposed surfaces.
    - .6 Clean other electrical equipment and devices.
  - .2 Refer to individual sections for additional specific cleaning instructions.

**3.26 SCAFFOLDING, HOISTING, AND RIGGING**

- .1 Unless otherwise noted, supply, erect and operate scaffolding, rigging, hoisting equipment and associated hardware required for work, and subject to approval from Owner and review with Consultant. Coordinate responsibilities and work with general trades.
- .2 Include scaffolds in manner with as little as possible interference to work of other trades.
- .3 Do not place major scaffolding or hoisting equipment loads on any portion of structure without approval from Owner and review with Consultant. Do not weld, bolt or otherwise affix supports, clips, brackets or similar devices to finished members or surfaces without approval from Owner and review with Consultant.
- .4 Immediately remove from site, scaffolding, rigging and hoisting equipment when no longer required.

**3.27 PROTECTION**

- .1 Protect equipment and materials onsite from damage and defacement due to elements and work of trades. Upon Substantial Performance of the Work, provide equipment and materials in new condition.
  - .2 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.
  - .3 Protect personnel on job site from injury due to live equipment and circuits.
  - .4 Arrange for installation of temporary doors for rooms containing electrical distribution equipment. Keep these doors locked except when under direct supervision of electrician.
  - .5 Protect concrete floors and finished flooring from damage. Provide additional measures when moving heavy loads or equipment.
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- .6 Keep floors free from oils, grease or other materials likely to discolour them or affect bond of applied surfaces.
- .7 Attach and fasten fixtures and fittings in place in safe, sturdy, secure manner so that they cannot work loose, fall or shift out of position during normal use of building.
- .8 Protect finished and unfinished work from damage due to carrying out of this work.
- .9 Make good damages caused directly or indirectly by work to walls, floors, ceilings, woodwork, masonry, finishes, structures and existing installations.
- .10 After products are installed and tested, protect products from dirt, dust and moisture until building is ready for turnover and service, unless otherwise noted.
- .11 Protect existing areas above, below and adjacent areas of Work from debris, noise, or interruptions to existing services in accordance with requirements of Owner and as specified. Maintain in operation existing services to these areas, allowing Owner continued use of these areas. Where services that are required to be maintained run through areas of renovations, provide protection to services or reroute, in coordination with Owner and review with Consultant.

### **3.28 FINISH PAINTING OF ELECTRICAL WORK**

- .1 Unless otherwise noted, finish painting of exposed Electrical Divisions work is responsibility under work of Division 09.
- .2 Coordinate provision of identification painting for electrical distribution equipment in accordance with application requirements of Division 09. Review exact finish colours with Consultant. Equipment requiring special colour identification painting to include but not be limited to following:
  - .1 Pull boxes and junction boxes.
  - .2 Communication system conduit.
  - .3 Genset exhaust piping.
- .3 Spray painting is not permitted unless approved by Owner and reviewed with and recommended for acceptance by Consultant.

### **3.29 NOTICE FOR REQUIRED FIELD REVIEWS**

- .1 Whenever there is requirement for Consultant to perform field review prior to concealment of any work, to inspect/re-inspect work, give minimum 7 working days' notice in writing to Consultant.
- .2 If Consultant is unable to attend field review when requested, arrange alternative date and time.
- .3 Do not conceal work until Consultant advises that it may be concealed.
- .4 When Consultant is requested to perform field review and work is not ready to be reviewed, reimburse Consultant for time and travel expenses.

### **3.30 MAINTENANCE TO EQUIPMENT PRIOR TO ACCEPTANCE**

- .1 Provide maintenance to equipment in accordance with manufacturer instructions prior to start-up, testing and commissioning.
- .2 Check rechargeable batteries, storage capacitors and similar products to determine if installation and energizing onsite is in accordance with manufacturer instructions to maintain warranty and service life. Replace products as required.
- .3 Filters to be new upon Substantial Performance of the Work. This is in addition to spare filters.

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**3.31 PRELIMINARY TESTING**

- .1 When directed by Consultant, arrange, pay for and perform site tests on equipment or systems for such reasonable lengths of time and at such times as may be required to prove compliance with Specification and AHJ requirements.
- .2 When, in Consultant opinion, tests are required to be performed by certified testing laboratory, arrange and pay for such tests.
- .3 These tests are not to be construed as evidence of acceptance of work, and it is agreed and understood that no claim for delays or damage will be made for injury or breakage to any part or parts of equipment or system due to test where such injuries or breakage were caused by faulty parts or workmanship of any kind.
- .4 When, in Consultant opinion, tests indicate that equipment or products are defective or deficient, immediately remove such equipment or products from site and replace them with acceptable equipment or products, at no additional cost.

**3.32 FIELD QUALITY CONTROL**

- .1 Unless otherwise noted, provide minimum 10 working days advance notice to Consultant of inspection, testing or verification work.
- .2 After completion of installation, perform inspection, start-up, testing and verification work in accordance with requirements of following:
  - .1 As specified in respective Sections.
  - .2 Manufacturer instructions and recommendations.
  - .3 Commissioning Agent and commissioning sections.
- .3 Perform field quality control work in addition to requirements of standard factory testing of products as specified in respective Sections. Submit specified factory testing reports with shop drawings.
- .4 Product Manufacturer Instructions and Recommendations:
  - .1 Submit product manufacturer instruction procedures and recommendations for product onsite start-up, testing and verification.
  - .2 Include performance standards for verification, testing parameters, pass/fail or go/no-go standards.
- .5 Engage respective systems or equipment vendors or trades to be onsite during field quality control work to perform adjustments or remedial work to correct issues identified by field quality control work.
- .6 Manufacturer Certified Technician Field Quality Control Work:
  - .1 Onsite services as applicable to respective products as specified in Sections include providing basic requirements as follows:
    - .1 Visual Inspection:
      - .1 Ensure that shipping members have been removed.
      - .2 Ensure that interiors are free of foreign materials, tools and dirt.
      - .3 Check for damage (dents, scratches, frame misalignment, damage to devices).
      - .4 Check doors for proper alignment and operation.
    - .2 Mechanical Inspection:
      - .1 Check power wiring connections for tightness.
      - .2 Check control wiring connections for tightness.
    - .3 Electrical Inspection:

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- .1 Check input for proper voltage.
      - .2 Check output for proper voltage.
    - .4 Startup and Basic Commissioning:
      - .1 Startup of equipment and systems, installation, check, adjust, balance and calibrate components and instruct operating personnel.
      - .2 Energize units and perform manufacturer recommended start-up and commissioning procedures.
    - .5 Instructions: Instruct operating personnel in operation, care and maintenance of systems, system equipment and components.
  - .2 Services provided for such period, and for as many onsite visits as necessary to put equipment in operation and train operating personnel on aspects of operation and maintenance.
  - .3 Signed report or compliance certificate supplied verifying compliance of Work in performance, handling, installing, applying, protecting and cleaning of products. Submitting reports as noted.
  - .4 Product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer instructions.
  - .5 Initial inspection, start-up, programming, testing and verification work.
  - .6 Assistance to installers with specific instructions on installation of equipment and systems.
  - .7 Instructions to end users on operating and maintenance of equipment and systems.
  - .8 Coordination of and directing adjustments to and remedial of work in accordance with performance requirements, test and verification report results and testing and verification report comments.
  - .9 Assistance in integrations between systems and equipment.
- .7 Onsite Inspection, Start-up, Testing, Commissioning and Verification Work:
- .1 Prepare proposed schedule for onsite testing and verification work and submit to Consultant for review and recommendation for acceptance. Notify Consultant in writing at least 10 working days in advance of testing and verification work, unless otherwise noted.
  - .2 Inspect and test products for proper operation and performance meeting requirements of Specification, AHJ, Consultant and Commissioning Agent. Where testing procedures conflict, review with Consultant prior to proceeding with Work and obtain direction.
  - .3 Where noted or required by AHJ, perform integrated systems testing in accordance with CAN/ULC-S1001. Coordinate Work with other Divisions.
  - .4 Verify operations and performance.
  - .5 Perform manufacturers start-up and basic commissioning procedures.
  - .6 Perform testing and verification work in presence of Consultant and Commissioning Agent. Commissioning Agent and Consultant to have option to attend and witness testing. Review and coordinate administration.
  - .7 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of phase of project (as applicable) and project.
  - .8 Unless otherwise noted, perform testing as non-destructive.
- .8 Remedial Work:
- .1 Adjust and provide corrective work meeting performance requirements and in accordance with requirements as outlined in testing and verification reports.
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- .2 Rectify deficiencies and malfunctioning equipment.
- .3 Remove and replace equipment that cannot be repaired.
- .4 Re-test and verify corrected work.
- .5 Test and verify replacement products and work.
- .9 Reports:
  - .1 Prepare testing and verification reports, documenting results, observations and recommendations, signed by testing technician and witnesses.
  - .2 Where specified, submit reports stamped and signed by Professional Engineer.
  - .3 Submitted with product manufacturer report where required.
  - .4 Submitted with compliance certificates where required.
  - .5 Unless otherwise noted, submit electronic pdf versions to Consultant.

### **3.33 TRAINING AND DEMONSTRATION**

- .1 Responsibility: Systems and equipment manufacturer authorized representative.
- .2 Submit for review with Consultant:
  - .1 Proposed list of systems and equipment for training and demonstration.
  - .2 Proposed schedule of demonstration and training dates and times.
  - .3 Proposed use of equipment and systems for training and demonstration purposes.
- .3 Provide onsite sessions to train and demonstrate to end user designated personnel, aspects of operation and maintenance of equipment and systems. Unless otherwise noted, supply printed copies and electronic copies of training materials to each attendee. Obtain from Owner, list of Owner representatives to receive instructions.
- .4 System/Equipment: Number of sessions and durations:
  - .1 1 Session, 8 hour duration.
- .5 Provide dedicated separate sessions for each system, each with instruction duration time requirements to complexity of each system. For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Use Operating and Maintenance Manuals and audio-visual aids during training sessions. Supply required labour, material, and instruments.
- .6 Training modules consist of:
  - .1 Operational Requirements and Criteria: Equipment function, stopping and starting, safeties, operating standards, operating characteristics, performance curves, and limitations.
  - .2 Troubleshooting: Diagnostic instructions, testing and inspection procedures.
  - .3 Documentation: Equipment/system warranties, and manufacturer parts and service facilities, telephone numbers, email addresses and web sites.
  - .4 Maintenance: Inspection instructions, types of cleaning agents used as well as cleaning methods, preventive maintenance procedures and use of special tools.
  - .5 Repairs: Diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components and review of spare parts inventory.
  - .6 Other items as noted in Specification and items recommended by respective equipment manufacturers.
- .7 After training is completed, submit to Consultant, list of systems for which instructions were given, stating for each system:

- .1 Date instructions were given to Owner staff.
- .2 Duration of instruction.
- .3 Names of persons instructed.
- .4 Other parties present.
- .8 Obtain signatures of attendees to verify their attendance at these sessions and have received O&M instruction manuals.
- .9 Maintain record of training including:
  - .1 Topics covered.
  - .2 Dates and durations of sessions.
  - .3 List of attendees.
- .10 Submit to Consultant copy of electronic version of training materials loaded on USB flash drive. Include in operating and maintenance manuals submission.

### **3.34 SEMI-FINAL AND FINAL INSPECTIONS**

- .1 Perform semi-final and final inspections with Consultant. Review scheduling requirements with Consultant and obtain Consultant recommendations for acceptance.
- .2 Semi-Final Inspections:
  - .1 Prior to semi-final inspection, submit list of items which are either not finished or deficient at time of semi-final inspection.
  - .2 Verify following items prior to semi-final inspection. Provide declaration in writing that following items listed are completed:
    - .1 Systems capable of operation with controls functional and automatic controls generally in operation.
    - .2 Tests on equipment and systems made including tests required by AHJ.
    - .3 Equipment and system set-up and start-up procedures completed in accordance with manufacturer data.
    - .4 Equipment and system testing and identification completed.
    - .5 Warranty forms completed and registered with manufacturer. Include copies of original warranties with O & M manuals.
    - .6 Sample of O & M manuals submitted. Operating and maintenance instructions, and schedule submitted for Consultant review.
    - .7 Access doors inspected and verified in suitable location for easy access to equipment requiring maintenance and servicing.
    - .8 Equipment is located easily accessible for maintenance and servicing.
    - .9 Noise and vibration control devices and flexible connections inspected by manufacturer representative and report submitted.
- .3 Final Inspections:
  - .1 Submit to Consultant written request for final inspection of systems. Include written certification that:
    - .1 Deficiencies noted during job inspections and semi-final inspections have been completed.
    - .2 Field quality control procedures have been completed.
    - .3 Systems have been tested and verified, balanced and adjusted, and are ready for operation.
    - .4 Final calibration of controls completed.

- .5 Maintenance and operating data have been completed and submitted to, reviewed with Consultant and accepted.
- .6 Nameplates and labels are in place and equipment identifications have been completed.
- .7 Clean-up is complete. Equipment cleaned inside, outside and lubricated.
- .8 Spare parts and replacement parts specified have been provided, as reviewed with Consultant.
- .9 As-built and record drawings have been completed and submitted to and reviewed with Consultant and recommended for acceptance.
- .10 End users have been instructed in operation and maintenance of systems.
- .11 Commissioning procedures have been completed and recommended for acceptance.
- .12 AHJ has accepted installations.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    National Research Council Canada (NRC):
  - .1        National Building Code of Canada (NBC), 2020.
  - .2        National Fire Code of Canada (NFC), 2020.
- .2    Ontario Building Code (OBC), 2012 with amendments to 2024.

**1.2            SUBMITTALS**

- .1    Submit copies of compliance certificates.

**1.3            REGULATORY REQUIREMENTS**

- .1    Obtain required permits and inspections. Give required notices. Include copies of permits and inspection certificates with operation and maintenance manuals.
- .2    Perform work in accordance with following:
  - .1        NBC.
  - .2        NFC.
  - .3        OBC.
  - .4        Government of Canada, Labour Program: Workplace Safety.
  - .5        Ministry of the Environment, Conservation and Parks, governing waste management.
  - .6        Ministry of Labour.
  - .7        AHJ.

**Part 2            Products**

**2.1            MATERIALS**

- .1    General Patching and Repair Materials: Refer to Division 02 for listing of patching and repair materials incidental to removal or demolition of components associated with work of this Section.
  - .2    Repair Materials: Use only new materials required for completion or repair matching materials damaged during performance of work of this Section. Provide new materials to meet assembly or system characteristics as existing systems indicated to remain and carry CSA certification labels.
  - .3    Firestopping Repair Materials:
    - .1        Coordinate requirements with work of Section 07 84 10 - Comprehensive Firestopping.
    - .2        Use firestopping materials compatible with existing fire stopping systems where removal or demolition work affects rated assemblies, restore to match existing fire-rated performance.
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**Part 3            Execution**

**3.1                EXAMINATION AND SITE CONDITIONS**

- .1      Discovery of Hazardous Substances: Refer to requirements in Section 26 00 10 - Electrical Work General Instructions.
- .2      Refer to Section 02 41 19 - Selective Demolition for additional requirements.

**3.2                SALVAGE AND DEBRIS MATERIALS**

- .1      Review with Consultant existing items designated as salvage, designated as reused or designated to be turned over to party designated by Consultant.
- .2      Remove from site, existing materials that are disconnected and designated as obsolete or to be removed. Review such materials with Consultant. Transport materials being retained, to storage area designated by Consultant.
- .3      Coordinate performance of following with other trades:
  - .1          Removal from site and proper dispose of materials which are removed and are not designated for re-use in the Work.
  - .2          Removal of materials and items designated for salvage and storage in manner to prevent damage or devaluation of materials in accordance with Section 02 41 17 - Disassembly Removal and Storage.

**3.3                PREPARATION FOR DEMOLITION WORK**

- .1      Coordinate performance of following with other trades:
  - .1          Scheduling: Account for continued occupancy requirements during selective demolition in accordance with Section 02 41 19 - Selective Demolition.
  - .2          Verifying that prior to start of demolition work, affected building areas are unoccupied and discontinued in use and that required screens, partitions, hoardings are in place.
  - .3          Prior to start of Work, verifying that existing services in areas affected by demolition are disconnected, capped, made safe or removed as reviewed with Consultant.
  - .4          Prior to start of Work, notifying Consultant and onsite personnel of demolition work that may cause safety risks.
  - .5          Coordinating electrical disconnections of electrically powered mechanical equipment and making safe electrical services with work of Divisions 21, 22, 23 and 25.
- .2      During course of work, where asbestos-containing materials or other hazardous substances are encountered or suspected, cease work in area in question and immediately notify Consultant. Comply with requirements of AHJ. Do not resume work in affected area without direction from Consultant.

**3.4                PROTECTION**

- .1      Take steps to positively prevent uncontrolled falling of demolished materials.
  - .2      Verify that no part of existing structure is over-loaded due to work carried out under Work.
  - .3      Prevent debris from blocking surface drainage systems, elevators, mechanical and electrical systems that remain in operation. Provide temporary guards and hoardings during and until completion of work.
  - .4      Coordinate performance of following with other trades:
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- .1 Provision and maintenance of barricades, guards, railings, lighting, warning signs, security personnel and other safety measures for protection for workers and public during execution of the Work. Where demolition is proceeding, close off access to area to unauthorized personnel.
- .2 Provision of temporary bracing, shoring and supports as specified in Section 02 41 17 - Selective Structural Dismantling and Demolition and 02 03 46 - Shoring and Temporary Support.

### 3.5 ELECTRICAL DISCONNECTIONS AND REMOVALS

- .1 Examine and familiarise with existing systems and installations and other conditions affecting the Work.
- .2 Refer to applicable drawings which define extent of areas being demolished in existing building. Review drawings and site and demolition and renovation of services as required to accommodate alterations detailed.
- .3 Provide electricians licensed in place of Work to perform electrical disconnections. As required, disconnect electrical system circuits and feeders at power source.
- .4 Maintain in operation, existing installations retained in and around areas being renovated, maintaining operating conditions as follows:
  - .1 Without restrictions on Owner hours of work and access to areas as reviewed with Consultant.
  - .2 No disruptions to operations in adjoining and other areas. Provide required temporary bypass installations and removed after permanent installations/changes are complete.
  - .3 When respective work is deleted, such deletions are to in no way affect operation of existing interconnected mechanical or electrical components that remain. When existing circuits are being disconnected, maintain supervision of area such that circuits do not affect existing circuits being retained.
  - .4 Where existing services pass through or are in area to serve items which are to remain, or pass through areas being deleted, maintain services but reroute as required. Reroute existing services concealed behind existing finishes and which become exposed during renovation work and conceal behind new or existing finishes. Review with Consultant services being kept in service and operational.
  - .5 Protect existing electrical services including power, and existing life safety systems against damage during entire construction period.
  - .6 Maintain fire protection of areas which may include fire watch during temporary shutdowns of existing systems, in accordance with requirements of codes and AHJ.
- .5 Where noted on drawings or where required to perform Work of this Project, disconnect and remove items of existing obsolete electrical work or designated for removal.
- .6 Where noted, re-install existing electrical work being retained that was removed as part of demolition work.
- .7 Where noted, disconnect and remove existing fire alarm system including associated conduits, boxes, wiring, and similar items.
- .8 Where noted, disconnect and remove communication systems including associated conduits, boxes, cabling, and similar items.
- .9 Where noted, disconnect and remove telephone outlets, associated conduit, cabling and sub-terminal backboards and related accessories. Maintain telephone service and main terminal backboard as is, unless otherwise noted.

- .10 Relocate devices accommodating work of other Divisions. Where luminaires, switches, receptacles, and other devices and equipment are removed, disconnect at point of electrical supply, remove obsolete wiring and conduit up to source and make safe. Remove obsolete conduit/raceways in accessible ceiling spaces, exposed locations, and other noted locations. Where existing obsolete conduit and similar raceway material cannot be removed, such as embedded in concrete, cut back and cap obsolete conduit and raceways, unless otherwise noted.
- .11 When relocating luminaires, inspect luminaire for circuit identification and identify circuiting on as-builts if circuiting is maintained. Prior to relocating luminaires, remove lamps, glass and lenses and inspect for damages and deficiencies. Clean luminaires including lenses prior to installation. Advise Consultant of deficiencies and await directions.
- .12 Disconnect electrical circuits and panel feeders. Maintain electrical service and main distribution panel as is, ready for subsequent Work. Where breakers are no longer circuited, rename as 'SPARE', until re-used.
- .13 Provide revised panelboard directories or identification nameplates, when affected by renovation, disconnection, or removal of work. Use actual room names/numbers, as applicable.
- .14 Protect existing devices being relocated, preventing damage to devices. Test such devices prior to disconnection and de-energization, verifying that each device is in working condition. Examine and test that motors are in proper rotation direction. Prior to initiating work, report devices not working or with damage, to Consultant.
- .15 Provide junction boxes, outlet boxes, wiring, plates and conduits, as necessary for complete relocation of devices. Before being reinstalled, clean relocated or temporary removed devices and equipment and test verifying that they are in good operating condition. Splice conductors only with Consultant review and recommendation, and with provision of junction boxes and terminal devices for proper extension of circuits. Otherwise, replace circuits with continuous homeruns extending from devices to circuit panel. Provide access panels suiting intended applications and luminaire locations in ceilings inaccessible.
- .16 Provide blank cover plates on existing obsolete boxes which remain in position, as reviewed with Consultant. Provide weather-resistant covers for boxes in non-climate-controlled areas.
- .17 After installation is complete, test parts of re-used or relocated electrical equipment for proper operation and correct faults and grounds. For fire alarm work, engage existing fire alarm system manufacturer to verify relocated devices and remaining devices on either side of removed or relocated devices on same circuit, and test and verify system suiting relocation work. For other existing systems, engage manufacturer authorized representative or existing system maintenance contractor as reviewed with Consultant, to inspect, test and verify relocated devices. Perform testing and documenting to similar standards specified for new Work. Document testing in test reports, signed by testing technician. Review requirements with Consultant. Submit reports to Consultant.
- .18 Maintain in operation, interior, exterior or underground electrical services (including auxiliary services, telephone, fire alarm, P.A. and other communications systems) to operating parts of building. Maintain existing risers in service as required to feed other areas of building or other building as applicable. Do not interrupt services without review with Consultant and prior written recommendations or instructions from Consultant. Submit formal requests to Consultant, outlining in detail, requirements of proposal.
- .19 Where references are made on drawings that existing receptacles and other wiring devices be extended and relocated to suit new construction, test devices and when found

- defective replace with new devices. Test and verify operation of replacement devices. Replace cracked or broken cover plates with plate finishes reviewed with Consultant.
- .20 Disconnect power supply to branch circuits controlling lighting, receptacles, panels and mechanical equipment, for safe removal of equipment, conduit, wiring and boxes, affected by demolition.
- .21 Close openings in and around boxes, panels, fixtures and devices, that result from their removal. Close openings with patching suitable for application and terminate and insulate cables to restore system to safe operating condition.
- .22 Disconnect and remove electrical equipment, luminaires, communication devices, and other system components, during demolition of ceilings, walls, floors and structures. Temporarily relocate until demolition work is completed, existing equipment not relocated but interferes with demolition. Maintain in operation services to temporarily relocated equipment. Test and verify operation of equipment and devices temporarily relocated.
- .23 Remove underground cables designated as deleted and cut back conduit systems to depth of 600 mm below finished grade and abandoned in place. Grind off conduits and make flush with surface of concrete where conduits are cast into concrete. Seal open ends of conduit with silicone sealant and leave in place.
- .24 Check luminaires designated for deletion, for PCB and mercury materials. Disconnect and remove ballasts containing PCBs and mercury-containing lamps. Remove and dispose of such materials offsite.
- .25 Check transformers designated for deletion, for PCB materials. Decommission, disconnect and remove transformers and PCB wastes offsite. Refer to requirements of Section 26 05 90 - Hazardous Materials.
- .26 Decommission, disconnect and transport transformers designated for deletion and not containing PCBs, off site or salvaged or transported to storage sites as reviewed with Consultant.
- .27 Handle and dispose of PCB and mercury materials in accordance with Division 02 and AHJ.

### **3.6 CUTTING, PATCHING AND CORE DRILLING**

- .1 Cutting and patching of existing building surfaces required for electrical work, including core drilling walls and slabs for conduits or raceways, is responsibility of another Division of the Work and is excluded from electrical work.
- .2 Accurately and carefully mark out location and extent of cutting or drilling required and coordinate with trades performing work. Obtain Consultant approval of location and size of cut or drilled openings before work commences. Cut or drilled openings must not be larger than is absolutely necessary for installation of conduits, duct or similar materials.
- .3 Seal openings in fire-rated construction with firestopping and sealing as specified. Ensure openings are not left open overnight unless approved by Owner and reviewed with Consultant.

### **3.7 CUTTING AND PATCHING**

- .1 Perform cutting and core drilling of existing building required for installation of Electrical Divisions work. Perform cutting in neat and true fashion, with proper tools and equipment
- .2 Prior to drilling or cutting openings, determine by review with Consultant (including Structural Consultant) and with use of non-destructive radar scan (magnetic scan) of slab or wall or surface, presence of existing services and reinforcement bars concealed behind building surface being cut. Locate openings to suit.
- .3 Criteria for cutting holes for additional services:

- .1 Coordinate holes and chases required for work.
  - .2 Cut holes through slabs only. Do not cut holes through beams or girders.
  - .3 Cut holes 150 mm diameter or smaller only. Review with and obtain direction from Consultant (Structural Engineer) for larger holes.
  - .4 Core drill or saw cut opening of size leaving minimum 13 mm clearance around materials passing through opening.
  - .5 Keep at least 100 mm clear from beam faces.
  - .6 Space at least 3-hole diameters on centre.
  - .7 Holes closer than 25% of slab span from supporting beam face: Use cover meter above slab to clear slab top bars.
  - .8 Holes within 50% of slab span: Use cover meter underside of slab to clear slab bottom bars.
  - .9 Submit sleeving drawings indicating holes and their locations for Consultant (structural engineer) review.
  - .10 Prior to cutting or drilling structural elements, review with and obtain recommendations from Consultant.
- .4 Provide firestopping and sealing materials for packing and sealing void between opening and material passing through opening for length of opening.
  - .5 Patch surfaces to match existing and adjoining surfaces, as reviewed with Consultant. Coordinate with work of general trades, suiting surface applications.
  - .6 Refer to drawing notes.

### **3.8 PAINTING RESTORATION WORK**

- .1 Coordinate provision of painting and restoration work with work of Division 09.
- .2 Provide painting to match existing finishes as reviewed with Consultant.

### **3.9 DEMOLITION**

- .1 Perform demolition of concrete, brick, timber, masonry structures, pole footings, equipment pads, and concrete poles, in manner and with equipment as not to disturb adjacent pavement, utilities, electrical equipment and other works remaining in position. Leave material designated as salvaged, in undamaged condition.
- .2 Prior to start of demolition work, review with Consultant extent of demolition of existing work to accommodate Work.
- .3 Demolish work in safe and systematic manner, from top to bottom.
- .4 Demolish in manner to contain and minimize dusting.
- .5 Demolish masonry and concrete elements in small sections. Remove and lower structural framing and other heavy and large objects.
- .6 Leave work in safe condition, so that no part is in danger of uncontrolled toppling or falling.
- .7 Install temporary supports preventing uncontrolled collapse of structures.
- .8 Where partial removal of pavement, sidewalk, curb and gutter, or other structures is required for removal of equipment and results in broken edges of object remaining in place, square up and trim along straight lines at minimum distance of 300 mm from areas disturbed by removal operations. Remove for disposal, steel reinforcement, conduits, ducts, wires, and debris associated with removed portions of such structures.
- .9 Maintain adequate ventilation when using cutting torches.

- .10 Do not start any "Hot Works" without appropriate permits.
- .11 Do not overload floor or wall with accumulations of waste material or debris or by other loads.

### **3.10 DISPOSAL, CLEAN-UP, PATCHING AND MAKING GOOD**

- .1 Package materials, rubbish, and debris resulting from demolition and remove from site and legally dispose.
- .2 Separate recyclable and reusable materials to maximum extent possible from general waste stream and place in recycling containers and bins. When full and Work is complete, remove recycling containers and bins from site and dispose of materials at appropriate authority having jurisdiction designated facilities.
- .3 Do not allow demolished materials to accumulate on site. As work progresses, remove and legally dispose of materials away from site.
- .4 Selling, burning or burying of materials on site is not permitted.
- .5 Prior to end of each work day, leave work and storage areas in clean condition with required hoardings and guards in place.
- .6 Where existing surfaces are damaged by work or where existing devices are removed from wall, ceilings, floors and other surfaces, and such deleted devices are not being replaced in same locations, patch locations of these removed devices and re-finish. Where openings are left in existing ceiling tiles, replace ceiling tiles with new matching tiles. Include for:
  - .1 Surfaces being filled and repainted: Clean, removing dirt, dust, oil, grease, loose paint, rust and other foreign matter which would prevent proper bonding of new finish.
  - .2 Sanding glossy surfaces to uniform dull texture.
  - .3 Filling-in and patching surfaces with same material as existing surfaces. Finish surfaces, matching and aligning with existing adjoining surfaces.
  - .4 Providing firestopping materials, maintaining fire-rating of existing surfaces.
  - .5 Using paint rollers or brushes to apply and extend paint finish over full height and width of area affected, to straight line in location reviewed with Consultant.
  - .6 Applying sufficient number of coats such that patched area is indistinguishable to surrounding area.
  - .7 Provide materials of equivalent quality to existing finishes standards and that are compatible with finishes to which they are applied.
  - .8 Prior to ordering, reviewing finishes with Consultant.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.2 No. 35-20, Extra-Low-Voltage Control Circuit Cable, Low-Energy Control Cable, and Extra-Low-Voltage Control Cable.
  - .2 CSA C22.2 No. 38-18, Thermoset-insulated Wires and Cables (Trinational Standard with UL 44 and ANCE NMX-J-451).
  - .3 CSA C22.2 No. 51-20, Armoured Cables.
  - .4 CSA C22.2 No. 123-16(R2021), Metal Sheathed Cables.
  - .5 CSA C22.2 No. 127-18, Equipment and Lead Wires.
  - .6 CSA C22.2 No. 131-17, Type TECK 90 Cable.
  - .7 CSA C22.2 No. 208-18, Fire Alarm and Signal Cable.
- .2 Underwriters Laboratories of Canada (ULC):
  - .1 CAN/ULC-S139-2017-REV2, Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
  - .3 For fire-rated type FAS 105 cables, identify ULC tested rating designations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

**Part 2 Products**

**2.1 GENERAL BUILDING WIRES**

- .1 CSA certified, or ULC labeled and certified.
  - .2 Ratings, number of conductors and sizing of conductors: As noted.
  - .3 Conductors constructed of 98% conductive copper and certified for minimum 1000 volts, unless otherwise noted.
  - .4 Minimum No. 12 AWG stranded conductors. Stranded conductors in sizes larger than No. 12 AWG.
  - .5 RW90 XLPE:
    - .1 In accordance with CSA C22.2 No. 38.
    - .2 Single copper conductor, 1000 V, maximum 90°C conductor temperature, minus 40°C minimum installation temperature.
    - .3 X-link polyethylene (XLPE) insulation, colour coded.
  - .6 RWU90 XLPE:
-

- .1 In accordance with CSA C22.2 No. 38.
- .2 Single copper conductor, 1000 V, maximum 90°C conductor temperature, minus 40°C minimum installation temperature.
- .3 Extra thickness X-link polyethylene (XLPE) insulation suitable for wet and buried installations, colour coded.
- .7 AC90:
  - .1 In accordance with CSA C22.2 No. 51.
  - .2 Flexible armoured cable with RW90 copper conductors and bare copper ground conductor.
  - .3 Overall interlocked aluminium tape armour.
  - .4 Anti-short bushing connectors.
- .8 Flexible Armoured Cable Fittings:
  - .1 Saddle type, constructed of malleable iron/steel, electro-zinc plated inside and outside.
  - .2 With nylon-insulated throat or anti-short bushing to suit specific applications.

## **2.2 TECK 90 CABLE**

- .1 In accordance with CSA C22.2 No. 131.
- .2 Rated for outdoor, weather-resistant and wet locations including direct burial applications.
- .3 1000 V rated.
- .4 Conductor: Bare, soft drawn, Class B compact or compressed stranded copper conductors.
- .5 Insulation: Chemically cross-linked thermosetting polyethylene (XLPE).
- .6 Bonding Conductor (1/C Cable): Soft drawn bare copper.
- .7 Inner Jacket: Sunlight resistant PVC jacket tightly applied over assembly, to prevent slipping of core in a vertical position.
- .8 Armour: Flexible interlocked aluminum armour, over inner jacket for mechanical protection.
- .9 Overall PVC jacket rated minus 40°C.
- .10 Barrier tape over shield.
- .11 Terminations to suit specific applications and approved for TECK cable.
- .12 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.
  - .3 Threaded Rods: Not less than 6 mm diameter to support suspended channels.

## **2.3 FIRE RATED TYPE FAS 105 CABLES**

- .1 Type FAS 105 circuit integrity fire-rated communication cable system as follows:
  - .1 Cable manufacturer approved and recommended complete package of cables, fittings, connectors, clamps, securing hardware, EMT conduits, electrical boxes and other installation components, tested by UL/ULC as packaged system.
  - .2 Two hour fire-rated and wet location rating, 300 V, 105°C.

- .3 CSA listed as type FAS 105 and in accordance with CSA C22.2 No. 208.
- .4 Certified in accordance with CAN/ULC-S139 Electrical Circuit Integrity System 40A (FHIT7), for each conductor size used. Exact ULC tested rating designations confirmed with cable manufacturer for intended specific applications.
- .5 Installed in accordance with manufacturer instructions and qualification criteria of ULC standards.
- .6 Two Conductor Cable: Solid annealed copper conductor covered with LSZH silicon rubber insulation, copper/polyester tape shield and overall outer jacket of LSZH polyolefin construction.
- .7 Where use is approved by AHJ.
- .2 Include connectors, cable clips, straps, identification labeling and ancillary materials as recommended by cable manufacturer to suit specific installation applications. Provide support spacing not exceeding manufacturer instructions, suiting intended applications.
- .3 Include for manufacturer authorized technician to perform initial coordination with and providing training to installing personnel on installation and termination of cabling runs. After completion of Work, manufacturer technician to review installation work, test cabling and terminations and provide formal report of test results with observations, and certification that installation work is complete, and cabling and terminations perform as required, in accordance with cable manufacturer and specified requirements.

## **2.4 CONTROL CABLES**

- .1 Type LVT 30 V Shielded Control Cable:
  - .1 In accordance with CSA C22.2 No. 35, FT4 rated.
  - .2 Applications: Extra-low-voltage circuits.
  - .3 Conductors: Soft annealed solid copper conductors, sized suiting intended applications, unless otherwise noted.
  - .4 Insulation: Type TW - PVC thermoplastic.
  - .5 Shielding: Paramagnetic foil tape.
  - .6 Overall Covering: PVC jackets.
  - .7 Sheath and jacket for applications requiring additional protection: PVC thermoplastic jacket with armour of closely wound aluminum wire.
  - .8 Temperature Rating: Minus 20°C to 60°C.
  - .9 Where installed in plenums, cable certified to C22.2 No. 214 and FT6 rated.
- .2 Type LVT 300 V Shielded Control Cable:
  - .1 In accordance with CSA C22.2 No. 35, FT4 rated.
  - .2 Applications: Low voltage circuits.
  - .3 Conductors: Solid annealed solid copper conductors sized suiting intended applications, unless otherwise noted.
  - .4 Insulation: Polyethylene.
  - .5 Shielding: Paramagnetic foil tape.
  - .6 Overall Covering: PVC jackets.
  - .7 Sheath and jacket for applications requiring additional protection: PVC thermoplastic jacket with armour of closely wound aluminum wire.
  - .8 Temperature Range: Minus 20°C to 80°C.
  - .9 Where installed in plenums, cable certified to CSA C22.2 No. 214 and FT6 rated.
- .3 Type TEW:
  - .1 In accordance with CSA C22.2 No. 127.



- .2 Solid bare copper conductor, rated for 600 volts, No. 18 AWG.
- .3 Thermoplastic insulated with nylon overall jacket.
- .4 105°C conductor temperature.
- .5 With required number of copper conductors and colour coding, suiting intended applications.
- .4 Provide other types of control wiring reviewed with respective equipment manufacturer requirements and in accordance with applicable local electrical code requirements.

## 2.5 TRACER WIRE

- .1 Tracer wire, also called locator wire, are provided to assist in locating ducts, conduits, pipes and other lines after they have been buried underground.
- .2 Standards: ULC listed and labeled, and direct burial rated.
- .3 Standard Tracer Wire:
  - .1 Solid copper conductor insulated with high molecular weight polyethylene (HMWPE).
  - .2 Manufactured according to ULC constructions in both 30 V and 600 V versions.
  - .3 Suitable for use at maximum continuous operating temperature of 75°C in wet and dry locations.
- .4 Tracer wire is compatible for use and connection to industry standard frequency generator, which is connected directly to cable being traced, and high or low frequency signal is applied. In passive method, power voltages are sometimes applied at frequency of 50 - 60 Hz.
- .5 Connectors are moisture displacement connectors as recommended by wire manufacturer, suiting intended applications.
- .6 Typically, size No.14 AWG for installation in open trench. No. 2 AWG typically in conjunction with trenching machine. For directional boring applications, minimum No. 10 AWG. Comply with manufacturer recommendations.
- .7 Jacket Colour: Unless otherwise required by authority having jurisdiction, or by Owner, and reviewed with and recommended by Consultant, provide jacket colour for applications as follows:
  - .1 Electrical: Red.
  - .2 Communication: Orange.
- .8 Include for after installation inspection and testing. Refer to Part 3 for additional requirements.

## 2.6 ACCEPTABLE PRODUCT MANUFACTURERS

- .1 Low Voltage Cables:
  - .1 Nexans.
  - .2 Prysmian Cables (Pirelli).
  - .3 General Cable.
  - .4 Aetna Cables.
  - .5 Kerite Company.
  - .6 Texcan.

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**Part 3                      Execution**

**3.1                      PROJECT CONDITIONS**

- .1      Verify that field measurements and conditions are as noted.
- .2      Cable routing on drawings is schematic and approximate and not reflective of elevations. Route cable, meeting project conditions. Determine exact routing and lengths onsite.
- .3      Review fire protection ratings of construction to identify rooms and paths of conductors that are fire-rated. Where fire-rated conductors are required as noted, provide fire-rated conductors where rooms and paths are not fire-rated.

**3.2                      CO-ORDINATION**

- .1      Co-ordinate work with work provided under other electrical work and work of other trades.
- .2      Coordinate and maintain separation between cable and other work.
- .3      Determine cable routing avoiding interference with other work.

**3.3                      GENERAL CABLE INSTALLATION**

- .1      Install and terminate cables.
- .2      Install and pull cables in accordance with cable manufacturer requirements for bending radii and pulling tensions.
- .3      Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors - (0-1000 V).
- .4      Conductor length identical for parallel feeders.
- .5      Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .6      Wiring in Walls: Drop or loop vertically from above to better facilitate future renovations. Avoid wiring from below and horizontal wiring in walls.
- .7      Conductor Types and Sizes: As noted on drawings and in accordance with electrical code. Increase where required, suiting length of run and voltage drop. Includes conductors not sized or specified of type. Where conductor sizing schedule is issued with Contract Documents, size in accordance with schedule.
- .8      Ground cabling in accordance with cable manufacturer instructions and governing electrical code requirements.
- .9      Take precautions when handling cable on reel ensuring that no damage results in uncoiling process.
- .10     Where cables penetrate fire-rated construction, provide ULC listed and labeled, fire stopping and smoke seal materials or fittings to protect integrity of fire-rated construction in accordance with ULC standards. Refer to requirements of Division 07.

**3.4                      INSTALLATION OF CONDUCTORS**

- .1      Provide fire-rated conductors for applications as required by building code and authority having jurisdiction.
  - .2      Typically, install wiring in conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
  - .3      Install conductors, unless otherwise noted as follows:
-

- .1 Underground inside or outside building and for non-climate-controlled areas: RWU90.
- .2 Connections to electric heating coils in supply air ductwork systems, and for connections to other electric heating equipment where use of 90°C rated conductors are recommended by heating equipment manufacturer: RW90.
- .3 Conductors requiring fire-rating by building code and authority having jurisdiction, including feeders for emergency systems, fire fighter elevators, fire alarm systems, other life safety systems and for applicable signal and control circuits of these systems: type MI, fire rated, copper sheathed mineral insulated copper conductors.
- .4 Climate controlled areas branch circuit wiring in accessible ceiling spaces and within stud wall construction consisting of drops down to luminaries and drops down stud walls to devices and in furniture systems: AC90 flexible armoured cable (BX) with maximum 6 m run permitted.
- .5 Isolated power system load side wiring: RW90.
- .6 For climate-controlled areas wiring except as noted above or specified elsewhere in Specification or as noted: RW90.
- .4 In applications where, multiple conductors in conduit are being run, provide trapeze configuration of metal C-channels and threaded rod hangers to support cable/conduit from ceiling slab. Wall-mounted cable/conduit brackets and ring type conduit hangers may be permitted in applications approved by Owner and reviewed with Consultant. Provide required cable support system accessories for proper installation.
- .5 Support flexible armoured cable in ceiling spaces or in stud wall construction with steel 2 holes cable straps. Run flexible armoured cables in parallel to building lines. Utilize centralized conduit runs to maintain maximum permitted runs of flexible armoured cables. Provide insulating grommet at cut ends of flexible armoured cable to protect conductor insulation. Provide saddle termination connectors at boxes.
- .6 Provide fire-rated type cabling for specific conductors as noted and as required for specific applications by local governing codes. Install fire-rated type conductors in accordance with manufacturer instructions and recommendations. Arrange for manufacturer technician to provide onsite services as specified.
- .7 Install control wiring as follows:
  - .1 Review type of control wiring with manufacturers of equipment and systems being interconnected.
  - .2 Provide cables for fire alarm system applications and security system applications as recommended by respective system manufacturer and complying with requirements of electrical code.
  - .3 Run control wiring in conduit or raceways.
  - .4 Provide conductors not installed in conduit or raceways, with fire-insulated rating in accordance with building code flame spread ratings.
  - .5 Mechanically protect cable by means reviewed with and recommended by Consultant.
  - .6 Provide conductors with fire-ratings (FT6 rating) requirements when run in plenums and similar construction.
  - .7 Coordinate responsibility for provision of control wiring for mechanical equipment and equipment of other Divisions.
- .8 Do not use conductors smaller than No. 12 AWG in systems over 30 volts, except where otherwise noted. Do not use conductors smaller than No. 6 AWG for exterior luminaire wiring, unless otherwise noted.

- .9 Colour code conductors throughout to identify phases, neutrals and ground by means of self-laminating coloured tape, coloured conductor insulation, or properly secured coloured plastic discs. Colours, unless otherwise noted, to be as follows:
  - .1 Phase A – red.
  - .2 Phase B – black.
  - .3 Phase C – blue.
  - .4 Ground – green.
  - .5 Neutral – white.
  - .6 Control – orange.
- .10 Colours for isolated power system "load" side power wiring to be as follows:
  - .1 Live No. 1 – brown.
  - .2 Live No. 2 – orange.
  - .3 Ground – green.
- .11 Use talcum powder or equivalent, for pulling in isolated power centre "load" side wiring.
- .12 When pulling wires into conduit use lubricant and ensure that wires are kept straight and are not twisted or abraded.
- .13 Provide numbered wire collars for control wiring. Numbers to correspond to control shop drawing legend. Obtain wiring diagram for control wiring.
- .14 Number control conductors with push-on PVC Z type markers.
- .15 Colour code conductors for communications systems in accordance with system component manufacturer recommendations.
- .16 Neatly secure exposed wire in apparatus enclosures with approved supports or ties.

### **3.5 INSTALLATION OF TECK 90 CABLE (0-1000 V)**

- .1 Provide Tech 90 cables for applications as noted. Handle, install, and terminate in accordance with manufacturer recommendations and instructions and as specified.
- .2 Group cables wherever possible on channels.
- .3 Install cable exposed or concealed suiting intended area of installation. Securely support with straps and hangers.
- .4 When pulling cable, apply pulling tension to conductor not to sheath of cable. Limit cable pulling tension as recommended by cable manufacturer.
- .5 Terminate cable in equipment with lugs and termination kits.
- .6 Ground shielding.
- .7 Splices not permitted except where justified by cable pulling tension calculations and reviewed with and recommended for acceptance by Consultant. Where splices are recommended by Consultant, locate in accessible area. Identify locations on as-built drawings.

### **3.6 INSTALLATION OF FIRE-RATED TYPES FAS 105 CABLES**

- .1 Obtain installation and testing training from cable manufacturer. Install cable and terminate.
- .2 Submit with shop drawings, copy of manufacturer detailed installation manual and testing procedures. Provide fire-rated type cables for applications as noted.

- .3 For type FAS 105 cables, run in EMT conduits as approved by cable manufacturer. Comply with conductor conduit fill requirements of cable manufacturer installation guides.
- .4 Provide metal C-channels, clips, wall brackets, and ancillary devices as required and as recommended by cable manufacturer suiting on-site installation conditions. Provide system of metal type C-channel hangers and rods spaced at minimum 1200 mm but as confirmed with cable manufacturer, for running of cables. Where clips and other hardware are in contact with cables, insulate cables and hardware with suitable tape in accordance with cable manufacturer recommendations for applications of dissimilar metals.
- .5 Make terminations of conductors with manufacturer approved components and connectors in accordance with manufacturer recommendations. Obtain tools for cable terminals from cable manufacturer. Terminations must be completed immediately once started to avoid moisture ingress from the surrounding air.
- .6 Splicing of cables is not permitted, unless recommended for acceptance by Consultant and splicing method is approved by cable manufacturer.
- .7 Where electrical boxes are used in installation, comply with cable manufacturer guidelines.
- .8 Terminate cables to transformers, motors and other vibrating equipment, with means isolating vibration in accordance with cable manufacturer recommendations.
- .9 Arrange for cable manufacturer certified technician to perform field quality work, including inspection, testing and verification of cables, and preparation and signing of verification reports.

### **3.7 INSTALLATION OF TRACER WIRES**

- .1 Install tracer wires in accordance with wire manufacturer recommendations for specific applications. Review with Consultant, runs to be traced.
- .2 Connect with proper connectors, protecting from moisture and corrosion. Do not twist wires together and wrap with electrical tape.
- .3 Place tracer wire in same orientation to installed cable/duct. Using spacer, tape tracer wire to cable/duct, every 2.4 m to 3 m, in three o'clock position or provide fill between cable/duct and tracer wire. Install colour coded warning tape minimum 300 mm above pipe.
- .4 Bring tracer wire above ground for ease of terminating signal and terminate in test station. Identify wire ends. Review locations with Consultant and identify locations on as-builts.
- .5 Ground ends of wire.
- .6 After installation is complete, perform conductivity test or locate test and demonstrate to Consultant.

### **3.8 FIELD QUALITY CONTROL**

- .1 Inspection, Testing and Verification:
  - .1 Perform work in accordance with wire and cable manufacturer recommendations.
  - .2 Visually inspect wires and cables for damage or irregularities not consistent to new products.
  - .3 Perform installation insulation resistance tests on new wire and cable only.
  - .4 Perform installation tests directly after cable installation, and before termination to equipment or accessories.

- .5 Perform test is “pass/fail” type of test, to determine if insulation has been damaged during installation.
- .6 Verify that insulation resistance is in accordance with manufacturer acceptable limits.
- .7 After terminations and connections are made, inspect terminations and connections.
- .2 Prepare testing and verification reports signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.2 No. 41-13(R2017), Grounding and Bonding Equipment (Tri-National Standard, with NMX-J-590- ANCE and UL 467).
  - .2 CAN/CSA-C22.2 No. 65-18, Wire Connectors (Tri-National Standard with NMX-J-543-ANCE and UL 486A-486B).
  - .3 CSA C22.2 No. 188-18, Splicing Wire Connectors (Tri-National Standard, with UL 486C and NXM-J- 548-ANCE), Includes Update No. 1 (2019).
  - .4 C22.2 No. 1691-21, Single Pole Locking-Type Separable Connectors (Bi-National Standard, with UL 1691).

**1.2            SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.

**Part 2            Products**

**2.1            COMPRESSION TYPE CONNECTORS**

- .1 In accordance with CAN/CSA-C22.2 No. 65 and CSA C22.2 No. 41.
- .2 CSA certified and marked.
- .3 With current carrying parts of copper sized fitting copper conductors.
- .4 Rated for copper solid, stranded and flexible conductors to 90°C.
- .5 Manufactured from high strength seamless copper tubing.
- .6 Electro-Tin plated.
- .7 Short and long barrel length, with chamfered entry.
- .8 Single hole and two holes.
- .9 Colour coded for die identification.
- .10 Capable of installation during types of weather events, humidity levels, and field conditions using standard industry tools.

**2.2            FIXTURE TYPE SPLICING CONNECTORS**

- .1 In accordance with CAN/CSA-C22.2 No. 65 and CSA C22.2 No. 188.
  - .2 CSA certified.
  - .3 600-Volt maximum voltage.
  - .4 With current carrying parts of copper or copper alloy sized fitting copper conductors.
  - .5 Set Screw Type:
-

- .1 2 - piece wire connectors, with thermoplastic locking cap and brass insert with set screw.
- .6 Twist-On Type Connectors:
  - .1 Twist-on wire connector to join and insulate 2 or more wires.
  - .2 Flame-retardant shell rated at 105°C.
  - .3 Zinc plated steel insert.
  - .4 Springs expand accepting wire shape and size.

## **2.3 BUSHING STUD CONNECTORS**

- .1 CSA certified.
- .2 Connector body and stud clamp fitting conductors.
- .3 Clamp for copper conductors.
- .4 Stud clamp bolts.
- .5 Bolts for copper conductors.
- .6 Sized fitting conductors.

## **2.4 FLEXIBLE ARMOURED CABLE FITTINGS**

- .1 Saddle type, constructed of malleable iron/steel, electro-zinc plated inside and outside.
- .2 Equipped with nylon-insulated throat or anti-short bushing suiting specific applications.

# **Part 3 Execution**

## **3.1 INSTALLATION - GENERAL**

- .1 Remove insulation from ends of conductors and cables.
- .2 Clean conductor contact area.
- .3 General circuit conductors sized 3/0 AWG and greater: Provide long barrel double crimp, 2 hole compression type lug connectors.
- .4 Install compression pressure type connectors with compression tool and application die suiting intended applications.
- .5 Install fixture type connectors to conductors and tighten-on.
- .6 Install bushing stud connectors.
- .7 Install devices in accordance with manufacturer instructions.
- .8 Perform installations meeting secureness tests in accordance with CAN/CSA-C22.2 No. 65.

## **3.2 FIELD QUALITY CONTROL**

- .1 Inspection, Testing and Verification:
  - .1 Inspect, test and verify products.
  - .2 Check connections and operations.
  - .3 Perform secureness tests in accordance with CAN/CSA-C22.2 No. 65.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.



**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 American National Standards Institute/Telecommunications Industries Association (ANSI/TIA):
  - .1 ANSI/TIA-607-D-2019, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
- .2 CSA Group (CSA):
  - .1 CSA C22.1-24, Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No. 41-13(R2017), Grounding and Bonding Equipment (Tri-national Standard, with NMJ-J-590- ANCE and UL 467).
- .3 Institute of Electrical and Electronics Engineers (IEEE):
  - .1 IEEE 80-2013, IEEE Guide for Safety in AC Substation Grounding (Incorporates IEEE Std P80-2013/Cor 1-2015).
  - .2 IEEE 837-2014, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports. Where requested in Specification, provide test reports, prepared and sealed by Professional Engineer.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Standards:
  - .1 CSA certified, or ULC listed and labeled.
  - .2 In accordance with CSA C22.2 No. 41.
  - .3 For substations and vaults, and other locations as required by authorities having jurisdiction: IEEE 80 and IEEE 837.
- .2 Conductor Sizes:
  - .1 As specified or as indicated or scheduled.
  - .2 Where not indicated or scheduled, in accordance with CSA C22.1 and local governing electrical code.

**2.2 GROUNDING AND BONDING CONDUCTORS**

- .1 Bare:
-

- .1 Stranded copper, soft annealed.
- .2 Insulated:
  - .1 Green polyvinylchloride jacketed.
  - .2 Compacted and stranded copper conductors.

## **2.3 GROUNDING SYSTEM COMPONENTS**

- .1 Non-corroding, of compatible materials, including:
  - .1 Rod Electrodes: Copper clad steel, 19 mm diameter by not less than 3 m long, unless otherwise noted.
  - .2 Plate Electrodes: Copper, surface area not less than 0.2 m<sup>2</sup>, not less than 1.6 mm thick, unless otherwise noted.
  - .3 Grounding Bar: Copper in accordance with details.
  - .4 Ground Bus: Copper, complete with insulated supports, fastenings, connectors and pre-drilled for two-hole lug connectors. Bus sized as noted, but not less than 50 mm x 9 mm x 900 mm. Provide continuous lengths where noted.
  - .5 Grounding and bonding bushings.
  - .6 Clamps for grounding of conductors.
  - .7 Bolted type conductor connectors.
  - .8 Bonding jumpers, straps.
  - .9 Pressure wire connectors.
  - .10 Bolted removable test links.
  - .11 Cable sheath isolating sleeves.
  - .12 Wire Connectors and Terminations: Suiting wiring types and specific applications.
- .2 Exothermic Welded Grounding:
  - .1 Process of welding conductor connectors.
  - .2 Consisting of manufacturer packaged materials providing welding connections made by exothermic welding process of joining similar metals using high temperature reaction of powdered copper oxide and aluminum.
- .3 Mechanical Grounding Connector:
  - .1 Type for above ground or within inspection pits.
  - .2 Connecting cable to rod or pipe, or other types suiting intended applications.
  - .3 High copper alloy.
  - .4 U-Bolts, nuts and lock-washers of bronze construction.
  - .5 Corrosion-resistant.
- .4 Miscellaneous Ancillary Components: Suiting requirements for completing grounding and bonding work.

## **2.4 TELECOMMUNICATIONS GROUNDING AND BONDING**

- .1 Include requirements specified in this Section and additional requirements in Division 27.
- .2 Telecommunications Equipment Rack and Cabinet Ground Bars: Solid copper ground bars designed for mounting on framework of open or cabinet-enclosed equipment racks with dimensions not less than 6 mm thick by 20 mm wide.

- .3 At equipment mounting location (backboards and hinged cover enclosures) where rack-type ground bars cannot be mounted: Screw lug-type terminal blocks. Where bolting to painted surfaces, use paint piercing type washers.
- .4 LAN Room Ground Bus: Not less than 50 mm x 9 mm x 300 mm unless otherwise noted, copper ground bus with eight drilled taped holes, mounted on walls with standoff insulators.
- .5 Ground Conductor for Grounding Grid and Associated Connections: Not less than No. 3/0 AWG unless otherwise noted, bare, seven-strand medium hard-drawn copper.
- .6 Ground Braid: Constructed from flat 98% conductivity tinned copper grounding braid.

## **2.5 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Compression Connectors, Ground Rods, Bus Bars, Fittings:
  - .1 nVent – Erico.
  - .2 ABB – T&B.
  - .3 ILSCO.
- .2 Exothermic Process:
  - .1 Cadweld (nVent - Erico).
  - .2 Hubbell – Burndy.

## **Part 3 Execution**

### **3.1 INSTALLATION – GENERAL**

- .1 Provide bare grounding and bonding conductors for following applications, unless otherwise noted:
  - .1 Ground busses.
  - .2 Electrode interconnections.
  - .3 Metal structures.
  - .4 Gradient control mats.
  - .5 Transformers.
  - .6 Switchgear.
  - .7 Motors.
  - .8 Equipment grounding connections as noted.
  - .9 Lightning protection ground grids.
- .2 Provide insulated grounding and bonding conductors for following applications unless otherwise noted:
  - .1 Grounding meters.
  - .2 Relay cases.
  - .3 Grounding cable sheaths.
  - .4 Raceways.
  - .5 Pipe work.
  - .6 Screen guards.
  - .7 Switchboards and panelboards.
  - .8 Potential transformers.
  - .9 Equipment grounding connections as noted.

### 3.2 LOW VOLTAGE WORK GROUNDING AND BONDING

- .1 Provide grounding and bonding work in accordance with drawings and authorities having jurisdiction and referenced standards.
- .2 Provide electrical utility grounding requirements for stations, vaults and electrical rooms. Review requirements with electrical utility. Comply with requirements of IEEE 837.
- .3 Install complete permanent, continuous grounding system including, electrodes, conductors, connectors, accessories. Where EMT is used, run separate ground wire in conduit.
- .4 Install bonding conductors and connect.
- .5 Install connectors in accordance with manufacturer instructions.
- .6 Protect exposed grounding conductors from mechanical injury.
- .7 Make exposed ground connections using compression connectors and other grounding fittings suitable for applications.
- .8 Make buried connections, and connections to electrodes, and structural steel work, using copper welding by thermite process and manufacturer packaged materials in accordance with manufacturer instructions.
- .9 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .10 Soldered joints not permitted.
- .11 Install bonding wire for flexible conduit, connected at both ends to grounding bushing, solderless lug, clamp or cup washer and screw. Cleat bonding wire to exterior of flexible conduit.
- .12 Install flexible ground straps for bus duct enclosure joints, where such bonding is not inherently provided with equipment.
- .13 Install separate ground conductor to outdoor lighting standards.
- .14 Connect building structural steel and metal siding to ground.
- .15 Make grounding connections in radial configuration only, with connections terminating at single grounding point typically at street side of metallic water pipe. Avoid loop connections.
- .16 Bond single conductor, metallic armoured cables to cabinet at supply end and load end.
- .17 Ground secondary service pedestals.
- .18 Install grounding connections to equipment including following:
  - .1 Service equipment, transformers, switchgear, motor control centres, starters, control panels, generators, panel boards.
  - .2 Cable trays, duct systems, frames of motors.
  - .3 Outdoor lighting.
  - .4 Building steel work.
- .19 Connect grounding conductors to motors 1 HP and above or circuits 20 A and above, with solderless terminal and bolt tapped to motor frame or equipment housing. Connect to smaller motors or equipment by fastening terminal to connection box. Connect junction boxes to equipment grounding system with grounding clips mounted directly on box or with machine screws. Remove paint, dirt, or other surface coverings at grounding conductor connection points to provide good metal-to-metal contact.

- .20 Ground metal sheathing and exposed metal vertical structural elements of buildings. Ground metal fences enclosing electrical equipment. Bond metal equipment platforms which support electrical equipment to equipment ground. Bond rooftop equipment.
- .21 Bond metal work associated with pools such as reinforcing steel, piping, ladders and ancillary devices, above ground loops by copper conductors in accordance with local governing electrical code. Clean water pump prior to bond being using approved clamps. As required, make several bonds at various locations or collect wires and make one bond. Ground electrical equipment associated with these piping systems, adequately by installing flexible conduit and ground jumper wire to motors. Ground telephone boxes, speakers, pull stations and other such equipment within pool area with jumper wires within connecting conduit to ensure proper grounding. Include for ground connections to pool reinforcing steel.
- .22 Provide separate ground connection for bathtubs.
- .23 Ground and bond various telecommunications, audio visual systems, security, life safety and control systems in accordance with respective system manufacturer recommendations.
- .24 Install system and circuit grounding connections to systems.
- .25 Provide separate insulated ground wire for each isolated ground receptacle.
- .26 Size ground conductors that are not sized on drawings in accordance with authorities having jurisdiction requirements. Size ground conductor no smaller than requirements specified or indicated on drawings.
- .27 Electrodes:
  - .1 Within designated electrical rooms, provide ground electrodes consisting of ground rods as required by governing electrical code, driven into grade and interconnected with copper ground conductors. Provide, drive and bury ground rods at depth, in accordance with electrical code. Refer to details on drawings.
  - .2 Make ground connections to continuously conductive underground water pipe on street side of water meter.
  - .3 Install concrete encased electrodes in building foundation footings, with terminal connected to grounding network.
  - .4 Install rod and plate electrodes and make grounding connections to suit intended applications.
  - .5 Bond multiple electrodes together and bond locations of groups of electrodes together.
  - .6 Provide size No. 3/0 AWG copper conductors or greater, for connections to electrodes.
  - .7 Make grounding provision for installing electrodes with acceptable resistance to ground value, where rock or sand terrain prevails.
- .28 Grounding Bus:
  - .1 Install copper grounding bus mounted on insulated supports on wall of electrical rooms and communication equipment rooms.
  - .2 For electrical rooms provide no smaller than 50 mm x 9 mm x 900 mm electrical grade copper ground bus on perimeter wall of electrical rooms, 300 mm above finished floor level. Secure ground bus on 20 mm standoff insulators. Connect electrical rooms ground grid with ground bus with no smaller than 3/0 copper ground conductor in conduit. Connect each electrical room perimeter ground electrode system back to main electrical room ground electrode with no smaller than No. 3/0 copper conductors. Refer to drawings and increase dimensions of ground bus and conductors to drawing indicated sizes.

- .3 Ground items of electrical equipment in electrical room and IT equipment in communication equipment room to ground bus with individual bare stranded copper connections no smaller than No. 2/0 AWG. Increase size to suit intended applications and local electrical code requirements.

### **3.3 CABLE SHEATH GROUNDING**

- .1 Bond single conductor, metallic sheathed cables together at one end only. Break sheath continuity by inserting insulating sleeves in cables or using special isolating transformer.
- .2 Provide minimum No. 6 AWG flexible copper wire soldered, not clamped, to cable sheath.
- .3 Connect bonded cables to ground with minimum No. 2/0 AWG copper conductor.

### **3.4 GROUNDING IN MAINTENANCE HOLES**

- .1 Install grounding stud, electrode, and stranded copper conductor sized in accordance with local governing electrical code, in each maintenance hole.
- .2 Install ground rod in each maintenance hole so that top projects through bottom of maintenance hole. Provide with lug for grounding connection. Test that ground resistance is in accordance with CSA C22.1 and provincial electrical code requirements.

### **3.5 PROVISIONS FOR PERMAFROST**

- .1 Bond non-current carrying metal parts together, of following:
  - .1 Hot water heating system.
  - .2 Main water pipe.
  - .3 Main building drain.
  - .4 Oil line.
  - .5 Telephone, radio/TV, emergency and fire alarm lead-in or service conduits, near panels.
- .2 Make connections to pipes on building side of main valves and tanks. Connect jumpers across boilers to supply and return hot water heating pipes.
- .3 Drive required quantity of copper ground rods at least 1.8 m apart in original undisturbed ground. Where rods cannot penetrate permafrost, drive at angle not more than 60 degrees from vertical, and in same direction. Do not trench rods into position.
- .4 Install ground wire from service neutral bar to rods and where buried use bare copper not smaller than size 1 AWG strand or size 4 AWG solid, and at least 640 mm below ground. Bond ground conductor, or short tap from it to outside metal sheathing of building close to power service conduit. Use lug or cast clamp, with bronze or plated bolt, nut and washers (not sheet metal screw or wood screw). Remove paint from sheathing for good contact. Run ground conductor in conduit where installed outside wall of buildings. For indoors non-finished service areas, run conductor bare and fasten as specified for equipotential bonding wire.
- .5 Install electrode interconnections where metal parts, circuits or grounding conductors and electrodes are in proximity to lightning rod conductors.

### **3.6 TELECOMMUNICATIONS GROUNDING**

- .1 Provide grounding and bonding in accordance with ANSI/TIA-607-E requirements.
- .2 Provide wire and hardware required to properly ground, bond, and connect communications raceway, cable tray, metallic cable shields, and equipment to ground source.

- .3 Provide continuous ground bonding jumpers with no splices. Use shortest length of bonding jumper possible.
- .4 Provide ground paths which are permanent and continuous with resistance of 5 ohms or less from raceway, cable tray, and equipment connections to building grounding electrode. Test that measured resistance across individual bonding connections is of value 10 milliohms or less.
- .5 Provide communications room telecommunications ground busbar hardware at cable tray height.
- .6 Connect busbar to building ground busbar located in same room using two-hole compression lugs and grounding jumper of same size as pigtail extension of main building grounding ring (minimum 3/0 AWG).
- .7 Ground metallic conduits, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray pan or telecommunications ground busbar, whichever is closer, using insulated minimum No. 6-AWG ground wire bonding jumpers.
- .8 Ground metallic conduit at each end using minimum No. 6-AWG bonding jumpers.
- .9 Perform cable tray grounding and bonding in accordance with manufacturer recommendations. Bond metallic structures of wireway to provide 100% electrical continuity throughout wireway system.
- .10 Refer to additional grounding and bonding requirements specified in Division 27.

### **3.7 FIELD QUALITY CONTROL**

- .1 After installation work is complete, inspect work and check connections.
- .2 Before backfilling, engage independent testing agent to inspect grounding and perform ground resistance test. Before energizing electrical system, perform tests.
- .3 Perform ground continuity and ground resistivity tests using method appropriate to site conditions, approved by AHJ and reviewed with Consultant.
- .4 Provide step-and-touch potential calculations using measured station ground resistance measurements. Document results in report.
- .5 Test grounding and bonding systems, verifying 100% electrical continuity throughout.
- .6 Telecommunications Systems: Test that measured resistance across individual bonding connections is 10 milliohms or less.
- .7 Disconnect ground fault indicators during tests.
- .8 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**



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**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1 American Society for Testing and Materials (ASTM):
  - .1 ASTM A123/A123M-17, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
  - .2 ASTM A653/A653M-20, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .3 ASTM A1011/A1011M-18a, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
  - .4 ASTM B633-19, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

**1.2                SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, load ratings, installation spacing, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
  - .2 Include with shop drawings for equipment supports designed by manufacturer specifically for project equipment:
    - .1 Full details of design criteria.
    - .2 Design calculations.
    - .3 Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
    - .4 Installation procedures and instructions.
    - .5 Testing and verification procedures.
    - .6 Stamp and seal of design Professional Engineer licensed in Place of Work.
- .3 Submit testing and verification reports.

**Part 2            Products**

**2.1                EQUIPMENT SUPPORTS**

- .1 Design, construct and install metal supports, stands, platforms and other metal structures required for and associated with equipment. Design equipment supports to properly distribute loads and impact loads onto building structure. Design to be provided by a seismic and structural engineer.
  - .2 Where equipment is indicated or specified to be floor mounted on stands or legs, fabricate these from structural steel section or steel pipe with adequate bracing and steel plate flanges for bolting to concrete housekeeping pad.
  - .3 Where ceiling or wall mounting is indicated on drawings or specified, provide suspended platform, bracket or shelf, whichever is most suitable for equipment and its location.
-

Fabricate from standard structural steel sections and plate or steel pipe. Securely fasten structures to building structure.

- .4 Support equipment suspended above floor level with suitable welded or bolted prime coat painted structural steel angles or channels bracketed to wall or secured by hanger rods.
- .5 Provide supports large enough to support equipment along entire length and width. Install isolators when necessary, either below support or between support and equipment.

## **2.2 ANCHOR BOLTS, ANCHOR RODS, LIFTING EYES AND HOOKS**

### **.1 Anchor Bolts, Anchor Rods and Anchors:**

- .1 Engage delegated design Professional Engineer to design and certify required anchors for applications.
- .2 Corrosion-resistant.
- .3 Suiting applicable requirements for seismic and vibration isolation.
- .4 Suiting materials of construction on which embedded.
- .5 Concrete: Refer to Section 03 30 00 - Cast-in-Place Concrete.
- .6 Reinforcement: Refer to Section 03 20 00 - Concrete Reinforcing.

### **.2 Lifting Eyes and Hooks:**

- .1 Where lifting eyes, hooks or similar means are not included with equipment from manufacturers, provide steel lifting eyes and hooks of type and lifting capacity to accommodate weight of equipment.
- .2 Provide galvanized steel types or other corrosion-resistant finish for products located in non-climate-controlled areas.

### **.3 Anchor Bolt Templates:**

- .1 Templates accurately locate anchor bolts suiting equipment requirements.

### **.4 Provide anchors, fasteners and other securing hardware of capacity and type suiting application and for which materials to which hardware are being installed. Include manufacturer product literature with shop drawing submissions detailing that supplied hardware is suitable for respective applications.**

## **2.3 SUPPORT CHANNELS**

### **.1 Climate-controlled Areas:**

- .1 In accordance with ASTM A653/A653M SS GR 33.
- .2 Pre-galvanized steel, 0.75 mil zinc-coated by hot-dip process, U-shape, sized suiting application but no smaller than 41 x 41 mm and greater where noted, and not less than 2.5 mm thick.
- .3 Type used in poured concrete walls and ceilings or suspended or surface-mounted, suiting intended applications.

### **.2 Non-climate-controlled Areas:**

- .1 In accordance with ASTM A1011/A1011M.
- .2 Finishes: In accordance with ASTM A123/A123M.
- .3 Hot dipped galvanized steel, 2.6 mil zinc-coated, U shape, sized suiting application but no smaller than 41 x 41 mm, and greater where noted, and not less than 2.5 mm thick.
- .4 Type set in poured concrete walls and ceilings or suspended or surface-mounted, suiting specific applications.

- .3 Selected channel type to support loading for specific applications in accordance with manufacturer limitations.
- .4 Include anchorage, suspended supports flanges, brackets, rods, pedestals and clamps, suiting intended applications.

## **2.4 ROOFTOP CONDUIT SUPPORT SYSTEM**

- .1 Rooftop support systems with features as follows:
  - .1 CSA certified, or ULC listed and labeled.
  - .2 Non-penetrating of roof.
  - .3 Vibration dampening.
  - .4 Does not float.
  - .5 Suitable for outdoor wet and freezing environments without damage caused by weather or freeze and thawing when exposed to de-icing chemicals.
  - .6 Environmentally friendly.
  - .7 Constructed of recycled rubber.
- .2 Materials:
  - .1 Constructed of 100% recycled rubber and polyurethane pre-polymer with a uniform load capacity suiting intended load application of support (minimum rating 744 kg/m). Each base with reflective red stripe.
- .3 Low Lying Base:
  - .1 Dimensions: 150 mm wide by 125 mm tall by required overall length (minimum 225 mm). This is minimum dimensions, but increase base requirements, suiting intended applications as recommended by system manufacturer.
  - .2 Low base galvanized steel frame C channel 14 gauge - 25 mm high strut galvanized in accordance with ASTM A653/A653M.
  - .3 Pipe roller assembly.
- .4 Elevated Base:
  - .1 Two 13 mm diameter electro zinc threaded rod risers and 14 gauge - 25 mm high galvanized steel slotted channel.
  - .2 Adjustable height up to 400 mm, and as indicated.
  - .3 Pipe roller assembly.
- .5 Attaching Hardware: Zinc-plated threaded rod, nuts and attaching hardware in accordance with ASTM B633.
- .6 Pipe Clamps: Single pipe supports constructed of galvanized steel and sized accommodating sizing of installed conduits.
- .7 Review with system manufacturer that selected products provide proper support for intended application.

## **2.5 SEISMIC RESTRAINTS**

- .1 Refer to Section 26 05 48 - Vibration and Seismic Controls.

## **2.6 OTHER EQUIPMENT SUPPORTS**

- .1 Fabricate equipment supports from structural grade steel in accordance with requirements of Division 05.
- .2 Submit structural calculations with shop drawings.

- .3 Concrete Pads: Refer to Section 26 05 00 – Common Work Results for Electrical.

## **2.7 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Support Channels:
  - .1 Unistrut.
  - .2 ABB (T&B).
  - .3 Hilti.
  - .4 Eaton B-Line.
- .2 Roof Top Conduit Support Systems:
  - .1 Eaton – Cooper.
  - .2 Clearline Technologies.
  - .3 Erico.

## **Part 3 Execution**

### **3.1 INSTALLATION - GENERAL**

- .1 Fastenings:
  - .1 Provide metal fastenings and accessories in same texture, colour and finish as adjacent materials.
  - .2 Prevent electrolytic action and corrosion between dissimilar metals and materials by using suitable non-metallic strips, washers, sleeves, or other permanent separators to avoid direct contact.
  - .3 Use non-corrosive fasteners and anchors for securing exterior work and in spaces where high humidity levels are anticipated.
  - .4 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage.
  - .5 Keep exposed fastenings to a minimum, space evenly and install neatly.
  - .6 Do not use fastenings or fastening methods that may cause spalling or cracking of material to which anchorage is made.
  - .7 For equipment, use fastenings of standard commercial sizes and patterns with material and finish suitable for service. Install bolts not projecting more than one diameter beyond nuts.
- .2 Secure equipment to surfaces with nylon shields or lead anchors, suiting types of surfaces and applications.
- .3 Secure equipment to poured concrete with expandable inserts.
- .4 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .5 Secure surface mounted equipment with twist clip fasteners to inverted T bar ceilings. Support T bars to carry weight of equipment specified.
- .6 Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories, to basic channel members.
- .7 Fasten exposed conduit or cables to building construction or support system using straps, by means as follows:
  - .1 One-hole steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.

- .8      **Suspended Support Systems:**
  - .1      Support individual cable or conduit runs with not smaller than 6 mm diameter threaded rods and spring clips.
  - .2      Support 2 or more cables or conduits on channels supported by not smaller than 6 mm diameter threaded rod hangers where direct fastening to building construction is impractical.
- .9      For surface mounting of two or more conduits, provide steel C- channels secured to surfaces with manufacturer recommended hardware, suiting intended application.
- .10     Install C-channel supports in accordance with manufacturer instructions and recommendations, maintaining span and loading limits.
- .11     Provide metal brackets, frames, hangers, clamps and related types of support structures, to support conduit and cable runs.
- .12     Provide support for raceways and cables dropped vertically to equipment where there is no wall support.
- .13     Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .14     Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade, review with Consultant and obtaining recommendation from Consultant.
- .15     Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer installation recommendations.
- .16     Review with and obtain recommendation for acceptance from Consultant if wood shims are proposed to be used with hangers.
- .17     Coordinate provision of concrete for concrete pads in accordance with 26 05 00 – Common Work Results for Electrical.
- .18     Coordinate work with applicable requirements of Division 13 and Structural Consultant.
- .19     Vibration Control Devices: Install on piping systems at pumps, chillers, cooling towers, and other equipment as noted. Refer to Section 26 05 48 - Vibration and Seismic Controls.

### **3.2                      INSTALLATION OF ANCHOR BOLTS, ANCHOR RODS, LIFTING EYES AND HOOKS**

- .1      Install anchors, alignment guides and lifting components in accordance with equipment manufacturer recommendations suiting equipment and anchoring requirements.
- .2      Set anchor bolts, anchor rods, sleeves, washers, nuts and provide templates to locate positions of bolts.
- .3      Set sleeves flush with or slightly above top surface or rough concrete.
- .4      Provide anchor bolts with right-angles bends or hooks, or with square plate washers, threads and nuts for anchoring. Do not use expansion shields or similar devices for anchoring equipment to concrete bases.
- .5      Locate anchors suiting equipment as installed and requirements of reviewed anchor shop drawings.
- .6      Where equipment is not in banks, provide two-eye hooks above each piece of equipment.

### **3.3                      INSTALLATION OF ROOFTOP CONDUIT SUPPORT SYSTEMS**

- .1      Select and install rooftop support system for conduits/raceways in accordance with manufacturer instructions and recommendations, suiting type and size of raceway, and

roofing materials. Verify load ratings with manufacturer and provide support system to accommodate required loads.

- .2 Install system at height as indicated and as reviewed with Consultant.
- .3 For gravel top roofs, remove gravel from around and under pipe support. Coordinate work with building roofing vendor confirmed with Owner and reviewed with Consultant.
- .4 Consult vendor of installed roofing for roof membrane compression capacities and roof loading limitations. Comply with restrictions.
- .5 Use clamps sized suiting conduit sizes. Verify that installation and use of system does not invalidate installed roof warranties.
- .6 Engage vendor of installed roofing to inspect installation and verify that installation has not damaged roof.

### **3.4 FIELD QUALITY CONTROL**

- .1 Inspection, Testing and Verification:
  - .1 Inspect, test and verify products.
  - .2 Check connections and operations.
- .2 Where delegated design, include for delegated design Professional Engineer to witness testing and also sign reports.
- .3 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.1-24, Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No. 40-17, Junction and Pull Boxes.
  - .3 CSA C22.2 No. 76-14(R2019), Splitters.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, load ratings, installation spacing, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

**Part 2 Products**

**2.1 SPLITTERS**

- .1 Standards: In accordance with CSA C22.2 No. 76.
- .2 Construction: CSA certified, factory primed and painted sheet metal enclosure, welded corners and formed hinged cover suitable for locking in closed position. Complete with suitable mounting provisions.
- .3 Terminations: Connection blocks, or main and branch lugs, matching size, type and number of incoming and outgoing conductors.
- .4 Spare Terminals: No less than three spare terminals or lugs, suiting intended applications, on each connection or lug block sized less than 400 A.

**2.2 STANDARD JUNCTION BOXES AND PULL BOXES**

- .1 Standards: In accordance with CSA C22.2 No. 40.
  - .2 Galvanized or prime coat plated steel construction, with screw-on or hinged covers suiting intended applications, and connectors suiting connected conduit.
  - .3 CSA certified, "FS" or "FD" Series cast ferroalloy and aluminium boxes.
  - .4 CSA certified rigid plastic (PVC) boxes.
  - .5 Covers Flush Mounted: 25 mm minimum extension beyond box sides.
  - .6 Covers Surface Mounted: Screw-on flat or turned edge covers, suiting intended applications.
  - .7 Provide boxes suiting intended applications, with securing lugs, connectors suiting connected conduit, knockouts, plaster rings, concrete rings, covers, carpet flanges and other accessories suiting surface constructions.
-

- .8 Boxes exposed exterior of building or in non-climate-controlled locations: Weatherproof boxes with gasketed covers or faceplates.
- .9 Physical Size of Boxes: Unless otherwise noted, in accordance with electrical code, suiting number and size of conduits and conductors, and conductor bending radii.

## **2.3 ENCLOSURE RATINGS**

- .1 Provide enclosures for products rated in areas as follows:
  - .1 Enclosures mounted in climate-controlled areas: NEMA 1, unless otherwise noted.
  - .2 Enclosures mounted in non-climate-controlled applications: NEMA 3R, unless otherwise noted.
  - .3 Enclosures mounted in corrosive environment applications: NEMA 4X, unless otherwise noted.
- .2 Equivalent IP rating is acceptable.

## **Part 3 Execution**

### **3.1 INSTALLATION OF SPLITTERS**

- .1 Mount plumb, true and square to building lines.
- .2 Install with clearance for access for operation and maintenance.
- .3 Extend splitters full length of equipment arrangement, unless otherwise noted.
- .4 Secure splitter trough in place independent of connecting conduit, secure into position and connect complete.
- .5 Provide grounding and bonding.

### **3.2 INSTALLATION OF JUNCTION AND PULL BOXES**

- .1 Provide pull boxes in conduit systems wherever:
  - .1 Indicated.
  - .2 Necessary facilitating conductor installations.
  - .3 Conduit runs exceed 30 m in length, or with more than two, 90° bends, and installed at convenient and suitable inconspicuous but accessible location.
- .2 Size boxes accommodating requirements of supplied system and for bending radii of installed cables. Review requirements with respective system vendors.
- .3 Provide sealing around boxes in walls where insulation and vapour barrier is present or for walls of rooms that are sealed. Maintain sealing system of wall.
- .4 Boxes in rigid conduit and EMT inside building: Stamped galvanized or prime coated steel.
- .5 Boxes in exterior rigid conduit and boxes in perimeter wall where insulation and vapour barrier is present: Cast gasketed boxes.
- .6 Boxes in Plastic Conduit: Rigid PVC plastic boxes complete with PVC couplings.
- .7 Accurately locate and identify concealed pull boxes and junction boxes on "As-built" record drawings.
- .8 Identify system of main pull or junction boxes by painting outside of covers. Review paint colour scheme with Consultant.



- .9 Cover boxes in fire walls with aluminium tape and seal with caulking. Provide specified firestopping and smoke seal materials.
- .10 Identify on drawings, main junction and main pull boxes. Install additional pull boxes as required by CSA C22.1 and local governing electrical code.
- .11 Provide grounding and bonding.
- .12 Provide blank coverplates on existing obsolete boxes that remain in position.

### **3.3 IDENTIFICATION**

- .1 Equipment Identification: In accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Identification Labels: Size 2 indicating voltage and phase and system name, unless otherwise noted.
- .3 Clearly identify main pull or junction boxes (excluding obvious outlet boxes) by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Provide paint colours in accordance with following schedule, as reviewed with Consultant:
  - .1 Lighting: Yellow.
  - .2 Normal Power: Blue.
  - .3 Fire Alarm: Red.
  - .4 Telephone: Green.
  - .5 Miscellaneous Signals: Brown.
- .4 In addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.
- .5 Identify on as-built drawings, main junction and main pull boxes.

### **3.4 FIELD QUALITY CONTROL**

- .1 Inspection, Testing and Verification:
  - .1 Inspect, test and verify products.
  - .2 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.1-24, Canadian Electrical Code (CEC), Part 1 (26<sup>th</sup> Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No. 18.1-13(R2022), Metallic Outlet Boxes (Tri-national Standard, with UL 514A and ANCE NMX- J-023/1).
  - .3 CSA C22.2 No. 18.2-06(R2021), Nonmetallic Outlet Boxes.
  - .4 CSA C22.2 No. 85-14(R2023), Rigid PVC Boxes and Fittings.
- .2 Ontario Electrical Safety Code (OESC), 28<sup>th</sup> Edition, 2021.

**1.2                SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.

**Part 2            Products**

**2.1                OUTLET AND CONDUIT BOXES - GENERAL**

- .1 General Requirements:
  - .1 In accordance with CSA C22.1 and provincial electrical code.
  - .2 CSA certified.
  - .3 With Internal green ground screws.
  - .4 Metallic Outlet Boxes: In accordance with CSA C22.2 No. 18.1.
  - .5 Non-Metallic Boxes: In accordance with CSA C22.2 No. 18.2.
  - .6 PVC Boxes: In accordance with CSA C22.2 No. 85.
  - .7 Faceplates: Refer to Section 26 27 26 - Wiring Devices.
- .2 Provide 102 mm square or larger outlet boxes.
- .3 Gang boxes where wiring devices are grouped.
- .4 Provide blank cover plates for boxes without wiring devices.
- .5 Provide 347 V outlet boxes for 347 V switching devices.
- .6 Provide combination boxes with barriers, where outlets for more than one system are grouped.

**2.2                GALVANIZED STEEL OUTLET BOXES**

- .1 Construction:
    - .1 One-piece electro-galvanized.
    - .2 Single and multi-gang as required.
-

- .3 Flush device boxes for flush installation.
- .2 Types and Sizing:
  - .1 Minimum size 76 x 50 x 38 mm, or as noted.
  - .2 When more than one conduit enters one side with extension and plaster rings: 102 mm square outlet boxes.
  - .3 Utility boxes for outlets connected to surface mounted EMT conduit: Minimum 102 x 54 x 48 mm.
  - .4 Luminaire outlets: 102 mm square or octagonal outlet boxes.
- .3 Provide extension and plaster rings for flush mounting devices in finished tile or plaster walls.

## **2.3 CONCRETE BOXES**

- .1 Concrete type boxes for flush mounting in concrete: Electro-galvanized sheet steel, with matching extension and plaster rings.

## **2.4 MASONRY BOXES**

- .1 Masonry type boxes for devices flush mounted in exposed block walls: Electro-galvanized steel, single and multi-gang as required.

## **2.5 PVC BOXES**

- .1 Standards: CSA certified rigid plastic (PVC) outlet boxes.

## **2.6 CAST BOXES**

- .1 Cast FS/FD boxes:
  - .1 Ferrolloy iron construction.
  - .2 Gasketed covers, factory-threaded hubs and mounting feet for surface wiring of devices.
  - .3 Finish of electrogalvanized and aluminum acrylic paint.

## **2.7 OUTLET BOXES FOR NON-METALLIC SHEATHED CABLE**

- .1 Electro-galvanized, sectional, screw ganging steel boxes, minimum size 76 x 50 x 63 mm with two double clamps to take non-metallic sheathed cables.

## **2.8 FITTINGS - GENERAL**

- .1 Bushing and connectors: Include nylon insulated throats.
- .2 Device Plates: Of type and configurations suiting type of devices.
- .3 Knock-out fillers prevent entry of debris.
- .4 Conduit outlet bodies provided for conduit up to 35 mm and pull boxes provided for larger conduits.
- .5 Conduit outlet bodies NEMA 3R provided with raintight gasketed cover suitable for wet locations.
- .6 Double locknuts and insulated bushings provided on sheet metal boxes.
- .7 Weather-resistant and corrosion resistant for non-climate-controlled environments.

## **2.9 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Outlet Boxes, Conduit Boxes and Fittings:

- .1 ABB (T&B).
- .2 Eaton (Crouse-Hinds).
- .3 Appleton.
- .4 Iberville.

**Part 3**

**Execution**

**3.1**

**GENERAL INSTALLATION**

- .1 Provide outlet box or back box for each luminaire, wiring device, telecommunications outlets, fire alarm system component, communications systems components and each other such outlet.
- .2 Each box is suitable in respects for application and complete with suitable securing lugs, connectors suitable for connected conduit, knockouts and, where necessary, suitable plaster rings, concrete rings, covers, carpet flanges and accessories.
- .3 Electrical boxes exposed exterior of building or in non-climate controlled locations are weatherproof and corrosion-resistant boxes complete with gasketed covers/faceplates.
- .4 Size boxes to accommodate intended applications and for bending radii of installed cables. Depending on location size boxes suiting thickness of floor slabs or depth of wall construction. Review requirements with respective system vendors. For telecommunications devices and cabling, refer to telecommunications systems specified in Division 27.
- .5 Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where connecting conduit is EMT: Stamped and galvanized steel outlet boxes.
- .6 Outlet boxes for surface mounted exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where connecting conduit is rigid and boxes in perimeter wall where insulation and vapour barrier is present, and boxes in non-climate-controlled areas: Type "FS" or "FD" Series cast boxes.
- .7 Outlet boxes in plastic conduit systems: Rigid PVC plastic outlet boxes.
- .8 Outlet boxes for flush floor mounted devices: Refer to Section 26 05 38 - Floor Boxes and Fittings.
- .9 Provide barriered outlet box for switches connected to normal and emergency power and sharing common faceplate.
- .10 Provide barriered boxes when boxes contain both power and communication outlets and different voltage levels.
- .11 Support boxes independently of connecting conduits.
- .12 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.
- .13 For flush installations, mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .14 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.
- .15 Provide outlet boxes for special wiring devices, for special equipment and special applications. Refer to requirements specified in other Sections, or as noted.
- .16 Size and arrangement of outlet boxes to suit device which they serve.

- .17 Mounting heights and locations for outlet boxes are typically indicated on drawings. Prior to roughing-in, review location and arrangement of outlets with Consultant. Architectural drawings and Consultant instructions have precedence over electrical drawing diagrammatic layouts and specified mounting heights and locations.
- .18 Do not install boxes "back-to-back" in walls and partitions. Stagger such boxes and seal against noise transmission. Through-wall type boxes are not permitted.
- .19 Properly support exterior mounted boxes for receptacles. Where location is not adjacent to structure or support indicated, provide rigid conduit support properly imbedded into ground and secure box at suitable required height. Prior to start of work, review exact installation requirements with Consultant.
- .20 Vacuum clean interior of boxes before installation of wiring devices.
- .21 Provide sealing around boxes in walls where insulation and vapour barrier is present, or for walls of rooms that are sealed. Wrap boxes in firestop putty shields. Maintain sealing system of wall. Coordinate with applicable requirements of Division 09.
- .22 Provide acoustic sealing around boxes as reviewed with Consultant.
- .23 Provide explosion-proof boxes and fittings suitable for hazardous location classifications of areas.
- .24 Provide blank coverplates over boxes left empty for future installation of devices. Clearly identify each box as to its intended use and reviewed with Consultant. Provide coverplates as follows:
  - .1 Temporary during construction: Impact-resistant plastic.
  - .2 Unfinished service areas equipment rooms: Galvanized steel.
  - .3 Public areas, front of house and finished areas: Stainless steel.
  - .4 On existing obsolete boxes which are to remain in position.
- .25 Inspect installed boxes verifying proper installation suiting installation surfaces.

### 3.2 IDENTIFICATION

- .1 Identification Labels: Size 2 indicating voltage and phase and system name, or as noted.
- .2 Identify systems for outlet boxes. Clearly identify system of boxes by painting outside of covers. Spray painting is not permitted unless approved by Owner and reviewed with Consultant. Provide paint colours in accordance with following schedule, as reviewed with Consultant:
  - .1 Lighting: Yellow.
  - .2 Normal Power: Blue.
  - .3 Essential Power: Orange.
  - .4 Fire Alarm: Red.
  - .5 Telephone: Green.
  - .6 Miscellaneous Signals: Brown.
  - .7 PV: Yellow and blue.
- .3 Where required by Owner, in addition to painting miscellaneous signal boxes, clearly identify specific system in which box is installed.

**END OF SECTION**

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**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA A23.1-24/CSA A23.2-24, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.
  - .2 CSA C22.2 No. 18.3-12(R2022), Conduit, Tubing, and Cable Fittings (Tri-national standard, with ANCE NMX-J-017 and UL 514B).
  - .3 CSA C22.2 No. 18.4-15(R2019, Hardware for the Support of Conduit, Tubing, and Cable (Bi-national standard with UL 2239).
  - .4 CSA C22.2 No. 45.1-22, Electrical Rigid Metal Conduit - Steel (Tri-National standard, with UL 6 and NMX-J-534-ANCE-2007).
  - .5 CSA C22.2 No. 56-17(R2022), Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .6 CSA C22.2 No. 83.1-07(R2022), Electrical Metallic Tubing - Steel (Tri-National Standard, with UL 797 and NMX-J-536-ANCE-2007).
  - .7 CSA C22.2 No. 85-14(R2023), Rigid PVC Boxes and Fittings.
  - .8 CSA C22.2 No. 211.2-06(R2021), Rigid PVC (Unplasticized) Conduit.
  - .9 CSA C22.2 No. 327-18(R2023, HDPE Conduit, Conductors-in-Conduit, and Fittings.

**1.2                SUBMITTALS**

- .1 Product Data and Shop Drawings:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
  - .3 Submit for:
    - .1 Flexible metal liquid-type conduits, boxes and fittings.

**Part 2            Products**

**2.1                CONDUITS**

- .1 Rigid Metal Conduit (RMC) or Rigid Galvanized Steel (RGS):
    - .1 In accordance with CSA C22.2 No. 45.1.
    - .2 Exterior zinc and interior enamel coatings, galvanized threads where factory cut and red lead coated threads where site cut.
    - .3 Factory made bends where site bending is not possible.
    - .4 Factory made and threaded steel fittings.
    - .5 Connectors and terminations with rigid steel couplings, concrete tight where run in concrete.
  - .2 Electrical Metallic Tubing (EMT):
    - .1 In accordance with CSA C22.2 No. 83.1.
    - .2 Factory made bends where site bending is not possible.
    - .3 Joints and terminations made with steel compression couplers and connectors with insulated throats.
-

- .4 Set-screws for EMT conduits are not acceptable except for applications in accessible ceiling spaces, office shafts or tight spaces where compression connectors cannot be used.
- .5 Raintight steel compression type connectors: Where EMT located in sprinklered areas, service areas, service shafts, elevator shafts and service tunnels.
- .3 Flexible Metal Liquidtight Conduit:
  - .1 In accordance with CSA C22.2 No. 56.
  - .2 Hot dipped zinc galvanized steel core inside and outside.
  - .3 Outer flame-retardant thermoplastic jacket.
  - .4 Liquid-tight, gasketed flexible conduit connectors at terminations.
  - .5 Suitable for wet locations.
- .4 Galvanized Steel Flexible Metallic Conduit:
  - .1 In accordance with CSA C22.2 No. 56.
  - .2 Galvanized steel core inside and outside.
  - .3 Proper and suitable squeeze type connectors at terminations.
- .5 Rigid PVC Conduit:
  - .1 In accordance with CSA C22.2 No. 211.2.
  - .2 FT-4 rated, rigid plastic.
  - .3 Site made heat gun bends on conduit to 50 mm diameter.
  - .4 Factory made elbows in conduit larger than 50 mm diameter.
  - .5 Solvent weld joints.
  - .6 Factory made expansion joints.
  - .7 Terminations made with proper and suitable connectors and adaptors.
- .6 High Density Polyethylene (HDPE) Flexible Plastic Conduit:
  - .1 CSA certified to CSA C22.2 No. 327.
  - .2 Manufactured from HDPE resin.
  - .3 Internal longitudinal ribbing and low co-efficient of friction inner wall lining eliminates need for wet lubricants.
  - .4 Rated for temperature range of minus 34°C to 82°C.
  - .5 In continuous coil.
  - .6 With pull tape and tracer wire.

## **2.2 CONDUIT FASTENINGS**

- .1 In accordance with CSA C22.2 No. 18.4 and manufactured for use with conduit specified.
- .2 One-hole steel straps to secure surface conduits 50 mm and smaller.
- .3 Two-hole steel straps for conduits larger than 50 mm.
- .4 Beam clamps to secure conduits to exposed steel work.
- .5 Channel type supports for two or more conduits at suitable spacing to support weight of entire assembly.
- .6 Threaded rods, minimum 6 mm diameter or greater, to support suspended channels.

## **2.3 CONDUIT FITTINGS**

- .1 In accordance with CSA C22.2 No. 18.3 and manufactured for use with conduit specified.

- .2 Coating: Same as conduit.
- .3 Factory "ells" for 90 degrees bends of 25 mm and larger conduits.
- .4 Concrete tight where embedded in concrete.

## **2.4 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 In accordance with CSA C22.2 No. 18.3 and manufactured for use with conduit specified.
- .2 Coating: Same as conduit.
- .3 Weatherproof expansion fittings with internal bonding assembly suitable for 200 mm linear expansion.
- .4 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .5 Weatherproof expansion fittings for linear expansion at entry to panel.

## **2.5 PULL CORDS**

- .1 Unless otherwise noted, synthetic polypropylene fibre (plastic) twine cord, at least 6 mm or greater diameter, supporting pulling of cables.
- .2 Refer to Division 27 for pull cord requirements related to telecommunications work.
- .3 Approved by electrical utility, where required.

# **Part 3 Execution**

## **3.1 GENERAL INSTALLATION REQUIREMENTS**

- .1 Refer to and examine architectural drawings and room finish schedules to determine finished, partially finished or unfinished areas of building. Documents do not identify exact routing. Where shown, routing is diagrammatic, identifying general requirements of routing and locations. Include for necessary offsets, fittings, transformations and similar items required as result of obstructions and other architectural or structural details not shown.
- .2 Install conduit concealed in finished areas, and concealed to degree made possible by finishes in partially finished and unfinished areas. Run parallel or perpendicular to building lines. Do not install horizontal runs in masonry walls. Do not install conduits in terrazzo or concrete toppings.
- .3 Surface Conduits:
  - .1 Run conduits exposed in unfinished interior areas such as Electrical and Mechanical Rooms, unless otherwise noted.
  - .2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass. Run parallel or perpendicular to building lines. Arrange them to avoid interference with other work and install as high as possible.
  - .3 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
  - .4 Run conduits in flanged portion of structural steel.
  - .5 Group conduits wherever possible on suspended or surface metal channels.
  - .6 Do not pass conduits through structural members except as noted.
  - .7 When running conduit, maintain clearance of at least 150 mm where conduit runs parallel to steam or hot water lines with at least 50 mm clearance at crossovers.
  - .8 Do not run conduits within 900 mm of equipment access opening covers.



- .9 Support conduit runs from wall or ceiling structure, not from ceiling hangers, ductwork, piping, cable trays, formed steel decking, and other elements secured to wall or ceiling.
- .4 Conduit Embedded in Concrete:
  - .1 Install sleeves prior to pouring of concrete.
  - .2 Install conduits and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
- .5 Areas with Raised Floors:
  - .1 Install EMT conduit from branch circuit panel to outlet boxes or junction boxes located in sub floor.
  - .2 Run flexible liquidtight conduit from junction box to outlet boxes in sub-floor, as noted.
- .6 Provide conduit sized as noted. Size conduit that is not sized, in accordance with local governing electrical code. Additionally, indicated sizes of conductors are minimum sizes, and require increasing to suit length of run and voltage drop, in accordance with electrical code voltage drop requirements. Increase conductor sizes suiting voltage drop requirements and increase conduit size to suit.
- .7 Provide conduit for power or lighting circuits, of size no smaller than 19 mm diameter, unless otherwise noted.
- .8 Where conduit is proposed for embedding within structural concrete, review with Consultant and obtain recommendation from Consultant. Install such conduit in accordance with requirements of CSA A23.1/CSA A23.2.
- .9 For conduit cast in concrete at floors-on-ground, additionally include:
  - .1 Running conduits 25 mm and larger, below slab and encasing in 75 mm concrete envelope.
  - .2 Providing 50 mm of sand over concrete envelope below floor slab.
- .10 For conduit runs underground below slab include following provisions:
  - .1 Concrete encased ductbank with conduits of non-ferrous materials and sloped to drain properly into pit.
  - .2 Drain pit.
  - .3 Pull-in system.
  - .4 20% spare conduits (with minimum of at least 1).
  - .5 System proposal to consider and address effects of magnetic fields.
  - .6 Refer to details on drawings.
  - .7 Refer to requirements of Division 33.
  - .8 Refer to requirements of Section 26 05 43 - Installation of Cables in Trenches and Ducts.

### 3.2 INSTALLATION OF CONDUIT

- .1 Provide conduit for conductors except armoured cable and copper sheathed mineral insulated conductors, and except where duct or similar raceway materials are provided.
- .2 Provide conduit as follows:
  - .1 For interior building surface mounted conductors greater than 600 V: Rigid galvanized steel.
  - .2 For conductors exceeding 600 V for main distribution wiring in Electrical rooms, and for concealed conduit in exterior walls: Rigid galvanized steel.

- 
- .3 For exposed conduit outside building, for semi-exterior areas such as loading areas: Rigid galvanized steel (rigid PVC where permitted by local codes and recommended by Consultant).
  - .4 For branch circuit conductors underground inside building, and underground outside building beneath concrete, asphalt, and similar paving material: Rigid PVC.
  - .5 For branch circuit conductors underground outside building clear of concrete, asphalt and similar paving material: Flexible polyethylene or high density polyethylene plastic conduit, as noted on drawings.
  - .6 For exposed conduit mounted at height of less than 1200 mm in electrical, mechanical or other service areas, and for areas subject to mechanical injury: Rigid galvanized steel.
  - .7 For short branch circuit connectors to motorized equipment and distribution transformers (minimum length 450 mm, maximum length 600 mm with 180° loop where possible): Galvanized steel flexible liquid-tight conduit.
  - .8 At points, where conductors cross building expansion joints: Galvanized steel flexible conduit with no less than 600 mm of extra curve.
  - .9 For branch circuit conductors in poured concrete slab: Rigid PVC.
  - .10 For interior conduit above 50 mm diameter containing distribution conductors or communication systems conductors (fire alarm, telephone, security, telecom) (except as noted above): EMT with separate insulated ground conductor.
  - .11 For conductors unless otherwise noted above or elsewhere in Specification: EMT.
- 
- .3 Run rigid conductors in rigid type conduits suitable for application. Do not use flexible conduit.
  - .4 Provide manufactured expansion joints in rigid PVC plastic conduit at spacing as recommended by conduit manufacturer.
  - .5 Provide separate ground conductor in plastic conduits.
  - .6 Install flexible HDPE conduits with bending radii in accordance with manufacturer instructions and joined using fusion methods or mechanical non-weld couplings approved by conduit manufacturer and AHJ.
  - .7 Support and secure surface mounted and suspended single or double runs of metal conduit at support spacing in accordance with electrical code requirements by means of galvanized pipe straps, conduit clips, ringbolt type hangers, or by other suitable manufactured devices.
  - .8 Support multiple mixed size metal conduit runs with conduit racks spaced to suit spacing requirements of smallest conduit in group.
  - .9 Provide conduit fittings constructed of same materials as conduit and suiting intended application.
  - .10 Provide adaptors for joining conduits of different materials.
  - .11 Cut square and properly ream site cut conduit ends such that field threads on rigid conduit are of sufficient length to draw conduits up tight.
  - .12 Site made bends for conduit to maintain full conduit diameter with no kinking, and conduit finishes to not flake or crack when conduit is bent. Bend conduit cold. Replace conduit kinked or flattened more than 1/10<sup>th</sup> of its original diameter. Mechanically bend steel conduit over 19 mm diameter.
  - .13 Plug ends of roughed-in conduits which are exposed during construction with suitable plugs.
-

- .14 Clean, clear, cap and properly identify at each termination point, conduit systems left empty for future wiring. Provide end bushing and suitable pull cords in such conduits.
- .15 Run 2 - 25 mm spare conduits up to ceiling space and 2 - 25 mm spare conduits down to ceiling space of floor below from each flush panelboard. Terminate these conduits in 152 x 152 x 102 mm junction boxes in ceiling space or in case of exposed concrete slab, terminate each conduit in flush or surface concrete type box. Install fish cords in conduits.
- .16 Install pull cords in conduits sized for future conductors as noted.
- .17 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.
- .18 Dry conduits out before installing wire.

### 3.3 CONDUITS IN CAST-IN-PLACE CONCRETE

- .1 Where conduit is proposed for embedding within concrete, review with Consultant and obtain recommendation from Consultant. Install such conduit in accordance with CSA A23.1/CSA A23.2.
- .2 Secure conduit located in poured concrete work in place in manner such that conduit does not float or move when concrete is poured. Protect such conduit from damage prior to and during concrete pour, and from concrete and water penetration. Install rigid PVC type conduit.
- .3 Prior to Start of Work, review with Consultant, maximum allowable size of conduit for installation in poured concrete.
- .4 Placement of reinforcing steel in structural concrete work takes precedence over placement of conduit.
- .5 Space multiple runs of conduit in poured concrete work at least three diameters or width on center, as reviewed with and recommended by Consultant.
- .6 Do not run conduits in slabs where slab thickness is not at least 4 times conduit diameter.
- .7 Locate suiting reinforcing steel.
- .8 Install in centre one third of slab.
- .9 Protect conduits from damage where they stub out of concrete.
- .10 Install sleeves where conduits pass through slab or wall.
- .11 Prior to installation of waterproof membranes, install oversized sleeve for conduits passing through membrane. Coordinate with waterproofing work of Division 07.
- .12 Use cold mastic between sleeve and conduit.
- .13 Encase conduits completely in concrete with minimum 25 mm concrete cover.
- .14 Organize conduits in slab to minimize crossovers.
- .15 Conduit cast in concrete at floors-on-ground, additionally include:
  - .1 Running conduits 25 mm and larger, below slab and encasing in 75 mm concrete envelope.
  - .2 Providing 50 mm of sand over concrete envelope below floor slab.
- .16 For installation of ducts in concrete ductbanks, refer to Section 26 05 43 - Installation of Cable in Trenches and Ducts, or requirements of Division 33.

### 3.4 FIELD QUALITY CONTROL

- .1 Inspection and Verification:
  - .1 Inspect and verify product installations.

- .2 Check connections and operations.
- .3 Check for manufacturer proper markings of conduits, boxes and fittings.
- .2 Prepare verification reports, signed by technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.2 No. 211.1-06 (R2021), Rigid Types EB1 and DB2/ES2 PVC Conduit.
  - .2 CSA C22.2 No. 2420-09(R2023), Below Ground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-National Standard, with UL 2420).
  - .3 CSA Z809-16(R2021), Sustainable Forest Management.
- .2 Forest Stewardship Council (FSC):
  - .1 FSC-STD-01-001-V5-3 ES 2015, FSC Principles and Criteria (P&C) for Forest Stewardship Standard.
- .3 Sustainable Forestry Initiative (SFI):
  - .1 SFI 2015-2019- Extended through 2021, Standards and Rules.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports, and compliance certificates.

**Part 2 Products**

**2.1 DUCT FOR CONCRETE ENCASEMENT**

- .1 DB/2 PVC:
  - .1 CSA certified.
  - .2 In accordance with CSA C22.2 No. 211.1.
  - .3 Non-metallic, PVC solid wall duct.
- .2 Conduit suitable for concrete encasement or direct burial installations and installed in accordance with requirements of AHJ.
- .3 Installed with synthetic polypropylene fibre (plastic) twine cord or 19 mm diameter polyethylene rope, and where required, approved by AHJ.

**2.2 CABLE PROTECTION**

- .1 Minimum 38 mm x 140 mm spruce-pine-fir pressure-treated type wood planks and with colour finish reviewed with Consultant. Provide treatment and finishes that do not injure conductors or conductor insulation.

**2.3 MARKERS**

- .1 Concrete Type Cable Markers:
    - .1 600 mm x 600 mm x 100 mm.
-

- .2 Wording: "CABLE", "JOINT" or "CONDUIT" impressed in top surface.
- .3 Arrows: Indicating change in direction of cable and duct runs.
- .2 Cedar Post Type Markers:
  - .1 In accordance with CSA Z809 or FSC-STD-01-001 or SFI 2015-2019 Standards and Rules.
  - .2 89 x 89 mm, 1.5 m long.
  - .3 Pressure treated and with colour finish reviewed with Consultant.
  - .4 Nameplates:
    - .1 Aluminum anodized, 89 x 125 mm, 1.5 mm thick.
    - .2 Mounted on cedar post with mylar label 0.125 mm thick.
    - .3 Wording: "CABLE", "JOINT" or "CONDUIT"
    - .4 Arrows to indicate change in direction.

## 2.4 WARNING TAPE

- .1 Standard 4 mil polyethylene 76 mm wide tape.
- .2 Yellow with black letters, imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW".

## Part 3 Execution

### 3.1 DIRECT BURIAL OF CABLES

- .1 After laying sand bed in place, lay cables maintaining at least 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.
- .2 Direct bury cables as noted and as reviewed with Consultant.
- .3 Make cable terminations suiting cable and applications. Make splices only where reviewed with and as recommended by Consultant, and as noted. Leave at least 0.6 m of surplus cable in each direction. Make splices and terminations in accordance with manufacturer recommendations using manufacturer approved splicing kits.
- .4 Unless otherwise noted and recommended for acceptance by Consultant, do not make underground cable splices.
- .5 Minimum permitted radius at cable bends for rubber, plastic or lead-covered cables, is 8 times diameter of cable and in accordance with manufacturer recommendations. For metallic armoured cables, minimum permitted radius is 12 times diameter of cables and in accordance with manufacturer instructions.
- .6 Include offsets for thermal action and minor earth movements. Offset cables 150 mm minimum for each 60 m run, maintaining cable separation and bending radius in accordance with cable manufacturer requirements.
- .7 Cable Separation:
  - .1 Maintain at least 75 mm separation between cables of different circuits.
  - .2 Maintain at least 300 mm horizontal separation between low and high voltage cables.
  - .3 When low voltage cables cross high voltage cables, maintain at least 300 mm vertical separation with low voltage cables in upper position.
  - .4 At crossover, maintain at least 75 mm vertical separation between low voltage cables and at least 150 mm between high voltage cables.

- .5 Maintain at least 300 mm 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 at least 0.6 m in each direction at crossings.
- .8 After laying sand protective cover in place, install continuous row of overlapping pressure treated wood planks to cover length of run, unless otherwise noted.

### 3.2 CABLE INSTALLATION IN DUCTS

- .1 Install cables in ducts.
- .2 Do not pull spliced cables inside ducts.
- .3 Install multiple cables in duct simultaneously.
- .4 Use CSA certified lubricants of type compatible with cable jacket to reduce pulling tension.
- .5 To facilitate matching of colour coded multiconductor control cables, reel off in same direction during installation.
- .6 Before pulling cable into ducts and until cables are terminated, seal ends of lead covered cables with wiping solder. Seal ends of non-leaded cables with moisture seal tape.
- .7 After installation of cables, seal duct ends with duct sealing compound.
- .8 For applications when installing cables in direct buried underground ducts, refer to Section 26 05 52 - Direct Buried Underground Cable Ducts.

### 3.3 INSTALLATION OF DUCT FOR CONCRETE ENCASED DUCTBANK

- .1 Provide ducts and concrete encasement in accordance details and with requirements of AHJ. Coordinate Work with trades responsible for performing excavation, backfill, and concrete Work.
- .2 Use standard duct lengths and fittings as much as possible and practicable. When cutting is necessary, taper duct ends with special field tapering machine. Make joints by means of standard couplings. Maintain minimum bending radius of 1 m.
- .3 Make concrete encased duct joints with use of couplings which provide a smooth watertight joint between ducts, using suitable cement that is specifically designed for use with duct pipe being used.
- .4 Separate ducts by means of plastic 75 mm spacers and placed 75 mm away from wooden forms on both sides ensuring that there is 75 mm of concrete between ducts and 75 mm concrete envelope around duct assembly. Refer to elevations and slopes of ducts as indicated or based on minimum 760 mm below finished grade and minimum 1% slope. Separate ducts with spacers at distance as required by AHJ and in accordance with duct manufacturer instructions. Do not locate spacers of vertical rows of ducts directly above each other. Maintain minimum 150 mm separation.
- .5 Where ducts cross roads, paved areas, disturbed ground, new or future, provide concrete envelope with 15 mm diameter reinforcing steel bars laid longitudinally along trench with 100 mm lateral spacing and 50 mm above base of concrete. Provide overlap of 600 mm on reinforcing bars, where necessary. Extend reinforcing 1.5 m beyond backfilled areas, driveways, roadways and other areas subject to vehicular traffic.
- .6 Reinforce duct runs at building entries for distance of 1.5 m out from such entry walls, bars being embedded in walls.

- .7 Do not place concrete around ducts, and do not backfill until duct line is inspected and reviewed with Consultant and AHJ. Where concrete is poured around ducts or where trenches are backfilled before ducts have been reviewed by Consultant and AHJ, remove and replace concrete allowing for approval inspections.
- .8 When conduit is laid and duct banks work completed and set, draw steel test mandrel through each duct, in presence of Consultant. Provide mandrel of diameter 13 mm less than inside diameter of duct. Remove obstruction found in duct and leave duct system completely clear. Before installation of feeders, allow Consultant to inspect and recommended as ready for feeder installation.
- .9 Whenever Work is suspended, protect ends of ducts by means of suitable plugs and leave such plugs in use as long as may be necessary. When conduit is installed for future extension, plug ducts and end of duct bank boxes for protection.
- .10 Do not lay defective ducts under any circumstances.
- .11 Concrete Used for Encasing Ducts: Minimum compressive strength of 20.7 mPa, unless otherwise noted in Division 03.
- .12 Compact and cover bottom of trench with freshly poured concrete bed minimum 75 mm thick, for full width of trench.
- .13 Lay lowest row of ducts on concrete bed, completely enclosed in concrete. Install subsequent layers in similar manner. Space ducts 150 mm centre to centre, both vertically and horizontally. Fill spaces between ducts with concrete.
- .14 Enclose ducts in minimum 75 mm thick envelope of concrete for full width of trench.
- .15 Fill entire space between ducts with concrete. Do not use concrete which has started to set to a point that it will not properly pour to smoothly fill spaces between and around ducts.
- .16 Use of monolithic method by placing ducts and pouring concrete around complete installation, is subject to approval from AHJ and review with and recommended by Consultant.
- .17 When placing concrete around ducts, maintain ducts in correct position with proper spacing and keep concrete from entering ducts.
- .18 Reinforce duct where duct crosses filled or disturbed ground.
- .19 Do not encircle a single conduit in a duct bank with metallic reinforcing rods or other conducting material. Entire duct bank may be encircled.
- .20 Maximum Size of Aggregate in Concrete: 10 mm.
- .21 Provide reinforcing rods and dowels in ductbank at building wall. Refer to detail.
- .22 Provide sloping and drainage of ducts, preventing pooling of water within ducts. Prior to start of Work, review requirements with Consultant.
- .23 Unless drainage provisions have been provided within building for duct draining, seal openings where ducts enter building, with elastomeric, fire rated, waterproof sealing material, preventing egress of water. Provide sealing material that can easily be removed for access to ducts.
- .24 Provide marking tape and marking pavers as required by AHJ.
- .25 Provide one continuous length of polyethylene rope in each duct indicated as spare or for future use.
- .26 Prior to covering, allow Consultant and AHJ to access and witness Work.
- .27 Refer to drawing details for additional requirements.



### **3.4 INSTALLATION OF MARKERS AND IDENTIFICATION TAPE**

- .1 After laying sand protective cover in place:
  - .1 Install row of concrete cable markers covering length of runs. Lay concrete markers flat and centred over duct with top flush with finish grade.
  - .2 Apply identification tape on direct buried cable every 50 m along cable and underground duct runs.
  - .3 Mark changes in direction.
  - .4 Mark underground splices.
- .2 Install cedar post type markers where noted.
- .3 Where markers or tape are removed permitting installation of additional cables, reinstall markers or tape.

### **3.5 FIELD QUALITY CONTROL**

- .1 Perform inspection, testing and verification work in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Before installation of cables and burying of ducts:
  - .1 Inspect ducts verifying free of foreign materials.
  - .2 Inspect connections and terminations, verifying installation in accordance with manufacturer instructions.
- .3 Check phase rotation and identify each phase conductor of each feeder.
- .4 Check each feeder for continuity, short circuits and grounds. Check resistance to ground measurement 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 on each phase conductor.
  - .2 Check insulation resistance after each splice and termination. Check that cable system is ready for acceptance testing.
- .6 Acceptance Tests:
  - .1 Perform testing of cables.
  - .2 Check that terminations and accessory equipment are disconnected.
  - .3 Ground shields, ground wires, metallic armour and conductors not under test.
- .7 Remove and replace entire length of cable where cable fails to meet test criteria.
- .8 Obtain compliance certificates for work. Include copies of certificates with reports.
- .9 Prepare testing and verification reports, signed by testing technicians. Include test results showing location at which each test was made, circuit tested and result of each test. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 American National Standards Institute/Society of Cable Telecommunications Engineers (ANSI/SCTE):
  - .1 ANSI/SCTE 77-2017, Specifications for Underground Enclosure Integrity.
- .2 ASTM International (ASTM):
  - .1 ASTM C857-19, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
- .3 CSA Group (CSA):
  - .1 CSA A23.1-19, Concrete Materials and Methods of Concrete Construction.
  - .2 CSA A23.2-19, Test Methods and Standard Practices for Concrete.
  - .3 CSA A23.4-16(R2021), Precast Concrete - Materials and Construction.
  - .4 CSA G40.20-13/G40.21-13(R2018) General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
  - .5 CSA G164-18, Hot Dip Galvanizing of Irregularly Shaped Articles.
- .4 Ontario Provincial Standard Specifications (OPSS):
  - .1 OPSS PROV 602, Construction Specification for Installation of Electrical Chambers 2017.

**1.2            SUBMITTALS**

- .1 Product Data:
    - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
    - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Shop Drawings:
    - .1 Submit shop drawings for products of this Section.
  - .3 Submit certificates from manufacturer certifying that maintenance vault materials comply with specified performance characteristics and physical properties.
  - .4 Submit certified test reports for poured concrete from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties for intended applications to approval of AHJ.
  - .5 Submit test data and certification by qualified independent inspection and testing laboratory that materials and mix designs used in concrete mixture meet specified requirements for intended applications to approval of AHJ.
  - .6 Concrete pours: Submit accurate records of poured concrete items indicating date and location of pour, quality, air temperature and test samples taken.
  - .7 Submit compliance certificates, and testing and verification reports.
-

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**Part 2                      Products**

**2.1                      TRANSFORMER PADS**

- .1      Precast concrete transformer pad, accommodating electrical utility transformer and generally with following features:
  - .1          Consisting of precast concrete top cover and foundation.
  - .2          Sized in accordance with transformer requirements and electrical utility details.
  - .3          Concrete of minimum strength of 32 MPa, as confirmed with transformer manufacturer.
  - .4          Steel reinforced.
  - .5          Lifting holes.
  - .6          Top cover openings coordinated with final design of transformer as approved by electrical utility.
  - .7          Foundation cable openings coordinated with duct bank entry.
  - .8          Duct drainage suiting designed sloping of ducts.
  - .9          Drainage provisions consisting of sump pit, or duct opening in bottom for connection of drainage ducts, as noted, and as reviewed with Consultant.
- .2      Confirm and coordinate exact requirements with transformer requirements and electrical utility.

**2.2                      IN-GROUND HANDHOLES AND PULL BOXES**

- .1      Construction Features:
    - .1          Fully weatherproof, watertight and corrosion-resistant types for splices, pulls and junction applications.
    - .2          Cast-in-place concrete.
    - .3          Precast concrete.
    - .4          Prefabricated made of semi-concrete or non-concrete materials polymer concrete.
  - .2      In accordance with:
    - .1          ASTM C857.
    - .2          ANSI/SCTE 77.
    - .3          CSA certified.
    - .4          OPSS PROV 602.
    - .5          AHJ requirements.
  - .3      Concrete:
    - .1          In accordance with CSA A23.1 and CSA A23.2.
    - .2          Minimum compressive strength: 32 MPa (4600 psi), 6-8% air entrainment.
    - .3          Suitable for installation and use through temperature range of minus 40°C to 70°C.
  - .4      Drainage Provisions: Consisting of sump pit or duct opening in bottom for connection to drainage ducts, as noted, and as reviewed with Consultant.
  - .5      Enclosures:
    - .1          Designed and installed to withstand loads likely to be imposed.
    - .2          Size and of type suiting intended applications.
    - .3          With wiring/duct entries, covers and bottoms (as noted).
-

- .6 Steel Covers:
  - .1 Galvanized steel in accordance with CSA G40.20/G40.21 and CSA G164.
  - .2 Checker tread on top side for skid resistance.
  - .3 Tamper-proof, stainless steel head bolts recessed into cover.
  - .4 Area for logo.
  - .5 Flush mounted with gaskets preventing ingress of water.
  - .6 No protrusions extending out from top of cover; no tripping hazards.
  - .7 Minimum Thickness of Cover: 10 mm.
- .7 Cable Termination Hardware:
  - .1 Accommodates cables and required grounding hardware.
  - .2 Corrosion-resistant and in accordance with local governing code requirements.
- .8 PVC seals: On cable entry openings.
- .9 Identification:
  - .1 Identification engraving/warning signage, weather and corrosion-resistant.
  - .2 Identification markings on each box embedded on outside vertical surface of box, showing manufacturer name or trademark, and date of manufacture.
  - .3 Top surface of cover permanently marked, showing manufacturer name or trademark, and date of manufacture. Marking embedded into top surface of cover or embedded into corrosion-resistant metal plate securely cemented to top surface of cover.
- .10 Dimensions: As noted, and as reviewed with Consultant.

## **2.3 IN-GROUND MAINTENANCE VAULTS (MANHOLES)**

- .1 General:
  - .1 In-ground maintenance vaults provided for concrete encased ductbank runs.
  - .2 With cast iron covers and collars/frames, ladders, cable pulling eyes, cable management trays, and ancillary devices.
  - .3 Sizing and locations: Suiting design requirements and applications.
  - .4 Work complying with electrical utility requirements, specifications, and details on drawings.
  - .5 In accordance with CSA A23.1 and CSA A23.4, and other applicable CSA Standards for intended applications.
- .2 Precast or cast in place concrete vaults to generally be as follows:
  - .1 Sized in accordance with detail.
  - .2 Concrete: Minimum strength of 32 MPa at 28 days (6-8%), suiting specific applications and code requirements.
  - .3 Steel reinforced.
  - .4 Cable openings coordinated with duct bank entry.
- .3 Provide accessories as follows:
  - .1 Minimum 800 mm diameter, minimum 10 mm thick, flush mounted cast iron cover with warning text on cover. Prior to ordering covers, review nomenclature with Consultant.
  - .2 No protrusions from top that may be tripping hazard.
  - .3 Covers with skid resistant surface and tamperproof corrosion-resistant cover bolts with suitable lifting provisions.

- .4 Minimum 150 mm thick cast iron frame.
- .5 Concrete levelling collars.
- .6 Aluminum access ladders extending from access opening down to bottom of manhole.
- .7 Galvanized steel cable pulling eye loops.
- .8 Galvanized steel cable racks and trays.
- .9 Structural lifting hooks on pre-cast units.
- .10 Drainage: Storm sewer connection with cast iron service saddle with oil resistant gasket, stainless steel clamp and oil resistant O ring.
- .11 Drainage Pits: 300 mm x 300 mm 125 mm, suitable for sump pump operation.
- .4 Coordinate exact drainage requirements with General Contractor and Mechanical Contractor (as applicable), suiting project design requirements and onsite provisions.

## **2.4 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Pre-cast Transformer Pads, Hand Holes, Pull Boxes and Maintenance Vaults:
  - .1 Brooklin Concrete.
  - .2 Industrial Cast Stone.
  - .3 Utility Structures.
  - .4 Hanson Pipe and Pre-cast.

## **Part 3 Execution**

### **3.1 INSTALLATION OF TRANSFORMER PAD**

- .1 Provide transformer pad and foundation in location.
- .2 Coordinate responsibilities for provision of excavation, concrete, and backfilling work requirements.
- .3 Prepare ground, providing level and good draining foundation for pad and transformer. Coordinate cable entry opening with location of duct bank.
- .4 Perform installation in accordance with electrical utility requirements and with generally accepted trade practices.
- .5 Provide duct drainage.
- .6 Provide guard posts.
- .7 Provide grounding and bonding work.
- .8 Perform work under general supervision of General Contractor.

### **3.2 INSTALLATION OF IN-GROUND HANDHOLES AND PULL BOXES**

- .1 Coordinate installation work with trades responsible for excavation and backfilling work.
- .2 Install handholes and junction boxes plumb, true to alignment and grade, and firmly bedded on drainage pocket backfill.
- .3 During installation, orient duct entry holes in required direction. Enlarging of duct entry holes is prohibited.
- .4 Coordinate connection of ducts, ensuring that proper sloping is maintained, suiting designed elevations and slope of duct run and required drainage.
- .5 Refer to drawing detail for additional requirements.

- .6 Provide grounding and bonding.
- .7 Confirm drainage provisions and provide. Coordinate work with General Contractor to connect drains.
- .8 Prior to backfilling and covering, obtain compliance certificates of work from electrical utility and review with Consultant.
- .9 Coordinate responsibilities for provision of excavation, concrete, and backfilling work requirements.

### **3.3 INSTALLATION OF IN-GROUND MAINTENANCE VAULTS**

- .1 Provide maintenance vaults and associated work.
- .2 Coordinate responsibilities for provision of excavation, concrete, and backfilling work requirements.
- .3 Prepare ground, providing level and good draining foundation for vaults. Coordinate cable entry opening with location of duct bank.
- .4 Perform installation in accordance with electrical utility requirements and with generally accepted trade practices.
- .5 Provide grade levelling collars and neck such that cover is flush with finished grade in paved areas and 38 mm above grade in unpaved areas. Provide extension collars as required. Confirm final grade level with General Contractor.
- .6 Confirm drainage provisions and provide. Coordinate work with General Contractor to connect drains.
- .7 Coordinate connection of ducts and duct bank, ensuring that proper sloping is maintained, suiting designed elevations and slope of duct bank and required drainage.
- .8 Provide grounding and bonding.
- .9 Perform work under general supervision of General Contractor.
- .10 Prior to backfilling and covering, obtain approvals of work from electrical utility and review with Consultant.

### **3.4 INSTALLATION OF DUCT FOR CONCRETE ENCASED DUCTBANK**

- .1 Provide ducts and concrete encasement as noted, in accordance with requirements of AHJ and applicable codes and standards. Coordinate Work with trades responsible for performing excavation, backfill, and concrete Work. Confirm requirements with AHJ.
- .2 Coordinate work with Division 03 and Structural Consultant, as applicable.
- .3 Do not place concrete during rain or weather events that could damage concrete.
- .4 Use standard duct lengths and fittings as much as possible and practicable. When cutting is necessary, carefully taper duct ends with special field tapering machine. Make joints by means of standard couplings. Maintain minimum bending radius of 1 m.
- .5 Make concrete encased duct joints with use of couplings which provide a smooth watertight joint between ducts, using suitable cement that is specifically designed for use with duct pipe being used.
- .6 Separate ducts by means of plastic 75 mm spacers and placed 75 mm away from wooden forms on both sides ensuring that there is 75 mm of concrete between ducts and 75 mm concrete envelope around duct assembly. Provide elevations and slopes of ducts as noted or based on minimum 760 mm below finished grade and minimum 1% slope. Separate ducts with spacers at distance as required by AHJ and duct manufacturer instructions. Do not locate spacers of vertical rows of ducts directly above each other.

Maintain minimum 150 mm separation. Where ducts crossroads, paved areas, disturbed ground, new or future, concrete envelope to have 15 mm diameter reinforcing steel bars laid longitudinally along trench with 100 mm lateral spacing and 50 mm above base of concrete. Provide overlap of 600 mm on reinforcing bars, where necessary. Extend reinforcing 1.5 m beyond backfilled areas, driveways, roadways and similar applications. Reinforce duct runs at building entries for distance of 1.5 m out from entry walls, with bars embedded in walls.

- .7 Do not place concrete around ducts, and do not backfill until duct line is inspected and reviewed for acceptance with Consultant and AHJ. If concrete is poured around ducts or if trenches are backfilled before ducts have been reviewed, be responsible for removing and replacing concrete at no extra cost to allow for approval inspections.
- .8 When duct has been laid and duct banks work completed and set, draw steel test mandrel through each duct in presence of Consultant. Diameter of mandrel to be 13 mm less than inside diameter of duct. Remove obstruction found in duct and leave duct system completely clear. No conduit will be accepted as being ready for installation of feeders until this is done.
- .9 Whenever Work is suspended, protect ends of ducts by means of suitable plugs and leave such plugs in use as long as may be necessary. When conduit is installed for future extension, plug ducts and end of duct bank boxes for protection.
- .10 Do not lay defective ducts under any circumstances.
- .11 Perform following requirements:
  - .1 Concrete used for encasing ducts to have minimum compressive strength of 20.7 mPa and in accordance with CSA A23.1 and CSA A23.2.
  - .2 Compact and cover bottom of trench with freshly poured concrete bed minimum 75 mm thick, for full width of trench.
  - .3 Lay lowest row of ducts on concrete bed, completely enclosed in concrete. Install subsequent layers in similar manner. Space ducts 150 mm centre to centre both vertically and horizontally. Fill spaces between ducts with concrete.
  - .4 Enclose ducts in minimum 75 mm thick envelope of concrete for full width of trench.
  - .5 Fill entire space between ducts with concrete. Do not use concrete which has started to set to a point that it will not properly pour to smoothly fill spaces between and around ducts.
  - .6 Use of monolithic method (i.e. placing all ducts and pouring concrete around complete installation) is subject to approval of AHJ and review with Consultant.
  - .7 Exercise with care when placing concrete around ducts to ensure that ducts remain in correct position with proper spacing and that no concrete enters any of ducts.
  - .8 Reinforce duct where duct crosses filled or disturbed ground.
  - .9 There must be no metallic reinforcing rods or other conducting material encircling a single conduit in a duct bank (entire duct bank may be encircled).
  - .10 Maximum size of aggregate in concrete to be 10 mm.
  - .11 Provide reinforcing rods and dowels in ductbank at building wall as detailed.
  - .12 Provide sloping and drainage of ducts to prevent pooling of water within ducts; review requirements with Consultant prior to start of Work.
  - .13 Unless drainage provisions have been provided within building for duct draining, seal openings where ducts enter building with elastomeric, fire-rated, waterproof sealing material to prevent egress of water and that can easily be removed for access to ducts.
  - .14 Provide marking tape and marking pavers as required by AHJ.

- .15 Provide one continuous length of polyethylene rope in each duct noted as spare or for future use.
- .12 Allow Consultant and AHJ (as applicable) access and opportunity to witness Work, prior to covering.
- .13 Refer to requirements of drawing details.

### **3.5 FIELD QUALITY CONTROL**

- .1 Inspection, Testing and Verification:
  - .1 Inspect, test and verify products. Allow Consultant and AHJ to perform onsite inspection and testing.
  - .2 Testing of Cast-in-place Concrete Onsite:
    - .1 Test:
      - .1 Concrete pours.
      - .2 Slump.
      - .3 Air content.
      - .4 Compressive strength at 7 and 28 days.
      - .5 Air and concrete temperature.
    - .3 Check connections and operations.
  - .2 Obtain compliance certificates for work. Include copies of certificates with reports.
  - .3 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**



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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1    ASTM International (ASTM):
  - .1        ASTM B117-19, Standard Practice for Operating Salt Spray (Fog) Apparatus.
- .2    National Building Code of Canada-2020, (NBC).

**1.2            SUBMITTALS**

- .1    Product Data:
    - .1        Submit manufacturer product literature, specifications, installation instructions and datasheets.
    - .2        Include product characteristics, performance criteria, physical size, finish and limitations.
  - .2    Shop Drawings:
    - .1        Submit shop drawings for products of this Section.
    - .2        Submit separate shop drawings for each vibration isolator and include performance and product data.
  - .3    Delegated Design Submittals:
    - .1        Submit detailed drawings of seismic control measures for equipment, equipment bases and suspended electrical raceways, stamped and signed by Seismic Engineer.
    - .2        Submit following design data for seismic restraint systems (SRS):
      - .1            Full details of design criteria.
      - .2            Design calculations (including restraint loads resulting from seismic forces in accordance with NBC detailed work sheets, tables).
      - .3            Separate shop drawings for each SRS and devices for each system and equipment.
      - .4            Identification of location of devices.
      - .5            Schedules of types of SRS and devices.
      - .6            Details of fasteners and attachments to structure, anchorage loadings, attachment methods.
      - .7            Installation procedures and instructions.
      - .8            Testing and verification procedures.
  - .4    Compliance Certificates:
    - .1        After installation is complete, obtain compliance certificates from system manufacturer and manufacturer Seismic Engineer certifying that products are properly installed in accordance with requirements of AHJ and building codes.
    - .2        Seismic Engineer to apply professional stamp to certificates.
  - .5    Submit sample of each of following:
    - .1        Vibration isolators.
    - .2        Seismic restraints.
    - .3        Supports.
    - .4        Structural bases.
    - .5        PV system restraints.
-

- .6 Submit sample format of testing and verification report.
- .7 Submit compliance certificates, and testing and verification reports.

### **1.3 QUALITY ASSURANCE**

- .1 Seismic restraint system manufacturer authorized Seismic Engineer to design SRS and devices.
- .2 Seismic Engineer to be Professional Engineer.
- .3 Tradesmen under supervision of and to approval of Seismic Engineer to install SRS and devices.
- .4 Design SRS and devices in accordance with:
  - .1 AHJ.
  - .2 Building codes.
  - .3 Product manufacturer instructions.
- .5 Provide products tested in independent testing laboratory, or certified by Seismic Engineer, verifying products meet requirements of this Section, such as dynamic ultimate limit load state as required by building code, and "Fail Safe" design. Where tests are carried out to represent a restraint type, provide tests valid for full load range of restraint. Submit copies of tests or certification.
- .6 SRS and devices product manufacturers are to provide assistance during installation, and, when installation is complete, submit certified reports listing installation deficiencies.

## **Part 2 Products**

### **2.1 VIBRATION ISOLATORS - GENERAL**

- .1 Provide vibration isolation for motorized equipment and equipment that vibrates when in operation. Provide vibration isolation for equipment or parts connected rigidly to isolated equipment.
- .2 Standard vibration isolation requirements of equipment include following:
  - .1 Select equipment isolation mounts on basis of achieving 98% vibration isolation efficiency at lowest operating speed.
  - .2 Natural frequency of each vibration isolation system: At least 1/10 of lowest excitation frequency of rotating machinery, whenever practicable, but in no case less than 1/7.
  - .3 Where structural floor deflection exceeds 1/10 of determined static deflection of isolator, increase isolator static deflection to maintain this minimum ratio of floor to isolator deflection.
  - .4 Where static deflections are noted, they are a guide only.
  - .5 Actual isolators to achieve required static deflection under load, with at least 50% reserve deflection.
  - .6 Prior to ordering or fabrication, submit shop drawings identifying equipment, lowest operating speed, weight, brand, type and location of isolators.
- .3 Neoprene Isolators:
  - .1 Neoprene isolators: Bridge bearing rated type manufactured from bridge bearing quality neoprene, CSA S6.
  - .2 Where ribbed pad is used, height of ribs not to exceed 0.7 times width of rib.
  - .3 Provide steel layers to distribute load in multi-layered unit.

- .4 Select neoprene pads or elements at suppliers optimum recommended loading and do not load beyond limit specified in neoprene manufacturers literature.
- .5 Submit following data verifying performance of neoprene isolators:
  - .1 Data sheet listing ASTM test results.
  - .2 Load deflection curves for isolator indicating deflection to full compression for both laterally restrained and unrestrained isolators.
- .4 Open Steel Spring Isolators:
  - .1 Springs: Spring coefficient 1.0 to 1.5 with working deflection between 0.3 and 0.6 of solid deflection.
  - .2 Spring mounts: Include levelling devices, minimum 6 mm thick neoprene sound pads, and zinc chromate plated hardware.
  - .3 Sound pads: Sized for minimum deflection of 1.2 mm and in accordance with requirements for neoprene isolators.
- .5 Provide vibration isolation for transformers by means of bridge bearing neoprene isolators or open steel spring isolators. Typical guidelines for static deflection of vibration isolators for electrical transformers are indicated in schedule below. For isolators requiring static deflection greater than 13 mm, provide open spring isolators except where otherwise noted. Alternative proposals by vibration isolation manufacturers Engineer may be submitted to Consultant for review and recommendations of acceptance, with detailed supporting shop drawings with calculations supporting use of proposed products. Acceptance at sole discretion of Consultant.

Power Range (kVA)	On Grade (Isolated Slab)	Location On Grade (Continuous Slab)	Upper Floor (Suspended Slab)
Under 10	6 mm	6 mm	18 mm
10 - 100	6 mm	12 mm	25 mm
Over 100	6 mm	25 mm	38 mm

## 2.2 ELASTOMERIC PADS

- .1 Neoprene Waffle or Ribbed:
  - .1 9 mm minimum thick, 50 durometer.
  - .2 Maximum loading 350 kPa.
- .2 Rubber Waffle or Ribbed:
  - .1 9 mm minimum thick, 30 durometer natural rubber.
  - .2 Maximum loading 415 kPa.
- .3 Neoprene-Steel-Neoprene:
  - .1 9 mm minimum thick neoprene bonded to 1.71 mm steel plate.
  - .2 50 durometer neoprene, waffle or ribbed.
  - .3 Holes sleeved with isolation washers.
  - .4 Maximum loading 350 kPa.
- .4 Rubber-Steel-Rubber:
  - .1 9 mm minimum thick rubber bonded to 1.71 mm steel plate.
  - .2 30 durometer natural rubber, waffle or ribbed.
  - .3 Holes sleeved with isolation washers.
  - .4 Maximum loading 415 kPa.

## **2.3 ELASTOMERIC MOUNTS**

- .1 Colour-coded, neoprene in shear.
- .2 Maximum durometer of 60.
- .3 Threaded insert and two bolt-down holes.
- .4 Ribbed top and bottom surfaces.

## **2.4 SRS MANUFACTURERS AND SEISMIC ENGINEER**

- .1 Provide seismic restraint systems (SRS) and devices as products from one manufacturer experienced and regularly engaged in SRS production.
- .2 Provide services of experienced Seismic Engineer who is registered professional engineer licensed in jurisdiction of Work, member registered and licensed in good standing of Professional Engineers Association in Place of Work.
- .3 Seismic Engineer Responsibilities:
  - .1 Determine seismic hazard level.
  - .2 Design, recommend, and review: Proposed work seismic restraint shop, and placement and securing drawings.
  - .3 Prior to submittal for review, sign and stamp drawings.
  - .4 Supervise installation of seismic restraint work and, when work is complete, certify in writing that seismic restraint work has been installed in accordance with signed, stamped and reviewed drawings.
  - .5 At beginning of seismic restraint work and when work is complete, prepare and submit to AHJ, on form approved by AHJ, original signed and sealed letters of assurance for design, installation and field review of seismic restraint work.
  - .6 Prepare detailed testing procedures, testing criteria with pass/fail criteria. Prepare format of reports.
- .4 Where Seismic Engineer requirements exceed or contradict manufacturers written recommendations or specifications, notify Consultant and obtain direction. Unless otherwise recommended by Consultant, include for more stringent arrangement.

## **2.5 SEISMIC CONTROL AND VIBRATION ISOLATION MEASURES**

- .1 General:
  - .1 SRSs designed by Seismic Engineer specializing in design of SRS and with previously defined professional qualifications.
  - .2 During seismic event, SRS components prevent systems and equipment non-structural components from moving from normal position.
  - .3 Review with Consultant:
    - .1 Systems and equipment that are to remain operational during and after seismic event.
    - .2 Seismic hazard zone rating used in determining extent of vibration isolation and seismic restraints.
  - .4 Verify vibration isolation and seismic restraint requirements with manufacturers of equipment requiring isolation and restraints.
  - .5 SRSs fully integrated into, and compatible with:
    - .1 Noise and vibration controls.
    - .2 Structural, mechanical, electrical design of project.
  - .6 SRSs provide gentle and steady cushioning action and avoid high-impact loads.

- .7 SRSs restrain seismic forces in every direction.
- .8 SRSs utilizing cast iron, threaded pipe, or other brittle materials not permitted.
- .9 Seismic control measures not to interfere with integrity of firestopping.
- .10 Drilled or power-driven anchors and fasteners not permitted.
- .11 No equipment, equipment supports or mounts to fail before failure of structure.
- .12 Adjust Restraints Clearances: Between 3 mm and 6 mm under normal operating conditions of equipment.
- .13 Refer to additional requirements noted on drawings.
- .14 Provide:
  - .1 SRSs for restraining equipment in each direction and sized in accordance with 4.1.8.18 of NBC and provincial building code.
  - .2 Attachment points and fasteners that withstand load of three times sized capacity of restraint.
  - .3 Size and shape of bases, and type and performance of vibration isolation as noted and meeting seismic ratings.
  - .4 Fasteners and attachment points resisting same load as SRSs.
- .2 Static Equipment:
  - .1 Anchor equipment to equipment supports. Anchor equipment supports to structure.
  - .2 Suspended Equipment: Use one or more of following methods depending upon site conditions and where noted:
    - .1 Install tight to structure.
    - .2 Cross brace in every direction.
    - .3 Brace back to structure.
    - .4 Cable restraint system.
- .3 Seismic Restraints:
  - .1 Cushioning action gentle and steady.
  - .2 Never reach full metal-to-metal compression.
- .4 Vibration Isolated Equipment:
  - .1 Seismic control measures not to jeopardize noise and vibration isolation systems. Provide 6 to 9 mm clearance during normal operation of equipment and systems between seismic restraint and equipment.
  - .2 Incorporate seismic restraints into vibration isolation system, resisting complete isolator unloading.
- .5 Bracing Methods:
  - .1 Structural angles or channels suiting intended applications.
  - .2 For cable restraint system incorporating grommets, shackles and other hardware, verify alignment of restraints and avoiding bending of cables at connection points. Incorporate neoprene into cable connections to reduce shock loads.

## **2.6 SRS FOR STATIC EQUIPMENT AND SYSTEMS**

- .1 Floor-Mounted Equipment and Systems:
  - .1 Anchor equipment to equipment supports.
  - .2 Anchor equipment supports to structure.
  - .3 Provide size of bolts noted in reviewed shop drawings.

- .2 Suspended Equipment and Systems:
  - .1 Provide one or combination of following methods:
    - .1 Installation tight to structure.
    - .2 Cross-brace in every direction.
    - .3 Brace back to structure.
    - .4 Slack cable restraint system.
  - .3 SRS prevents sway in horizontal plane, rocking in vertical plane, sliding and buckling in axial direction.
  - .4 Hanger rods withstand compressive loading and buckling.

## **2.7 SRS FOR VIBRATION ISOLATED EQUIPMENT**

- .1 Floor-mounted Equipment and Systems:
  - .1 Provide one or combination of following methods:
    - .1 Vibration isolators with built-in snubbers.
    - .2 Vibration isolators and separate snubbers.
    - .3 Built-up snubber system additionally reviewed with Consultant, consisting of structural elements and elastomeric layer.
  - .2 SRS resist complete isolator unloading.
  - .3 SRS do not jeopardize noise and vibration isolation systems. Provide 4 to 8 mm clearance between seismic restraint snubbers and equipment during normal operation of equipment and systems.
  - .4 Cushioning Action: Gentle and steady by utilizing elastomeric material or other means, avoiding high impact loads.
- .2 Suspended Equipment and Systems:
  - .1 Provide one or combination of following methods:
    - .1 Slack cable restraint system.
    - .2 Brace back to structure via vibration isolators and snubbers.

## **2.8 SLACK CABLE RESTRAINT SYSTEM (SCS)**

- .1 Provide elastomer materials or similar, avoiding high impact loads and providing gentle and steady cushioning action.
- .2 SCS prevents sway in horizontal plane, "rocking" in vertical plane, sliding and buckling in axial direction.
- .3 Hanger rods withstand compressive loading and buckling.

## **2.9 SPRING ISOLATORS**

- .1 Spring isolators consist of stable springs and spring mounts. Include housings where noted.
- .2 Stable Springs:
  - .1 Ratio of lateral to axial stiffness is equal to or greater than 1.2 times ratio of static deflection to working height.
  - .2 Select for 50% travel beyond rated load.
  - .3 Units with levelling devices.
  - .4 Ratio of height when loaded to diameter of spring: Between 0.8 to 1.0.
  - .5 Cadmium plate for 100% relative humidity and outdoor installations.

- .6 Colour-coded springs.
- .7 Finished in corrosion-resistant polyester powder coat, with 1000-hour salt spray rating in accordance with ASTM B117.
- .3 Applications to reduce transmission of noise and vibration from low speed mechanical equipment that is not subject to lateral forces:
  - .1 Stable Open Spring with capacity up to 2267 kg:
    - .1 Free standing, unhooused, laterally stable.
    - .2 Based on Seismic Engineers design requirements, supported either with neoprene cup or metal base plate complete with ribbed neoprene acoustic pad, minimum 6 mm thick, bonded to base plate.
  - .2 Stable Open Spring with capacity over 2267 kg:
    - .1 Free standing, unhooused, laterally stable.
    - .2 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad, bonded under isolator and on isolator top plate.
    - .3 Springs welded to top and bottom load plate assemblies.
    - .4 Springs assembled between top and bottom steel load plate.
    - .5 Upper load plate provided with steel levelling bolt for rigidly mounting to equipment.
- .4 Restrained Stable Spring:
  - .1 For applications of noise and vibration isolation for equipment:
    - .1 Located near critically quiet areas.
    - .2 Having significant changes of weight (load variations).
    - .3 Subjected to moderate external forces or wind loads (torquing forces).
  - .2 Laterally stable steel springs.
  - .3 Capacity from 16 kg to 1500 kg.
  - .4 Supported either with neoprene cup or metal base plate complete with ribbed neoprene acoustic pad, minimum 6 mm thick, bonded to base plate.
  - .5 Supported on bonded 6 mm minimum thick ribbed neoprene or rubber friction and acoustic pad.
  - .6 Housing assembly:
    - .1 Formed or fabricated steel members.
    - .2 Top-load plate with adjusting and leveling bolts, vertical restraints, isolation washers.
    - .3 Bottom plate with non-skid noise stop pads and holes provided for anchoring to supporting structure.
- .5 Housed Spring Isolators:
  - .1 Consists of high deflection, colour-coded, stable springs assembled into telescoping housings.
  - .2 Isolates high and low frequency vibration and allows adjustable damping of vertical motion.
  - .3 Capacity from 23 kg to 1500 kg.
  - .4 6 mm thick ribbed noise isolation pad bonded to lower load surface, and with adjusting and leveling bolt as part of top assembly. Leveling bolt extends above isolator and acts as leveling and attachment bolt for supported equipment.
  - .5 Holes or slots provided for bolting to structure.
  - .6 Adjustable snubbing feature to reduce movement during startup and shutdown.

- .7 Housing:
  - .1 Hot dipped galvanized steel or aluminum construction.
  - .2 Coated with rust-resistant paint.
  - .3 Internal elastomeric snubbers preventing metal to metal contact and isolation.
- .6 Hardware:
  - .1 Based on Seismic Engineers requirements.
  - .2 Zinc or cadmium plated.
- .7 Performance:
  - .1 As noted on drawings or schedules.
  - .2 Suiting intended applications.

## **2.10 HANGERS**

- .1 Spring Hangers:
  - .1 Vibration isolator hanger supports with colour coded steel springs and welded steel housings.
  - .2 Designed to carry 500% overload without failure and allows support rod misalignment through 30-degree arc without metal-to-metal contact or other short circuit.
  - .3 Isolators for suspended equipment, with minimum static deflection requirement exceeding 10 mm.
    - .1 Elastomeric washer in series with spring, self-centering load cap with moulded isolation bushing which passes through hanger box.
    - .2 Moulded oil-resistant neoprene insert in series with spring, with load transfer plates and rod isolation bushing which passes through hanger box.
    - .3 Pre-compressed molded fiberglass insert in series with spring, with load transfer plates and deflection indicator.
- .2 Neoprene Hangers:
  - .1 Vibration isolators with maximum static deflection requirements under operating load conditions not exceeding 10 mm.
  - .2 Designed to carry 500% overload without failure and allows support rod misalignment through 30-degree arc without metal-to-metal contact or other short circuit.
  - .3 Elastomer-in-shear insert encased in welded steel bracket and provided with stamped load transfer cap.
  - .4 Elastomer Insert: Neoprene, molded from oil resistant compounds, colour coded to indicate load capacity and selected to operate within published load range.
- .3 Performance:
  - .1 As noted on drawings or schedules.
  - .2 Suiting intended applications.

## **2.11 STRUCTURAL BASES**

- .1 Prefabricated Steel Base:
  - .1 Integrally welded on sizes up to 2400 mm on smallest dimension.
  - .2 Split for field welding on sizes over 2400 mm on smallest dimension.



- .3 Reinforced for alignment of drive and driven equipment.
- .4 Without supplementary hold-down devices.
- .5 Isolation element attached to base brackets arranged minimizing height.
- .6 Pre-drilled holes receiving equipment anchor bolts.
- .7 Adjustable built-in motor slide rail, where noted.
- .2 Steel Rail Base:
  - .1 Structural steel, positioned for alignment of drive and driven equipment.
  - .2 Without supplementary hold down devices.
  - .3 Isolation element attached to base brackets arranged minimizing height.
  - .4 Pre-drilled holes receiving equipment anchor bolts.

## **2.12 SHIMS**

- .1 Metal shims.
- .2 Stainless steel shims in non-climate-controlled areas or corrosive environments.

## **2.13 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Vibration Isolators, Seismic Restraints and Bases:
  - .1 Vibro-Acoustics.
  - .2 Mason Industries.
  - .3 Kinetic Noise Control.
  - .4 Eaton (B-Line).
  - .5 VMC Group.

## **Part 3 Execution**

### **3.1 INSTALLATION OF VIBRATION ISOLATION MATERIALS**

- .1 Provide vibration isolation products for designated equipment and work.
- .2 Supply to vibration isolation product manufacturer or supplier, copy of reviewed shop drawing or product data sheet for each piece of isolated equipment with dimensioned suspended raceways layouts of associated isolated raceways.
- .3 Verify that vibration isolation manufacturer coordinates material selections with equipment provided in order to verify adherence to performance criteria. Allow for expansion and contraction when material is selected and installed.
- .4 Install isolation materials for base-mounted equipment on concrete housekeeping pad bases which extend at least over full base and isolated area of isolated equipment. Additional requirements are as follows:
  - .1 Block and shim bases level so conduit and conductor connections can be made to rigid system at proper operating level before isolated adjustment is made. Verify there is no physical contact between isolated equipment and building structure.
  - .2 Steel bases to clear sub-base by minimum 25 mm.
  - .3 Concrete bases to clear sub-base by minimum 50 mm.
- .5 Secure top of spring hanger frame rigidly to structure, and do not install spring hangers in concealed locations.

- .6 Where it is impossible to use at least 2 spring hangers, provide twin sphere, moulded rubber flexible connection assemblies, selected by manufacturer and suitable for intended application, and complete with required nipples and connections to provide proper vibration isolation.
- .7 Isolate designated conduit and duct risers at floor support points.
- .8 Control wiring connections to vibration isolated equipment:
  - .1 Provide flexible metallic conduit with 90° bend for conduit 25 mm diameter and smaller.
  - .2 Provide explosion-proof type flexible liquid tight, with brass or stainless steel couplings for conduit larger than 25 mm diameter.
  - .3 Make connections long enough for conduit to remain intact, where equipment moves 300 mm laterally from its installed position, and flexible enough to transmit less vibration to structure than is transmitted through vibration isolation.
- .9 Arrange for vibration isolation product manufacturer authorized technician to visit site to inspect installation of manufacturers equipment. and submit letter stating manufacturer technician has inspected installation and equipment is properly installed.

### **3.2 INSTALLATION OF SEISMIC RESTRAINTS SYSTEMS**

- .1 Provide seismic control measures.
- .2 Install vibration isolation equipment in accordance with manufacturer instructions and adjust mountings to level equipment.
- .3 Verify that conduit and electrical connections to isolated equipment do not reduce system flexibility and that conduit and cable passage through walls and floors do not transmit vibrations.
- .4 Install SRS at least 25 mm from equipment, systems, services.
- .5 Where isolation is bolted to floor, provide vibration isolation rubber washers.
- .6 Attachment Points and Fasteners: In accordance with Seismic Engineer design requirements, withstands same maximum load that seismic restraint resists and in every direction.
- .7 Before isolator adjustment is made, block and shim level bases so that connections can be made to rigid system at operating level. Verify that there is no physical contact between isolated equipment and building structure.
- .8 Slack Cable Systems (SCS):
  - .1 Connect to suspended equipment so that axial projection of wire passes through centre of gravity of equipment.
  - .2 Provide appropriate grommets, shackles, other hardware to verify alignment of restraints and avoiding bending of cables at connection points.
  - .3 Orient restraint wires on ceiling hung equipment at approximately 90 degrees to each other (in plan), tie back to structure at maximum of 45 degrees to structure.
  - .4 Adjust restraint cables so that they are not visibly slack but permit vibration isolation system to function normally.
  - .5 Tighten cable to reduce slack to 40 mm under thumb pressure. Cable not to support weight during normal operation.
- .9 Miscellaneous Equipment Not Vibration-Isolated: Bolt through base concrete pad to structure.
- .10 Co-ordinate connections with other disciplines.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer Seismic Engineer Field Services:
  - .1 Arrange with Seismic Engineer to review work of this Section and submit written sealed reports verifying compliance with Contract Documents.
  - .2 Submit product use recommendations and perform periodic site visits to review installation, scheduled as follows:
    - .1 During installation, at 60% completion stages.
    - .2 Upon completion of installation.
  - .3 Perform onsite inspection, testing and verification of installed products. Refer to Seismic Engineer testing procedures.
  - .4 Coordinate and direct adjustments and corrections in accordance with Seismic Engineer test report.
- .2 Inspection, Testing and Certification Work:
  - .1 Seismic restraint system and vibration isolation products: Upon completion of installation, inspected and certified by Seismic Engineer.
  - .2 Take vibration measurements for equipment as noted and reviewed with Consultant.
  - .3 Inspect for removal of breakaway hardware to verify torques of installed systems meet design requirements.
  - .4 Test, adjust, and certify installation.
  - .5 Comply with AHJ requirements for testing, certification, documenting and labeling of seismic restraints.
  - .6 Establish adequacy of equipment isolation and acceptability of noise levels in occupied areas and where appropriate, remedial recommendations (including sound curves).
  - .7 Non-visually verifiable product: Manufacturers to verify proper torque for minimum 10% of application, unless otherwise directed by Consultant or AHJ. Document torques for applications in accordance with manufacturer instructions.
- .3 Prepare testing and verification reports, signed by testing technician and Seismic Engineer. Include copies of compliance certificates. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 Government of Canada:
  - .1 Canadian Environmental Protection Act, (1999) amended 2020.
  - .2 Hazardous Products Act, (1985) amended 2018.
  - .3 Transportation of Dangerous Goods Act, (1992) amended 2019.
- .2 Institute of Electrical and Electronics Engineers (IEEE):
  - .1 IEEE 644-2019, IEEE Standard Procedures for Measurement of Power Frequency Electric and Magnetic Fields from AC Power Lines.

**1.2            SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit following as applicable to work:
    - .1 Identification of waste treatment facility proposed and description of type of waste that facility is licensed to handle.
    - .2 Certificate of PCB material treatment laboratory credentials.
    - .3 Waste tracking procedure.
    - .4 Testing reports with completed test results sheets.
    - .5 Compliance certificates or certificate of approvals.
    - .6 Description of closure plan of facility.
    - .7 Copies of insurance and bonding.
    - .8 Certificates of destruction.

**Part 2            Products**

**2.1            GENERAL**

- .1 Products: As specified under Part 3 descriptions for providing respective Work.

**2.2            ACCEPTABLE SERVICE COMPANIES**

- .1 Hazardous Waste Removal Companies:
    - .1 Aevitis.
    - .2 Sanexen.
  - .2 EMI Mitigation Companies:
    - .1 C-Intech.
    - .2 Power Line Systems Engineering.
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**Part 3            Execution**

**3.1                HAZARDOUS MATERIALS**

- .1 Hazardous materials and infectious materials are known to be present on site in existing buildings, including but not limited to following:
  - .1 Asbestos.
  - .2 Lead.
  - .3 Mercury.
- .2 Division 00 and/or Division 01 identify additional specific requirements and where such materials are present, become educated and trained on special working conditions, to work in areas with hazardous materials, requiring protective clothing (PPE), gear, tenting, enclosures, and other protective means, and performing necessary partitioning/tenting/ventilation work to isolate areas and maintain disturbances of such material to a minimum. Comply with infection control requirements and requirements of Health and Welfare AHJ requirements. Asbestos abatement report may be available for review from Owner or Consultant. Unless otherwise noted, abatement removal is responsibility of another Division of Work or is not included under scope of work of this project.
- .3 Where proper abatement procedures are not followed, be responsible for bearing full cost of full-time qualified abatement inspector chosen by Owner. In areas where work is being done above or below area occupied by Owner personnel, or building occupants, perform slab penetrations into vertically adjacent occupied space with proper enclosure in area of that work on that occupied floor. Be responsible for failure to comply with special requirements in working in areas of hazardous materials.
- .4 Include for company specializing in removal and disposal of materials containing polychlorinated biphenyls (PCBs) to disassemble equipment to access material containing PCBs and remove and properly dispose of such material off site.
- .5 Check luminaires being deleted for ballast containing PCBs. Disconnect and dispose off-site ballast containing PCBs. Only companies that are certified and comply with local governing Ministry of Environment and Ministry of Transport regulations with regards to hazardous waste materials to perform this Work. Prior to start of Work, submit to Consultant, copy of PCB disposal certificate and identification of Ministry authorized and designated disposal site. Remove and transport lamps containing mercury (fluorescent lamps) to government approved disposal site. Do not send ballasts containing PCBs to metal recycling.

**3.2                PCB REMOVAL, TRANSPORTATION AND DISPOSAL**

- .1 Engage specialty service company to perform polychlorinated biphenyls (PCBs) abatement removal work.
  - .2 General Scope of Work:
    - .1 Coordination with Owner, submission of Generator Registration Report (GRR).
    - .2 Completing and submitting to AHJ, Generator Registration Report (GRR) and making fee payments.
    - .3 Perform removal work of existing equipment (transformers, capacitors and ballasts) and associated cables containing PCBs.
    - .4 Perform PCBs abatement removal work.
    - .5 Workers act in manner that is consistent with safe handling, loading, testing, and transporting PCB material.
    - .6 Engage approved treatment facility to test PCB materials.
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- .3 Company Qualifications:
    - .1 Experienced and certified in province of Place of Work.
    - .2 Approved by governing Ministry of Environment (MOE).
    - .3 Licensed by AHJ.
    - .4 Employ workers involved in handling, loading, transportation and destruction of PCB material that are trained and licensed in accordance with Workplace Hazardous Materials Information System (WHMIS) and Transportation of Dangerous Goods Act, Transport Canada (TDG).
  - .4 Certificates of Insurance to be carried:
    - .1 Minimum \$5,000,000.00 CDN Pollution Legal Liability Insurance.
    - .2 Minimum of \$5,000,000.00 CDN Aggregate Consultant Environmental Liability Insurance.
    - .3 Minimum of \$5,000,000.00 CDN Umbrella Commercial General Liability Policy.
  - .5 Work performed in accordance with Federal and Provincial Regulations, Codes, Standards and Policies, including:
    - .1 Occupational Health and Safety Act.
    - .2 Transportation of Dangerous Goods Act.
    - .3 Canadian Environmental Protection Act, Environment Canada.
    - .4 For applications of PCB transformers: PCB Transformer Decontamination: Standards and Protocols.
    - .5 Workplace hazardous materials as outlined in Hazardous Materials Information System as established in Hazardous Products Act.
    - .6 Ministry of the Environment and Climate Change.
  - .6 Work includes but is not limited to providing following:
    - .1 Administering, supervising, arranging, and coordinating of work.
    - .2 Obtaining permits and approvals and payment of fees associated with performing Work.
    - .3 Submission to Consultant:
      - .1 Detailed report of work.
      - .2 Copies of permits and certificate of approvals (compliance certificates).
      - .3 Documentation identifying site where equipment and materials are delivered. Identify proposed transporting route and means for moving materials from building and site. Submit these details as shop drawings.
    - .4 Disconnection and decommissioning of equipment containing PCBs.
    - .5 Disconnection and making safe of connections (primary and secondary power cabling, controls and protection circuits, and monitoring circuits) to existing transformers. Replace connectors and wiring that have come into contact with PCBs.
    - .6 Sampling and testing of liquids for PCBs.
    - .7 Waste Oil Handling:
      - .1 Not containing PCBs less than amount in accordance with AHJ regulations: Send to recycling facility.
      - .2 Containing PCBs in amounts exceeding governing regulations: Send to approved facility for storage and destruction in accordance with governing regulations.
    - .8 Draining of PCB containing liquid from equipment.
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- .9 Dismantling and cutting-up of equipment, for PCB decontamination and removal from building and site.
  - .10 Packaging of PCB containing and contaminated materials, for removal from building and site.
  - .11 Removal from site of materials and transportation of PCB containing materials to AHJ approved designated facility.
  - .12 Remove materials from site and properly dispose of in manner approved by AHJ.
  - .13 Not storing any PCB containing materials onsite.
  - .14 Perform work required for inspecting, characterizing packaging, labelling, loading, transportation, decontamination and/or destruction of PCB material.
  - .15 Prior to start of Work, review with Consultant and obtain Consultant recommendations for acceptance of path of egress for removal of equipment and components. Protect egress from spills and other damage that may occur in movement of material.
  - .16 Perform Work at scheduled times approved in writing by Owner and reviewed with Consultant.
  - .17 Remove waste in expedient manner in accordance with agreed project schedule.
  - .18 Engage approved facility to store, destruct, decontaminate and dispose PCB containing materials.
  - .19 No later than 30 days after PCB waste is removed from site, submit copies of final Certificates of Destruction for All Waste (solid/liquid) to Consultant.
  - .20 Obtain Certificate of Approvals as follows:
    - .1 Waste Management Systems.
    - .2 Transportation.
    - .3 Transfer.
    - .4 Treatment.
  - .7 Inspections and Characterization:
    - .1 Provide materials and labour required for inspection of PCB materials prior to each shipment of PCB Material.
    - .2 Characterize and profile PCB material as required in accordance with requirements of TDG and WHMIS and other applicable federal, provincial, or municipal regulations.
    - .3 Sample, characterize, and profile PCB material, including preparation of waste profile sheets (WPS) with WPS Numbers assigned specifically to each existing PCB filled power transformer. Utilize comprehensive computerized bar-coded waste tracking system by treatment facility, ensuring accurate tracking of PCB Material. Computerized bar-coding system minimizes risk of human error when moving waste. Consultant reserves right to inspect waste tracking procedures throughout duration of Work.
  - .8 Treatment Facility:
    - .1 Canadian Association for Laboratory Accreditation (CALA) approved laboratory facility for analysis of various types of PCB Materials. Submit certificate of laboratory credentials and description of types of waste that treatment facility can receive, with shop drawings.
    - .2 Test PCB samples taken from materials before and after decontamination treatment.
    - .3 Submit copy of waste tracking procedure as part of shop drawings. This procedure includes tracking of PCB material sent to third party for incineration.
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This procedure explains how specific WPS used for this project is tracked throughout work.

- .4 PCB Materials carry bar coding from point of pick-up of PCB Materials from site.
- .5 Include with shop drawings:
  - .1 Copy of Certificate of Approval.
  - .2 Description of closure plan of facility, that includes closure bond, which can be used in event of insolvency or bankruptcy of service specialty company. Include amount of this bond sufficient to cover cost of destruction for materials which appear in Certificate of Approval for storage at service specialty company facility at any given time.

**END OF SECTION**



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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 American National Standards (ANSI):
  - .1 ANSI Z535.1-2022, American National Standard for Safety Colours.
- .2 CSA Group (CSA):
  - .1 CSA C9-17, Dry-Type Transformers.
  - .2 CSA C22.2 No. 47-13(R2018), Air-Cooled Transformers (Dry Type).
  - .3 CAN/CSA-C802.2-18, Test Method and Minimum Efficiency Values for Dry-Type Transformers.
- .3 Institute of Electrical and Electronics Engineers (IEEE):
  - .1 IEEE C57.110-2018, IEEE Recommended Practice for Establishing Liquid Immersed and Dry-Type Power and Distribution Transformer Capability when Supplying Nonsinusoidal Load Currents.
- .4 Government of Canada:
  - .1 SOR/2016-311-2019, Energy Efficiency Regulations, 2016.
- .5 Government of Ontario:
  - .1 Green Energy Repeal Act, 2018.
  - .2 O. Reg. 509/18-2021, Energy And Water Efficiency - Appliances and Products.
- .6 National Electrical Manufacturers Association (NEMA):
  - .1 NEMA ST 20-2021, Dry Type Transformers for General Applications.

**1.2            SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
  - .2 Indicate on drawings:
    - .1 Dimensions showing enclosure, mounting devices, terminals, taps, internal and external component layout.
    - .2 Technical Data:
      - .1 kVA rating.
      - .2 Primary and secondary voltages.
      - .3 Frequency.
      - .4 Number of phases.
      - .5 Polarity or angular displacement.
      - .6 Full load efficiency.
      - .7 Regulation at unity pf.
      - .8 BIL.
      - .9 Insulation type.

- .10 Sound rating.
- .3 Submit testing and verification reports.

## **Part 2 Products**

### **2.1 LOW VOLTAGE DRY TYPE DISTRIBUTION TRANSFORMERS – GENERAL REQUIREMENTS**

- .1 Types, Capacities and Ratings: As noted.
- .2 Standards:
  - .1 CSA certified, ULC listed and labeled.
  - .2 Constructed and factory tested in accordance with applicable requirements of following:
    - .1 CSA C9.
    - .2 CSA C22.2 No. 47.
    - .3 CAN/CSA-C802.2.
    - .4 Green Energy Repeal Act.
    - .5 O. Reg. 509/18.
    - .6 NEMA ST 20.
    - .7 SOR/2016-311.
- .3 Provide transformers from same manufacturer throughout Project.
- .4 Include hardware and supports for floor-mounting, wall-mounting, or suspended from ceiling. Refer to drawings.
- .5 Modules/Contacts: For integration to BAS, to monitor transformer over-temperature, where noted.
- .6 Aluminum Nameplates:
  - .1 Riveted to front of enclosure.
  - .2 With following identification:
    - .1 Electrical ratings, primary and secondary voltage levels, impedance rating, weight, style and serial number.
    - .2 Connection diagram and CSA certification mark.
- .7 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and transformer manufacturer recommendations.

### **2.2 GENERAL LOW VOLTAGE DRY TYPE TRANSFORMERS**

- .1 Transformers Features:
  - .1 Copper windings.
  - .2 Class "H", 220°C class, coil insulation, such that winding temperature rise to not exceed 150 C° and enclosure temperature rise not exceed 65 C° under full load in 40°C ambient temperature.
  - .3 Core construction consisting of stacked laminations of high permeability silicone steel.
  - .4 Vacuum impregnated polyester or epoxy-resin types.
  - .5 Lugs or pressure type terminals suiting primary and secondary conductors.

- .6 Voltage Taps:
  - .1 Up to 15 kVA: Two - 5% full capacity taps, one above normal and one below normal. Taps located on primary winding.
  - .2 Greater than 15 kVA: Four - 2-1/2% full capacity taps, two above normal and two below normal. Taps located on primary winding.
- .7 Integral vibration dampening system with anti-vibration pads used between coil and core and enclosure.
- .8 Basic impulse level: In accordance with CSA C9, unless otherwise noted.
- .9 Average Sound Level: As noted on drawings or schedules.
- .10 Average sound level: In accordance with NEMA ST 20 and CSA C9, unless otherwise noted.
- .11 Average Sound Level: Where noted, low sound noise of minus 3 db below requirements of NEMA ST 20 and CSA C9.
- .12 Efficiency meeting or exceeding latest efficiency levels of referenced standards listed above including CAN/CSA-C802.2.
- .13 Flexible copper grounding strap, grounding core and coil assembly to enclosure.

## **2.3 ENCLOSURES AND DRIP SHIELDS**

- .1 Standard Indoor Applications: Unless otherwise noted, minimum NEMA 2 ventilated, drip proof enclosure with rigid end frame, removable plates, terminal compartment.
- .2 Sprinklered Areas: Unless otherwise noted, minimum NEMA 3R enclosure with rigid end frame, removable plates, terminal compartment; ventilation louvres designed preventing penetration of water spray from activated sprinklers onto live parts, and gasketed doors and component openings.
- .3 Indoor Industrial Applications: Unless otherwise noted, minimum NEMA 12 non-ventilated, drip proof, dust-tight enclosure with rigid end frame, removable plates, terminal compartment.
- .4 Outdoor Applications: Unless otherwise noted, minimum NEMA 4 non-ventilated, water-tight enclosure.
- .5 Top-mounted factory painted drip shield for indoor enclosures.
- .6 Bottom-mounted drip tray for wall/ceiling mounted transformers.
- .7 Factory painted with ANSI grey enamel finish, as reviewed with Consultant.

## **2.4 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 General Dry Type Transformers:
  - .1 Hammond Power Solutions.
  - .2 Delta Group.
  - .3 Schneider Electric.
  - .4 REX Power Magnetics.
  - .5 Siemens.
  - .6 STI.
  - .7 ABB.
  - .8 Hitachi.

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**Part 3                      Execution**

**3.1                      INSTALLATION**

- .1      Locate transformers into position. Install with clearance space for access for operation and maintenance. Provide ventilation for transformers to operate as specified and that there is no transfer of heat to adjacent surfaces or equipment. Install in accordance with manufacturer instructions and recommendations.
- .2      Unless otherwise noted, secure transformers 75 KVA and larger to concrete housekeeping pad on vibration isolation pads.
- .3      Unless otherwise noted, secure transformers smaller than 75 KVA in place on angle wall mounting bracket support assembly located approximately 300 mm below ceiling. Provide support assembly and secure to wall and/or ceiling construction.
- .4      Provide seismic restraints as specified.
- .5      Install transformers in level upright position.
- .6      Remove shipping supports only after transformer is installed and just before putting into service.
- .7      Loosen isolation pad bolts until no compression is visible.
- .8      Make primary and secondary connections in accordance with manufacturer wiring diagram.
- .9      Equip transformers with lugs or connections suitable for primary and secondary connections. Provide factory installed lugs for dual output transformers where noted. Isolate primary and secondary connections from transformer enclosures by means of 300 mm to 450 mm length of liquid-tight flexible conduit. Typically, install conduit connections in lower one-third of transformer.
- .10     Ground and bond equipment to ground electrode grids.
- .11     Seal openings and conduit entries of enclosures and drip shield, watertight.
- .12     Interconnect to BAS to monitor overtemperature. Extend wiring in conduit to interconnection terminal cabinet. Provide relays suiting intended applications. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with BAS system vendor.
- .13     Prior to ordering, review finish colours of enclosure with Consultant.
- .14     Provide equipment main identification nameplates of size 4 unless otherwise noted.

**3.2                      FIELD QUALITY CONTROL**

- .1      Inspection, Start-up, Testing, Commissioning and Verification:
    - .1      Perform inspection, start-up procedures, and testing as recommended by manufacturer.
    - .2      Test and commission equipment.
    - .3      Test and check secondary voltages.
    - .4      Make required adjustments and verify secondary voltage readings and identify adjustments made to achieve proper voltages.
    - .5      When building is in normal use, re-check voltages and make required adjustments.
  - .2      Prepare test and verification reports, signed by test technician. Submit reports to Consultant.
-

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 American National Standards Institute (ANSI):
  - .1 ANSI C12.20-2015, Electricity Meters - 0.1, 0.2, and 0.5 Accuracy Classes.
  - .2 ANSI C37.50-2018, Switchgear - Low Voltage AC Power Circuit Breakers Used In Enclosures -Test Procedures.
  - .3 ANSI Z535.1-2022, American National Standard for Safety Colors.
- .2 CSA Group (CSA):
  - .1 CSA C22.2 No. 5-16(R2021), Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures (Tri-national standard with UL 489 and NMX-J-266-ANCE-2016).
  - .2 CSA C22.2 No. 31-18, Switchgear Assemblies.
  - .3 CSA C22.2 No. 244-19, Switchboards (Trinational standard with UL 891 and NMX-J-118/2-ANCE).
  - .4 CSA C61869-2-14(R2019), Instrument transformers - Part 2: Additional requirements for current transformers (Adopted IEC 61869-2:2012, edition 1.0:2012, with Canadian deviations).
- .3 Institute of Electrical and Electronics Engineers (IEEE):
  - .1 IEEE C37.13-2015, IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
  - .2 IEEE C37.16-2009, IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.
  - .3 IEEE C37.17-2022, IEEE Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.
  - .4 IEEE C37.20.1-2015, IEEE Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
- .4 Underwriters Laboratories (UL):
  - .1 ANSI/UL 489-Edition 13, 2017, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
  - .2 ANSI/UL 891-Edition 12, 2019, Standard for Switchboards.
  - .3 ANSI/UL 1066-Edition 5, 2022, Power Circuit Breakers up to 1000 V AC and 1500 V DC Used in Enclosures.
  - .4 ANSI/UL 1558-Edition 5, 2016, Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.

**1.2 SUBMITTALS**

- .1 Product Data:
    - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
    - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
    - .3 Submit copies of CSA and UL compliance certificates.
  - .2 Shop Drawings:
-

- .1 Submit shop drawings for products of this Section.
- .2 Switchgear: Submit compliance certificates from manufacturer identifying that switchgear is certified and in accordance with ANSI/UL 1558 and CSA C22.2 No. 31.
- .3 Indicate on Drawings:
  - .1 Ratings.
  - .2 Floor anchoring method and foundation template.
  - .3 Dimensioned cable or bus duct entry and exit locations.
  - .4 Dimensioned position and size of bus.
  - .5 Overall length, height and depth of complete switchgear/switchboard.
  - .6 Dimensioned layout of internal and front panel mounted components.
  - .7 Breakers.
- .3 Submit certified factory inspection and test reports.
- .4 Submit testing and verification reports.

## **Part 2 Products**

### **2.1 LOW VOLTAGE SWITCHGEAR**

- .1 General Features:
  - .1 Indoor, metal enclosed units, CSA certified and ULC listed and labeled.
  - .2 Bussing, structure and power circuit breakers (also referred to as air circuit breakers (ACB) are rated for 30 cycle withstand rating.
  - .3 Suitable for use with building ground system and with minimum short circuit current rating (S.C.C.R.) as noted, but in absence of direction, suiting intended application to local electrical code requirements and with short circuit current rating that is at least equal to or exceeds the available short circuit current at that point of distribution.
  - .4 In accordance with electrical utility standards and regulations for incoming electrical services, where required.
  - .5 Designed, manufactured and tested in accordance with:
    - .1 CSA C22.2 No. 31.
    - .2 IEEE C37.20.1.
    - .3 ANSI/UL 1558.
    - .4 IEEE C37.20.7.
  - .6 Clearly labeled on manufacturer identification nameplate as being certified by CSA to applicable standards of Canada.
- .2 Include with shop drawings, copies of certificates verifying switchgear is in accordance with CSA C22.2 No. 31 and ANSI/UL 1558.
- .3 Power circuit breakers or ACBs designed, manufactured and tested in accordance with:
  - .1 IEEE C37.13, IEEE C37.16 and IEEE C37.17.
  - .2 ANSI/UL 1066.
- .4 Switchgear Structure:
  - .1 Consists of individual vertical sections bolted together forming enclosed, self-contained, self-supporting structure on channel type base, and with necessary facilities for proper ventilation.

- .2 Sections welded or bolted construction, fabricated from sheet steel in accordance with NEMA and CSA requirements. Sections align front and rear.
  - .3 Front access only.
  - .4 Front doors formed type, fabricated with cold rolled sheet steel and with handle lock operators and locking tabs.
  - .5 Grounded vented metal barriers isolate main bus and connections from cable compartment. Vertical barriers provided between cable sections. Full depth section barriers isolate one section from adjacent sections. Barriers isolate incoming line side connections to main breakers from load side bus and connections in switchgear section.
  - .6 Ventilators located on top of switchgear over breaker and bus compartments provide adequate ventilation within enclosure.
  - .7 Each vertical steel section forming part of switchgear is self-contained housing having one or more individual breaker or instrument compartments, centralized bus compartment and rear cable compartment.
  - .8 Each individual circuit breaker compartment or cell is segregated from adjacent compartments and sections by means of steel barriers to maximum extent possible.
  - .9 Insulating flash shield mounted above each circuit breaker preventing flashover from arc chutes to ground.
  - .10 Safety shutter in cells when circuit breakers withdrawn, which automatically covers line and load stabs and protects against incidental contact. Pad-lockable breaker door prevents access to shutter when breaker is removed from cell.
  - .11 Entire enclosure in accordance with minimum NEMA 2 requirements, and with additional sprinkler protection requirements. Top of each cell complete with drip shield for shedding water without dripping on cell. Enclosure prevents penetration of water spray from activated sprinklers onto live components. Doors and component openings are gasketed and conduit entries sealed watertight.
  - .12 Enclosure finished in manufacturer standard ANSI grey enamel, unless otherwise noted.
  - .5 Arc-Resistant Switchgear Additional Requirements:
    - .1 Switchgear labeled identifying that assembly has been assembled and tested according to IEEE C.37.20.7
    - .2 Arc rating of switchgear is Type 2B in accordance with IEEE C37.20.7. such that operator is protected around entire perimeter of equipment with low voltage control, instrumentation and breaker secondary customer termination compartment doors open.
    - .3 Top of enclosures include arc ventilation that allows exhaust of arc gases during arcing event.
    - .4 Arc ventilation system provided within each breaker cell redirecting arc energy to top of enclosure away from operating personnel.
    - .5 Arc Plenums:
      - .1 Includes arc plenum tested in accordance with IEEE C.37.20.7 and equipped with external connections to arc duct.
      - .2 Where installed in locations with 3 m minimum floor-to-ceiling height for arc exhaust, with no obstructions in space above switchgear, arc plenum not required.
    - .6 Door bellows system installed around front of each breaker prevents arc gasses from escaping around breaker escutcheon, while also allowing easy racking of breaker into disconnected position with door closed.
-



- .7 Breaker secondary disconnecting devices consist of floating terminals mounted on stationary unit and engaging mating contacts at front of breaker. Breaker secondary disconnecting devices maintained in connected and test positions. Customer access to secondary terminations provided in separate compartment from breaker cell and compartment rated Type 2B in accordance with IEEE C37.20.7.
- .8 Trip Unit Arc-Flash Reduction Maintenance Systems:
  - .1 Trip units include arc-flash reduction maintenance system for reducing trip unit instantaneous pickup value when activated.
  - .2 System does not compromise breaker phase protection even when enabled.
  - .3 When system disabled, recalibration of trip unit phase protection is not required. Activation and deactivation of system setting accomplished without opening circuit breaker door and exposing operators to energized parts.
  - .4 System clearing time of 0.04 seconds, adjustable with minimum of five settings ranging from 2.5X to 10X of sensor value.
  - .5 System includes:
    - .1 System enabling switch on trip unit with confirmation of protection via LED indication.
    - .2 Remote "enable/disable" control.
    - .3 Switchgear panel mounted enable padlockable selector switch and indication via LED pilot light.
  - .6 System wired locally with interposing relays and wired to terminal blocks to enable remote selector switch and confirmation light to be mounted at downstream protected distribution equipment.
- .6 Bus Bars:
  - .1 Main Bus Bars:
    - .1 Constructed of 98% pure, rectangular copper bars, silver plated at joints with lap type joints bolted using high strength steel bolts and extra wide, extra thick washers providing maximum pressure and even current distribution at each joint.
    - .2 Bus and connections designed for maximum temperature rise in any part of switchgear not to exceed 65 C° over ambient temperature of 40°C.
    - .3 Bus properly isolated and designed to carry currents suiting intended applications.
  - .2 Ground Bus:
    - .1 Continuous ground bus not less than 6 mm x 50 mm cross section area extending length of switchgear.
    - .2 Solidly bolted to steel framework.
    - .3 Constructed of same material as main bus and with suitable lugs for grounding connections.
    - .4 Short-time withstand rating matches that of largest circuit breaker within assembly.
  - .3 Supplied with bolts, nuts, and washers for field connection of bus joints between cells. Hardware of high-tensile strength and zinc-plated with use of Belleville-type washers on bus joints.
- .7 Control Wiring:
  - .1 Each cell provided with control wiring and terminal blocks.

- .2 Control Wiring: Type "SIS", minimum size No. 14, extra flexible wire with thermoplastic insulation. Neatly harness and suitably secure control wiring.
- .3 Terminal Blocks: Pressure type, with removable marking strips.
- .4 Shorting Blocks: Enclosed barrier type within control cubicle.
- .8 Switchgear Arrangement and Components:
  - .1 Switchgear cell arrangements and components: As detailed on drawings.
  - .2 Main bussing not run lower than 300 mm above finished floor level.
  - .3 80% rated breakers unless otherwise noted.
- .9 UCDSB BAS Connected Remote Check Meter:
  - .1 Provide BAS connected electrical metering system c/w enclosure.
  - .2 Meter to be Veris Industries Compact Power and Energy Meter with BACNET MS/TP & fusing to standard acceptance E50H2.
  - .3 Provide 3-1200A split core current transformers on the phase conductors.
  - .4 Enclosure to be equipped with clear impact-resistant acrylic, hinged and locking cover.
- .10 Utility Metering Provisions:
  - .1 Review with and coordinate utility metering requirements with electrical utility. Provide products in accordance with electrical utility standards including ANSI level of accuracy.
  - .2 Metering cells for utility metering and current transformers (CTs) and potential transformers (PTs) and associated fuses: In accordance with utility requirements and suiting intended applications.
  - .3 Provide minimum 38 mm diameter conduit stub in bottom of each metering cell for site extension of conduit to meters.
- .11 Current and Potential Transformers:
  - .1 In accordance with CSA C61869-2.
  - .2 Dry type, indoor with ratings, suiting intended applications.
  - .3 Potential transformers are of compartment type and incorporate current limiting fuses.
  - .4 Current transformers have ratios suiting intended applications, mechanical rating equal to momentary rating of circuit breakers, and insulated for full voltage rating of switchgear.
  - .5 CTs and PTs for local electrical utility metering are typically supplied by local electrical utility. Where CTs and PTs are not supplied by electrical utility, provide in accordance with utility requirements and suiting intended applications.
  - .6 Electrogalvanized code gauge painted steel mounting brackets and channels to secure transformers in place.
  - .7 Ship CTs and PTs to switchgear manufacturer factory for factory mounting and connection into metering cells, and secondary connected to terminal blocks.
- .12 Incoming and Outgoing Conductor Connection Facilities:
  - .1 Provide facilities and hardware for cable in conduit and bus duct, as noted and suiting intended applications.
- .13 Surge Protective Devices (SPD):
  - .1 Integral SPD unit, factory installed in dedicated cell and connected onto bussing through integral breaker of type and size in accordance with manufacturer recommendations.

- .2 Unit includes diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts.
- .3 Unit maintenance-free.
- .14 Mimic Bus, Nameplates and Signage:
  - .1 Mimic Bus: Red, single line vinyl bus approximately 3 mm thick x 9 mm wide representing internal bussing and components rivetted to front of switchgear and extending through handles of respective breakers and switches.
  - .2 Nameplates: Engraved lamicoid nameplates secured with stainless steel screws, adjacent each panel component and identifying each component.
  - .3 Warning signage and labels: Affixed on face of compartment doors allowing access to live components.
  - .4 Label internally mounted devices with designation matching drawings.
  - .5 Label door mounted components, conveying their function to operations personnel.
  - .6 Equipment Rating Identification Nameplates: Identifying certifications, approvals and standards of compliance.
  - .7 Prior to manufacturing, submit proposed nameplate and signage nomenclature, finishes colours, and sizing to Consultant for review. Nomenclatures as noted, are for reference only. Provide temporary identification labels during testing.
  - .8 Approvals: As required by AHJ.
- .15 Accessories:
  - .1 Manufacturer standard accessories, spare parts and maintenance tool kit.
  - .2 Wall-mounting spare fuse rack.
  - .3 Manufacturer installation drawings.
  - .4 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and switchgear manufacturer recommendations.
  - .5 Rubber insulating mats: Minimum 900 mm wide x 9 mm thick and length of switchgear, for front and where accessible, rear of switchgear.

## 2.2 LOW VOLTAGE SWITCHBOARDS

- .1 General Features:
  - .1 Indoor, metal enclosed units, CSA certified, and ULC listed and labeled.
  - .2 Suitable for use with building ground system and with minimum short circuit current rating (S.C.C.R.) as noted, but in absence of direction, suiting intended application to local electrical code requirements and with short circuit current rating that is at least equal to or exceeds the available short circuit current at that point of distribution.
  - .3 Where required, in accordance with electrical utility standards and regulations for incoming electrical services.
  - .4 Designed, manufactured and tested in accordance with:
    - .1 CSA C22.2 No. 31.
    - .2 CSA C22.2 No. 244.
    - .3 ANSI/UL 891.
  - .5 Clearly labelled on manufacturer identification nameplate as being certified by CSA to applicable standards of Canada.

- .2 Insulated case and moulded case breakers designed, manufactured and tested in accordance with:
  - .1 CSA C22.2 No. 5.
  - .2 ANSI/UL 489.
- .3 Switchboard Structure:
  - .1 Consists of individual sections bolted together forming enclosed, self-contained, self-supporting structure on channel type base, and with necessary facilities for proper ventilation.
  - .2 Sections welded or bolted construction, fabricated from sheet steel in accordance with NEMA and CSA requirements. Sections align front and rear.
  - .3 Front doors formed type, fabricated with cold rolled sheet steel and with handle lock operators and locking tabs.
  - .4 Rear, top and side panels are bolt-on, unless otherwise noted.
  - .5 Entire enclosure in accordance with minimum NEMA 2 requirements, and with additional sprinkler protection requirements. Top of each cell complete with drip shield for shedding water without dripping on cell. Enclosure prevents penetration of water spray from activated sprinklers onto live components. Doors and component openings are gasketed and conduit entries sealed watertight.
  - .6 Enclosure finished in manufacturer standard ANSI grey enamel, as reviewed with Consultant.
- .4 Bus Bars:
  - .1 Main Bus Bars:
    - .1 Constructed of 98% pure, rectangular copper bars, silver plated at joints with lap type joints bolted using high strength steel bolts and extra wide, extra thick washers providing maximum pressure and even current distribution at each joint.
    - .2 Bus and connections designed for maximum temperature rise in any part of switchboard not to exceed 65 C° over ambient temperature of 40°C.
    - .3 Bus properly isolated and designed to carry currents suiting intended applications.
  - .2 Ground Bus:
    - .1 Continuous ground bus not less than 6 mm x 50 mm cross-section area extending length of switchboard.
    - .2 Solidly bolted to steel framework.
    - .3 Constructed of same material as main bus and with suitable lugs for grounding connections.
    - .4 Rated for momentary current rating equal to or greater than that of apparatus in switchboard.
  - .3 Supplied with required bolts, nuts, and washers for field connection of bus joints between cells.
- .5 Control Wiring:
  - .1 Each cell provided with control wiring and terminal blocks.
  - .2 Control Wiring: Type SIS, minimum size No. 14, extra flexible wire with thermoplastic insulation. Neatly harness and suitably secure control wiring.
  - .3 Terminal Blocks: Pressure type, with removable marking strips.
  - .4 Shorting Blocks: Enclosed barrier type within control cubicle.
- .6 Switchboard Arrangement and Components:

- .1 Switchboard cell arrangements and components: As detailed on drawings.
- .2 Main bussing not run lower than 300 mm above finished floor level.
- .3 Provide 80% rated breakers as noted.
- .7 Main Breakers and Tie Breakers:
  - .1 Refer to drawings or schedules for types and ratings.
  - .2 Insulated Types:
    - .1 As noted and as required for application, fixed mounted, solid state insulated case circuit breaker with adjustable trip unit. Provide minimum interrupting capacity as scheduled.
    - .2 Where noted, ULC listed for application of 80% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
    - .3 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
  - .3 Moulded Case Types:
    - .1 As noted and as required for application, fixed mounted, solid state moulded case circuit breaker with adjustable trip unit. Provide minimum interrupting capacity as scheduled.
    - .2 Where noted, ULC listed for application of 80% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
    - .3 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
- .8 UCDSB BAS Connected Remote Check Meter:
  - .1 Provide BAS connected electrical metering system c/w enclosure.
  - .2 Meter to be Veris Industries Compact Power and Energy Meter with BACNET MS/TP & fusing to standard acceptance E50H2.
  - .3 Provide 3-1200A split core current transformers on the phase conductors.
  - .4 Enclosure to be equipped with clear impact-resistant acrylic, hinged and locking cover.
- .9 Utility Metering Provisions:
  - .1 Review with and coordinate with electrical utility, utility metering requirements and provide as required by electrical utility. Provide products in accordance with electrical utility standards including ANSI level of accuracy. Prior to ordering, review requirements with Consultant.
  - .2 Provide metering cells for utility metering and current and potential transformers and associated fuses in accordance with utility requirements and intended applications.
  - .3 Provide minimum 38 mm diameter conduit stub in bottom of each metering cell for site extension of conduit to meters.
- .10 Current and Potential Transformers:
  - .1 In accordance with CSA C61869-2.
  - .2 Dry type, indoor with ratings, suiting intended applications.
  - .3 Potential transformers (PTs) are of compartment type and incorporate current limiting fuses.
  - .4 Current transformers (CTs) have ratios suiting intended applications, mechanical rating equal to momentary rating of circuit breakers, and insulated for full voltage rating of switchboard.

- .5 CTs and PTs for local electrical utility metering are typically supplied by local electrical utility. Where CTs and PTs are not supplied by electrical utility, provide in accordance with utility requirements and suiting intended applications.
- .6 Electrogalvanized code gauge painted steel mounting brackets and channels to secure transformers in place.
- .7 Ship CTs and PTs to switchgear manufacturer factory for factory mounting and connection into metering cells, and secondary connected to terminal blocks.
- .11 Circuit Breakers Distribution Section:
  - .1 Types and ratings: As noted.
  - .2 Fixed-mounted power circuit breakers: As specified for main breakers and as noted.
  - .3 Circuit breaker distribution section: Consisting of insulated case, bolt-on circuit breakers with interrupting capacity as noted and frame size suiting intended applications.
  - .4 Circuit breaker distribution section: Consisting of moulded case, bolt on circuit breakers with interrupting capacity as noted and frame size suiting intended applications.
  - .5 Breakers of frame size greater than 225 A: Provided with solid state adjustable trip units.
  - .6 For moulded case type distribution section, include full size hinged locking door over section.
  - .7 Refer to requirements specified in Section 26 28 17 - Low Voltage Breakers.
- .12 Switch and Fuse Distribution Section:
  - .1 Types and ratings: As noted.
  - .2 Quick-make, quick-break, visible contact load break switches with operating handles and facilities for locking in either ON or OFF position.
  - .3 HRC Form I, Class J current limiting fuses, unless otherwise noted.
- .13 Incoming and Outgoing Conductor Connection Facilities:
  - .1 Provide facilities and hardware for cable in conduit and bus duct, as noted and suiting intended applications.
- .14 Surge Protective Devices (SPD):
  - .1 Integral SPD unit, factory installed in dedicated cell and connected onto bussing through integral breaker of type and size in accordance with manufacturer recommendations.
  - .2 Unit includes diagnostic package with status indicators on each phase, LCD surge counter display, audible alarm with silence button and Form C alarm contacts.
  - .3 Unit maintenance-free.
- .15 Thermographic Scanning Windows:
  - .1 Locate thermographic scanning windows in locations allowing for infrared survey cameras to scan live components, breakers and switches and their connections, cable connection and bussing, without opening of doors and panels.
  - .2 Infrared inspection windows with features as follows:
    - .1 CSA certified, or ULC listed and labeled, and in accordance with IEC 62271-200.
    - .2 Rated for respective switchgear.

- .3 Locking ring with teeth to lock tight to inside of panel that automatically grounds metal components and requires no screw holes.
  - .4 Quick access hinged cover with thumb screw release of permanently hinged IR window cover with inside label for permanent identification.
  - .5 Broadband crystal IR window lens encased in anodized aluminum frame suitable for indoor (NEMA 12) and outdoor (NEMA 4) scans.
  - .6 Transmits short, mid and longwave IR images.
  - .7 Supports visual inspections and fusion features.
  - .8 Allows laser pointers and illumination to shine through.
  - .9 Maximum operating temperature 260°C.
  - .10 Round sizes from 50 mm to 100 mm diameters.
- .16 Mimic Bus, Nameplates and Signage:
- .1 Mimic Bus: Red, single line vinyl bus approximately 3 mm thick x 9 mm wide representing internal bussing and components rivetted to front of switchboard and extending through handles of respective breakers and switches.
  - .2 Nameplates: Engraved lamicoid nameplates secured with stainless steel screws, adjacent each panel component and identifying each component.
  - .3 Warning signage and labels: Affixed on face of compartment doors allowing access to live components.
  - .4 Label internally mounted devices with designation matching drawings.
  - .5 Label door-mounted components, conveying their function to operations personnel.
  - .6 Equipment Rating Identification Nameplates: Identifying certifications, approvals and standards of compliance.
  - .7 Prior to manufacturing, submit proposed nameplate and signage nomenclature, finishes colours, and sizing to Consultant for review. Nomenclatures as noted, are for reference only. Provide temporary identification labels during testing.
  - .8 Approvals: As required by AHJ.
- .17 Accessories:
- .1 Manufacturer standard accessories, spare parts and maintenance tool kit.
  - .2 Wall-mounting spare fuse rack.
  - .3 Manufacturer installation drawings.
  - .4 Provide additional adjustable steel vibration isolators and seismic restraints as noted. Include seismic restraints in accordance with requirements of AHJ, governing building code and switchboard manufacturer recommendations.
  - .5 Rubber Insulating Mats: Minimum 900 mm wide x 9 mm thick and length of substation, for front and where accessible, rear of switchboard.

## **2.3 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Switchgear and Switchboards:
  - .1 Schneider.

## **Part 3 Execution**

### **3.1 INSTALLATION OF SWITCHGEAR AND SWITCHBOARDS**

- .1 Arrange for equipment manufacturer to provide necessary drawings for assembly and installation of equipment. Obtain from manufacturer, copies of installation, detail and

- assembly drawings required for approval of installation from AHJ. Obtain compliance certificates.
- .2 Install switchgear and switchboards into positions. Base layout, design, connections and requirements for supplied accessories from documents and reviewed shop drawings. Examine drawings and site conditions, verifying that equipment can be positioned into their designated positions, without difficulty. Install with access clearance for operation and maintenance.
  - .3 Assemble individual sections of equipment in accordance with manufacturer recommendations and instructions, and secure assembly to concrete base. Torque bus joint bolts in accordance with manufacturer recommendations. Arrange equipment in configuration as indicated on drawings and reviewed shop drawings.
  - .4 Provide seismic restraints.
  - .5 Make incoming and outgoing power cable connections to equipment in accordance with equipment and cable manufacturer recommendations. Make connections and terminations and provide bus flanges suitable for specific incoming and outgoing cables and bus ducts.
  - .6 Coordinate cable, bus duct and conduit (as applicable and as noted) entry location to match incoming cable and bus duct. Allow sufficient space for required cable bending radii and connections. Where bus duct is used for connections, coordinate orientation to match and provide appropriate bus duct connection flanges.
  - .7 Do not penetrate enclosure tops or drip shields unless reviewed with and recommended for acceptance by Consultant. Where Consultant makes such recommendation, provide raintight fittings for armoured cable and conduit entries into switchgear and switchboards, and make water-tight seal penetrations through drip shields and equipment enclosure openings.
  - .8 Coordinate delivery and installation of electrical utility supplied metering transformers.
  - .9 Install controls and displays at height of between minimum 1200 mm to maximum of 1800 mm above finished floor level.
  - .10 Provide breakers and switches. Set-up and adjust breaker trip settings as determined by results of distribution system coordination studies specified in Section 26 05 73 - Power System Studies, and reviewed with Consultant.
  - .11 Provide alarm and communications circuits. Integrate equipment to BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors. Integration points to BAS include:
    - .1 Switchgear or switchboard ground fault.
    - .2 Metering data.
    - .3 SPD fault.
  - .12 Ground and bond equipment to ground electrode grids.
  - .13 Install, connect and test SPD with connected breaker, in accordance with manufacturer instructions.
  - .14 Review final finishes with Consultant, during shop drawing process.
  - .15 Subject to electrical utility requirements, provide following:
    - .1 Prior to submittal of shop drawings to Consultant, submit switchgear/switchboard shop drawings to electrical utility for approval.
-



- .2 Prior to energization, arrange for electrical utility inspection and approval of completed equipment installation. Arrange and coordinate primary cable connections and metering requirements with electrical utility.
- .3 Extend minimum 38 mm diameter conduit from each metering cell to meter backboard for meter connection wiring. Confirm metering requirements with electrical utility and with Consultant.
- .4 Utility compliance certificates. Submit with testing and verification reports.

### **3.2 IDENTIFICATION**

- .1 Provide product with engraved lamicaid nameplates.
- .2 Equipment Main Nameplates: Size 4 unless otherwise noted and engraved as noted.
- .3 Nameplate for Each Circuit Breaker: Size 2 unless otherwise noted and engraved as noted.
- .4 Identify breakers feeding essential services with nameplates of dedicated colour, reviewed with Consultant.

### **3.3 FIELD QUALITY CONTROL**

- .1 Manufacturer technician to:
  - .1 Perform standard factory testing and submit copy of detailed reports to Consultant for review.
  - .2 Assist in onsite installation of equipment, and to onsite inspect installation, test equipment, perform start-up and verify equipment.
  - .3 Assist in integration of equipment to other building systems and equipment (such as BAS, Gensets/ UPS/ATS/Central monitoring system).
  - .4 Perform after installation final tuning of power factor system when building is in normal operations.
- .2 Inspection, Start-up, Testing and Verification:
  - .1 Inspect, start-up, test and verify products.
  - .2 Check connections and operations.
  - .3 Test SPD with connected breaker.
  - .4 Test and adjust controls and safeties.
  - .5 Test remote alarms and remote communications to other building systems.
  - .6 Verify equipment operations are in accordance with Specifications and manufacturer requirements.
- .3 Prepare testing and verification reports signed by testing technician. Submit reports and compliance certificates to Consultant.

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 American National Standards (ANSI):
  - .1 ANSI Z535.1-2022, American National Standard for Safety Colors.
- .2 CSA Group (CSA):
  - .1 CSA C22.2 No. 29-15(R2019), Panelboards and Enclosed Panelboards.
  - .2 CSA C22.2 No. 248.4-00(R2019), Low-Voltage Fuses - Part 4: Class CC Fuses (Tri-National standard, with UL 248-4 and NMX-J-009/248/4-2000-ANCE).

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
  - .2 Identify:
    - .1 Breakers and ratings.
    - .2 Panelboard dimensions.
    - .3 Lock keying requirements, as applicable.
- .3 Submit testing and verification reports.
- .4 Submit copies of completed and typed breaker circuit directory cards.

**Part 2 Products**

**2.1 GENERAL**

- .1 In accordance with reference standards.
  - .2 Product of one manufacturer.
  - .3 Factory fully assembled and tested. Ship fuses loose for onsite installation.
  - .4 CSA approved, or ULC listed and labeled.
  - .5 In addition to CSA requirements, provide manufacturer nameplates identifying fault current that panelboards, breakers and fused switches are built to withstand.
  - .6 250 V Panelboards: Bus and switch and fuse units rated as noted.
  - .7 600 V Panelboards: Bus and switch and fuse units rated as noted.
  - .8 Refer to drawings/schedules for:
    - .1 Enclosure configurations and types.
    - .2 Panelboards mains ratings.
    - .3 Types of breakers and ratings.
    - .4 Bussing ratings.
    - .5 Number of circuits, and number and size of breakers.
-

- .6 Spare breakers.
- .7 Spaces.

## **2.2 BRANCH CIRCUIT PANELBOARDS – BREAKER TYPE**

- .1 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .2 Enclosures constructed of code gauge galvanized steel with removable box ends, wiring gutter space on sides, and dead-front construction to shield user from energized parts. Trim for flush or surface-wall mounting suiting installation as noted.
- .3 Hinged door with concealed fasteners, concealed hinge, chrome-plated door-latch and keyed-alike lock with key. Front panel not removable with door locked. Provide flush locks for each panel board with minimum 2 keys for each panelboard. Key panelboards alike, unless otherwise noted.
- .4 Steel frame holder and typed circuit directory card protected by clear acetate and secured to back of door, and Mylar circuit breaker identification strips.
- .5 Copper Bussing: With neutral of same ampere rating of mains, unless otherwise noted.
- .6 Provide 200% neutrals for panelboards as noted, and with surge protective device connected.
- .7 Mains: Main lug connections or main bolt-on breakers, as noted.
- .8 Isolated ground bus.
- .9 Include grounding busbar with three terminals for bonding conductor equal to breaker capacity of panelboard.
- .10 Filler plates covering unused mounting space.
- .11 Enclosures in Climate-Controlled Areas:
  - .1 Minimum NEMA 1 unless otherwise noted,
  - .2 Ventilation louvres designed to prevent penetration of water spray onto live components.
  - .3 Enclosures, trims and doors factory painted in manufacturer standard ANSI gray baked enamel, unless otherwise noted.
  - .4 Surface mounted:
    - .1 Drip shield with no penetrations.
    - .2 Rain-tight conduit fittings sealing conduit entries watertight.
- .12 Surge Protection Device (SPD):
  - .1 Integral or external to panelboards as noted.
  - .2 Unit installed and connected onto bussing through integral disconnect or breaker as recommended by manufacturer.
  - .3 Unit includes diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts.
  - .4 Unit is maintenance-free.
  - .5 Refer to Section 26 43 00 - Surge Protection Devices for additional requirements.

## **2.3 DISTRIBUTION PANELBOARDS – BREAKER TYPE**

- .1 Panelboard mains, number of circuits, and number and size of branch circuit breakers: As noted.

- .2 Single or double row as required and with moulded case, bolt-on circuit breakers. Locate both main lugs and neutral bar at same end. Shield main lugs through a removable cover. Identify each circuit breaker adjacent breaker handle.
- .3 Panelboard Interior: Three flat bus bars stacked and aligned vertically with insulators laminated between phases. Insulators support and provide phase isolation to entire length of bus. Solidly bonded equipment ground bar and neutral bar provided.
- .4 Bus Bars (phases, grounds and neutrals): Constructed of hard-drawn electrical grade copper, silver-plated and extending throughout panel.
- .5 Interior Trim: Dead-front construction shielding user from energized parts.
- .6 Main circuit breaker and main lug interiors field convertible for top or bottom incoming feed.
- .7 Panelboard Boxes: Constructed of code gauge, hot zinc-dipped galvanized steel. With removable ends and wiring gutter space on sides in accordance with CSA requirements.
- .8 Floor-Mounted Enclosures: Free-standing type, reinforced providing support strength. Provide seismic restraints specified.
- .9 Enclosures Located in Climate-Controlled Areas:
  - .1 Minimum NEMA 1 unless otherwise noted,
  - .2 Ventilation louvres designed to prevent penetration of water spray onto live components.
  - .3 Factory painted in manufacturer standard ANSI gray baked enamel, unless otherwise noted.
  - .4 Surface mounted:
  - .5 Drip shield with no penetrations.
  - .6 Rain-tight conduit fittings sealing conduit entries watertight.
- .10 Distribution panelboards not located in secured electrical rooms or closets, require doors. Provide doors with latches and keyed-alike locks on panelboards located in unsecure areas. Locks of cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. Supply at least 2 keys with each lock. Key panelboards alike, unless otherwise noted.
- .11 Future Provisions: As noted. Include space provision for breakers, and bussing for full panel size. Where spare breakers are noted, provide breakers. For unused spaces, equip for future devices, with connectors and mounting hardware.
- .12 Mains: Suiting bolt-on breakers.
- .13 Drip shield for surface-mounted panelboards.
- .14 Filler plates covering unused mounting space.
- .15 Surge Protection Device (SPD):
  - .1 Integral or external to panelboards as noted.
  - .2 Unit installed and connected onto bussing through integral disconnect or breaker as recommended by manufacturer.
  - .3 Unit includes diagnostic package with status indicators on each phase, audible alarm and Form C alarm contacts.
  - .4 Unit is maintenance-free.
  - .5 Refer to Section 26 43 00 - Surge Protection Devices (SPD) for additional requirements.

- .16 Include grounding busbar with three terminals for bonding conductor equal to breaker capacity of panelboard.

## **2.4 BREAKERS**

- .1 Refer to Section 26 28 17 - Low Voltage Breakers, for additional requirements.
- .2 Breakers with thermal and magnetic tripping in panelboards as noted: Provide inverse time current tripping and instantaneous tripping for short circuit protection.
- .3 Main Breaker: Separately mounted on top or bottom of panel suiting cable entry. When mounted vertically, down position opens breaker.
- .4 Lock-on devices for 10% of 15 to 30 A breakers installed. Turn over unused lock-on devices to Consultant.
- .5 Lock-on Devices for Circuits: As noted.
- .6 Breaker Accessories: As noted.

## **2.5 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Panelboards:
  - .1 Schneider.

## **Part 3 Execution**

### **3.1 INSTALLATION OF PANELBOARDS**

- .1 Provide panelboards with breakers, switch and fuses, and accessories. Provide lock keying requirements as reviewed with Consultant.
- .2 Locate panelboards and mount securely, plumb, true and square, to adjoining surfaces. Install panelboards with clearance for access for operation and maintenance. Support cabinets and enclosures independent of connecting conduit and install with reference to wall finishes.
- .3 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.
- .4 Install floor-mounted panelboards on concrete housekeeping pads. Provide seismic restraints.
- .5 Equip each panelboard with lugs to accommodate main and branch conductors as scheduled.
- .6 Mount panelboards to height specified in Section 26 05 00 - Common Work Results – Electrical or as noted. Prior to roughing-in, review height with Consultant.
- .7 Connect loads to circuits.
- .8 Connect neutral conductors to common neutral bus.
- .9 Where SPD is required for panelboards, install and test in accordance with SPD manufacturer instructions.
- .10 Ground and bond equipment.
- .11 Set trip unit functions suiting intended applications.
- .12 Seal openings and conduit entries of enclosures and drip shield, watertight.

### **3.2 INSTALLATION OF FUSES**

- .1 Before energizing circuits, install fuses in mounting devices.
- .2 Verify correct fuses fitted to physically matched mounting devices.
- .3 Install rejection clips for Class R fuses.
- .4 Verify correct fuses fitted to assigned electrical circuit.
- .5 Where UL Class RK1 fuses are specified, install warning label "Use only UL Class RK1 fuses for replacement" on equipment.

### **3.3 IDENTIFICATION**

- .1 Identify distribution panelboards and breakers and switches with identification nameplates.
- .2 Nameplate for Each Panelboard:
  - .1 Manufacturer Nameplate: In accordance with CSA requirements and identify fault current that panel including breakers are built to withstand.
  - .2 Identification Nameplate: Size 4 engraved, unless otherwise noted.
- .3 Nameplate for each circuit breaker and disconnect switch in distribution panelboards: Size 2 engraved, unless otherwise noted.
- .4 Breakers in branch circuit panelboards: Identify in permanent manner with typed circuit directories identifying circuit number and type and location of loads supplied from each breaker. Mount directories in plastic envelope at inside of panel. Include copies of panelboard directories in O&M manuals.

### **3.4 FIELD QUALITY CONTROL**

- .1 Inspection, Start-up, Testing and Verification:
  - .1 Inspect, start-up, test and verify products for:
    - .1 Correct system and component installation.
    - .2 Correct breakers and fuse types and sizes.
    - .3 Correct cable wiring and termination.
    - .4 Correct grounding.
    - .5 Correct and completed system start-up.
  - .2 Check connections and operations.
  - .3 Verify openings and conduit entries of surface mounted enclosures and drip shields are watertight.
  - .4 Perform adjusting and settings as recommended by manufacturer, coordination and short circuit studies, and in accordance with Section 26 05 00 – Common Work Results for Electrical.
- .2 Prepare testing and verification reports, signed by testing technician. Submit reports to Consultant.

**END OF SECTION**

---

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.2 No. 42-10(R2020), General Use Receptacles, Attachment Plugs and Similar Wiring Devices.
  - .2 CSA C22.2 No. 42.1-13(R2017), Cover Plates for Flush-Mounted Wiring Devices (Bi-National Standard, with UL 514D).
  - .3 CSA C22.2 No. 55-15(R2020), Special Use Switches.
  - .4 CSA C22.2 No. 144.1-16(R2020), Ground-Fault Circuit-Interrupters (Tri-National standard, with UL 943 and NMX-J-520-ANCE).
  - .5 CSA C22.2 No. 270:16(R2021), Arc Fault Protective Devices.
- .2 Underwriter Laboratories (UL):
  - .1 UL 1669A-2010, Outline of Investigation for Outlet Branch Circuit Arc-Fault Circuit-Interrupters.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
  - .2 Submit each type and clearly identify.

**Part 2 Products**

**2.1 GENERAL**

- .1 CSA certified, or ULC listed and labeled products.
- .2 Ratings and Types: As specified herein or as noted on drawings.
- .3 Provide wiring devices (switches and receptacles) of one manufacturer throughout project.
- .4 Unless otherwise noted, devices typically are flush types that fit flush in standard single gang wall boxes.
- .5 20 A Receptacles: T- slot type of respective series of respective receptacles.
- .6 In addition to devices specified herein, refer to drawings for requirements for other devices.

**2.2 SWITCHES**

- .1 Ratings and Poles:
    - .1 15 A and 20 A, and as noted.
    - .2 347 VAC and 120 VAC, and as noted and suiting intended applications.
    - .3 Single pole, double pole, three-way and four-way switches, and as noted.
-

- .4 In accordance with CSA C22.2 No. 55 and CAN/CSA C22.2 No. 111.
- .2 Manually operated general purpose AC toggle type switches with following features:
  - .1 Commercial grade.
  - .2 Heavy duty nylon toggle and elastomer rocker, permanently lubricated assembly.
  - .3 Impact-resistant thermoplastic housing.
  - .4 One-piece steel zinc plated bridge and mounting strap with integral grounding terminal.
  - .5 Brass binding head screws.
  - .6 Copper alloy spring contact arm and silver alloy contacts.
  - .7 Suitable for back and side wiring.

## 2.3 RECEPTACLES

- .1 Standard Duplex Straight Blade Receptacles:
  - .1 Commercial grade.
  - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
  - .3 In accordance with CSA C22.2 No. 42.
  - .4 Nylon smooth face and base construction.
  - .5 Galvanized steel mounting strip with automatic self-grounding clips.
  - .6 Plated steel terminal screws.
  - .7 Side wiring.
  - .8 Break-off links for use as split receptacles.
  - .9 Triple wipe brass contacts.
- .2 Decorative Duplex Straight Blade Receptacles:
  - .1 Commercial grade.
  - .2 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
  - .3 In accordance with CSA C22.2 No. 42.
  - .4 Nylon base and decorative style front nylon face.
  - .5 Galvanized steel mounting strip with automatic self-grounding stainless steel clips.
  - .6 Steel-nickel finished wiring clamps with plated steel terminal screws.
  - .7 Back and side wiring.
  - .8 Break-off links for use as split receptacles.
  - .9 Eight back wired entrances, four side wiring screws.
  - .10 Triple wipe brass power contacts and brass grounding contacts.

## 2.4 SPECIAL WIRING DEVICES

- .1 Ground Fault Circuit Interrupting (GFCI) Receptacles:
  - .1 Standard GFCI Receptacles:
    - .1 Heavy-duty grade, CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, duplex, ULC Class "A", Group One.
    - .2 In accordance with CSA C22.2 No.42 and CSA C22.2 No. 144.1.
    - .3 Automatically monitor GFCI functionality.
    - .4 Loss of GFCI protection disables power and provides visual and/or audible indication of loss of protection.



- .5 Incorrect wired line conductor prevents power to receptacle.
- .6 Automatic self-test diagnostics testing within every 30 seconds.
- .7 Housing: High impact and UV-resistant thermoplastic nylon construction.
- .8 LED status lights:
  - .1 Green: Power ON.
  - .2 Red: Trip condition/ground fault.
  - .3 Flashing Red: End of life.
- .9 10 KA short circuit current rating, unless otherwise noted.
- .10 Internal back wiring clamp and guide for quick and secure termination.
- .11 Brass power contacts, brass ground straps and zinc-plated mounting straps.
- .12 Zinc-plated steel mounting screws.
- .13 Triple wipe contacts construction.
- .14 Fits in standard single gang wall box.
- .2 Additional To Standard Features for Special GFCI Receptacles:
  - .1 Weather-Resistant GFCI Receptacles:
    - .1 Features of Standard GFCI Receptacles.
    - .2 Weather-resistant against UV and corrosion.
- .2 Arc-Fault Circuit Interrupting (AFCI) Duplex Receptacles:
  - .1 CSA Type 5-15R or 5-20R, 15 A or 20 A, 125 V, U ground.
  - .2 In accordance with CSA C22.2 No. 42 and CSA C22.2 No. 270.
  - .3 Tamper-resistant and self-grounding construction features.
  - .4 Green power ON LED indicator.
  - .5 Automatically tests AFCI each time reset button is pressed in place.
  - .6 No reset when tested if AFCI functionality is compromised.
  - .7 Meets or exceeds UL requirements for tripping time on series and parallel arcs.
  - .8 RTP reinforced thermoplastic base and flush nylon front face.
  - .9 One-piece mounting strip with automatic self-grounding clips.
  - .10 Back and side wired.
  - .11 Fits in standard single gang wall box.

## **2.5 COVER PLATES (FACEPLATES) FOR WIRING DEVICES**

- .1 In accordance with CSA C22.2 No. 42.1.
- .2 Type 302/304 stainless steel faceplates.
- .3 High impact strength and flame-resistant wall plates of nylon or thermoplastic construction, minimum thickness 2.5 mm for wiring devices mounted in flush-mounted outlet box.
- .4 Galvanized sheet steel utility box cover for wiring devices installed in recessed and surface-mounted electrical utility boxes. Sizes suiting box sizes and specific surface and recessed mounting applications.
- .5 Cast cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.
- .6 Single gang, AC toggle switch weatherproof plate, flexile silicone rubber or neoprene bubble.

- .7 Weatherproof-in-use, double lift spring-loaded, cast aluminum cover plates, with gaskets for duplex regular or GFCI type receptacles. Horizontal or vertical mounting as indicated.
- .8 Weatherproof-in-use, spring-loaded cast aluminum cover plates with gaskets for single receptacles or switches. Horizontal or vertical mounting as noted.
- .9 Provide cover plates from same manufacturer as wiring devices, unless otherwise noted.

## **2.6 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Wiring Devices:
  - .1 Hubbell.
  - .2 Leviton.

## **Part 3 Execution**

### **3.1 INSTALLATION OF WIRING DEVICES**

- .1 Provide devices of types based on drawings and Specifications.
- .2 Refer to drawings to determine flush or surface mounting requirements. Unless otherwise noted, flush mount devices in finished areas.
- .3 Install in electrical outlet boxes. Size electrical boxes suiting device requirements, ganging requirements and in accordance with device manufacturer recommendations.
- .4 Ground device to box and grounding system.
- .5 Prior to start of Work, confirm finishes and mounting heights with Consultant.
- .6 Submit sample board with samples of each type of device and finishes.
- .7 Switches:
  - .1 Install single throw switches with handle in UP- position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height as indicated or in accordance with Section 26 05 00 - Common Work Results for Electrical and reviewed with Consultant.
  - .4 Switches connected to essential (emergency) power circuits, are illuminated toggle type.
  - .5 Install switches located adjacent to doors on strike side of door. Review door swing requirements on architectural drawings, not on electrical drawings.
  - .6 Coordinate installation of door switches with trades responsible for provision of doors and frames.
  - .7 Locate switches to provide optimum operation of switch to door position.
- .8 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height as indicated or in accordance with Section 26 05 00 - Common Work Results for Electrical, and as reviewed with Consultant.
  - .3 Install GFCI-type receptacles as noted in locations and in locations in accordance with electrical code.

- .4 Provide typed label identifying circuit number and panelboard from where each device is fed, permanently identified at outlets. Review location for identification with Consultant.
- .5 For receptacles installed in counters and benches, provide box cut-out in counter and bench. Provide box, receptacle, plate and branch circuit wiring. Provide flexible armoured cable, in accordance with electrical code and connect devices.
- .9 Cover Plates (Faceplates):
  - .1 Provide each device with cover plate or faceplate with opening or openings suitable for device it conceals and covers openings around boxes. Secure faceplates to device frames with screws to match faceplates. Provide larger than standard type faceplates for devices that require engraved nomenclature to define special purpose for that device.
  - .2 Install weather-proof in-use type cover plates for receptacle devices in non-climate-controlled areas.
  - .3 Install common cover plates where wiring devices are grouped.
  - .4 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.
- .10 Ground and bond devices.

### **3.2 IDENTIFICATION AND SIGNAGE**

- .1 Provide products with engraved lamicaid nameplates.
- .2 Prior to ordering of labels and nameplates, review locations and nomenclature with Consultant.
- .3 Provide faceplates with identification labels for devices. In addition to identification requirements specified with devices, provide faceplates with printed self-adhesive label on inside faces and to wall under faceplate, identifying circuit number and panel feeding device. Apply layer of clear coat finish over each label. Provide labels with heavy-duty and water-resistant adhesive.
- .4 Provide engraved lamicaid nameplate to identify equipment, system being operated, circuit number and panel feeding device.
- .5 Provide signage identifying special instructions.

### **3.3 FIELD QUALITY CONTROL**

- .1 Inspection, Start-up, Testing and Verification:
  - .1 Inspect, start-up, test and verify products.
  - .2 Check connections and operations.
  - .3 Test wiring devices for polarities and verifying operations are in accordance with manufacturer specifications.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.2 No. 248.1-11(R2020), Low-Voltage Fuses - Part 1: General Requirements (Tri-national Standard, with UL 248-1 and NMX-J-009/248/1-ANCE).
  - .2 CSA C22.2 No. 248.8-11(R2020), Low-voltage fuses - Part 8: Class J Fuses (Tri-national Standard, with UL 248-8 and NMX-J-009/248/8-ANCE).
  - .3 CSA C22.2 No. 248.10-11(R2020), Low-voltage fuses - Part 10: Class L fuses (Tri-national standard, with UL 248-10 and NMX-J-009/248/10-ANCE).
  - .4 CSA C22.2 No. 248.12-11(R2020), Low-voltage fuses - Part 12: Class R Fuses (Tri-national Standard, with UL 248-12 and NMX-J-009/248/12-ANCE).

**1.2            SUBMITTALS**

- .1 Product Data
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings
  - .1 Submit shop drawings for products of this Section.
- .3 Submit inspection and verification reports.

**1.3            EXTRA MATERIALS**

- .1 Provide three spare fuses of each type and size installed above 600 A.
- .2 Provide six spare fuses of each type and size installed up to and including 600 A.

**Part 2            Products**

**2.1            FUSES - GENERAL**

- .1 Fuse type references L1, L2, J1, and others, are adopted for use in this specification. Refer to drawings for additional information.
- .2 Fuses: Product of one manufacturer throughout project.
- .3 Plug and Standard Cartridge Fuses: In accordance with CSA C22.2 No. 248.1.

**2.2            FUSE TYPES**

- .1 Class L Fuses:
    - .1 For fuses over 600 A.
    - .2 In accordance with CSA C22.2 No. 248.10.
    - .3 Type L1, time delay, capable of carrying 500% of its rated current for 10 s minimum.
    - .4 Type L2, fast acting.
  - .2 Class J Fuses:
    - .1 For fuses up to and including 600 A and other high inrush circuits.
-

- .2 In accordance with CSA C22.2 No. 248.8.
- .3 For constantly running equipment.
- .4 Type AJT, time delay, capable of carrying 500% of its rated current for 10 s minimum. For use in motor control centres and motor starters.
- .5 Type J2, fast acting.
- .3 Class R Fuses:
  - .1 For high degree of current-limitation and short-circuit interrupting rating.
  - .2 In accordance with CSA C22.2 No. 248.12.
  - .3 Type R1, (UL Class RK1), time delay, capable of carrying 500% of its rated current for 10 s minimum, in accordance with requirements of UL Class RK1 maximum let-through limits.
  - .4 Type R2, time delay, capable of carrying 500% of its rated current for 10 s minimum.
  - .5 Type R3, (UL Class RK1), fast acting Class R, in accordance with requirements of UL Class RK1 maximum let-through limits.

## **2.3 FUSE STORAGE CABINETS**

- .1 Features:
  - .1 Manufactured from 2.0 mm thick aluminum, 750 mm high, 600 mm wide, 300 mm deep.
  - .2 With hinged, lockable front access door.
  - .3 Finish: Enamel paint as reviewed with Consultant.

## **2.4 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Fuses:
  - .1 Schneider
  - .2 Mersen (Ferraz Shawmut).
  - .3 English Electric.
  - .4 Noram.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Provide Type and Sizes of Fuses:
  - .1 As noted.
  - .2 Suiting applications in accordance with AHJ and electrical codes.
  - .3 In coordination with respective equipment manufacturer recommendations in which fuses are installed.
- .2 Before energizing circuit, install fuses in mounting devices.
- .3 Install rejection clips for Class R fuses.
- .4 Install correct fuses are fitted to assigned electrical circuit.
- .5 Fuses for use in motor control centres and motor starters: Class "J" type, dual element, time delay type, unless otherwise noted.

- .6 Where UL Class RK1 fuses are specified, install warning label "USE ONLY UL CLASS RK1 FUSES FOR REPLACEMENT" on equipment.
- .7 Install spare fuses in fuse storage cabinet. Review quantity of fuses and locations of cabinets with Consultant.

### **3.2 FIELD QUALITY CONTROL**

- .1 Inspect and verify fuses for correct types, quantities, sizes and ratings.
- .2 Prepare inspection and verification reports, signed by technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.1-24, Canadian Electrical Code, Part I (26th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.2 No. 5-16(R2021), Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures (Tri-national standard with UL 489 and NMX-J-266-ANCE-2016).
  - .3 CSA C22.2 No. 144.1-16(R2020), Ground-Fault Circuit-Interrupters (Tri-National standard, with UL 943 and NMX-J-520-ANCE).
  - .4 CSA C22.2 No. 270-16(R2021), Arc Fault Protective Devices.
- .2 Institute of Electrical and Electronics Engineers (IEEE):
  - .1 IEEE Standard C37.2-2022, IEEE Standard for Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.
  - .2 IEEE C37.13-2015, IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
  - .3 IEEE C37.16-2009, IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.
  - .4 IEEE C37.17-2012, IEEE Standard for Trip Systems for Low-Voltage (1000 V and below) AC and General Purpose (1500 V and below) DC Power Circuit Breakers.
- .3 Underwriters Laboratories (UL):
  - .1 ANSI/UL 489-2019, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
  - .2 ANSI/UL 1066-2022, Power Circuit Breakers up to 1000 V AC and 1500 V DC Used in Enclosures.

**1.2            SUBMITTALS**

- .1 Product Data:
    - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
    - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Shop Drawings:
    - .1 Submit shop drawings for products of this Section.
    - .2 Submit time-current phase protection co-ordination characteristic curves for breakers sized greater than 225 A.
    - .3 Identify:
      - .1 Types and ratings.
      - .2 Trip units and functions/settings.
  - .3 Submit testing and verification reports.
-

---

**Part 2 Products**

**2.1 GENERAL**

- .1 Breakers:
  - .1 Unless otherwise noted, to be NEMA rated types.
  - .2 Switchboards and Distribution Panelboards:
    - .1 Breakers when frame sized greater than 225 amperes, or where scheduled or where noted, provide with solid state adjustable trip units with long time, short time and instantaneous time (LSI) functions and time delays.
    - .2 Set trip units at ratings in accordance with coordination study as required for proper selective coordination.
    - .3 Unless otherwise noted, provide ground fault alarm and trip functions at breaker trip unit rating above 600 A, and set as coordinated with results of coordination study and as reviewed with Consultant.
    - .4 For coordination study requirements, refer to Section 26 05 73 - Power System Studies.
  - .3 Shock and Arc Flash Protection:
    - .1 For breakers sized equal to and greater than 1200 A, provide arc flash energy-reducing maintenance switching with positive feedback status indication in accordance with CSA C22.1.

**2.2 POWER AIR CIRCUIT BREAKERS**

- .1 Standards: In accordance with IEEE C37.13, IEEE C37.16, IEEE C37.17 and ANSI/UL 1066.
  - .2 Type and Ratings:
    - .1 Draw Out or Fixed Types, 3-pole Units, 600 V Class: As noted.
    - .2 Continuous Current Rating: As noted.
    - .3 Trip Rating: As noted.
    - .4 Interrupting Rating: As noted.
    - .5 UL listed for application of 100% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
  - .3 General Features:
    - .1 Electrically operated, with normal stored energy, closing mechanism providing quick-make operation for ratings.
    - .2 No external source of power is necessary to trip breaker in event of fault or overload. Necessary tripping energy derived from monitoring current transformers provided with breaker.
    - .3 Motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and isolating switch, isolating power supply to spring charging motor. Manual closing lever permits closing circuit breaker with compartment door closed.
    - .4 Breaker control interface includes colour-coded visual indicators indicating contact open or closed positions as well as mechanism charged and discharged positions.
    - .5 120 V fused secondary control circuit transformer for breaker closing and tripping current.
-



- .6 Electrically operated breaker pushbuttons, manual trip button, breaker position indicators, breaker 'open/close' lamps, "push to test" lights and provisions for padlocking breaker in open position and also secures breaker in connected, test, or disconnected position by preventing levering.
  - .7 Circuit breaker door design allow performing following functions without need to open circuit breaker door:
    - .1 Lever circuit breaker between positions.
    - .2 Operate manual charging system.
    - .3 Close and open circuit breaker.
    - .4 Examine and adjust trip unit.
    - .5 Read circuit breaker rating nameplate.
  - .8 Safety cover to prevent inadvertent operation of breaker open operators.
  - .9 Solid state adjustable tripping units.
  - .10 Engraved identification lamacoid nameplates.
- .4 Solid State Tripping Units:
- .1 Integral microprocessor based true RMS sensing, solid state tripping unit having adjustable tripping functions including:
    - .1 Long time pick-up and long-time delay.
    - .2 Short time pick-up and short time delay.
    - .3 Instantaneous pick-up.
    - .4 Ground fault pick-up and ground fault delay.
  - .2 Trip Settings: As determined by the coordination study and reviewed with Consultant. Include for trip unit settings in accordance with results of coordination studies, providing coordinated protective devices throughout electrical distribution system.
  - .3 Three sensors, one on each phase conductor, arranged such that trip signal from sensor opens three poles of breaker.
  - .4 LED indication of mode and trip and LCD panel indicating protection function settings and system data. Unit is continuously self-checking and monitoring.
  - .5 Complete system selective coordination provided with individually adjustable time/current shaping solid-state elements.
  - .6 High load alarm provided, fixed at 85% of long delay pickup setting.
  - .7 Energy monitoring and display of peak demand, present demand and energy consumption.
  - .8 Collect and store pertinent information to trip unit and circuit breaker health and event history, and breaker diagnostics.
  - .9 Test plug terminals to permit convenient field checking of calibration.
  - .10 Actuator mechanically trips breaker when tripping pulse is emitted by trip unit.
- .5 Current Limiting Breakers with Fuses:
- .1 For applications reducing peak apparent fault current of breaker, to lesser value and isolate fault in less than half cycle time.
  - .2 Interrupting capacity rating of breakers provided without current limiting fuses.
  - .3 Current limiting fuses in series and internally mounted in breakers.
  - .4 Anti-single-phasing coils act on tripper bar in parallel with current limiting fuses to prevent single phasing.
  - .5 Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker.

- .6 Accessories:
  - .1 Shunt trip operators.
  - .2 Auxiliary switches.
  - .3 Undervoltage tripping device with instantaneous and time delay.
  - .4 Alarm switch.
  - .5 Reverse power relay.
  - .6 Three spare fuses of each type and size used. Control fuses of form II HRC types.
  - .7 Engraved identification lamicoid nameplates.

## 2.3 INSULATED CASE CIRCUIT BREAKERS

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Type and Ratings:
  - .1 Draw Out or Fixed Types, 3-pole Units, 600 V Class: As noted.
  - .2 Continuous Current Rating: As noted.
  - .3 Trip Rating: As noted.
  - .4 Interrupting Rating: As noted.
  - .5 UL listed for application of 100% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.
- .3 General Features:
  - .1 Electrically or manually operated as noted, with normal stored energy, closing mechanism providing quick-make operation for ratings.
  - .2 30-cycle short-time withstand capability equal to their symmetrical interrupting ratings through 42,000 amperes, regardless of whether equipped with instantaneous trip protection or not.
  - .3 Closing time of not more than 3 cycles.
  - .4 Electrically Operated Breakers:
    - .1 With close/open pushbuttons or control switches.
    - .2 Motor operators:
      - .1 Charging time of motor not to exceed 6 seconds.
      - .2 Control power transformer internal to switchgear assembly.
  - .5 Breaker control interface includes colour-coded visual indicators indicating contact open or closed positions as well as mechanism charged and discharged positions.
  - .6 Manual control pushbuttons on breaker face provides for opening and closing breaker.
  - .7 "Positive On" feature with breaker flag reading "Closed" when contacts are welded, and breaker is attempting to be tripped or opened.
  - .8 Pad-lockable pushbutton covers.
  - .9 Solid state adjustable tripping units.
  - .10 Engraved identification lamacoid nameplates.
- .4 Solid State Tripping Units:
  - .1 Integral microprocessor based true RMS sensing, solid state tripping unit having adjustable tripping functions including:
    - .1 Long time pick-up and long-time delay.

- .2 Short time pick-up and short time delay.
    - .3 Instantaneous pick-up.
    - .4 Ground fault pick-up and ground fault delay.
  - .2 Trip Settings: As determined by the coordination study and reviewed with Consultant. Include for trip unit settings in accordance with results of coordination studies, providing coordinated protective devices throughout electrical distribution system.
  - .3 Three sensors, one on each phase conductor, arranged such that trip signal from sensor opens three poles of breaker.
  - .4 LED indication of mode and trip and LCD panel indicating protection function settings and system data. Unit is continuously self-checking and monitoring.
  - .5 Complete system selective coordination provided with individually adjustable time/current shaping solid-state elements.
  - .6 High load alarm provided, fixed at 85% of long delay pickup setting.
  - .7 Energy monitoring and display of peak demand, present demand and energy consumption.
  - .8 Collect and store pertinent information to trip unit and circuit breaker health and event history, and breaker diagnostics.
  - .9 Test plug terminals to permit convenient field checking of calibration.
  - .10 Actuator mechanically trips breaker when tripping pulse is emitted by trip unit.
- .5 Current Limiting Breakers with Fuses:
- .1 For applications reducing peak apparent fault current of breaker, to lesser value and isolate fault in less than half cycle time.
  - .2 Interrupting capacity rating of breakers provided without current limiting fuses.
  - .3 Current limiting fuses in series and internally mounted in breakers.
  - .4 Anti-single-phasing coils act on tripper bar in parallel with current limiting fuses to prevent single phasing.
  - .5 Time current limiting characteristics of fuses coordinated with time current tripping characteristics of circuit breaker.
- .6 Accessories:
- .1 Undervoltage tripping device with instantaneous and time delay.
  - .2 Alarm switch.
  - .3 Reverse power relay.
  - .4 Three spare fuses of each type and size used. Control fuses of form II HRC types.
  - .5 Engraved identification lamicoid nameplates.

## **2.4 SOLID STATE MOULDED CASE CIRCUIT BREAKERS**

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Circuit Breaker Types, Sizing and Ratings: As noted.
- .3 Features:
  - .1 Fixed mounted, solid state moulded case circuit breaker with minimum interrupting capacity as noted.
  - .2 Where noted, ULC listed for application of 100% of its trip setting and carry its full rated ampere capacity, indefinitely without tripping.

- .3 Bolt-on, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40°C ambient.
- .4 Common-trip breakers equipped with single handle for multi-pole applications.
- .5 Magnetic instantaneous trip elements in circuit breakers operate only when value of current reaches setting.
- .6 Trip settings on breakers with adjustable trips ranging from 3 to 8 times current rating.
- .7 Circuit breakers with interchangeable trips as indicated or scheduled.
- .4 Solid State Tripping Units:
  - .1 Equipped on breakers of frame size greater than 225 amperes. Breakers operate by means of solid-state adjustable trip unit with associated current monitors and self-powered shunt trip units.
  - .2 Adjustable Tripping Functions: Long time pick-up, long time delay; short time pick-up; short time delay; instantaneous pick-up; ground fault pick-up; and ground fault delay.
  - .3 Three sensors, one on each phase conductor, arranged such that trip signal from sensor opens all three poles of breaker.
  - .4 Provide functions and settings, suiting project specific short circuit and coordination studies, and reviewed with Consultant.
- .5 Accessories:
  - .1 Under-voltage release.
  - .2 On-off locking device.
  - .3 Handle mechanism.
  - .4 Engraved identification lamicoid nameplates except for branch circuit panelboard breakers.

## **2.5 THERMAL MAGNETIC BREAKERS**

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
- .2 Circuit Breaker Types, Sizing and Ratings: As noted.
- .3 Moulded case circuit breakers operate automatically by means of thermal and magnetic tripping devices, providing inverse time current tripping and instantaneous tripping for short circuit protection.

## **2.6 CURRENT LIMITING AND SERIES RATED THERMAL MAGNETIC BREAKERS**

- .1 In accordance with CSA C22.2 No. 5 and ANSI/UL 489.
  - .2 Circuit Breaker Types, Sizing and Ratings: As noted.
  - .3 Thermal magnetic breakers with current limiters.
  - .4 Time current limiting characteristics of fuses limiters coordinated with time current tripping characteristics of circuit breaker.
  - .5 Co-ordination to result in interruption by breaker of fault-level currents up to interrupting capacity of breaker.
  - .6 Provide breakers for applications in accordance with manufacturer guidelines and accepted best practice.
-

## **2.7 BREAKER TYPE GROUND FAULT INTERRUPTERS**

- .1 Single and two-poles, as noted, suiting intended applications, ground fault circuit interrupters for panelboard circuits, for 15/20 A, 120 V, 1-phase circuits.
- .2 In accordance with CSA C22.2 No. 5, ANSI/UL 489 and CSA C22.2 No. 144.1.
- .3 GF Protection: 5 mA.
- .4 Interrupt Rating: 22 kAIC unless otherwise noted.
- .5 Overvoltage protection
- .6 Continuous self-test of electronic components with test and reset facilities.
- .7 Coiled pigtail suiting intended applications.
- .8 Manufacturer: Same as panelboard and other breakers in panelboard.

## **2.8 ARC FAULT CIRCUIT INTERRUPTER BREAKERS**

- .1 Single and two-poles, as noted, suiting intended applications, ground fault circuit interrupters for panelboard circuits, for 15/20 A, 120 V, 1-phase circuits.
- .2 In accordance with CSA C22.2 No. 5, ANSI/UL 489 and CSA C22.2 No. 270.
- .3 Interrupt Rating: 22 kAIC unless otherwise noted.
- .4 Overvoltage protection.
- .5 Continuous self-test of electronic components with test and reset facilities.
- .6 Coiled pigtail suiting intended applications.
- .7 Manufacturer: Same as panelboard and other breakers in panelboard.

## **2.9 ENCLOSURES FOR MOULDED CIRCUIT BREAKERS**

- .1 Individually mounted moulded case breaker enclosures:
  - .1 CSA certified.
  - .2 Front operated.
  - .3 Surface or flush wall-mounted, as noted.
  - .4 Automatic or non-automatic breaker, as noted.
  - .5 Climate-controlled areas: Enamel finished steel, NEMA 2.
  - .6 Non-climate-controlled areas: Weather-resistant, corrosion resistant enamel finished steel, NEMA 4, with gasketing.
  - .7 Circuit breaker can be padlocked in OFF position.
  - .8 Cover interlocked such that cover cannot be opened when breaker is in ON position.

## **2.10 ADDITIONAL DEVICES FOR EXISTING EQUIPMENT**

- .1 Additional breakers and switch and fuses assemblies for existing panelboards or switchboards, match existing device standards and are compatible to board in which they are installed. Provide product types from manufacturers of existing equipment.
- .2 Check requirements of existing equipment onsite, verifying that additional devices can be accommodated. Make modifications to equipment to accommodate device and feeder installation.
- .3 Provide engraved lamicoid identification nameplate on additional components. Provide revised typed circuit directory cards on branch circuit panelboards.

- .4 Mount additional devices to standards of existing equipment manufacturer. Refer to notes on drawings.

## **2.11 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Unless otherwise noted, breakers to be same manufacturer as panelboard/switchboard/distribution equipment in which they are installed.
- .2 Breakers and Enclosures:
  - .1 Schneider.

## **Part 3 Execution**

### **3.1 INSTALLATION OF BREAKERS**

- .1 Unless otherwise noted, provide breakers factory installed in switchgear, switchboards and panelboards. Provide other breakers where noted as installed onsite in equipment.
- .2 Install and connect breakers for circuits as noted, in accordance with manufacturer instructions.
- .3 Set and adjust trip settings in accordance with final reviewed coordination study settings.

### **3.2 INSTALLATION OF ENCLOSED CIRCUIT BREAKERS**

- .1 Provide wall-mounted, enclosed circuit breakers for equipment, of type and operation as noted and suiting intended applications. Include accessories. Secure to wall construction and connect complete.
- .2 Prior to roughing-in, review locations with Consultant.
- .3 Ground and bond equipment.

### **3.3 IDENTIFICATION**

- .1 Provide product identification.
- .2 Nameplates:
  - .1 Enclosures: Size 4 unless otherwise noted.
  - .2 Power air circuit breaker: Size 4 unless otherwise noted.
  - .3 Moulded Case Circuit Breakers: Refer to Section 26 24 16 - Panelboards.

### **3.4 FIELD QUALITY CONTROL**

- .1 Inspection, Testing and Verification:
  - .1 Inspect, start-up, test and verify products.
  - .2 Check connections and operations.
  - .3 Perform following in accordance with breaker manufacturer recommendations:
    - .1 Inspect and test motor operators.
    - .2 Breakers of size greater than 250 A: Insulation/contact resistance and secondary current injection testing of electronic trip units.
    - .3 Secondary Current Injection Testing: Verifies correct operation of protection system such as protective relays and their tripping settings, and associated circuits and devices.

- .4 Primary Current Injection Testing: After secondary injection testing, further testing current transformer and potential transformer ratios, polarity and phasing.
- .4 Inspect, set and test adjustable breakers, interlocked breakers and motorized breakers for proper operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.2 No. 144.1-16(R2020), Ground-Fault Circuit-Interruption (Tri-National standard, with UL 943 and NMJ-J-520-ANCE).
- .2 Underwriter Laboratories (UL):
  - .1 UL 943-2016, Ground-Fault Circuit-Interruption.

**1.2            SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
  - .2 Identify ratings including sensitivity ratings to ground faults.
- .3 Submit of testing and verification reports.

**Part 2            Products**

**2.1            GENERAL**

- .1 Standards: In accordance with CSA C22.2 No. 144.1.
  - .2 Provide ground fault protection equipment components from same manufacturer throughout project.
  - .3 Provide ground fault protection on:
    - .1 Services and conductors as noted.
    - .2 1000 A, 600 V, 4-wire, 3-phase service, and 2000 A, 208 V, 4-wire, 3-phase service and above.
  - .4 Ground Fault Unit Features:
    - .1 Ground fault sensing relay suiting operation at 500 mA and of control voltage 120 V, unless otherwise noted.
    - .2 Three position sensitivity control switch to select value of leakage current at which relay will operate.
    - .3 Switches:
      - .1 SPDT contacts for alarm, and where noted for trip.
      - .2 Mechanical target indication.
      - .3 Manual reset.
    - .4 Reset button for contacts and target.
    - .5 Data logging module providing time and date stamping of up to 99 most recent events (non-volatile memory).
    - .6 Include following for ungrounded or high resistance grounded systems only:
      - .1 Ammeter with scale 0 to 5 A indicating ground current value.
-



- .2 Indicating lamp illuminated when no ground fault exists, extinguished on ground fault or test.
- .7 Auxiliary contacts for remote alarm connections to BAS as coordinated with Division 25 BAS.
- .8 Provisions for panel-mounting, coordinated with switchboard or panel in which it is installed.
- .9 Minimum NEMA 2 unless otherwise noted rated indoor enclosure with drip shield and gasketing.
- .5 Zero Sequence Transformers:
  - .1 Toroidal type for cable installations.
  - .2 Rectangular for bus installations.
  - .3 Split type on existing installations.
  - .4 300 to 3000 mA range.
- .6 Neutrals:
  - .1 Delta ungrounded systems: Artificial neutral and grounding resistor.
  - .2 High resistance grounded wye systems: Neutral ground resistor unit.
- .7 System operates instantaneously at ground current setting, unless otherwise noted. Review with Consultant.
- .8 Provide following components to interconnect to ground fault protection devices in equipment specified in other Sections and as noted:
  - .1 Zero sequence transformers.
  - .2 Ground fault relays.
  - .3 Ground resistor units.

## **2.2 GROUND FAULT PROTECTOR UNITS**

- .1 GF protector units provide ground fault protection to equipment (GFPE). Units connect to overload breakers in panelboards and load centers. GF protector units provide ground fault protection to circuits while overload breakers protect wiring.
- .2 Features:
  - .1 CSA certified, or ULC listed and labeled.
  - .2 Interconnects and works with overload circuit breakers.
  - .3 Provides 30 mA trip point GFPE protection.
  - .4 In accordance with requirements of CEC 62-300.
  - .5 Protects 120/208/240VAC systems up to 60A.
  - .6 NEMA 4X enclosure for indoor or outdoor use.
  - .7 Latching, gasketed-sealed, hinged front cover for easy testing and reset access.
  - .8 Operating temperatures: Minus 40°C to 60°C.

## **2.3 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Ground Fault Protection Equipment:
  - .1 Schneider.
  - .2 I-Gard.
  - .3 Bender.
- .2 Ground Fault Protector Units:

- .1 Equivalent to Pro Them Industries.

## **Part 3 Execution**

### **3.1 INSTALLATION OF GROUND FAULT PROTECTION EQUIPMENT**

- .1 Provide ground fault protection equipment for applications as noted, including applications in accordance with electrical code.
- .2 Install products in accordance with manufacturer instructions, suiting intended applications.
- .3 Provide system components and sequence of operations as reviewed with Consultant. Where system detects ground fault and sequence of operation requires tripping and opening of specific breakers, provide shunt trip type breakers.
- .4 Do not ground neutral on load side of sensor or ground fault relay.
- .5 Install phase conductors including neutral through zero-sequence transformer.
- .6 Connect supply and load wiring to equipment.
- .7 Make connections as noted and in accordance with manufacturer recommendations.
- .8 Provide alarm and communications circuits. Integrate equipment to BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors.
- .9 Review mounting arrangements and finishes with Consultant.
- .10 Ground Fault Circuit Interrupter Receptacles: Refer to Section 26 27 26 - Wiring Devices.

### **3.2 IDENTIFICATION**

- .1 Provide product identification.
- .2 Nameplate for enclosures: Size 3 unless otherwise noted, and engraved as noted.
- .3 Identify and label breakers to standards specified for panelboard breakers.

### **3.3 FIELD QUALITY CONTROL**

- .1 Arrange for equipment manufacturer technician to:
  - .1 Perform onsite setup, adjustments, testing and verification work.
  - .2 Test ground fault equipment.
  - .3 Check trip unit settings verifying proper working operation and protection of components. Demonstrate simulated ground fault tests.
  - .4 Check and inspect completed installation including:
    - .1 System and component installations.
    - .2 Cable wiring and termination.
    - .3 NGR and enclosure ratings and installation.
    - .4 Grounding.
  - .5 Provide compliance certificates and include with reports.
- .2 Prepare testing and verification reports signed by testing technician. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1                REFERENCE STANDARDS**

- .1    CSA Group (CSA):
  - .1    CSA C22.2 No. 4-16(R2020), Enclosed and Dead-Front Switches (Tri-National standard, with NMX-J-162-ANCE-2016 and UL 98).
  - .2    CSA C22.2 No. 39-13(R2017), Fuseholder Assemblies.
  - .3    CSA C22.2 No. 160-15(R2020), Voltage and Polarity Testers.

**1.2                SUBMITTALS**

- .1    Product Data:
  - .1    Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2    Include product characteristics, performance criteria, physical size, finish and limitations.
- .2    Shop Drawings:
  - .1    Submit shop drawings for products of this Section.
- .3    Submit testing and verification reports.

**Part 2            Products**

**2.1                DISCONNECT SWITCHES**

- .1    In accordance with CSA C22.2 No. 4.
  - .2    Types and Ratings: As noted.
  - .3    Heavy duty, CSA certified, disconnect (safety) switches. Features include:
    - .1    Front operated with handle suitable for padlocking in "OFF" position and arranged so that enclosure cover cannot be opened while handle is in "ON" position.
    - .2    ON-OFF switch position indication on switch enclosure cover.
    - .3    Operating Mechanisms: quick-break, positive acting with visible blades and line terminal shield.
    - .4    100% load break/make rated.
    - .5    Non-fusible units: As noted.
    - .6    Fusible units with fuse clips suitable for HRC fuses: As noted.
    - .7    Factory primed and painted switch enclosures.
    - .8    Factory installed neutral assembly for service entrance applications.
    - .9    For Solar DG Disconnect switch, viewing windows on front cover enabling personnel to clearly see that blades are disengaged from stationary contacts when switch handle is in OFF position and include enhanced visible blades.
  - .4    Fuses and Fuse Ratings: As indicated, or scheduled, and as required for specific application. Refer to Section 26 28 13 - Fuses - Low Voltage, for additional fuse requirements.
  - .5    Fuse Holders: In accordance with CSA C22.2 No. 39, suitable without adaptors, for type and size of fuses.
-

- .6 Disconnects for Variable Speed Drives: Suitable for use with such drives and include auxiliary switch or contacts to de-energize control power circuit.

## **2.2 DOUBLE THROW DISCONNECT SWITCHES**

- .1 In accordance with CSA C22.2 No. 4.
- .2 Types and Ratings: As noted.
- .3 Heavy duty, CSA certified, double throw disconnect switches. Features include:
  - .1 Front operated handle operating mechanism actuates either upper or lower switch. When handle is in centre position, both switches are OFF.
  - .2 Handle and door interlocked to keep door closed when switch is ON and hold handle OFF when door is open.
  - .3 Triple padlocking – 2 on door and up to 3 locks in centre OFF position.
  - .4 100% load break and make rated.
  - .5 Non-fusible units: As noted.
  - .6 Fusible units with fuse clips suitable for HRC fuses: As noted.
  - .7 Factory primed and painted switch enclosures.
- .4 Fuses and fuse ratings: As noted and suiting intended applications. Refer to Section 26 28 13 - Fuses – Low Voltage, for additional fuse requirements.
- .5 Fuse Holders: In accordance with CSA C22.2 No. 39, suitable without adaptors, for type and size of fuses.

## **2.3 DISCONNECT ENCLOSURES**

- .1 CSA certified.
- .2 Standard Climate-controlled Areas and Non-climate-controlled Areas: Minimum NEMA 3R, unless otherwise noted.

## **2.4 ABSENCE-OF-VOLTAGE TESTERS**

- .1 Features:
  - .1 CSA certified and in accordance with CSA C22.2 No. 160.
  - .2 Factory-mounted, integral with three-phase disconnect switches.
  - .3 Provides positive indication that voltage is not present. Active indication visually conveys when absence of voltage confirmed, typically when voltage is measured below 3.0 volts.
  - .4 Powered directly from 3-phase with capacitor technology for offline power.
  - .5 Supervisory circuitry ensures proper connection of sensors to system and is continually monitored.
  - .6 Consists of:
    - .1 Control unit with sensor leads.
    - .2 Display unit with Green LED indications and TEST buttons.
    - .3 Connection cabling with connectors
    - .4 Mounting hardware.
    - .5 Instruction labelling.
  - .7 Operating Voltage Range: 3 to 600 VAC, 60Hz.
  - .8 Operating Temperature: 0°C to 60°C.

## **2.5 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 Disconnects:
  - .1 Schneider.
- .2 Absence-of-Voltage Testers:
  - .1 I-Gard.
  - .2 Panduit.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Provide disconnects switches and install into locations and connect to equipment.
- .2 Install disconnects with fuses as noted.
- .3 Install absence -of-voltage testers for disconnects as noted.
- .4 Locate disconnects in positions providing clearance for access for operation and maintenance. Install as follows:
  - .1 Wherever noted.
  - .2 Wherever required by electrical code.
  - .3 Wherever required by motor control equipment/VFD/starter schedules.
  - .4 Motorized equipment which cannot be seen from motor starter location or is more than 9 m from starter location (in accordance with electrical code requirements).
  - .5 "Packaged" equipment fed from motor starter panel.
- .5 Where double throw switches are required, connect providing operations as noted.

### **3.2 IDENTIFICATION**

- .1 Provide product identification.
- .2 Provide on each disconnect switch, engraved lamicoid nameplate with nomenclature reviewed with Consultant.
- .3 Indicate name of load controlled on nameplate.

### **3.3 FIELD QUALITY CONTROL**

- .1 Inspection, Start-up, Testing and Verification:
  - .1 Inspect, start-up, test and verify products.
  - .2 Check ratings of switches, fuses and enclosures.
  - .3 Check connections and operations.
- .2 Prepare testing and verification reports, signed by testing technicians. Submit reports to Consultant.

**END OF SECTION**

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**Part 1            General**

**1.1            DESCRIPTION**

- .1      The solar photovoltaic (PV) system shall be installed on the ground of Lombardy Public School according to the project drawings and specifications. The system is a ground mounted PV system and anchored to a PV support frame located on the North East side of the property.

**1.2            SCOPE OF WORK**

- .1      Register with Ontario Power Authority whether its MicroFit or Fit.
- .2      Engineer, procure, construct, and commission a complete and operational photovoltaic system as described in the specifications and project drawings, including a monitoring system.
- .3      Install the system to project specifications and project drawings.
- .4      Perform commissioning activities and provide support documentation for Owner review.
- .5      Coordination with Hydro One utility for design, permitting, commissioning, and connection of the system to the electrical utility grid, including all applications, submissions, and associated fees for Utility net metering. The system shall be capable of operating as a grid-tied, utility-interactive system capable of exporting energy to the grid for net metering.
  - .1      The Contractor shall provide the electrical permit, electrical inspection, and any other information required to the Consultant to assist with the Hydro One Net Metering interconnection process.
  - .2      Perform work to Hydro One requirements including Hydro Ones Distributed Generation Technical Interconnection Requirements at Voltages < 50kV and below.
    - .1      The Contractor shall be responsible for supplying and installing all components required by the Hydro One for monitoring and remote monitoring including but not limited to protection relays, remote terminal unit (RTU), UPS, enclosure, antenna, antenna mount, and accessories as required by Hydro One.
    - .2      The Contractor shall be responsible for interconnecting, programming, configuring, and commissioning protection relays, breakers, and RTU equipment.
- .6      Coordination with the Authority Having Jurisdiction (AHJ) for the relevant permitting, inspections, approvals, and other activities required for the system to be approved, including for the purpose of operating the PV system as a grid-tie system. The Contractor shall be responsible for applying for and paying for any required permits and inspections.
- .7      Provide operations and maintenance manual for all equipment.
- .8      Provide warranty documents.
- .9      Perform work to the requirements of Ontario Electrical Safety Code (OESC) 2024 (29th Edition).
- .10     Where these project specifications or drawings differ from manufacturer, Hydro One or OESC documents, the more strict requirement shall be used.

**1.3            REFERENCE STANDARDS**

- .1      American Society for Testing and Materials (ASTM)
    - .1      ASTM E-1038, Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls
-

- .2 Ontario Electrical Safety Code 2024 (29<sup>th</sup> Edition)
- .3 Hydro One Distributed Generation Technical Interconnection Requirements at Voltages < 50kV and below.
- .4 CSA/IEC C61215-1-1:08, Terrestrial Photovoltaic (PV) modules - Design Qualification and Type
- .5 CSA/ANSI C450-18, Photovoltaic (PV) Module Testing Protocol for Quality Assurance Programs.
- .6 CSA-22.3 NO. 9-08, Interconnection of Distributed Resources
- .7 CSA-22.2-107.1, Power Conversion Equipment.
- .8 CSA B72:20, Installation code for lightning protection systems
- .9 CSA/IEC C61215-1-1:18, Terrestrial Photovoltaic (PV) modules - Design Qualification and Type Approval.
- .10 CSA/ANSI C450-18, Photovoltaic (PV) Module Testing Protocol for Quality Assurance Programs.
- .11 CSA-22.3 NO. 9-08, Interconnection of Distributed Resources
- .12 CSA-22.2-107.1, Power Conversion Equipment.
- .13 CSA Z462– Workplace Electrical Safety
- .14 IBC 1509.7.4, Photovoltaic panels and modules
- .15 IBC 1509.7.2, Fire Classification
- .16 IBC 1505.8, Photovoltaic systems
- .17 IBC 1507.17.3 Wind resistance
- .18 IEC 60364-4-44 (2007), Low voltage electrical installations – Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances
- .19 IEC 61853, Photovoltaic (PV) Module Performance Testing and Energy Rating
- .20 IEC 61701, Salt mist corrosion testing of photovoltaic (PV) modules
- .21 IEC 61000-6-3, CIS/H, Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
- .22 IEC 61000-6-2, TC 77, Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
- .23 IEEE 1584-2018 – Guide for Performing Arc-Flash Hazard Calculations.
- .24 ULC-1703, Standard for Flat-Plate Photovoltaic Modules and Panels
- .25 ULC-1741, Standard for Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources
- .26 UL 2703, Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels
- .27 UL 6703, Standard for Connectors for Use in Photovoltaic Systems

#### 1.4 QUALITY ASSURANCE

- .1 Where this specification deviates from any of the listed standards or references, the more stringent requirement shall be followed. The Consultant shall be consulted on all deviations.
- .2 Designs shall be submitted to the Consultant for review prior to construction or procurement of materials.
- .3 Investigate any other local ordinances that may apply to installation of a solar energy electrical generating system in the proposed location. Bring any conflicts with the drawings and specifications to the attention of the Consultant.



- .4 Warranties:
  - .1 The workmanship of the installation shall be warrantied for 2 years.
  - .2 Manufacturer warranties for specific components are noted in Part 2 of this Section.
  - .3 It is Contractor's responsibility to verify that the Design and Installation does not void manufacturer warranties.
  - .4 It is Contractor's responsibility to verify that the Design and Installation of PV system does not void any building warranties.

## 1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit shop drawings and product data in accordance with section 26 05 00-Common Work Electrical Section 1.6 including:
- .2 Manufacturer's printed product literature, specifications and data sheets for power generators and include product characteristics, performance criteria, physical size, finish and limitations.
  - .1 PV modules
  - .2 Inverter
  - .3 Instrumentation
  - .4 Transformer
  - .5 Over-current protection devices (e.g. circuit breaker, fuse)
  - .6 Panelboard
  - .7 AC and DC disconnects
  - .8 Rapid shutdown devices (if required)
  - .9 Electrical boxes (e.g. combiner box, transition box, junction boxes, pull boxes etc.)
  - .10 Isolation equipment
  - .11 Disconnect specific to Hydro One requirements
  - .12 Interconnection equipment
- .3 Shop drawings in both CAD and PDF format with sufficient information to demonstrate compliance with drawings and specifications. This may include but is not limited to:
  - .1 As-built Single Line Diagram which includes the following:
    - .1 Electrical ratings and nameplate data
    - .2 Detailed sizing and rating for equipment / equipment schedules
    - .3 Wire / conduit sizing
    - .4 Overcurrent protection (indicating available fault current/rating)
  - .2 DC string/inverter configuration drawing
  - .3 DC string configuration layout drawing
  - .4 PV module and optimizer locations and labels.
  - .5 Electrical / mechanical details which includes the following:
    - .1 Bonding/grounding equipment and strategy details
    - .2 Transition boxes (if applicable)
    - .3 Wire management (support and protection)
    - .4 Wiring details and cable support
    - .5 Inverter/combiner mounting
  - .6 PV module support assemblies, mounting details, materials and required clearances.

- .1 Contractor shall provide a racking shop drawing stamped by a professional engineer registered in the province of Ontario.
- .2 Contractor shall provide seismic restraint system and drawing/report stamped by a professions engineer registered in the province of Ontario.
- .7 Monitoring systems
  - .1 URL, username, and password for the inverter web monitoring portal shall be set up by the Contractor and provided to the Consultant as part of the O&M manual submission.
- .8 Metering
  - .1 Providing Hydro One with required metering enclosure and wiring.
- .4 Client Review
  - .1 The Contractor shall submit their proposed design, drawings, shop drawings, datasheet, and other relevant technical information to the Consultant and Owner for approval prior to procurement and construction.
- .5 If equipment submitted differs in arrangement from that shown on the drawings, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract and acceptable to the Consultant or their designated Consultant in tendering stage.

## 1.6 CLOSEOUT SUBMITTALS

- .1 Provide operation and maintenance (O&M) manual for the photovoltaic system. One (1) electronic copy on a memory device/thumb drive and one (1) hard copy in a binder of the O&M manual shall be provided.
  - .1 O&M manual should include instructions and information pertinent to operation and maintenance of the system, all as-built drawings, shop drawings, equipment datasheets, manuals, warranties, completed commissioning forms, monitoring system login information (including username and password), etc.
  - .2 The O&M manual should include information on the following topics (non-exhaustive):
    - .1 System major components and equipment locations (PV modules, inverters, rapid shutdown initiating devices, rapid shutdown boxes, rapid shutdown relay box, AC combiner panels, etc.)
    - .2 Operating Procedures
      - .1 Normal operation of system – built-in inverter screens, web monitoring
      - .2 Navigating and operating inverters from built-in screen
      - .3 Rapid shutdown operation and major components
      - .4 Inverter DC disconnects
      - .5 Solar AC CDP and disconnection processes
      - .6 How to access and electrically isolate individual PV modules
    - .3 Monitoring system
      - .1 Webpage URLs and login information (username and password) for inverter monitoring webpage
      - .2 Webpage URLs and login information (username and password) for submeter
      - .3 Exporting data from the inverter monitoring system
    - .4 System troubleshooting
      - .1 Identifying and troubleshooting inverter performance

- .2 Identifying and troubleshooting failed/underperforming PV modules (using inverter web monitoring tool)
    - .5 Documentation (O&M manuals, manufacturer manuals, warranties, contracts)
    - .6 Maintenance schedule
  - .2 Certifications: Two weeks prior to final inspection, submit the following.
    - .1 Certification by the manufacturers of all major items of the solar energy electric generation system that the system conforms to the requirements of the drawings and specifications, and that they have jointly coordinated and properly integrated their equipment and controls to provide a complete and functional installation.
    - .2 Certification by the Contractor that the solar energy electric generation system has been properly installed, adjusted, tested, commissioned, and warranted. Contractor shall make all necessary field measurements and investigations to ensure that the equipment and assemblies meet contract requirements.
  - .3 Manuals:
    - .1 Submit simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
      - .1 Safety precautions.
      - .2 Startup, shutdown, and post-shutdown procedures.
      - .3 Normal operations.
      - .4 Emergency operations.
      - .5 Environmental conditions.
      - .6 Preventive maintenance plan and schedule.
      - .7 Troubleshooting guides and diagnostic techniques.
      - .8 Wiring and control diagrams.
      - .9 Equipment installation manuals.
      - .10 Removal and replacement instructions.
      - .11 Tracking systems (where applicable).
      - .12 Spare parts and supply list.
      - .13 Parts identification.
      - .14 Testing equipment and special tool information.
      - .15 Warranty information.
      - .16 Testing and performance data.
      - .17 Contractor information.
    - .2 If changes have been made to the maintenance and operating manuals originally submitted, then submit updated maintenance and operating manuals two weeks prior to the final inspection.
  - .4 As-Built Drawings
    - .1 The Contractor shall mark up and provide a set of 'As-Built' drawings. Deviations from the drawings provided in this tender package shall not be made without approval from the Consultant. Where information is not directly visible (e.g. trench configuration, etc.) the as-built drawings shall be augmented by record photographs
  - .5 Complete and submit commissioning forms and documents.
  - .6 Provide on-site training for operations and maintenance of the PV system including new equipment labels, updated site safety plan, and standard operating procedures.

- .1 One training session is required: One (1) 4-hour session at system turnover.
- .2 Training session may be recorded by the Owner for future reference.

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Provide materials to fabricate functioning photovoltaic system in accordance with ASTM, IEEE, NEMA, NFPA, and UL, as specified in this section, and as shown on the drawings.
- .2 All materials shall be new and unused.
- .3 Acceptable Materials: where materials are specified by trade name, refer to the Instructions to Bidders for the procedure to follow when requesting approval of alternates.

### **2.2 SYSTEM DESCRIPTION**

- .1 PV System AC Output Capacity
  - .1 The total AC system capacity must be 48KVA AC. Less may be considered due to location restraints.
  - .2 The system must be able to reach between 5% and 90% capacity at a minimum.
- .2 The PV system shall consist of the following components:
  - .1 PV modules.
  - .2 PV module mounting (racking) system for ground.
  - .3 Inverters.
    - .1 Arc fault detection and protection system (if not integral to the inverter system).
  - .4 Surge Protective Devices (SPD).
  - .5 Critter/Squirrel Guards and/or Rodent Protection.
    - .1 Not required for ballasted systems due to the practical challenge of installing rodent protection for ballasted systems.
  - .6 Utility Metering.
  - .7 Safety Switches.
  - .8 If Required, Rapid Shutdown System (including Rapid Shutdown Initiating Devices, relay and control boxes, and accessory hardware).
    - .1 Not required for this project as the Contractor is expected to place all DC conductors and inverters within 1.0m of the array in order to meet OESC rule 64-218.
  - .9 Protection relays, remote terminal unit (RTU), UPS, enclosure, antenna, antenna mount, and accessories that may be required by the LDC.
  - .10 System shall be designed and installed to operate as a grid-tied solar installation.
  - .11 Miscellaneous equipment to include provision of required system ancillary products including but not limited to:
    - .1 Intermediate transformers;
    - .2 AC and DC cables;
    - .3 Terminal and AC and DC Combiner Boxes;
    - .4 Quick-Connect Electrical Connectors;
    - .5 Disconnecting DC combiner;
    - .6 Utility required AC disconnect;
    - .7 Overcurrent devices such as circuit breakers and fuses, including PV-application specific DC fuses;

- .8 Disconnects, grounding, and bonding components;
- .9 System ground fault detection;
- .10 Other sensors including irradiance and temperature, etc.;
- .11 Mounting hardware, supports, identification nameplates, and warning signage.

## 2.3 PHOTOVOLTAIC (PV) MODULES

- .1 PV Module Types:
  - .1 Monocrystalline Modules listed to UL/CSA-61730.
  - .2 PV technology manufacturers to possess production facilities which comply with standards OHSAS 18001 (Workplace Health and Safety), ISO 9001 (Quality Management System) and ISO 14001 (Environmental Management System).
  - .3 Other PV technology that satisfies the module efficiency requirements may be considered.
- .2 Equipment Specifications:
  - .1 Rated Power (STC): 505W
    - .1 Deviations of +/- 10W are allowed with Owner approval based on availability of module power classes.
  - .2 Minimum Efficiency: 21.1%
  - .3 Cells: Half-cut monocrystalline
    - .1 Monofacial is acceptable given the low tilt, ground clearance, and high ground coverage ratio. Bifacial is also acceptable.
  - .4 Maximum System Voltage: 1000V or 1500 V (UL).
  - .5 Cable and Connectors: NO. 10AWG and RVPU, or equivalent.
  - .6 Module Fire Performance: Type 1 (UL1703) or Class C (IEC/EN 61730-2)
  - .7 Limited Warranty: 12 years on materials and workmanship.
  - .8 Power Warranty: 25-year manufacturer's power output warranty, with the first year at 5% minimum rated power output and the balance of the 25 years at 90% minimum rated power output.
  - .9 Bypass diodes shall be built into each PV module either between each cell or each string of cells.
  - .10 Modules shall be from a Tier 1 manufacturer and the final module shall be submitted to the Owner for approval.
  - .11 Other Components: per UL 61730, UL 61215.
- .3 PV Module Size – 2073mm x 1133mm x 35mm, other sizes may be considered if equivalent power generation can be achieved.
- .4 PV Module Weight – 25.1kg other weight may be considered if equivalent power generation can be achieved.
- .5 Module and System Identification
  - .1 Module labels to satisfy UL 61730 for marking contents and format and UL 969 for weather resistance.
  - .2 Main Service Disconnect: per OESC section 64 requirements and Hydro One.
  - .3 Identification Content and Format: per OESC section 64 requirements.
  - .4 Identification for DC Conduit, Raceways, Enclosures, Cable Assemblies, and Junction Boxes: IFC 6055. Identification for Inverter: per OESC section 64 requirements.

- .6 Hail Protection: Compliant with testing procedure per IEC 61853 or ASTM E-1038. Must meet the following minimum test requirements:
  - .1 Diameter: 25 mm (1 inch) hail balls
  - .2 Mass: 7.54 g
  - .3 Velocity: 22.4 m/s (50 mph)
- .7 Bonding and grounding:
  - .1 Shall ground according to manufacturer instructions per UL 61730.
  - .2 Shall meet CSA B72:20.
  - .3 Shall be grounded according to OESC 64 requirements.
- .8 Module Fire Performance: Type 1 (UL1703) or Class C (IEC/EN 61730-2)
  - .1 IBC 1505.8 for building-integrated photovoltaic.
  - .2 IBC 1509.7.2: Although not technically enforceable, every effort shall be made to ensure the solar photovoltaic module is not combustible.
- .9 Minimum Performance Parameters as per IBC 1509.7.4, UL 1703.
- .10 Basis of Design Product:
  - .1 Longi LR5-66HPH-505M 505W modules or Consultant-approved equivalent product meeting the above specifications.

## 2.4 PHOTOVOLTAIC INVERTERS

- .1 Inverter Location:
  - .1 DC/AC inverters shall be located per the project drawings.
  - .2 The Contractor shall place all DC conductors and inverters within 1.0m of the array in order to meet OESC rule 64-218 (rapid shutdown rule) so that no additional rapid shutdown hardware (e.g. optimizers) are required.
  - .3 DC/AC inverters shall be within 3m and line of sight of a disconnecting device (e.g. electrical distribution panel with circuit breakers) per OESC rule 64-060(3).
  - .4 The inverters shall be mounted vertically on a rack. The Contractor shall be responsible for designing, procuring, and installing an adequate racking structure to support the inverter capable of withstanding wind, snow, and other loading forces and the environmental conditions.
- .2 DC/AC Oversizing Ratio
  - .1 The ratio of DC nameplate Capacity (kW) and AC nameplate capacity (kW) shall be no greater than 1.5.
  - .2 Must be within the inverter manufacturer approved design limits.
  - .3 Clipping losses should be less than 5%.
  - .4 The final DC/AC oversizing ratio shall be approved by the Consultant.
- .3 The DC string design for the modules shall be designed such that the strings operate within the MPPT voltage range of the inverters.
- .4 Shall be listed to UL 1741 (including UL 1741 SA/SB) with Utility-interactive capabilities, including any additional requirements from the LDC.
- .5 Capable of supporting DC string voltage of 1000VDC minimum.
- .6 True sinewave (60HZ) current source.
- .7 AC Output Voltage of 208 V 3-phase output as shown in the drawings.
- .8 Integral Arc-Fault Current Interruption (AFCI).

- .9 Includes integral maximum power point trackers (MPPT).
- .10 Integrated DC Wiring compartment & DC Disconnect.
- .11 Shall be connected to the rapid shutdown system such that the inverter will limit the voltage of any DC circuits to OESC 64-218 if DC conductors are placed outside of 1.0m of PV modules.
- .12 Shall include anti-islanding protection.
- .13 Inverter technology to have a minimum efficiency of 98.5% under standard test conditions.
- .14 Shall be connected to the internet and provide a web portal interface to allow remote monitoring of each and every inverter via the internet.
- .15 Shall be capable of integrating to the building management system (BMS) by way of Modbus TCP or other method.
- .16 Each inverter shall possess AC and DC disconnect switches. The AC disconnect switch does not need to be integral to the inverter.
- .17 Minimum 10-year warranty (optional extended warranty will be considered).
- .18 Certifications: CSA C22.2 No. 107.1-01, IEEE 519, IEEE 1547, UL 1741-SA/SB.
- .19 Each PV inverter shall be connected to its own dedicated branch circuit breaker in the distribution panel or combiner panel.
  - .1 Provide lock-off devices for each circuit breaker.
  - .2 Identify panelboard(s) with a lamicaid reading "PV Panel connection only".
  - .3 Provide dedicated PV distribution panelboard(s) where multiple, individual branch circuit panelboards are required for PV distribution.
- .2 Total harmonic distortion of the PV system shall not exceed 5%.
- .20 Basis of Design Product:
  - .1 Fronius Symo 10.0-3, 12.0-3 & 15.0-3 208V three-phase grid-tied inverters or Consultant-approved equivalent product meeting the above specifications.

## **2.5 OPTIMIZERS**

- .1 Optimizers are not required for this project.

## **2.6 RAPID SHUTDOWN SYSTEM**

- .1 Rapid shutdown system is not expected to be required as the Contractor shall place all DC conductors and inverters within 1.0m of the array in order to meet OESC rule 64-218 (rapid shutdown rule) so that no additional rapid shutdown hardware (e.g. optimizers) are required.

## **2.7 POWER WIRE/CABLE**

- .1 PV Array Cable
  - .1 Shall be stranded #10 AWG RWU90 minimum (copper only) for home runs, refer to drawing for final wire size and inter-row jumpers and #10 AWG for factory supplied wires on modules.
  - .2 PV array cables shall be factory-supplied wiring with compatible quick connectors and single-conductor RPVU90 (Minimum Voltage Rating 1000 VDC, temperature rating 90-degree C, with sunlight resistant black and/or red jacket) CSA listed for use as photovoltaic wire.

- .3 All dissimilar metal connections shall be protected from galvanic corrosion through the use of stainless-steel hardware and anti-oxidant paste.
- .4 All wire connections and terminations shall be made solid, safe, and secure in accordance with manufacturer instructions.
- .5 All DC string terminations are to be made using CSA approved quick connect product (e.g. Multi-Contact MC4, EVO2, Amphenol UTX or equivalent). All terminations are to be made using CSA approved crimping tool designed specifically for the connector; universal crimpers are unacceptable. Where possible avoid the use of any screw terminations for DC strings – select spring loaded breakers, and terminal blocks where practicable. Quick connect terminations shall be a certified and tested mated pair (MC4-MC4, Amphenol-Amphenol, etc.) and shall not have connectors from different manufacturers nor models in the same connection. Preference is for a single type of connector per site to simplify operations and maintenance activities. DC string termination connectors shall match those supplied with the PV modules (i.e. be a certified and tested mated pair).
- .6 All DC connectors shall meet OESC rule 64-220.
- .7 PV array cables shall be installed to meet OESC rule 64-210.
- .8 Where Y-connectors are used to combine two PV strings together before a rapid shutdown box, the Y-connector shall be installed as close to the rapid shutdown box as practical. Each circuit coming into the Y-connector shall be protected by a PV-application specific DC fuse.
- .9 Standard plastic cable ties and electrical tape shall not be used to support, fasten or secure conductors. Stainless steel PV wire cable clips (e.g. Heyco Heyclip Sunrunner Cable Clip), or specialized UV resistant cable ties w/ metal pawl locking mechanism and suitable for outdoor use will be accepted.
- .10 Where a conductor or cable is at risk of damage due to abrasion with another component of the system, UV resistant slit tubing (e.g. Heyco-Flex V Nylon Slit Tubing) shall be applied for protection.
- .11 Refer to project electrical specifications for general electrical items such as conduits, boxes, labelling etc.
- .12 DC Losses - The total DC losses should not exceed 2.0% on average at STC across the system.

## **2.8 AC WIRING AND BALANCE OF SYSTEM**

- .1 AC Losses - Shall be accordance with the OESC rule 64-204 and must be designed and constructed to never exceed 2.0% on average at Standard Test Conditions (STC).
- .2 AC distribution panels connected to solar PV inverters shall be supplied and installed with an adequately rated surge protection device (SPD). The SPD shall be protected by a circuit breaker which protects only the SPD.

## **2.9 AC CIRCUIT BREAKERS AND PANELBOARDS**

- .1 AC circuit breakers installed for the PV system shall be capable of being backfed.
- .2 Any and all distribution panels which feed any solar inverters shall be supplied and furnished with a main breaker complete with shunt trip if rapid shut down control is required and auxiliary contact accessories.
- .3 Provide lock-out devices for each solar PV circuit breaker.
- .4 The solar branch breaker on the main switchgear/panelboard shall be supplied complete with auxiliary contacts (for indicating the open/closed status of the breaker) and with 120VAC shunt trip accessory if rapid shut down required.
  - .1 Two normally open (NO) and two normally closed (NC) contacts minimum.



- .5 Replacement AC circuit breakers installed shall be of the same manufacturer, type and rated for the same voltage and interrupting capacity as other breakers on the panel.
- .6 Refer to Section 26 for additional requirements.

## **2.10 WIRING SPECIALTIES**

- .1 Outdoor Direct Current Conductors:
  - .1 If Exposed: Shall be USE-2, UF (inadequate at 60°C), or SE, 90°C wet-location rated and sunlight-resistant (usually for tracking modules).
  - .2 If in Conduit: Shall be RWU-90, wet-location rated.
- .2 Outdoor Conduits and Raceways:
  - .1 Shall use steel conduit listed per UL 6, UL 1242, UL 797 (as appropriate), except for tracking modules. Weathertight EMT installations shall be allowed for DC wiring in weather-protected areas.
  - .2 Shall use expansion joints on long conduit runs.
  - .3 Shall not be installed on photovoltaic modules.
- .3 Enclosures subject to weather shall be rated NEMA 3R or better.
- .4 Cable Assemblies and Junction Boxes:
  - .1 Shall be UL-listed.
  - .2 Shall be rated to 5VA flammability per UL 94.
- .5 Prohibited Wiring Materials: Those which are not UL-listed, or listed materials used in environments outside those covered in their listing.

## **2.11 BONDING AND GROUNDING**

- .1 All racking, supports, raceways, and other metallic systems shall be Approved in accordance with UL2703 certification for bonding systems.
- .2 In compliance with:
  - .1 CSA C22.2 NO.41 – Grounding and Bonding of Equipment
  - .2 OESC section 64.
- .3 Install complete permanent, continuous, system and circuit, equipment, grounding systems including conductors, connectors, accessories, as required by code and to conform to requirements of local authority having jurisdiction. Which may include the following:
  - .1 Protect exposed grounding conductors from mechanical injury.
  - .2 All nuts, bolts, and washers shall be stainless steel rated for exterior environments.
  - .3 Where ground lugs are used, they are to be constructed of copper, be tinned and be rated for exterior or direct burial applications and must be installed per manufacturer direction.
  - .4 Grounding and bonding connectors shall be installed as per manufacturer instructions with respect to both hardware and torque values.
  - .5 Copper conductors used to ground/bond the racking system shall be green jacketed to provide isolation against galvanic corrosion with dissimilar metals.
  - .6 Materials shall be selected to avoid galvanic corrosion.
  - .7 If required by the manufacturer, apply suitable anti-oxide paste to the exposed ends of conductors before installing them in ground lugs.

- .4 All module frames, panel/array support structures, metal enclosures, panel boards and the inverter equipment shall be bonded to a common grounding conductor terminated in the array and bonded to building ground as required by the OESC section 64. All grounding connections and terminations shall be made using permanent non-reversible compression connections.
  - .1 Modules shall be bonded to the UL2703 certified racking system using UL2703 certified module clamps with built-in lugs which pierce the module frame anodization.
  - .2 PV racking shall be connected to bonding conductors using lay-in outdoor-rated tin-plated grounding lugs. IlSCO SGB-4 or approved equivalent product only.
  - .3 Cable trays shall be bonded using lay-in outdoor-rated tin-plated grounding lugs. ILSCO GBL series or approved equivalent product only.

## **2.12 PHOTOVOLTAIC ARRAY CIRCUIT COMBINER BOX**

- .1 Combiner boxes are not expected to be required for this project outside of the combiner box integral to solar PV inverters. Where used, they shall meet the requirements below.
- .2 Shall be listed to UL 1741.
- .3 Shall include internal overcurrent protection devices with dead front.
- .4 Shall be contained in non-conductive NEMA Type 4X enclosure for outdoor location and NEMA 3 for indoor locations.
- .5 Shall use PV specific UL-listed DC fuses/breakers that meet OESC section 64 requirements for overcurrent protection.
- .6 Where applicable, combiner box shall be a disconnecting combiner box.

## **2.13 SWITCH/DISCONNECTING MEANS**

- .1 Shall be UL-listed and conform to OESC section 64 requirements.
- .2 Shall be lockable in the open position
- .3 Fused

## **2.14 LABELLING**

- .1 Equipment labels and notices shall be provided per the OESC section 64.
- .2 Heat shrink labels for all DC cabling, including individual DC home run cables, shall be provided and labels shall match the as-built DC stringing layout diagram to be provided by the Contractor.
- .3 All major equipment including PV inverters shall be labelled.
- .4 All optimizers (if present) shall be labelled. Individual modules do not need to be labelled.
- .5 Solar PV distribution panels shall be labeled with a lamacoid reading "PV PANEL CONNECTION ONLY".
- .6 A single line diagram of the solar PV system (minimum 600mm x 600mm in size) and framed in Plexiglass shall be provided in the main electrical room or as Lamicoid.
- .7 A permanent, weatherproof, and UV resistant PV system single line diagram sized a minimum 300 x 300mm shall be provided and located on the outside of the PV Kiosk.

## **2.15 PV MODULE RACKING SYSTEM AND STRUCTURAL COORDINATION**

- .1 The Contractor shall be responsible for procuring a solar PV racking shop drawing from a solar racking manufacturer that is designed and stamped by a professional engineer registered in Ontario,

- .1 A draft shop drawing shall be provided to the Owner for review prior to stamping
- .2 Solar PV system loading on the ground shall not exceed the maximum weight as defined by structural load. The solar PV system loading shall include, but is not limited to, the weight of the PV modules, racking system, ballasts, cabling, and any and all accessory equipment.
- .3 The racking system shall be an anchored rail-based racking system.
  - .1 The racking system shall be 10 degree tilt with modules in landscape orientation. Deviations require Consultant and Owner review and approval.
  - .2 The solar PV racking design shall consider the post-disaster rating of the building.
- .4 Seismic anchoring of the solar PV system shall be provided as part of the shop drawing and stamped by a professional engineer registered in the province of Ontario.
- .5 The mounting system shall be demountable, enabling individual PV panel to be easily replaced.
- .6 Wind Resistance Requirement:
  - .1 Building-integrated photovoltaic: IBC 1507.17.8.
  - .2 Ontario Building Code – 2024, OBC
  - .3 Mechanical Load Requirement: per UL 1703.
  - .4 Load Requirement: per UL 1703.
- .7 Stainless steel hardware shall be used throughout.
- .8 Mounting should ensure that backside clearance satisfies the module manufacturer's requirements.
- .9 Basis of Design Product:
  - .1 Opsun Sunground Fixed Tilt or Consultant-approved equivalent product meeting the above specifications.
    - .1 The Contractor shall be responsible for paying for and supplying an engineer-stamped racking shop drawing.

## **2.16 MONITORING SYSTEM AND WEATHER INSTRUMENTATION**

- .1 Inverter monitoring system
  - .1 A remote web-accessible solar PV monitoring system showing total system (and each and every inverter's individual) production and status (accessible via the internet) shall be supplied and installed.
    - .1 The web-accessible system shall be made accessible to the Owner.
  - .2 Install the hardware and network connections needed to connect all inverters to the internet.
    - .1 A hardwired ethernet connection shall be used.
  - .3 Coordinate with the facility's IT personnel to ensure the inverters are able to communicate with the internet.
  - .4 Verify that all inverters are reporting correct data to the web monitoring portal.
  - .5 Use an inverter manufacturer who provides free web monitoring software to allow for monitoring of the inverters from an internet webpage.
  - .6 Set up the project-specific inverter monitoring system and webpage.
  - .7 Set up accounts with different levels of permissions for the Owner's staff. The login information (username and password) shall be provided to the Consultant as part of the Closeout Submittals.
    - .1 One account with 'full' level access

- .2 One account with 'maintenance' level access
  - .3 One account with 'view-only' level access
  - .4 Other accounts as requested by the Consultant.
- .2 Weather instrumentation
  - .1 Supply, install, and commission a Fronius Sensor Card.
  - .2 Supply, install, and commission one irradiance sensor, one ambient temperature sensor, and one back of module temperature sensor.

## **2.17 LDC PROTECTION AND SCADA EQUIPMENT**

- .1 The Contractor shall supply protection relays, remote terminal unit (RTU), UPS, enclosure, antenna, antenna mount, and accessories as required by the LDC. LDC equipment specifications shall be followed.
- .1 The Contractor shall be responsible for interconnecting, programming, configuring, and commissioning protection relays, breakers, and RTU equipment to LDC requirements.

## **2.18 SPARE PARTS**

- .1 The Contractor is responsible for supplying an initial supply of spare parts as outlined below. The Contractor may suggest additional spare parts and quantities.
  - .1 One (1) spare PV modules shall be supplied. This does not include replacement of PV modules damaged during shipping, installation or commissioning which are the responsibility of the Contractor.
  - .2 Consumables
    - .1 Contractor to provide a spares parts for consumables (e.g. fuses, nuts and bolts) with make and model numbers.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Perform the work described in this Section per the project drawings, the OESC, this section, and the latest printed instructions of the manufacturer.
  - .1 Perform the work to OESC requirements.
- .2 Prior to system start-up, ensure no copper wire remains exposed except for grounding wire as allowed in certain circumstances per manufacturer's instructions.
- .3 In seismic areas, systems shall be adequately anchored and braced per details on structural contract documents including racking systems shop drawings to withstand seismic forces at the locations where installed.
- .4 Wiring Installation: Workers shall be made aware that photovoltaic modules will be live and generating electricity when there is any ambient light source and shall take appropriate precautions. Utilize on-site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections. Locate wires out of the way of windows, doors, openings, and other hazards. Ensure wires are free of snags and sharp edges that have the potential to compromise the wire insulation. All cabling shall be mechanically fastened. Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring.
  - .1 Conduits, cables, trays, PV array and racking shall be a minimum of 1.2m from ground level.

- .5 Instrumentation: Install instruments as recommended by the manufacturer. Locate control panels inside a room accessible only to qualified persons.
- .6 PV modules and inverters shall be installed in accordance with the manufacturer's installation instructions.
- .7 Provide safety signage per OESC section 64 requirements.

### **3.2 FIELD QUALITY CONTROL**

- .1 Field Inspection: Perform in accordance with manufacturer's recommendations. Prior to initial operation, inspect the solar energy electrical power generation system for conformance to drawings, specifications, and OES. In addition, include the following:
  - .1 Visual Inspection and Tests
  - .2 Compare equipment nameplate data with specifications and approved shop drawings.
  - .3 Inspect physical, electrical, and mechanical condition.
  - .4 Verify required area clearances.
  - .5 Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method or performing thermographic survey after energization.
  - .6 Verify the correct operation of all sensing devices, alarms, and indicating devices.
  - .7 Verify that all cable entries from top of junction boxes are sealed per junction box rating.
  - .8 Verify all connections and integrity of printed circuit boards in all applicable junction boxes.
- .2 Tests: Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct tests in the presence of the Engineer of Record.
  - .1 Module String Voltage Test: Prior to connecting wiring to the combiner box, use a digital multi-meter to ensure each series string's polarity is correct.
  - .2 Operational Tests: Perform tests in accordance with the manufacturer's written recommendations. Tests for stand-alone systems shall be performed per IEEE 1526.

### **3.3 FOLLOW-UP VERIFICATION**

- .1 Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the solar photovoltaic electrical power generation system is in good operating condition and properly performing the intended function.

### **3.4 COMMISSIONING**

- .1 The objective of the commissioning process is to review, verify, and document that the project design meets good engineering principles. A commissioning agent will be the Hydro One primary party responsible for performing commissioning, with the Contractor to support the commissioning agent with activities as required.
- .2 Where a minor deficiency is identified, and it can be quickly resolved, the Contractor may correct the deficiency during the commissioning tests. Where a deficiency cannot be corrected immediately, the Contractor shall provide a reasonable timeline for correction and shall redo all tests.
- .3 Where commissioning activities may need to be coordinated between the commissioning agent and Hydro One, the Contractor shall be responsible for coordinating these activities.

- .4 Initial Set-up of Inverters & System Startup
  - .1 System startup procedures shall be conducted only after all products have been installed and all electrical and mechanical connections have been made secure. The Contractor shall verify that all manufacturer guidelines and recommendations have been followed and the system is correctly installed, properly wired, and safe for startup.
  - .2 The Contractor shall verify that all necessary approvals, permits, and inspections from the Authorities Having Jurisdiction have been obtained prior to system startup.
  - .3 The Contractor shall obtain written permission from the Hydro One prior to energizing the system.

### **3.5 BASELINE INFRARED THERMAL IMAGING**

- .1 Infrared thermal images of the rooftop system shall be provided as part of the commissioning documents once the system is energized and the system is running near full power with irradiance in the plane of the array greater than 400 W/m<sup>2</sup>.

### **3.6 GRID INTERCONNECTION**

- .1 The Contractor shall include any required applications, submissions, and all associated fees for utility interconnection.
- .2 The Contractor shall provide the Consultant with the electrical permit and electrical inspection report once received from the AHJ. These documents are required by the local distribution company for interconnection of the PV system.
- .3 The Contractor shall provide any other information, documentation, or commissioning necessary to assist the Consultant with the completion of the interconnection process with the local distribution company.
- .4 Hydro One Commissioning
  - .1 The Contractor shall meet the Hydro One commissioning requirements.
  - .2 The following activities may be carried out after System Startup and the Installation Verification Inspection have been completed by the Contractor and submitted to the Consultant for review.
  - .3 The Contractor will assemble all documentation required to ensure system is Commissioned to the satisfaction of Hydro One and is granted authorization to generate. The Consultant shall assist with the review documentation prior to Hydro One commissioning activities.

### **3.7 INSTRUCTION**

- .1 A complete set of operating instructions for the solar photovoltaic electrical power generation system shall be laminated or mounted under acrylic glass and installed in a frame at the main point of interconnection equipment location.
- .2 Submit the O&M manual described in item 1.6 of this Section prior to training.
- .3 Furnish the services of a factory-trained technician for the following training periods (or longer as required) for instructing personnel in the maintenance and operation of the solar photovoltaic electrical power generation system.
  - .1 One training session is required: One (1) 4-hour session at system turnover
- .4 The Contractor should inform the Consultant about maintenance and safety best practices before exiting the project. Some of these topics include isolation troubleshooting, emergency shutdown, and diagnosing low power production. Only qualified personnel should operate upon systems. System warranties must also be taken into account.

- .5 Provide as built drawings to Consultant and Owner in both hard copy and electronic copy (AutoCAD version to be satisfied with Consultant and Owner).

**END OF SECTION**

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**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.2 No. 269.1-17(R2022), Surge Protective Devices - Type 1 - Permanently Connected.
- .2 Institute of Electrical and Electronic Engineers (IEEE):
  - .1 IEEE C62.41.1-2002(R2008), IEEE Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
  - .2 IEEE C62.45-2002(R2008), IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.
- .3 Underwriters Laboratories (UL):
  - .1 ANSI/UL 1283-2024, Electromagnetic Interference Filters.
  - .2 ANSI/UL 1449-2022, Standard for Surge Protective Devices.

**1.2 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
- .3 Submit testing and verification reports.

**Part 2 Products**

**2.1 SURGE PROTECTIVE DEVICES (SPD) – GENERAL FEATURES**

- .1 Ratings and Standards:
    - .1 Ratings: As noted, suiting intended applications.
    - .2 CSA certified, or ULC listed and labeled.
    - .3 In accordance with:
      - .1 CSA C22.2 No. 269.1.
      - .2 IEEE C62.41.1 and IEEE C62.45.
      - .3 ANSI/UL 1283 and ANSI/UL 1449.
    - .4 IEEE Exposure: Category C.
  - .2 Mounting:
    - .1 Internally integrated to utility service entrance equipment.
    - .2 Internally integrated to distribution equipment, unless otherwise noted.
    - .3 Connect SPD units to equipment with breakers in accordance with manufacturer instructions.
    - .4 For switchgear and switchboards: Unless otherwise noted, mount in dedicated front facing cell or main breaker compartment or cubicle.
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- .3 Indicator LEDs on units identify protection integrity status of metal-oxide varistors. For integral units, indicator visible on front of switchgear/switchboard and panelboards.
- .4 High-performance EMI/RFI noise rejection filter.
- .5 Diagnostic package with status indicators on each phase.
- .6 LCD surge counter display.
- .7 Audible alarm with silence button.
- .8 Form C alarm contacts.
- .9 Internal disconnect.
- .10 Maintenance-free and not require user intervention throughout its life.
- .11 Standard manufacturer minimum 5 years parts and labour warranty.
- .12 Operating Temperatures: Minus 40°C to 60°C.
- .13 Internal Mounted Housings: Manufacturer standard steel housings, suiting requirements of internal to equipment installations.

## **2.2 SPD RATINGS AND TYPES**

- .1 Type 1 and Type 2 Units: Applications and with ratings as noted.
- .2 Type 1 Units: Suitable and rated for both Type 1 and Type 2 applications.
- .3 Maximum voltage protection rating to not exceed:
  - .1 700 V (120/208 V) or 1500 V (600/347 V): L-N, L-G, N-G.
  - .2 1200 V (120/208 V) or 3000 V (600 V): L-L.
- .4 Minimum Nominal Discharge Current Rating: 10 kA.
- .5 Minimum Short Circuit Current Rating: 100 kA.
- .6 Minimum Surge Current for Low Voltage Switchgear: 240 KA per phase (120 KA per mode).
- .7 Minimum Surge Current for Low Voltage Switchboards: 120 KA per phase (60 KA per mode).
- .8 Minimum Surge Current for Low Voltage Panelboards: 50 KA per phase (25 KA per mode).
- .9 Peak Surge Current for Low Voltage Switchgear and Switchboards: 250 KA per phase.
- .10 Peak Surge Current for Distribution Panelboards: 150 KA per phase.
- .11 Peak Surge Current for Branch Circuit Panelboards: 100 KA per phase.
- .12 EMI/RFI Filtering Attenuation: Up to 50 dB from 10 kHz to 100 MHz.

## **2.3 ACCEPTABLE PRODUCT MANUFACTURERS**

- .1 SPDs:
  - .1 Schneider.

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**Part 3            Execution**

**3.1            INSTALLATION OF SPDS**

- .1      Obtain training from manufacturer representative on special installation procedures. Install units in accordance with manufacturer instructions.
- .2      Coordinate installation with manufacturer of equipment to which SPDs are connected. For switchgear or switchboards, coordinate configuration, accommodating dedicated front facing cell or main breaker compartment for installing SPD units for applications of integral mounting. Install dedicated breaker device of type and rating in accordance with SPD manufacturer requirements. Mount SPD units such that connecting conductors to dedicated breaker do not exceed length in accordance with SPD manufacturer requirements.
- .3      Where internally mounted in equipment, mount SPD units so that MOV condition LED indicator is visible from front of respective switchgear, switchboard or panelboard.
- .4      Where retrofitting to existing switchboards/panels, mount externally as close as possible in accordance with connecting conductor length limitations of SPD manufacturer and connect with breaker.
- .5      Connect and make incoming and outgoing power cable connections to equipment in accordance with equipment manufacturer recommendations. Check wire range on lugs for SPD, verifying that wire size and number of conductors being connected are within range of lugs.
- .6      Provide alarm and communications circuits. Integrate equipment to Division 25 BAS. Extend wiring in conduit to interconnection terminal cabinet. Provide wiring in conduit from cabinet to respective BAS panel serving area. Make connections. Coordinate requirements with respective equipment vendors and work of Division 25.
- .7      Ground and bond components.

**3.2            IDENTIFICATION**

- .1      Provide product identification.
- .2      Nameplates: Size 4, unless otherwise noted.

**3.3            FIELD QUALITY CONTROL**

- .1      Include for manufacturer representative to inspect, test, and commission installed equipment.
- .2      Inspection, Start-up, Testing and Verification:
  - .1          Inspect, start-up, test and verify products.
  - .2          Check connections and operations.
  - .3          In accordance with manufacturer recommendations, do not perform hi-pot testing (meggering) of cabling or other equipment, with SPDs connected.
  - .4          Test units in accordance with manufacturer recommendations.
- .3      Prepare testing and verification reports signed by testing technician. Submit reports to Consultant.

**END OF SECTION**

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## **1. General**

### **1.01 REFERENCE STANDARDS**

- .1 CSA Group (CSA):
  - .1 CSA C22.1-24, Canadian Electrical Code (CEC), Part 1 (26th Edition), Safety Standard for Electrical Installations.
  - .2 CSA C22.1-24, Ontario Electrical Safety Code (OESC), (29th Edition).
- .2 Ontario Building Code of Canada (OBC), 2024.
- .3 Underwriters Laboratories of Canada (ULC):
  - .1 CAN/ULC-S524-2019, Standard for the Installation of Fire Alarm Systems.
  - .2 CAN/ULC-S525-2023, Standard for Audible Signal Devices for Fire Alarm Systems, Including Accessories.
  - .3 CAN/ULC-S526-2026, Standard for Visible Signal Devices for Fire Alarm and Signaling Systems, Including Accessories.
  - .4 CAN/ULC-S529-2023, Standard for Smoke Detectors for Fire Alarm Systems
  - .5 CAN/ULC-S530-Edition 1, M91-REV1, Standard for Heat Actuated Fire Detectors for Fire Alarm Systems.
  - .6 CAN/ULC-S537-2019-REV1, Standard for Verification of Fire Alarm Systems
  - .7 CAN/ULC-S1001-2023, Standard for Integrated Systems Testing of Fire Protection and Life Safety Systems.

### **1.02 SUBMITTALS**

- .1 Product Data:
  - .1 Submit manufacturer product literature, specifications, installation instructions and datasheets.
  - .2 Include product characteristics, performance criteria, physical size, finish and limitations.
- .2 Shop Drawings:
  - .1 Submit shop drawings for products of this Section.
  - .2 Submit proposed revisions to graphics, annunciators, software programming and sequence of operations.
- .3 Submit verification that system supplying, and programming vendor is existing manufacturer authorized, trained and certified local regional vendor.
- .4 Submit compliance certificates, and testing and verification reports.

## **2. Products**

### **2.01 EXISTING FIRE ALARM SYSTEM**

- .1 Existing system is Edwards FSD-1004 single stage.

- .2 Review with Consultant, manufacturer and type of existing fire alarm system serving building. Provide additional devices and work to retrofit and extend system to serve additional and renovated areas. Provide additional devices 100% compatible with and of same manufacturer as existing system. Provide control panel and annunciator work of existing system to accommodate work and integration of additional devices.
- .3 Engage existing system service contractor, as reviewed with Consultant, providing system products and work.
- .4 Verify with existing fire alarm system manufacturer during Bid period, exact requirements needed to provide renovation work. Where necessary, visit site with manufacturer to review existing conditions. Review and coordinate work responsibilities with system vendor. Review items of clarification or proposed revisions to Project Documents with Consultant.

## **2.02 RENOVATIONS WORK AND DEVICES**

- .1 Provide system work including but not limited to following:
  - .1 Modifications to existing head end equipment including provision of additional components and system programming accommodating renovation work.
  - .2 Modifications to annunciators and graphics reflecting renovation work.
  - .3 Disconnections, removals, relocations and reconnections of existing devices.
  - .4 Additional data gathering panels/transponders.
  - .5 Additional initiating devices.
  - .6 Additional alarm indicating devices.
  - .7 Additional wiring in conduit, fire rated cables, and ancillary devices.
- .2 Additional system components and devices are listed as products of a single manufacturer under appropriate category, by ULC and bear ULC label.
- .3 In conjunction with system work and installation, provided in accordance with specific application requirements of AHJ and of following:
  - .1 CSA C22.1 and provincial electrical code.
  - .2 Provincial building code.
  - .3 ULC S500 series of standards listed in Part 1 - Reference Standards.
  - .4 CAN/ULC-S1001.
  - .5 Building permit applications for approvals.
- .4 Transponders:
  - .1 Transponders or data gathering panels in accordance with CAN/ULC-S527, and matching type of existing manufacturer system serving facility and of series of intelligent, microprocessor-based control panels connecting back to existing system panel handling network communications. Transponders have full system operations data available on display on LCD. System connected data communications, control points and monitoring points are monitored and controlled by transponders. Information on transponder is available to network and is displayed at each transponder. Such points include:
    - .1 Initiating circuit devices such as addressable analogue detectors, including detector type and detector values.
    - .2 Conventional addressable or zone connected smoke, heat and flame detectors.
    - .3 Addressable devices such as manual stations and sprinkler devices.

- .4 Control circuits such as speaker/strobe circuits, fan/elevator/smoke exhaust controls, electromagnetic lock controls and other similar operations and integrated equipment.
- .2 Transponders include features and accessories matching existing units but supplemented with additional components to suit project renovation requirements in accordance with system manufacturer recommendations.
- .3 Connections back to existing system panels including cabling, wired in Class A (as required by AHJ and reviewed with system manufacturer) identifiable loops in addition to other fire rated conductors. Final wiring requirements determined by system manufacturer, suiting specific applications.
- .4 Transponder Enclosures: Minimum NEMA 1 with additional sprinkler-protection provisions including gasketing of openings and doors, and ventilation louvers protecting live components from water spray of activated sprinklers. Surface-mounted panels include drip shield. Panels are wall-mounted, enamel finished, steel cabinets. Where flush-mounted, include suitable flush trim. Review finish of panels mounted in finished areas with Consultant.
- .5 Devices:
  - .1 Manual Stations: In accordance with CAN/ULC-S528. Type suiting intended applications in accordance with existing system manufacturer recommendations.
  - .2 Smoke Detectors: In accordance with CAN/ULC-S529. Type and rating suiting intended applications in accordance with existing system manufacturer recommendations.
  - .3 Heat Detectors: In accordance with CAN/ULC-S530. Type and rating suiting intended applications in accordance with existing system manufacturer recommendations.
  - .4 Audible Horns: In accordance with CAN/ULC-S525. Matching existing system device standards.
  - .5 Strobes: In accordance with CAN/ULC-S526. Matching existing system device standards. Include additional strobes, meeting coverage requirements of building code.
  - .6 Combinations Strobes/Audible Devices: In accordance with respective CAN/ULC Standard. Matching existing system device standards.
  - .7 Signal devices (audible and visual) having similar sound and pattern, matching existing devices, and approved by AHJ.
  - .8 Addressable modules for connection of additional devices.
  - .9 Ancillary devices to complete system installation.
- .6 End-of-Line Resistors and Isolators:
  - .1 End-of-line resistors for standard alarm and signalling circuits, sized for correct supervisory current flows in each circuit, in accordance with requirements of system manufacturer.
  - .2 End-of-line resistors mounted on impact-resistant nylon plate for mounting on standard single gang box and bear ULC label.
  - .3 Provide isolators in accordance with requirements of AHJ and installed in accordance with system manufacturer requirements, isolating/monitoring zones, loops, group of devices within building and between buildings.
- .7 Devices in Non-Climate Controlled Areas:

- .1 Weatherproof, corrosion-resistant, ULC listed for operation in below freezing temperatures, and as recommended by system manufacturer for use for each intended application.
- .2 Where electronics are not recommended for cold temperature applications, include for manufacturer recommendations and directions in remotely locating addressable modules in closest heated areas and connecting to respective device in non-climate-controlled areas.
- .8 Refer to drawings for additional devices and relocation work.
- .9 Wiring:
  - .1 CSA certified and ULC listed and labeled wire and cable for fire alarm circuits.
  - .2 Colour coded, insulated solid copper conductors of type in accordance with electrical code and requirements of AHJ.
  - .3 Sized and installed in accordance with system manufacturer instructions.

### **3. Execution**

#### **3.01 INSTALLATION – GENERAL**

- .1 Prior to start of Work, as part of shop drawing submission process, review with system manufacturer following:
  - .1 Device types, verifying selected type is suitable for intended applications.
  - .2 Selection of audible and visual devices with field adjustable settings, suiting installation areas and intended applications and are in accordance with referenced codes and standards, including CAN/ULC-S524.
  - .3 Locations and mounting heights of devices, verifying proper operation and coverage is in accordance with requirements of AHJ, referenced standards and codes.
  - .4 Device back box requirements, verifying size and depth is in accordance with system manufacturer recommendations for specific devices.
  - .5 Types of system wiring and required sizing taking in consideration intended applications and voltage drop.
  - .6 System circuiting and device quantities for each circuit while maintaining limitations as specified.
  - .7 Proposed system sequence of operation.
- .2 Advise Consultant of requirements of above that may necessitate revisions to design documents.
- .3 Provide fire alarm system for building. Install products and perform installation work in accordance with manufacturer instructions and recommendations. Install, test, verify, and certify system in accordance with specified referenced standards, specific references to CAN/ULC-S524, building codes, electrical codes, and as required by AHJ.
- .4 Obtain training from manufacturer representative on special installation procedures and including recommendations and instructions from system and device manufacturers. Install system equipment, devices and perform work in accordance with manufacturer instructions and requirements.
- .5 Arrange for fire alarm system manufacturer authorized technician to:
  - .1 Perform control panel, transponder, and annunciator work.

- .2 Inspect related work by installing personnel.
- .3 Perform system programming of initial installed system.
- .4 After total completion of work and verification of system, but prior to turn-over, include additional onsite software programming sessions for changes to system recommended by Consultant or Commissioning Agent.
- .5 Review final software nomenclature with Consultant. Incorporate in software, final room names/area names/building names and equipment identification.
- .6 At turn-over, supply copy of system software in format reviewed with Consultant and submit copy to Consultant and include also with system O & M manuals.
- .6 Contact AHJ, in providing detailed description of Work and requirements for obtaining AHJ inspections and approvals.
- .7 Prior to roughing-in controls, panels and devices, review installation locations with Consultant.
- .8 Prior to ordering, review device finishes and colours with Consultant.
- .9 Prior to ordering, review identification products and signage requirements such as sizing, print types and sizing and nomenclature, with Consultant. Label devices as required by CAN/ULC-S524 and AHJ.
- .10 During work to existing fire alarm system, review with Consultant and obtain Consultant recommendations of proposed time and duration of interruption. At any time, due to emergency situations, Consultant may request by-passed zone(s) be re-instated immediately. In areas where renovation work requires shutdown of part of fire alarm protection system, provide manual fire alarm protection (Fire Warden) by means of supervising area as approved by AHJ. At no time allow fire alarm system or any one zone be left inoperative overnight. Provide required bypass wiring and temporary wiring to maintain each part of fire alarm system operative during construction and alterations.

### **3.02 SYSTEM WORK AND INSTALLATION OF DEVICES**

- .1 Install fire alarm system components and connect.
- .2 Program system to accommodate system modifications and to accommodate additional devices and zones. Update software and graphics. Typically, sequence of operation to match existing. Prior to start of work, submit proposed software programming revisions to Consultant for review and when required, to AHJ for review and approval.
- .3 Install additional transponders and revise annunciators, including replacing existing graphics with updated versions.
- .4 Perform work in accordance with system manufacturer instructions.
- .5 Secure each panel enclosure to walls and connect with fire rated type MI conductors where noted, or in accordance with requirements of AHJ. Coordinate location and installation requirements with trade responsible for wall finishes and review with Consultant.
- .6 Install manual stations in electrical boxes of type suiting device requirements, recessed boxes with plaster rings, except in unfinished areas where manual stations are surface mounted, in which case, install stations in surface mounted boxes. Comply with mounting height requirements in accordance with barrier free access, or as noted.

- .7 Install mounting plate of thermal detectors to ceiling mounted boxes. Secure detectors to plates. Refer to floor plans and drawing symbol list to determine rating of detectors in areas. Generally, do not install rate-of-rise type detectors in areas subject to sudden changes in temperatures, such as entrance vestibules. Review application requirements with system manufacturer and verify that devices are ULC listed for such applications.
- .8 Secure base of each ceiling mounted products of combustion detectors to boxes, either flush or surface-mounted suiting intended applications. Secure detector heads to bases.
- .9 Install cross zoned connection of detectors and remote indicating devices for:
  - .1 Within accessible ceiling spaces.
  - .2 For applications as noted.
- .10 Mount each duct mounted products of combustion detector on duct in question and connect with smoke sampling tubes which extend into duct air stream. Install remote alarm lamp assembly for each duct mounted detector. Wall-mount each lamp assembly on standard 100 mm outlet box as close as possible or practicable to detector. Do not locate detectors within 1 m of duct size increaser, or in decreaser fittings ,or in duct elbows. Provide wiring in conduit and extend to connect back to system control unit.
- .11 In applications with hold open devices on doors, activation of smoke detectors tied to hold open devices initiates signal causing release of door, in accordance with NFPA. Where electromagnetic locks are used on doors of egress, provide automatic release of locks upon activation of fire alarm, through connection to auxiliary contact of adjacent manual station. Provide conductors and connections to fire alarm system and to electromagnetic locks.
- .12 For each area, provide audible and visual devices of specific types as reviewed with Consultant. Install audible and visual devices flush and surface-mounted as noted and suiting architectural wall/ceiling types, each with backbox and trim plate suiting intended applications.
- .13 Wire horns in Class B, 2 wire circuit configurations, terminating in end of line devices. Wire alternate speakers in same circuits with minimum of 2 circuits for each floor.
- .14 Provide horns and strobes, flush and surface-mounted as noted, suiting architectural wall/ceiling types, each with backbox and trim plate suiting intended applications.
- .15 Mount exterior speakers and horns with weather sealed gland nut connection at proper dispersion angle.
- .16 Generally, audible and visual device locations are as indicated, however, determine requirements for additional device quantities and locations based on results of audibility and visibility device coverage site tests. Provide sound detection metering and personnel to make necessary tests. Relocate devices or provide additional devices, providing device coverage performance in accordance with requirements of AHJ and for obtaining approvals.
- .17 Support flush ceiling-mounted speaker backboxes from structure and not suspended ceiling grid or tiles. Connect speakers to taps providing sound levels in accordance with AHJ sound level requirements. Adjust and certify that levels are in accordance with requirements.
- .18 Typically, install visual notification appliances in accordance with CAN/ULC S524. Provide visual notification devices in areas subject to high ambient noise levels, such as mechanical equipment rooms, computer equipment rooms, and areas designated for hearing impaired in accordance with building code requirements. Provide minimum 2 circuits for each floor and connect devices in alternating scheme.



- .19 Install amplifiers sized to power additional speakers and include spare capacity as specified.
- .20 Relocate devices to accommodate renovations work. Maintain fire alarm protection in areas of Work to approval of AHJ. Provide temporary supporting structures to support temporary located devices and to maintain proper operation and fire protection. Obtain inspections and approvals. Relocate devices to suit requirements of AHJ.
- .21 When renovations work is complete, disconnect temporary devices and existing devices in temporary locations. Locate devices in permanent locations, suiting renovations work in accordance with Specification and Consultant recommendations. Connect, adjust, test and verify.
- .22 Circuit devices to existing standards and in accordance with requirements of AHJ. Determine quantities of circuits and loading of circuits based on electrical code requirements and recommendations of system manufacturer.
- .23 Where existing devices are relocated and existing wiring is of insufficient length to connect to relocated position, provide replacement wiring and conduit of sufficient length for full run. Do not splice wiring.
- .24 Install and circuit devices in accordance with manufacturer instructions for intended applications. Do not load device circuits more than 80% capacity, unless otherwise reviewed with and recommended by Consultant.
- .25 Provide system wiring in accordance to requirements of electrical code, system manufacturer recommendations and based on intended applications and consideration of voltage drop. Install wiring in conduit except for MI type.
- .26 Do not splice wiring. Perform wiring connections associated with fire alarm system on terminal strips in junction boxes and colour coded. Provide wiring colour coding consistent for entire length of each run. When pulling wires into conduit, use lubricant and run wires straight and not twisted or abraded. Neatly secure exposed wires in apparatus enclosures with supports or ties recommended by system manufacturer. Clearly identify wiring at each termination point. In addition, number wiring with suitable type markers.
- .27 Run alarm indicating circuits (audible/visual) and alarm receiving circuits (manual stations, detectors) in separate conduits from each other.
- .28 Arrange sprinkler system alarm valve alarm zones separate from manual station, thermal detector and products-of-combustion detector device zones, which may be connected together into zones.
- .29 Provide fire alarm system wiring connections to mechanical equipment and other building systems to perform interrelated functions in accordance with sequence of operations. Provide wiring, relays, contacts or contactors between fire alarm system and various equipment achieving automatic or manual control of equipment, and performing integrated fire alarm system functions. Provide shunt trip breakers suiting intended applications. Review requirements with Consultant.
- .30 Install end-of-line resistors to electrically supervise wiring. Generally, locate end-of-line resistors at ceiling lines above manual station location or in equipment rooms as reviewed with Consultant. Provide isolators in accordance with ULC standards, and label and identify. Do not locate end-of-line resistors and isolators in concealed locations. Generally, install in equipment rooms.
- .31 Inspect system remote monitoring provisions and verify provisions are in accordance with CAN/ULC-S561. Make necessary revisions and corrections.
- .32 Ground and bond system.

### **3.03 REQUIREMENTS FOR INTEGRATED SYSTEMS AND EQUIPMENT**

- .1 Contractor to hire and retain an integrated systems testing consultant (ITC).
  - .1 Integrated systems testing consultant shall be qualified in accordance with the S1001.
  - .2 ITC shall review the entire project scope including general contractor, mechanical, and electrical.
  - .3 ITC shall provide draft integrated systems testing plan for building permit submittal.
  - .4 ITC shall provide completed integrated systems testing report for review and acceptance by Owner and Consultant. ITC shall allow for multiple revisions to ensure final report is of sufficient quality and content.
- .2 Perform required fire alarm system wiring connections to mechanical equipment and other building systems to perform required interrelated functions. Provide required wiring, relays and/or contactors between fire alarm system and various equipment to achieve automatic or manual control of equipment, to perform required integrated fire alarm system functions. Provide shunt trip breakers as required. Provide ULC listed fire rated conductors where required by local codes and local authorities.
- .3 In addition to wiring connections to fire alarm system components, extend control wiring in conduit to (where applicable):
  - .1 fan equipment starters;
  - .2 dampers;
  - .3 devices and equipment as shown on drawings.

### **3.04 FIELD QUALITY CONTROL**

- .1 Manufacturer Authorized Technician Services:
  - .1 Provide technical training and assistance to certified installers of system.
  - .2 Perform onsite inspection, start-up, testing, verification and certification of installed system.
  - .3 Prepare and sign testing and verification reports for submittal to Consultant.
- .2 Testing Technicians:
  - .1 Registered technicians in good standing with Canadian Fire Alarm Association (CFAA) or be Certified Fire Alarm Electrician (CFAE) with local Electrical Contractors Association as deemed acceptable to Provincial Fire Marshall.
  - .2 Submit with test reports, copies of valid certification of testing company and technicians.
- .3 Submit to Consultant, proposed schedule for testing and verification of system. Notify Consultant and Commissioning Agent minimum 7 working days in advance of testing.
- .4 Arrange for fire alarm system manufacturer authorized representative to inspect, test, verify, commission and certify system components and wiring, individually and as complete system, in accordance with requirements of CAN/ULC-S537 and CAN/ULC-S1001. Work includes but not limited to verifying following:
  - .1 Type of equipment installed is that designated by Contract Documents.
  - .2 Wiring connections to equipment components show that installer observed ULC and CSA requirements.

- .3 Equipment installed in accordance manufacturer recommendations, and signaling devices operated or tested verifying operation.
- .4 Supervisory wiring of equipment connected to supervised circuit is operating and governmental regulations, concerning such supervisory wiring, are in accordance with requirements of AHJ.
- .5 Sequence of operation is in accordance with specified sequence of operation and approved by AHJ.
- .6 System and devices are commissioned and operable.
- .5 Additionally, include for following:
  - .1 Verifying that connections to security system and third-party monitoring party are in accordance with CAN/ULC-S561, where building includes such systems.
  - .2 Verifying fire alarm system on zone by zone basis, phase by phase basis in accordance with project phasing, and verify entire system in whole, at completion of installation.
  - .3 Testing system battery power supplies and demonstrate compliance with building code and AHJ requirements that battery supplies provide required duration of supervisory power followed by building code required time (or time directed by AHJ) of full load power. Reviewing and performing method of testing in accordance with AHJ, and reviewing with Consultant. Providing sound measurement devices and personnel for testing.
  - .4 Testing system audible devices verifying alarm sound levels in areas are in accordance with building code and AHJ requirements. Site adjust tap settings of audible devices to achieve required audibility levels. Test emergency voice communication system, verifying performance is in accordance with Specifications and requirements of AHJ.
  - .5 Testing of electromagnetic door locks to verify performance is in accordance with Specifications.
  - .6 Full reviewing, testing, and verification of operation of building ventilation and smoke exhaust system and its integrated operation with fire alarm system and various pieces of air handling equipment.
  - .7 Coordinating with AHJ to obtain certificates of approvals.
- .6 Do not use open flame, or smoke for testing, unless otherwise reviewed with and recommended by Consultant.
- .7 Where project work is phased and requires occupancy at various stages, provide system inspection, testing, commissioning, verification and certification after completion of each phase of work, to approval of AHJ. Upon Substantial Performance of the Project Work, include for providing system inspection, testing, commissioning, verification and certification of entire system work.
- .8 Contact and coordinate with AHJ, for inspections. Integrate AHJ inspection requirements with inspection, testing, commissioning, verification and certification work. Obtain AHJ approval and compliance certifications. Submit copies to Consultant.
- .9 Correct failures or deficiencies found in system during testing, witnessed or directed by AHJ, Consultant, or Commissioning Agent. Re-test and re-verify failures and deficiencies until successfully passed.

- .10 Arrange for manufacturers to supply reasonable amounts of technical assistance with respect to changes required to conform to paragraphs above. During periods of inspection, testing, commissioning, verification and certification work, make electricians available to perform correction work and to assist during this Work. Include for presence of trades responsible for integrated components and systems, during inspection, testing, commissioning, verification and certification work.
- .11 Prepare detailed test sheets of tested components. Submit documentation in form in accordance with referenced standards, acceptable to AHJ, and reviewed with Consultant. Submit testing report documents additionally in electronic format, as reviewed with Consultant.
- .12 On completion of inspection, testing, commissioning and verification of system, obtain from testing technician and forward to Consultant, compliance certificate together with detailed inspection reports listing each and every system component, its location in building and its acceptability. Prepare compliance certificate and inspection reports signed by certified testing technician. Signed test reports certify that systems are installed and perform in accordance with Specification.
- .13 Prepare and submit Integrated Testing report in accordance with CAN/ULC-S1001.
- .14 Obtain from system manufacturer and forward to Consultant, certificate of liability insurance of minimum amount of Two Million Dollars (\$2,000,000.00) CDN, registered for this project showing proof of liability coverage for both their product and personnel.
- .15 Combine required documentation into reports. Submit to Consultant.

### **3.05 MONITORING OF SYSTEMS**

- .1 In areas that remain occupied and used during Work, daily monitor and supervise existing fire alarm system and other fire protection systems serving renovation/working areas. Leave system in proper operating condition at end of each working day. Perform following:
  - .1 Under presence of Consultant, check system each morning and evening (start and end of work) of each day, verifying that system is in proper working condition.
  - .2 Where portions of system are not in proper working order, provide temporary bypass wiring (when fire alarm system is subject to approval of AHJ), or provide supervisory personnel to monitor systems for area affected.
  - .3 Document and sign off each respective daily check condition and review with Consultant.
  - .4 Retrofit work to system in manner that does not affect portion of system serving areas outside of renovation/working areas.
- .2 Maintain fire protection of areas which include fire watch during temporary shutdowns of existing systems, in accordance with requirements of AHJ.

### **3.06 REPLACEMENT OF / ADDITIONS TO EXISTING FIRE ALARM SYSTEMS**

- .1 Replace existing fire alarm system with new updated system as specified herein. Some areas of construction allow for demolition and removal of existing system prior to installation of replacement system. Some other areas are new construction only. Work in areas as noted that Owner is maintaining services to facilities, are to be performed in phases to suit work schedule as shown and noted on issued drawings and documents.

- .2 Maintain existing fire alarm system in operation until replacement system is fully installed, in operation, is fully certified and verified to satisfaction of Owner and Consultant. Obtain Owner authorization and review with Consultant, prior to any disconnection work to existing system. Phase work in a manner as noted and as required such that existing fire alarm system equipment in adjacent areas being renovated, is maintained in operation.
- .3 Perform modifications to existing control panels and annunciators as required to accommodate connection of additional fire alarm system to existing system as a trouble signal.
- .4 In renovated areas, where new panels are added, fully integrate additional panels to existing controls to maintain fire protection of areas. Integration of additional panels to existing controls, where required, is to be to extent required by AHJ to maintain proper fire protection of areas. Any work and interconnections required to existing controls to be included under Work of this Project.
- .5 Relocate devices to accommodate ceiling and wall demolitions and installation of ceilings and walls. Maintain fire alarm protection in areas of Work to satisfaction of Owner and AHJ. Provide required temporary supporting structures to support temporary located devices in order to maintain proper operation and fire protection. Obtain required inspections and approvals from AHJ and Owner. Relocate devices to suit AHJ directions.
- .6 When ceiling and/or wall work has been completed, disconnect temporary devices and existing devices in temporary locations. Locate devices in permanent locations to suit renovations work as perin accordance with issued drawings and Consultant directions. Connect, adjust, test and verify.
- .7 Provide required additional devices and install existing devices as required. Circuit device's to existing standards and in compliance with requirements of AHJ. Determine exact quantities of circuits based on requirements of codes and AHJ, and recommendations of system manufacturer.
- .8 Contact AHJ and provide detailed description of Work. Confirm AHJ requirements for Fire Watch and Fire Wardens for Work. Provide necessary requirements.
- .9 During work to existing fire alarm system, time and duration of interruption to be approved by Owner and reviewed with Consultant. In areas where renovation work requires shutdown of any part of fire alarm protection system, install manual fire alarm protection (Fire Warden) by means of supervising area as approved by AHJ. At no time is fire alarm system or any one zone to be left inoperative overnight. Install bypass wiring and temporary wiring as may be required to maintain required parts of fire alarm system operative during construction and alterations.
- .10 Tie new work into existing system until such time that new system can take control and replace existing system, to satisfaction and approval of AHJ and Owner, and reviewed with Consultant. Make required interconnections and system programming to provide these requirements.
- .11 Perform cut over work as required to change over from existing system being abandoned to replacement system.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED SECTIONS**

- .1      Section 26 05 43 – Installation of cables in trenches and ducts
- .2      Section 33 65 76 – Direct Buried Underground Cable Ducts
- .3      Section 33 71 75 – Underground Electrical Services

**1.2            REFERENCE**

- .1      American Society for Testing and Materials (ASTM)
  - .1      ASTM D 1056-07, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- .2      Canadian Standards Association (CSA)
  - .1      CAN/CSA-A3000-03(April 2001), Cementitious Materials Compendium. Includes:
  - .2      CAN/CSA-A5-98, Portland Cement
  - .3      CSA A23.1-04/A23.2-04 (June 2001), Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
  - .4      CSA G30.3-M1983(R1998), Cold-Drawn Steel Wire for Concrete Reinforcement.
- .3      CSA G30.5-M1983(R1998), Welded Steel Wire Fabric for Concrete Reinforcement.
- .4      CAN/CSA-G30.18-92(R1998), Billet-Steel Bars for Concrete Reinforcement.

**Part 2           Products**

**2.1           PVC DUCTS**

- .1      PVC ducts, type DB2, encased in reinforced concrete.

**2.2           PVC DUCT FITTINGS**

- .1      Rigid PVC opaque solvent welded translucent pushfit type couplings, bell end fittings, plugs, caps, adaptors as required to make complete installation.
- .2      Expansion joints.
- .3      Rigid PVC 5 degree angle couplings.

**2.3           PRECAST CONCRETE MANHOLES**

- .1      Precast concrete manholes and auxiliary sections fabricated in steel forms.
- .2      Aggregates: to CSA A23.1/A23.2.
- .3      Portland cement with 40% Fly ash replacement: to CAN/CSA-A3000-A5, Type 10 30 50.
- .4      Steel welded wire fabric mesh reinforcing: to CSA G30.3, CSA G30.5, CAN/CSA-G30.18.
- .5      Pulling inserts and bolts for racks integrally cast in concrete: to.
- .6      Neoprene gasket seals between manhole sections: to ASTM D 1056.
- .7      Size: 762 mm clear diameter.

**2.4           DRAINAGE**

- .1      Floor drain fittings in each manhole consisting of floor drain, back water valve, trap and pipe connection to drainage system. Dry sump.
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- .2 Storm sewer connection: cast iron service saddle consisting of oil resistant gasket, stainless steel clamp and oil resistant O ring.

- .3 Sump pit: 300 x 300 x 125 mm.

## **2.5 MANHOLE NECKS**

- .1 Concrete brick and mortar.

## **2.6 MANHOLE FRAMES AND COVERS**

- .1 Cast iron manhole frames and covers.
- .2 Bolted on covers to prevent unauthorized entry.
- .3 Size: 762 mm clear diameter.

## **2.7 GROUNDING**

- .1 Ground rods: in accordance with OPSD and the Ontario Electrical Safety Code.

## **2.8 CABLE RACKS**

- .1 Hot dipped galvanized cable racks and supports.
- .2 12 x 100 mm preset inserts for rack mounting.

## **2.9 CABLE PULLING EQUIPMENT**

- .1 Pulling iron: galvanized steel rods, size and shape as indicated.
- .2 Pull rope: 6 mm stranded nylon polypropylene, tensile strength 5 kN, continuous throughout each duct run with 3 m spare rope at each end.

## **2.10 MARKERS**

- .1 Concrete type cable markers: 600 x 600 x 100 mm, with words: "Cable", "Joint", "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.
- .2 Cedar post type markers: 89 x 89 mm square, 1.5 m long, pressure treated with clear coloured, or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing duct.
  - .1 Nameplate: aluminum anodized 89 x 125mm, 1.5 mm thick mounted on cedar post with mylar label 0.125 mm thick with words "Cable", "Joint", "Conduit" with arrows to indicate change in direction.
- .3 Execution

## **2.11 INSTALLATION**

- .1 Install underground duct banks and manholes including formwork.
- .2 Build duct bank and manholes on undisturbed soil or on well compacted granular fill not less than 150 mm thick, compacted to 95% of maximum proctor dry density.
- .3 Open trench completely between manholes to be connected before ducts are laid and ensure that no obstructions will necessitate change in grade of ducts.
- .4 Prior to laying ducts, construct "mud slab" not less than 75 mm thick.
- .5 Install ducts at elevations and with slope as indicated and minimum slope of 1 to 400.

- .6 Install base spacers at maximum intervals of 1.5 m levelled to grades indicated for bottom layer of ducts.
- .7 Lay PVC ducts with configuration and reinforcing as indicated with preformed interlocking, rigid plastic intermediate spacers to maintain spacing between ducts at not less than 40 mm horizontally and vertically. Stagger joints in adjacent layers at least 150 mm and make joints watertight. Encase duct bank with 75 mm thick concrete cover. Use galvanized steel conduit for sections extending above finished grade level.
- .8 Make transpositions, offsets and changes in direction using 5 degree bend sections, do not exceed a total of 20 degree with duct offset.
- .9 Use bell ends at duct terminations in manholes or buildings.
- .10 Use conduit to duct adapters when connecting to conduits.
- .11 Terminate duct runs with duct coupling set flush with end of concrete envelope when dead ending duct bank for future extension.
- .12 Cut, ream and taper end of ducts in field in accordance with manufacturer's recommendations, so that duct ends are fully equal to factory-made ends.
- .13 Allow concrete to attain 50% of its specified strength before backfilling.
- .14 Use anchors, ties and trench jacks as required to secure ducts and prevent moving during placing of concrete. Tie ducts to spacers with twine or other non-metallic material. Remove weights or wood braces before concrete has set and fill voids.
- .15 Clean ducts before laying. Cap ends of ducts during construction and after installation to prevent entrance of foreign materials.
- .16 Immediately after placing of concrete, pull through each duct steel wooden mandrel not less than 300 mm long and of diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Avoid disturbing or damaging ducts where concrete has not set completely. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .17 Install four 3 m lengths of 15M 10M reinforcing rods, one in each corner of duct bank when connecting duct to manholes or buildings. Wire rods to 15M 10M dowels at manhole or building and support from duct spacers. Protect existing cables and equipment when breaking into existing manholes. Place concrete down sides of duct bank filling space under and around ducts. Rod concrete with flat bar between vertical rows filling voids.
- .18 In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.
- .19 Backfill and compaction required as specified on drawings.

## **2.12 MANHOLES**

- .1 Build cast-in-place manholes.
- .2 Install precast manholes.
- .3 Place concrete in two lifts with slab and sump in first, walls, roof and neck in second lift. Provide key in walls to slab. Place 100 x 6 mm PVC water bar vertically in key. Install ground rod before placing slab and place reinforcing steel, inserts for cable rack, pulling irons, drain, duct outlets, duct run dowels before casting walls. Make manhole to duct connection as indicated.
- .4 Provide 115 mm deep window to facilitate cable bends in wall at each duct connection. Terminate ducts in bell-end fitting flush with window face. Provide four 10M steel dowels at each duct run connection to anchor duct run. On runs of 16 ducts and over, support



- concrete duct encasement on a 700 mm wide by 75 mm thick concrete pier poured against manhole wall between slab and bottom of duct run, provide dowels for anchoring.
- .5 Alternately connect large duct runs by leaving square opening in wall, later pouring duct run and wall opening in one pour, and install 10M x 3m reinforcing rods in duct run at manhole connection.
  - .6 Build up concrete manhole neck to bring cover flush with finished grade in paved areas and 40 mm above grade in unpaved areas.
  - .7 Install manhole frames and covers for each manhole. Set frames in concrete grout onto manhole neck.
  - .8 Drain floor towards sump with 1 to 48 slope minimum and install drainage fittings as indicated.
  - .9 Install cable racks, anchor bolts and pulling irons as indicated.
  - .10 Grout frames of manholes. Cement grout to consist of two parts sand and one part cement and sufficient water to form a plastic slurry.
  - .11 Ensure filling of voids in joint being sealed. Plaster with cement grout, walls, ceiling and neck.
  - .12 Spray paint "X" on ceiling of manhole above floor drain or sump pit.

#### **2.13 MARKERS**

- .1 Mark location of duct runs under hard surfaced areas not terminating in manhole with railway spike driven flush in edge of pavement, directly over run. Place concrete duct marker at ends of such duct runs. Construct markers and install flush with grade.
- .2 Mark ducts every 150 m along straight runs and changes in direction.
- .3 Where markers are removed to permit installation of additional duct, reinstall existing markers.
- .4 Lay concrete markers flat and centered over duct with top 25 mm above earth surface.
- .5 Provide drawings showing locations of markers.

#### **2.14 INSPECTIONS**

- .1 Inspection of duct will be carried out by Engineer Consultant prior to placing. Placement of concrete and duct cleanout to be done when Engineer Consultant present.

**END OF SECTION**

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**Part 1            General**

**1.1            RELATED SECTIONS**

- .1      Section 26 05 43 – Installation of cables in trenches and ducts
- .2      Section 33 65 77 – Concrete Enchased Duct Banks and Manholes
- .3      Section 33 71 75 – Underground Electrical Services

**1.2            STANDARDS.**

- .1      Canadian Standards Association (CSA)
  - .1      CSA C22.2 No. 211.1-06, Rigid Types EBI and DB2/ES2 PVC Conduit.
  - .2      CSA C22.2 No. 211.3-96(R2000), Reinforced Thermosetting Resin Conduit (RTRC) and Fittings (Bi-national standard, with UL 1684).

**Part 2            Products**

**2.1            PVC DUCTS AND FITTINGS**

- .1      Rigid PVC duct: to CSA C22.2 No. 211.1, Type DB2, with fabricated moulded fittings, for direct burial expanded flange ends.
- .2      Rigid PVC bends, couplings, reducers, bell end fittings, plugs, caps, adaptors same product material as duct, to make complete installation.
- .3      Rigid PVC 90° and 45° bends.
- .4      Rigid PVC 5° angle couplings.
- .5      Expansion joints as required by the Ontario Electrical Safety Code.

**2.2            SOLVENT WELD COMPOUND**

- .1      Solvent cement for PVC duct joints.

**2.3            PLASTIC POLYETHYLENE PIPE**

- .1      Flexible Rigid plastic polyethylene pipe with approved couplings and fittings required to make complete installation.

**2.4            CABLE PULLING EQUIPMENT**

- .1      6 mm stranded nylon pull rope tensile strength 5 kN.

**2.5            MARKERS**

- .1      Concrete type cable markers: as indicated, with words: "Cable", "Joint" or "Conduit" impressed in top surface, with arrows to indicate change in direction of duct runs.
  - .2      Cedar post type markers: 89 x 89 mm square, 1.5 m long, pressure treated with clear coloured, or copper naphthenate or 5% pentachlorophenol solution, water repellent preservative, with nameplate fastened near post top, on side facing duct.
    - .1      Nameplate: aluminum anodized 89 x 125mm, 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.
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**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Install duct pipe in accordance with manufacturer's instructions.
- .2        Clean inside of ducts before laying.
- .3        Ensure full, even support every 1.5 m throughout duct length.
- .4        Slope ducts with 1 to 400 minimum slope.
- .5        During construction, cap ends of ducts to prevent entrance of foreign materials.
- .6        Pull through each duct steel wooden mandrel not less than 300 mm long and of diameter 6 mm less than internal diameter of duct, followed by stiff bristle brush to remove sand, earth and other foreign matter. Pull stiff bristle brush through each duct immediately before pulling-in cables.
- .7        In each duct install pull rope continuous throughout each duct run with 3 m spare rope at each end.
- .8        Install markers as required.
- .9        Backfill and compaction required as specified on drawings.

**END OF SECTION**

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**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 26 05 28 - Grounding - Secondary.
- .2 Section 26 05 43 – Installation of cables in trenches and ducts
- .3 Section 33 65 73 – Concrete Encased Duct Banks and Manholes
- .4 Section 33 65 76 – Direct Buried Underground Cable Ducts

**1.2 STANDARDS**

- .1 Canadian Standards Association (CSA)
  - .1 CSA A23.1-04/A23.2-04(June 2001), Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.
  - .2 CSA C22.3 N0. 7:20 Underground Systems

**Part 2 Products**

**2.1 MATERIALS**

- .1 Underground ducts: to Section 33 65 76 - Direct Buried Underground Cable Ducts, rigid type DB2, size as indicated.
- .2 Rigid steel galvanized conduit and fittings: to Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.
- .3 Conductors: copper, type RWU-90, to Section 26, size and number of conductors as indicated.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install cables in conduits and ductbanks in accordance with Section 26 05 43 - Installation of Cables in Trenches and in Ducts.
- .2 Allow for adequate clearance of 300mm between duct banks and/or other site services in the vertical or horizontal direction, except for propane allow for 1.5m.
- .3 Allow adequate conductor length for connection to supply by power supply authority.
- .4 Allow adequate conductor length for connection to service equipment.
- .5 Make grounding connections in accordance with Section 26 05 28 - Grounding - Secondary.
- .6 Provide concrete encasement in accordance with CSA A23.1, where indicated on drawings.
- .7 Backfill and compaction required as specified on drawings.
- .8

**END OF SECTION**

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**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 31 00 99 - Earthwork.
- .2 Section 31 14 13 - Soil Stripping and Stockpiling.
- .3 Section 31 23 16.26 - Rock Removal.

**1.2 REFERENCE STANDARDS**

- .1 Canada Labour Code, Part 2, Canada Occupational Health and Safety Regulations.
- .2 Canadian Environmental Protection Act.
- .3 Canadian Environmental Assessment Act.
- .4 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 180, General Specification for the Management of Excess Materials.
- .5 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 833-R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.

**1.3 DEFINITIONS**

- .1 Clearing: consists of cutting off brush vegetative growth to not more than a specified height above ground and disposing of felled trees, stumps, and surface debris.
  - .1 Close-cut clearing: consists of cutting off standing trees, brush, scrub, roots, stumps and embedded logs, removing at, or close to, existing grade and disposing of fallen timber and surface debris.
  - .2 Clearing isolated trees: consists of cutting off to not more than specified height above ground of designated trees, and disposing of felled trees and debris.
  - .3 Underbrush clearing: consists of removal from treed areas of undergrowth, deadwood, and trees smaller than 50 mm trunk diameter and disposing of fallen timber and surface debris.
- .2 Grubbing: consists of excavation and disposal of stumps and roots to not less than specified depth below existing ground surface.
- .3 Erosion: deterioration, displacement, or transportation of land surface by wind or water, intensified by land clearing practices related to construction work.
- .4 Sediment: particulate matter transported and deposited as a layer of solid particles within a body of water.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Submit Site-specific Health and Safety Plan (HSP), within 7 days after date of Notice to Proceed and before mobilization to Site, in accordance with Section 01 35 30. Submit HSP for review and approval by the Consultant.

- .3 Submit Site-specific Environmental Protection Plan (EPP) within 7 days after date of Notice to Proceed and before mobilization to Site, in accordance with Section 01 35 43. Submit EPP for review and approval by the Consultant.
- .4 Submit certificates for tree wound paint and herbicide signed by manufacturer certifying that materials are in compliance with specified performance characteristics and physical properties.

## **1.5 HEALTH AND SAFETY**

- .1 Perform clearing and grubbing work in accordance with the Site-specific HSP recommendations as directed by the Consultant.
- .2 Safety Requirements: worker protection.
  - .1 Ensure workers are wearing gloves, respirators, dust masks, long sleeved clothing, eye protection, protective clothing, safety boots, and safety vests while performing clearing and grubbing activities.
  - .2 Ensure workers are wearing gloves, respirators, dust masks, long sleeved clothing, eye protection, and protective clothing while applying herbicide materials.
  - .3 Ensure that workers are not allowed to eat, drink or smoke while applying herbicide.

## **1.6 QUALITY CONTROL**

- .1 Regulatory Requirements
  - .1 Ensure Work is performed in compliance with CEPA, CEAA and applicable Provincial and Municipal regulations.
  - .2 Comply with hauling and disposal regulations of authority having jurisdiction.
- .2 Qualifications
  - .1 Provide proof of qualifications when requested by the Consultant.
  - .2 Qualification Statement: Contractor have documented proof that they have completed work of similar scope.

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

- .1 Prevent damage to fencing, trees, existing buildings, existing pavement, utility lines, site, appurtenances, water courses, root systems of trees which are to remain.
  - .1 Repair any damaged items to approval of the Consultant.
  - .2 Replace any trees designated to remain, if damaged, as directed by the Consultant.

## **1.8 ENVIRONMENTAL REQUIREMENTS**

- .1 Perform clearing and grubbing work in accordance with the Site-specific recommendations as directed by the Consultant.
- .2 Clean up spills of materials immediately with absorbent material and safely discard to landfill.
- .3 Do not dispose of unused materials into sewer system, into streams, lakes, onto ground or in other location where they will pose health or environmental hazard.

- .4 Ensure safe use and disposal of wood preservatives complies with all Federal, Provincial/Territorial and Municipal regulations, particularly the Canadian Environmental Assessment Act (CEAA), the Canadian Environmental Protection Act, and the Pest Control Products Act.
  - .1 For information and procedures on pest control products, call the Pest Management Information Service at 1-800-267-6315. Ensure that the use and disposal of wood preservatives complies with all departmental regulations, particularly the Environmental Assessment Review Process.
- .5 Waste Management and Disposal:
  - .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19.
  - .2 Consider felled timber from which saw logs, pulpwood, posts, poles, ties, or fuel wood can be produced as saleable timber.
  - .3 Trim limbs and tops and saw into saleable lengths.
  - .4 Manage ash wood mixed with the wood of other species and dispose of as ash wood.
  - .5 Remove soil and stockpile uncontaminated soil material free of debris for reuse as backfill materials.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Ensure that wood preservatives and other pesticides delivered to the Site are registered by Health Canada as part of the Pest Control Products Act.
- .2 Bituminous based paint of standard manufacture specially formulated for tree wounds.
- .3 Herbicide: effective for killing annual and perennial weeds, and bamboo grass, by being absorbed through roots and foliage.
- .4 Soil Material for Fill:
  - .1 Excavated soil material: free of debris, roots, wood, scrap material, vegetable matter, refuse, soft unsound particles, deleterious, or objectionable materials.

## **PART 3 EXECUTION**

### **3.1 PROTECTION**

- .1 Erosion and Sediment Control Measures
  - .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 drawings, sediment and erosion control plan, specific to site, that complies with EPA 833-R-06-004, or requirements of authorities having jurisdiction, whichever is more stringent.
  - .2 Inspect, repair, and maintain temporary erosion and sedimentation control measures during construction until permanent vegetation has been established.
  - .3 Remove temporary erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### **3.2 PREPARATION**

- .1 Inspect site and verify with the Consultant, items designated to remain.
- .2 Locate and protect utility lines: preserve in operating condition active utilities traversing Site.
  - .1 Notify the Consultant immediately of damage to or when unknown existing utility line(s) are encountered.
  - .2 When utility lines which are to be removed are encountered within area of operations, notify the Consultant in ample time to minimize interruption of service.
- .3 Notify utility authorities before starting clearing and grubbing.
- .4 Keep roads and walks free of dirt and debris.

### **3.3 APPLICATION**

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

### **3.4 CLEARING**

- .1 Clearing includes felling, trimming, and cutting of trees into sections and satisfactory disposal of trees and other vegetation designated for removal, including downed timber, snags, brush, and rubbish occurring within cleared areas.
- .2 Clear, as indicated, by cutting at a height of not more than 300 mm above ground. In areas to be subsequently grubbed, height of stumps left from clearing operations to be not more than 500 mm above ground surface.
- .3 Cut down tree overhangs as indicated on Contract Drawings and as directed by the Consultant.
- .4 Cut off unsound branches on trees designated to remain as directed by the Consultant.

### **3.5 CLOSE CUT CLEARING**

- .1 Close cut clearing to within 100 mm of ground surface.
- .2 Cut off branches overhanging area cleared as directed by the Consultant.
- .3 Cut off unsound branches on trees designated to remain as directed by the Consultant.

### **3.6 UNDERBRUSH CLEARING**

- .1 Clear underbrush from areas as indicated to within 100 mm of ground surface.

### **3.7 GRUBBING**

- .1 Grub out all stumps and roots below ground surface as indicated on Contract Drawings and as directed by the Consultant.
- .2 Fill depressions made by grubbing with suitable material and to make new surface conform with existing adjacent surface of ground.



**3.8 REMOVAL AND DISPOSAL**

- .1 Dispose of material in accordance with OPSS.MUNI 180 General Specification for the Management and Disposal of Excess Material.
- .2 Disposal of cleared and grubbed materials by burning will not be permitted.
- .3 Chipped or mulched material shall be disposed off-site.
- .4 Contractor is responsible for monitoring all cut ash wood and firewood until it is properly disposed of as determined by the Consultant.

**3.9 FINISHED SURFACE**

- .1 Leave ground surface in condition suitable for immediate grading operations to approval of the Consultant.

**3.10 CLEANING**

- .1 Perform cleaning in accordance with Section 01 74 00.
- .2 Clean and remove debris and sediment from work area drainage devices and dispose of to an approved landfill site.
- .3 Maintain Work in tidy condition, free from accumulation of waste products and debris.
- .4 Do not clean equipment in the waterbody or where the wash-water can enter the waterbody.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 31 00 99 - Earthwork.
- .2 Section 31 11 00 - Clearing and Grubbing
- .3 Section 31 22 13 - Rough Grading
- .4 Section 31 23 33.01 - Excavation, Trenching and Backfilling.
- .5 Section 32 11 23 - Aggregate Base Courses.

**1.2 REFERENCE STANDARDS**

- .1 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 833-R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.

**PART 2 PRODUCTS**

**2.1 NOT USED**

- .1 Not Used

**PART 3 EXECUTION**

**3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL**

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

**3.2 STRIPPING OF TOPSOIL**

- .1 Ensure that procedures are conducted in accordance with applicable Municipal requirements.
- .2 Remove topsoil before construction procedures commence to avoid compaction of topsoil.
- .3 Handle topsoil only when it is dry and warm.
- .4 Remove vegetation from targeted areas by non-chemical means and dispose of stripped vegetation by composting.
- .5 Remove brush from targeted area by non-chemical means and dispose of through mulching.
- .6 Strip topsoil by scraper to depths as indicated.

- .1 Avoid mixing topsoil with subsoil.
- .7 Pile topsoil by mechanical hoe in berms.
  - .1 Stockpile height not to exceed 2.0 m.
- .8 Dispose of unused topsoil off-site.
- .9 Protect stockpiles from contamination and compaction.
- .10 Cover topsoil that has been piled for long term storage, with trefoil or grass to maintain agricultural potential of soil.

### **3.3 PREPARATION OF GRADE**

- .1 Verify that grades are correct and notify the Consultant if discrepancies occur. Do not begin work until instructed by the Consultant.
  - .1 Grade area only when soil is dry to lessen soil compaction.
  - .2 Grade soil with scrapers establishing natural contours and eliminating uneven areas and low spots, ensuring positive drainage.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 00.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 31 23 33.01 - Excavation, Trenching and Backfilling.
- .2 Section 32 11 23 - Aggregate Base Course.

**1.2 REFERENCE STANDARDS**

- .1 ASTM International
  - .1 ASTM D698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
- .2 Underwriters' Laboratories of Canada (ULC)

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.

**1.4 EXISTING CONDITIONS**

- .1 Examine subsurface investigation report which is available for inspection upon request.
- .2 Known underground and surface utility lines and buried objects are as indicated on site plan.
- .3 Refer to dewatering in Section 31 23 33.01.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Fill material: Granular B Type II, in accordance with Section 31 23 33.01.
- .2 Excavated or graded material existing on site suitable to use as fill for grading work if approved by the Consultant.

**PART 3 EXECUTION**

**3.1 EXAMINATION**

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

**3.2 GRADING**

- .1 Rough grade to levels, profiles, and contours allowing for surface treatment as indicated.

- .2 Rough grade to depths below finish grades as per Drawings.
- .3 Slope rough grade away from building as indicated.
- .4 Grade ditches to depth as indicated.
- .5 Prior to placing fill over existing ground, scarify surface to depth of 150 mm minimum before placing fill over existing ground. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.
- .6 Compact filled and disturbed areas to ASTM D698, as follows:
  - .1 95% SPMDD under paved and walk areas.
- .7 Do not disturb soil within branch spread of trees or shrubs to remain.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.

### **3.4 PROTECTION**

- .1 Protect existing trees, fencing, buildings, pavement, surface or underground utility lines which are to remain as directed by the Consultant. If damaged, restore to original or better condition unless directed otherwise.
- .2 Maintain access roads to prevent accumulation of construction related debris on roads.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 31 22 13 - Rough Grading.
- .2 Section 31 23 33.01 - Excavation, Trenching and Backfill.

**1.2 REFERENCE STANDARDS**

- .1 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 202, Construction Specification for Rock Removal by Manual Scaling, Machine Scaling, Trim Blasting, or Controlled Blasting

**1.3 DEFINITIONS**

- .1 Rock: any solid material in excess of 1.00 m<sup>3</sup> and which cannot be removed by means of heavy-duty mechanical excavating equipment with 0.95 to 1.15 m<sup>3</sup> bucket. Frozen material not classified as rock.
- .2 PPV: peak particle velocity.

**1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Place materials defined as hazardous or toxic in designated containers in accordance with Section 01 74 19.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Not Used.

**PART 3 EXECUTION**

**3.1 ROCK REMOVAL**

- .1 Perform excavation in accordance with Erosion and Sedimentation Control Plan.
- .2 Co-ordinate this Section with Section 01 35 30.
- .3 Remove rock required to complete all work at alignments, profiles, and cross sections as indicated.
- .4 Explosive blasting is not permitted.
- .5 Use rock removal procedures to produce uniform and stable excavation surfaces. Minimize over break, and to avoid damage to adjacent structures.
- .6 Excavate trenches to lines and grades to minimum of 150 mm below pipe invert indicated. Provide recesses for bell and spigot pipe to ensure bearing will occur uniformly along barrel of pipe.
- .7 Cut trenches to widths as indicated.
- .8 Remove boulders and fragments which may slide or roll into excavated areas.
- .9 Correct unauthorized rock removal at no extra cost.

**3.2 CLEANING**

- .1 Clean in accordance with Section 01 74 00.
- .2 Rock Disposal:
  - .1 Dispose of removed rock off site in accordance with Section 01 74 19.
  - .2 Do not dispose removed rock into landfill. Send material to appropriate quarry or location as approved by the Consultant.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.

**END OF SECTION**

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**PART 1        GENERAL**

**1.1            RELATED REQUIREMENTS**

- .1      Section 02 41 13 - Selective Site Demolition.
- .2      Section 31 05 16 - Aggregate for Earthwork.
- .3      Section 31 22 13 - Rough Grading.
- .4      Section 31 23 16.26 - Rock Removal.
- .5      Section 32 91 19.13 - Topsoil Placement & Grading.
- .6      Section 32 11 16.01 - Granular Sub-Base.
- .7      Section 32 11 23 - Aggregate Base Courses.
- .8      Section 33 42 13 - Stormwater Culverts

**1.2            REFERENCE STANDARDS**

- .1      American Society for Testing and Materials (ASTM)
  - .1      ASTM C 117-17, Standard Test Method for Material Finer Than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
  - .2      ASTM C136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .3      ASTM D 698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>) (600 kN-m/m<sup>3</sup>).
  - .4      ASTM D 1557-02e1, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup>) (2,700 kN-m/m<sup>3</sup>).
  - .5      ASTM D 4318-17e1, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2      Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1      OPSS.MUNI 401, Construction Specification for Trenching, Backfilling, and Compacting.
  - .2      OPSS.MUNI 410, Construction Specification for Pipe Sewer Installation in Open Cut.
  - .3      OPSS.MUNI 1004, Material Specification for Aggregates - Miscellaneous.
  - .4      OPSS.MUNI 1010, Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material.
- .3      CSA Group (CSA)
  - .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      CAN/CSA-A23.1/A23.2-19, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .4      Canadian General Standards Board (CGSB)
  - .1      CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .5      U.S. Environmental Protection Agency (EPA)/Office of Water



- .1 EPA 833-R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.

### 1.3 DEFINITIONS

- .1 Excavation classes: two classes of excavation will be recognized; common excavation and rock excavation.
- .1 Rock: solid material in excess of 1.00 m<sup>3</sup> and which cannot be removed by means of heavy-duty mechanical excavating equipment with 0.95 to 1.15 m<sup>3</sup> bucket. Frozen material not classified as rock.
- .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.
- .2 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .3 Topsoil:
- .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
- .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .4 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .5 Borrow material: material obtained from locations outside area to be graded and required for construction of fill areas or for other portions of Work.
- .6 Recycled fill material: material, considered inert, obtained from alternate sources and engineered to meet requirements of fill areas.
- .7 Unsuitable materials:
- .1 Weak and compressible materials under excavated areas.
- .2 Frost susceptible materials under excavated areas.
- .3 Frost susceptible materials:
- .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D 4318, and gradation within limits specified when tested to ASTM D 422 and ASTM C 136: Sieve sizes to 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.
- .4 Unshrinkable fill: very weak mixture of Portland cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being readily excavated.

### 1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

- .2 Quality Control: in accordance with Section 01 45 00:
  - .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
  - .2 Submit for review by the Consultant proposed dewatering methods as described and sediment control methods as described in PART 3 of this Section.
  - .3 Submit to the Consultant written notice at least 7 days prior to excavation work.
  - .4 Submit to the Consultant written notice when bottom of excavation is reached.
  - .5 Submit to the Consultant testing and inspection results as described in PART 3 of this Section.
- .3 Preconstruction Submittals:
  - .1 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field, clearance record from utility authorities, location plan of relocated and abandoned services, as required.

## **1.5 QUALITY ASSURANCE**

- .1 Qualification Statement: submit proof of insurance coverage for professional liability.
- .2 Submit design and supporting data at least 2 weeks prior to beginning Work.
- .3 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in Ontario, Canada.
- .4 Keep design and supporting data on site.
- .5 Engage services of qualified professional engineer who is registered or licensed in Ontario, Canada in which Work is to be carried out to design and inspect cofferdams, shoring, bracing and underpinning required for Work.
- .6 Do not use soil material until written report of soil test results are reviewed and approved by the Consultant.
- .7 Health and Safety Requirements:
  - .1 Construction occupational health and safety in accordance with Section 01 35 30.

## **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for reuse and recycling in accordance with Section 01 74 19.
- .2 Divert excess aggregate materials from landfill to local quarry or recycling facility for reuse as directed by the Consultant.

## **1.7 EXISTING CONDITIONS**

- .1 Existing buried utilities and structures:
  - .1 Before commencing work verify and establish location of buried services on and adjacent to site.
  - .2 Arrange with appropriate authority for relocation of buried services that interfere with execution of work: pay costs of relocating services.
  - .3 Remove obsolete buried services within 2 m of foundations: cap cut-offs.
  - .4 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.

- .5 Prior to commencing excavation Work, notify applicable Owner or authorities having jurisdiction, establish location and state of use of buried utilities and structures. Owners or authorities having jurisdiction to clearly mark such locations to prevent disturbance during Work.
- .6 Confirm locations of buried utilities by careful test excavations.
- .7 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
- .8 Where utility lines or structures exist in area of excavation but had not been identified on the drawings, obtain direction of Engineer before removing or re-routing. Costs for such Work to be paid by Owner.
- .9 Record location of maintained, re-routed and abandoned underground lines.
- .10 Confirm locations of recent excavations adjacent to area of excavation.
- .2 Existing buildings and surface features:
  - .1 Conduct, with the Consultant, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey benchmarks 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 the Consultant.
  - .3 Where required for excavation, cut roots or branches as directed by the Consultant.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Granular A material to OPSS.MUNI 1010.
- .2 Granular B material, Type II to OPSS.MUNI 1010.
- .3 Select sub-grade material to OPSS.MUNI 1010. Any imported sub-grade backfill (earth fill) must be managed in accordance with Ontario Regulation 406/19 including the sampling frequency and types of analysis at the source site(s). The soil quality of the imported earth fill to be used at the site must meet as a minimum Table 3.1 of the Excess Soil Quality Standards.
- .4 Geotextiles: to Section 31 32 19.16.

## **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 and Environmental Protection specification.
- .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.

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### **3.2 SITE PREPARATION**

- .1 Protect existing features in accordance with Section 01 56 00 and applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.
- .4 Where soil is subject to significant volume change due to change in moisture content, cover and protect to the Consultant approval.
- .5 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.
- .6 Protect buried services that are required to remain undisturbed.

### **3.3 STOCKPILING**

- .1 Existing granular fill material shall be excavated and stockpiled. If the material is deemed acceptable following geotechnical review, the stockpiled granular fill shall be reused within the utility trench.
  - .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.

### **3.4 SHORING, BRACING AND UNDERPINNING**

- .1 Protect existing features in accordance with applicable local regulations.
- .2 Engage services of qualified professional engineer who is registered or licensed in the province of Ontario, Canada in which work is to be carried out to design and inspect shoring, bracing and underpinning required for work.
- .3 Submit design and supporting data at least 2 weeks prior to commencing work.
- .4 Design and supporting data submitted to bear stamp and signature of qualified professional engineer registered or licensed in the province of Ontario, Canada.

### **3.5 DEWATERING AND HEAVE PREVENTION**

- .1 Keep excavations free of water while work is in progress.
- .2 Avoid excavation below groundwater table if quick condition or heave is likely to occur. Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .3 Provide temporary drainage and pumping facilities to keep excavations and site free from standing water.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in accordance with Section 01 35 43 and in a manner not detrimental to public and private property, or any portion of Work completed or under construction.
  - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits as required.

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### **3.6 EXCAVATION**

- .1 Excavate to lines, grades, elevations and dimensions as indicated or as directed by the Consultant.
- .2 If soils with visual and/or olfactory evidence of contamination not previously identified within this document are observed during construction, the contractor shall contact the Consultant immediately. Determining the soil management procedures for these soils shall be handled as required on an incident basis, with close involvement of the contractor and the Consultant.
- .3 Remove concrete, paving, walks and other obstructions encountered during excavation.
- .4 Excavation must not interfere with bearing capacity of adjacent foundations.
- .5 Dispose of surplus and unsuitable excavated material off site.
- .6 Do not obstruct flow of surface drainage or natural watercourses.
- .7 For trench excavation, unless otherwise authorized by the Consultant in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
- .8 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .9 Obtain the Consultant's approval of completed excavation.
- .10 Remove unsuitable material from trench bottom to extent and depth as directed by the Consultant.
- .11 Correct unauthorized over-excavation as follows:
  - .1 Fill under areas with Granular B Type II compacted to not less than 95% SPMDD.
- .12 Install geotextiles in accordance with Section 31 12 19.16.
- .13 All open excavations shall be protected from freezing.

### **3.7 EXCAVATION FOR UTILITY TRENCH**

- .1 Material excavated from the utility trench shall be stockpile for reuse on-site. Refer to drawings for fill placement and stockpiling requirements.

### **3.8 BEDDING AND SURROUND OF UNDERGROUND SERVICES**

- .1 Place and compact granular A material for bedding and surround of underground services per detail drawings. Cover material to extend above pipe obvert as indicated.
- .2 Place bedding and surround material in unfrozen condition.

### **3.9 BACKFILLING**

- .1 Do not proceed with backfilling operations until the Consultant has inspected and approved installations as follows:
  - .1 The Consultant has inspected and approved installations.
  - .2 The Consultant has inspected and approved of construction below finish grade.
  - .3 Inspection, testing, approval, and recording location of underground utilities.
  - .4 Removal of concrete formwork.
- .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 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .5 Install drainage system in backfill as indicated.

**3.10 RESTORATION**

- .1 Upon completion of Work, remove waste materials and debris in accordance with Section 01 74 19. Trim slopes and correct defects as directed by the Consultant.
- .2 Replace topsoil as indicated.
- .3 Reinstall lawns to elevation which existed before excavation.
- .4 Reinstall pavements and sidewalks disturbed by excavation to thickness, structure and elevation which existed before excavation.
- .5 Clean and reinstall areas affected by Work as directed by the Consultant.
- .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 31 23 33.01 - Excavating, Trenching and Backfilling.

**1.2 REFERENCE STANDARDS**

- .1 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 1860, Material Specification for Geotextiles.

**1.3 DELIVERY AND STORAGE**

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 and manufacturer's written instructions.
- .2 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect geotextiles from direct sunlight and UV rays.
  - .3 Replace defective or damaged materials with new.

**PART 2 PRODUCTS**

**2.1 MATERIAL**

- .1 Geotextile: Class I non-woven synthetic fibre fabric, supplied in rolls, in accordance with OPSS.MUNI 1860.

**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 geotextile material installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of the Consultant.
  - .2 Inform the Consultant of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Consultant.

**3.2 INSTALLATION**

- .1 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.
- .2 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.
- .3 Overlap each successive strip of geotextile 500 mm over previously laid strip.

- .4 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.
- .5 After installation, cover with overlying layer within 4 hours of placement.
- .6 Replace damaged or deteriorated geotextile to approval of the Consultant.
- .7 Place and compact soil layers in accordance with Section 31 23 33.01.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.4 PROTECTION**

- .1 Vehicular traffic not permitted directly on geotextile.
- .2 Do not overload soil or aggregate covering on geotextile.

**END OF SECTION**



**PART 1 GENERAL**

**1.1 RELATED SECTIONS**

- .1 Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Section 31 32 19.16 - Geotextiles.

**1.2 REFERENCE STANDARDS**

- .1 CSA Group (CSA)
  - .1 CAN/CSA-A23.1-19, Concrete Materials and Methods of Concrete Construction.
  - .2 CAN/CSA-A3000-18, Cementitious Materials Compendium.
- .2 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 1004, Ontario Provincial Standard Specification, Material Specification for Aggregates – Miscellaneous.

**1.3 MEASUREMENT AND PAYMENT**

- .1 The requirement for rip-rap will not be measured separately for payment and shall be included in the Contract lump sum price.

**PART 2 PRODUCTS**

**2.1 STONE**

- .1 Hard, dense with relative density (formally specific gravity) not less than 2.65, durable quarry stone, free from seams, cracks or other structural defects, to meet following size distribution for use intended as per OPSS.MUNI 1004 R-10:
  - .1 Remaining percentage of total volume to have uniform distribution of stones between 5 and 15 dm<sup>3</sup>.
- .2 Rip rap shall be irregular stone having a minimum dimension not less than 100 mm in any one direction to meet size requirements as indicated on Drawings and in accordance with OPSS.MUNI 1004.

**2.2 GEOTEXTILE FILTER**

- .1 Geotextile: in accordance with Section 31 32 19.16.

**PART 3 EXECUTION**

**3.1 PLACING**

- .1 Where rip-rap is to be placed on slopes, excavate trench at toe of slope to dimensions as indicated.
- .2 Fine grade area to be rip-rapped to uniform, even surface. Fill depressions with suitable material and compact to provide firm bed.
- .3 Place geotextile on prepared surface in accordance with Section 31 32 19.16 and as indicated. Avoid puncturing geotextile. Vehicular traffic over geotextile not permitted.

- .4 Place rip-rap to thickness and details as indicated.
- .5 Place stones in manner approved by the Consultant to secure surface and create a stable mass. Place larger stones at bottom of slopes.
- .6 Hand placing:
  - .1 Use larger stones for lower courses and as headers for subsequent courses.
  - .2 Stagger vertical joints and fill voids with rock spalls or cobbles.
  - .3 Finish surface evenly, free of large openings and neat in appearance.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 31 23 33.01 - Excavating, Trenching & Backfilling.
- .2 Section 32 11 23 - Aggregate Base Courses.

**1.2 REFERENCE STANDARDS**

- .1 ASTM International
  - .1 ASTM C 117-17, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
  - .2 ASTM C 131/C131M-20, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - .3 ASTM C 136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .4 ASTM D 698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600kN-m/m<sup>3</sup>)).
  - .5 ASTM D 1557-12, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700kN-m/m<sup>3</sup>)).
  - .6 ASTM D 1883-16, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
  - .7 ASTM D 4318-17e1, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 1001, Material Specification for Aggregates - General.
  - .2 OPSS.MUNI 1004, Material Specification for Aggregates - Miscellaneous.
  - .3 OPSS.MUNI 1010, Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.
- .2 Submit to the Consultant, the gradation analysis at least 2 weeks before delivering to site.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Granular sub-base: Granular B, Type II as per OPSS.MUNI 1010.

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**PART 3 EXECUTION**

**3.1 EXAMINATION**

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

**3.2 PREPARATION**

- .1 Erosion and Sediment Control Measures
  - .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 drawings, sediment and erosion control plan, specific to site, that complies with EPA 833-R-06-004, or requirements of authorities having jurisdiction, whichever is more stringent.
  - .2 Inspect, repair, and maintain temporary erosion and sedimentation control measures during construction until permanent vegetation has been established.
  - .3 Remove temporary erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

**3.3 PROOF ROLLING**

- .1 For proof rolling use standard roller of 45,400 kg gross mass with four pneumatic tires each carrying 11,350 kg and inflated to 620 kPa. Four tires arranged abreast with centre-to-centre spacing of 730 mm maximum.
- .2 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- .3 Where proof rolling reveals areas of defective subgrade:
  - .1 Remove sub-base and subgrade material to depth and extent as directed by the Consultant.
  - .2 Backfill excavated subgrade with suitable select subgrade material in accordance with OPSS.MUNI 1010.
  - .3 Replace sub-base material and compact.

**3.4 PLACING**

- .1 Place granular sub-base after proof rolling. Place granular sub-base after subgrade is inspected and approved by the Consultant.
- .2 Construct granular sub-base to depth and grade in areas indicated.
- .3 Ensure no frozen material is placed.
- .4 Place material only on clean unfrozen surface, free from snow or ice.
- .5 Place granular sub-base materials using methods which do not lead to segregation or degradation.

- .6 Place material to full width in uniform layers not exceeding 150 mm compacted thickness. the Consultant 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 portion of layer in which material has become segregated during spreading.
- .9 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

### **3.5 COMPACTION**

- .1 Compaction equipment must be capable of obtaining required densities in materials on project.
- .2 Compact to density of not less than 100% SPMDD.
- .3 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.
- .4 Apply water as necessary during compaction to obtain specified density.
- .5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by the Consultant.
- .6 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

### **3.6 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Waste Management: separate waste materials for Reuse and recycling in accordance with Section 01 74 19.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.7 SITE TOLERANCES**

- .1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

### **3.8 PROTECTION**

- .1 Maintain finished sub-base in condition conforming to this section until succeeding base is constructed, or until granular sub-base is accepted by the Consultant.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 32 11 16.01 - Granular Sub-Base.
- .2 Section 32 16 00 - Curbs, Gutters and Sidewalks.

**1.2 REFERENCE STANDARDS**

- .1 ASTM International
  - .1 ASTM C 117-17, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
  - .2 ASTM C 131/C131M-20, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - .3 ASTM C 136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .4 ASTM D 698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600kN-m/m<sup>3</sup>)).
  - .5 ASTM D 1557-12, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700kN-m/m<sup>3</sup>)).
  - .6 ASTM D 1883-16, Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
  - .7 ASTM D 4318-17e1, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 1001, Material Specification for Aggregates - General.
  - .2 OPSS.MUNI 1004, Material Specification for Aggregates - Miscellaneous.
  - .3 OPSS.MUNI 1010, Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.
- .2 Submit to the Consultant, the gradation analysis at least 2 weeks before delivering to site.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Granular base: Granular 'A' to OPSS.MUNI 1010.

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**PART 3 EXECUTION**

**3.1 PREPARATION**

- .1 Erosion and Sediment Control Measures
  - .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 drawings, sediment and erosion control plan, specific to site, that complies with EPA 833-R-06-004, or requirements of authorities having jurisdiction, whichever is more stringent.
  - .2 Inspect, repair, and maintain temporary erosion and sedimentation control measures during construction until permanent vegetation has been established.
  - .3 Remove temporary erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

**3.2 PLACEMENT AND INSTALLATION**

- .1 Place granular base after sub-base surface is inspected and approved by the Consultant.
- .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 Place material using methods which do not lead to segregation or degradation of aggregate.
  - .5 Place material to full width in uniform layers not exceeding 150 mm compacted thickness.
  - .6 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
  - .7 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .3 Compaction Equipment:
  - .1 Compaction equipment to be capable of obtaining required material densities.
- .4 Compacting:
  - .1 Compact to density not less than 100% SPMDD.
  - .2 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
  - .3 Apply water as necessary during compacting to obtain specified density.
  - .4 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by the Consultant.

**3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.

- .3 Waste Management: separate waste materials for Reuse and recycling in accordance with Section 01 74 19.

- .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.4 SITE TOLERANCES**

- .1 Finished sub-base surface to be within 10 mm of elevation as indicated but not uniformly high or low.

### **3.5 PROTECTION**

- .1 Maintain finished sub-base in condition conforming to this section until succeeding material is applied or until acceptance by the Consultant.

**END OF SECTION**



**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 32 12 16.01 - Asphalt Paving.

**1.2 REFERENCE STANDARDS**

- .1 American Association of State Highway and Transportation Officials (AASHTO)
  - .1 AASHTO M081-92-UL-04, Standard Specification for Cutback Asphalt (Rapid-Curing Type).
- .2 ASTM International
  - .1 ASTM D140/D140M-16, Standard Practice for Sampling Bituminous Materials.
  - .2 ASTM D633-11, Standard Volume Correction Table for Road Tar.
  - .3 ASTM D1250-19e1, Standard Guide for Use of the Petroleum Measurement Tables.
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB 16.2-M89 (Withdrawn), Emulsified Asphalts, Anionic Type, for Road Purposes.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4 QUALITY ASSURANCE**

- .1 Upon request from the Consultant, submit manufacturer's test data and certification that asphalt prime material meets requirements of this Section.

**1.5 DELIVERY, STORAGE AND HANDLING**

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in dry location and in accordance with manufacturer s recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect asphalt tack coats from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.
- .4 Deliver, store and handle materials in accordance with ASTM D140.
- .5 Provide, maintain and restore asphalt storage area.

## **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate waste materials for recycling in accordance with Section 01 74 19.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Anionic emulsified asphalt: to OPSS.MUNI 1103, grade: SS-1.
- .2 Cut-back asphalt; to AASHTO M081-92-UL, grade RC-70 or RC-250.
- .3 Water: clean, potable, free from foreign matter.

### **2.2 EQUIPMENT**

- .1 Equipment required for Work of this Section to be in satisfactory working condition and maintained for duration of Work.
- .2 Pressure distributor:
  - .1 Designed, equipped, maintained and operated so that asphalt material can be:
    - .1 Maintained at even temperature.
    - .2 Applied uniformly on variable widths of surface up to 5 m.
    - .3 Applied at readily determined and controlled rates from 0.2 to 5.4 L/m<sup>2</sup> with uniform pressure, and with allowable variation from any specified rate not exceeding 0.1 L/m<sup>2</sup>.
    - .4 Distribute in uniform spray without atomization at temperature required.
  - .2 Equipped with meter, registering travel in metres per minute, visibly located to enable truck driver to maintain constant speed required for application at specified rate.
  - .3 Equipped with pump having flow metre graduated in units of 5 L or less per minute passing through nozzles and readily visible to operator. Pump power unit to be independent of truck power unit.
  - .4 Equipped with easily read, accurate and sensitive device which registers temperature of liquid in reservoir.
    - .1 Measure temperature to closest whole number.
  - .5 Equipped with accurate volume measuring device or calibrated tank.
  - .6 Equipped with nozzles of same make and dimensions, adjustable for fan width and orientation.
  - .7 Equipped with nozzle spray bar, with operational height adjustment in increments of 0.6 metres and capable of being raised or lowered.
  - .8 Cleaned if previously used with incompatible asphalt material.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

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

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

### **3.2 APPLICATION**

- .1 Apply asphalt tack coat only on clean and dry surface.
- .2 Dilute asphalt emulsion with water at 1:1 ratio for application.
  - .1 Mix thoroughly by pumping or other method approved by the Consultant.
- .3 Apply asphalt tack coat evenly to pavement surface at rate as directed by the Consultant.
- .4 Paint contact surfaces of curbs, gutters, headers, maintenance holes and like structures with thin, uniform coat of asphalt tack coat material.
- .5 Apply asphalt tack coat only when air temperature greater than 10 degrees C and when rain is not forecast within 2 hours minimum of application.
- .6 Apply asphalt tack coat only on unfrozen surface.
- .7 Evenly distribute localized excessive deposits of tack coat by brooming as directed by the Consultant.
- .8 Where traffic is to be maintained, treat no more than one half of width of surface in one application.
  - .1 Control traffic in accordance with Section 01 55 26.
- .9 Keep traffic off tacked areas until asphalt tack coat has set.
- .10 Re-tack contaminated or disturbed areas as directed by the Consultant.
- .11 Permit asphalt tack coat to set before placing asphalt pavement.
- .12 Inspect tack coat application to ensure uniformity.
  - .1 Re-spray areas of insufficient or non-uniform tack coat coverage as directed by the Consultant.
  - .2 Ensure tack coating performed using handheld devices is consistent in appearance with adjacent areas of machine applied material.

### **3.3 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 02 41 13 - Selective Site Demolition
- .2 Section 31 05 16 - Aggregate For Earthwork

**1.2 REFERENCE STANDARDS**

- .1 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.5-M91, Low Flash Petroleum Spirits Thinner.
  - .2 CAN/CGSB-1.74-2001, Alkyd Traffic Paint.
- .2 ASTM International
  - .1 ASTM C 88/C88M-18, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate.
  - .2 ASTM C 117-17, Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
  - .3 ASTM C123/C123M-14, Standard Test Method for Lightweight Particles in Aggregate.
  - .4 ASTM C 127-15, Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
  - .5 ASTM C 131/C131M-20, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
  - .6 ASTM C 136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .7 ASTM D 698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600kN-m/m<sup>3</sup>)).
- .3 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 302, Construction Specification for Primary Granular Base.
  - .2 OPSS.MUNI 310, Construction Specification for Hot Mix Asphalt.
  - .3 OPSS.MUNI 314, Construction Specification for Untreated Granular, Sub-base, Base, Surface Shoulder and Stockpiling.
  - .4 OPSS.MUNI 1010, Material Specification for Aggregates, Sub-base, Select Subgrade, and Backfill Material.
  - .5 OPSS.MUNI 1103, Material Specification for Emulsified Asphalt.
  - .6 OPSS.MUNI 1151, Material Specification for Superpave and Stone Mastic Asphalt Mixtures.
- .4 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 833-R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.

- .2 Submit manufacturer's instructions, printed product literature and data sheets for asphalt mixes and aggregate and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
  - .1 Inform the Consultant of proposed source of aggregates and provide access for sampling 4 weeks prior to beginning Work.

#### **1.4 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with Section 01 74 19.

### **PART 2 PRODUCTS**

#### **2.1 MATERIALS**

- .1 Aggregates to: OPSS.MUNI 1010.
  - .1 Granular A.
  - .2 Granular B Type II.
  - .3 Select subgrade.
- .2 Prime coat: SS-1 to OPSS.MUNI 1103.
- .3 Asphalt: Superpave 12.5 and Superpave 19.0 with thickness and lifts as per drawings.
- .4 Tack coat: SS-1 to OPSS.MUNI 1103.
- .5 Asphalt concrete: to OPSS.MUNI 1151.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

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

#### **3.2 PAVEMENT THICKNESS**

- .1 Pavement structure for roadways and parking lots as per the Contract Drawings.

#### **3.3 PAVEMENT CONSTRUCTION**

- .1 Application of tack coat: OPSS.MUNI 1103. Apply only on clean and dry surface. Paint contact surfaces of curbs, gutters, milled asphalt, manholes and like structures with thin, uniform coat of asphalt tack coat material.
- .2 Construction of asphalt concrete: OPSS.MUNI 310.

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**3.4 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.
  - .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 30 00 - Cast-in-Place Concrete.
- .3 Section 31 05 16 - Aggregate for Earthwork.
- .4 Section 32 11 23 - Aggregate Base Course
- .5 Section 31 23 33.01 - Excavating, Trenching and Backfilling.

**1.2 REFERENCE STANDARDS**

- .1 ASTM International
  - .1 ASTM C309-19, Liquid Membrane Forming Compounds for Curing Concrete.
  - .2 ASTM D1751-18, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
  - .3 ASTM D698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600kN-m/m<sup>3</sup>)).
- .2 CSA Group
  - .1 CSA-A23.1-14/A23.2-19, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete, Including Update No. 1.
  - .2 Delivery, CSA B651-18 Accessible Design for the Built Environment.
- .3 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.MUNI 1010, Material Specification for Aggregates - Base, Subbase, Select Subgrade, and Backfill Material.
  - .2 OPSS.PROV 1350, Material Specification for Concrete - Materials and Production.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submittals in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit WHMIS SDS in accordance with Section 01 47 15 and Section 02 81 00.
  - .2 Submit manufacturer's printed product literature, specifications and datasheet and include product characteristics, and limitations.
- .3 Inform the Consultant of proposed source of materials and provide access for sampling minimum 4 weeks prior to commencing work.

**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 19.

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## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Concrete mixes and materials: in accordance with OPSS.MUNI 1350 and Section 03 30 00. Compressive Strength: 32 MPa.
- .2 Curing Compound: in accordance with Section 03 30 00.
- .3 Granular base: Granular A material as per Section 32 11 23 requirements and OPSS.MUNI 1010.
- .4 Non-staining mineral type form release agent: chemically active release agents containing compounds reacting with free lime to provide water-soluble soap.
- .5 Fill material: to OPSS.MUNI 1010.
- .6 Curing Agent: to ASTM C309, Type I.
- .7 Expansion Joint Filler: Pre-moulded bituminous fibre board, conforming to ASTM D1751.
- .8 Tactile Walking Surface Indicators: Cast iron with truncated domes to CSA B651.

## **PART 3 EXECUTION**

### **3.1 GRADE PREPARATION**

- .1 Do grade preparation work in accordance with Section 31 23 33.01.
- .2 Construct embankments using excavated material free from organic matter or other objectionable materials.
  - .1 Dispose of surplus and unsuitable excavated material off site.
- .3 When constructing embankment provide for minimum 0.6 m shoulders, where applicable, outside of neat lines of concrete.
- .4 Place fill in maximum 150 mm layers and compact to at least 95% SPMDD to ASTM D698.

### **3.2 GRANULAR BASE**

- .1 Obtain the Consultant'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 a single 150 mm thick layer to minimum 95% SPMDD to ASTM D698.

### **3.3 CONCRETE**

- .1 Obtain the Consultant's approval of granular base prior to placing concrete.
- .2 Do concrete work in accordance with Section 03 30 00.
- .3 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 centre line.
- .4 Provide edging as indicated with 10 mm radius edging tool.



- .5 Slip-form pavers equipped with string line system for line and grade control may be used if quality of work acceptable to the Consultant can be demonstrated. Hand finish surfaces when directed by the Consultant.

### **3.4 TOLERANCES**

- .1 Finish surfaces to within 3 mm in 3 m as measured with 3 m straightedge placed on surface.

### **3.5 EXPANSION AND CONTRACTION JOINTS**

- .1 Install tooled transverse contraction joints after floating, when concrete is stiff, but still plastic, at intervals of 1.5 m.
- .2 Install expansion joints at intervals of 6 m.
- .3 When sidewalk is adjacent to curb, make joints of curb, gutters and sidewalk coincide.

### **3.6 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 Install joint filler in isolation joints in accordance with Section 03 30 00.
- .3 Seal isolation joints with sealant approved by the Consultant.

### **3.7 TACTILE WALKING SURFACE INDICATORS**

- .1 Install tactile walking surface indicators at curb ramp edges, as indicated and in accordance with OPSD 310.033.

### **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 the Consultant.
- .2 Where burlap is used for moist curing, place two prewetted layers on concrete surface and keep continuously wet during curing period.
- .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 the Consultant.
  - .1 Compact and shape to required contours as indicated.

### **3.10 CLEANING**

- .1 Proceed in accordance with Section 01 74 19.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 32 12 16.01 - Asphalt Paving.

**1.2 REFERENCE STANDARDS**

- .1 ASTM International
  - .1 ASTM E 1360-05, Standard Practice for Specifying Color by Using the Optical Society of America Uniform Color Scales System.
  - .2 ASTM D 4797-17, Standard Test Methods for Chemical and Gravimetric Analysis of White and Yellow Thermoplastic Pavement Marking.
- .2 Environment Canada (EC)
  - .1 Volatile Organic Compound (VOC) Concentration Limits for Architectural Coatings Regulations, SOR/2009-264.
- .3 Green Seal (GS)
  - .1 GS-11-Edition 3.2, Standard for Paints and Coatings.
- .4 Health Canada/Workplace Hazardous Materials Information System (WHMIS)
  - .1 Safety Data Sheets (SDS).
- .5 Master Painters Institute (MPI)
  - .1 Architectural Painting Specification Manual
    - .1 MPI #32, Traffic Markings Paint, Alkyd.
    - .2 MPI #97, Latex Traffic Marking Paint.
- .6 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  - .1 OPSS.PROV 710, Construction Specification for Pavement Markings.
  - .2 OPSS.PROV 1712, Material Specification for Organic Solvent Based Traffic Paint.
  - .3 OPSS.PROV 1750, Traffic Paint Reflectorizing Glass Beads.

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit samples in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature and data sheets for pavement markings and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit 2 copies of WHMIS SDS in accordance with Section 01 35 30 and Section 01 35 43.

**1.4 DELIVERY, STORAGE AND HANDLING**

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

- .3 Storage and Handling Requirements:
  - .1 Store materials off ground, indoors, in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Store and protect specified materials from nicks, scratches, and blemishes.
  - .3 Replace defective or damaged materials with new.

## **PART 2 PRODUCTS**

### **2.1 MATERIALS**

- .1 Traffic Paint and Markings:
  - .1 To OPSS.PROV 1712.
  - .2 Colour: to CGSB 1-GP-12C:
    - .1 White 513-301.
    - .2 Yellow 33538 - Shall match the yellow paint chip of the Ministry of Transportation of Ontario.
- .2 Thinner: to CAN/CGSB-1.5.
- .3 Glass reflective beads: to OPSS.PROV 1750, type suitable for application to wet paint surface for light reflectance.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION:**

- .1 Verification of Conditions: verify conditions of substrates and surfaces to receive pavement markings acceptable for product installation in accordance with MPI instructions prior to pavement markings application
  - .1 Visually inspect substrate in presence of the Consultant.
- .2 Pavement surface: dry, free from water, frost, ice, dust, oil, grease and other deleterious materials.
- .3 Proceed with Work only after unacceptable conditions rectified.

### **3.2 EQUIPMENT REQUIREMENTS**

- .1 Paint applicator: approved pressure type with positive shut-off distributor capable of applying paint in single, double and dashed lines and capable of applying marking components uniformly, at rates specified, and to dimensions as indicated.
- .2 Distributor: capable of applying reflective glass beads as overlay on freshly applied paint.

### **3.3 APPLICATION**

- .1 Pavement markings in accordance with Contract Drawings and OPSS.PROV 710.
- .2 Unless otherwise approved by the Consultant, apply paint only when air temperature is above 10°C, wind speed is less than 60 km/h and no rain is forecast within next 4h.
- .3 Do not thin paint unless approved by the Consultant.
- .4 Symbols and letters to conform to dimensions indicated.

- .5 Paint lines to be of uniform colour and density with sharp edges.
- .6 Thoroughly clean distributor tank before refilling with paint of different colour.
- .7 Apply glass beads to painted area immediately after application of paint.

### **3.4 TOLERANCE**

- .1 Paint markings to be within plus or minus 12 mm of dimensions indicated.

### **3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.
  - .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 00.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.
  - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

### **3.6 PROTECTION**

- .1 Protect pavement markings until dry.
- .2 Repair damage to adjacent materials caused by pavement marking application.

**END OF SECTION**

**PART 1 GENERAL**

**1.1 RELATED REQUIREMENTS**

- .1 Section 31 14 13 - Soil Stripping and Stockpiling

**1.2 REFERENCE STANDARDS**

- .1 Agriculture and Agri-Food Canada
  - .1 The Canadian System of Soil Classification.
- .2 Canadian Council of Ministers of the Environment (CCME)
  - .1 PN1340- 2005, Guidelines for Compost Quality.
- .3 United States Environmental Protection Agency (EPA), Office of Water.
  - .1 EPA-833-R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.
- .4 Canadian Society of Landscape Architects (CSLA)/Canadian Nursery Landscape Association (CNLA)
  - .1 Canadian Landscape Standard 2016.
  - .2 Canadian Nursery Stock Standard.
- .5 Ontario Provincial Standards (OPS)
  - .1 OPSS.MUNI 802, Construction Specification for Topsoil.
  - .2 OPSS.MUNI 803, Construction Specification for Sodding.
  - .3 OPSS.MUNI 804, Construction Specification for Seed and Cover

**1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Certificates: submit product certificates signed by manufacturer certifying materials comply with specified performance criteria and physical requirements.
- .3 Topsoil and seed mixes to be provided to the Consultant 4 weeks prior to beginning Work.

**PART 2 PRODUCTS**

**2.1 MATERIALS**

- .1 Topsoil shall be in accordance with OPSS.MUNI 802
- .2 Seed mix shall be Standard Roadside Mix per OPSS.MUNI 804 Table 1
- .3 Sod shall be a Commercial Grade Turfgrass Nursery Sod, Kentucky Bluegrass, in accordance with OPSS.MUNI 803.

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**PART 3 EXECUTION**

**3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL:**

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
  - .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
  - .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- .1 Strip topsoil per Section 31 14 13 - Soil Stripping and Stockpiling

**3.2 PREPARATION OF EXISTING GRADE**

- .1 Verify that grades are correct.
- .1 If discrepancies occur, notify the Consultant, and do not start work until instructed by the Consultant.
- .2 Grade soil, eliminate uneven areas and low spots, ensure positive drainage.
- .3 Remove debris, roots, branches, stones in excess of 50 mm diameter and other deleterious materials.
- .1 Remove soil contaminated with calcium chloride, toxic materials, and petroleum products.
  - .2 Remove debris which protrudes more than 75 mm above surface.
  - .3 Dispose of removed material off site.
- .4 Cultivate entire area which is to receive topsoil to minimum depth of 150 mm.
- .1 Cross cultivate those areas where equipment used for hauling and spreading has compacted soil.

**3.3 PLACING AND SPREADING OF TOPSOIL/PLANTING SOIL**

- .1 Place topsoil after Consultant has accepted subgrade.
- .2 Spread topsoil in uniform layers not exceeding 150 mm.
- .3 Keep topsoil 15 mm below finished grade for sodded areas.
- .4 Manually spread topsoil/planting soil around trees, shrubs and obstacles.
- .5 Avoid spreading or grading in wet, frozen, or saturated state.

**3.4 FINISH GRADING**

- .1 Grade to eliminate rough spots and low areas and ensure positive drainage.
  - .1 Prepare loose friable bed by means of cultivation and subsequent raking
- .2 Consolidate topsoil to required bulk density using equipment approved by the Consultant.
  - .1 Leave surfaces smooth, uniform and firm against deep foot printing.

**3.5 MECHANICAL SEEDING**

- .1 Unless otherwise specified, seeding shall be completed by mechanical means in accordance with OPSS.MUNI 804.

**3.6 SODDING**

- .1 Sodding shall be carried out in locations specified by the drawings.
- .2 Sodding shall be completed in accordance with OPSS.MUNI 803.

**3.7 ACCEPTANCE**

- .1 The Consultant will inspect and test topsoil in place and determine acceptance of material, depth of topsoil and finish grading.

**3.8 SURPLUS MATERIAL**

- .1 Dispose of surplus materials off-site.

**3.9 CLEANING**

- .1 Proceed with cleaning in accordance with Section 01 74 00.
  - .1 Leave Work area organized and tidy at end of each day.
  - .2 Keep pavement and area adjacent to site clean and free from mud, dirt, and debris at all times.
- .2 Upon completion remove surplus materials, rubbish, tools and equipment.
  - .1 Clean and reinstate areas affected by Work.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 19.
  - .1 Remove recycling containers and bins from site and dispose of materials at an appropriate facility.
  - .2 Divert unused fertilizer from landfill to official hazardous material collections site approved by the Consultant

**END OF SECTION**

## **PART 1 GENERAL**

### **1.1 RELATED REQUIREMENTS**

- .1 Section 31 05 16 - Aggregate For Earthwork.
- .2 Section 31 23 16.26 - Rock Removal.
- .3 Section 31 23 33.01 - Excavation, Trenching, and Backfilling.

### **1.2 REFERENCE STANDARDS**

- .1 ASTM International
  - .1 ASTM C117-17, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
  - .2 ASTM C136/C136M-19, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - .3 ASTM D698-12, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>(600 kN-m/m<sup>3</sup>)).
  - .4 ASTM D1248-16, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
  - .5 ASTM F667/F667M-16, Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.
- .2 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 U.S. Environmental Protection Agency (EPA)/Office of Water
  - .1 EPA 833-R-06-004, Developing Your Stormwater Pollution Prevention Plan, A Guide for Construction Sites.
- .4 Ontario Provincial Standard Specifications (OPSS):
  - .1 OPSS.MUNI 421, Construction Specification for Pipe Culvert Installation in an Open Cut.
  - .2 OPSS.MUNI 517, Construction Specification for Dewatering of Pipeline, Utility, and Associated Structure Excavation.
  - .3 OPSS.MUNI 518, Construction Specification for Control of Water from Dewatering Operations.

### **1.3 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01 33 00.
- .2 Product Data:
  - .1 Submit manufacturer s instructions, printed product literature and data sheets for pipes and backfill and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Samples:
  - .1 Inform the Consultant at least 4 weeks before beginning Work, of proposed source of bedding materials and provide access for sampling.
- .4 Certification: to be marked on pipe.



- .5 Test and Evaluation Reports:
  - .1 Submit manufacturer's test data and certification at least 4 weeks prior to beginning Work.

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

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
  - .1 Store materials in accordance with manufacturer's recommendations.
  - .2 Store and protect pipes from damage.
  - .3 Replace defective or damaged materials with new.
- .4 Packaging Waste Management: remove for reuse and return by manufacturer of crates, pallets, packaging materials padding, as specified in Waste Reduction Workplan Construction Waste Management Plan in accordance with Section 01 74 19.

### **PART 2 PRODUCTS**

#### **2.1 CORRUGATED POLYETHYLENE PIPE AND FITTINGS**

- .1 To ASTM F667.
  - .1 Polyethylene resin: to ASTM D1248, grade W8.
  - .2 Weathering resistance: to ASTM D1248, Class C.

#### **2.2 GRANULAR BEDDING AND BACKFILL**

- .1 Granular A as per OPSS.MUNI 1010.
- .2 Concrete mixes and materials for bedding, cradles, encasement, supports: to Section 03 30 00.

### **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 pipe culvert installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate in presence of the Consultant.
  - .2 Inform the Consultant of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Consultant.

#### **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 authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### **3.3 TRENCHING**

- .1 Do trenching Work in accordance with Section 31 23 33.01.
- .2 Obtain the Consultant's approval of trench line and depth prior to placing bedding material or pipe.

### **3.4 BEDDING**

- .1 Dewater excavation, as necessary, to allow placement of culvert bedding in dry condition.
- .2 Place 150 mm minimum thickness of approved granular material on bottom of excavation and compact to 95% SPMDD.
- .3 Shape bedding to fit lower segment of pipe exterior so that width of at least 50% of pipe diameter is in close contact with bedding and to camber as indicated or as directed by the Consultant, free from sags or high points.
- .4 Place bedding in unfrozen condition.

### **3.5 LAYING CORRUGATED POLYETHYLENE PIPE CULVERTS**

- .1 Begin laying at downstream end of culvert.
- .2 Install pipe in trench by lowering.
- .3 Ensure bottom of pipe is in contact with shaped bedding throughout pipe length.
- .4 Allow water to flow through pipes during construction only as permitted by the Consultant.

### **3.6 JOINTS FOR POLYETHYLENE CULVERTS**

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

### **3.7 BACKFILLING**

- .1 Backfill around and over culverts as indicated or as directed by the Consultant.
- .2 Place granular backfill material, in 150 mm layers to full width, alternately on each side of culvert, so as not to displace it laterally or vertically.
- .3 Compact each layer to 95% SPMDD taking special care to obtain required density under haunches.
- .4 Protect installed culvert with minimum 600 mm cover of compacted fill before heavy equipment is permitted to cross.
- .5 Place backfill in unfrozen condition.

### **3.8 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00.

- .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 00.

**END OF SECTION**