

**BARRIE FIRE STATION 6**

**845 MAPLEVIEW DRIVE EAST, BARRIE, ONTARIO**

**salter pilon architecture inc.**

# Project Manual

Volume 1

**Divisions 0-33**

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Pearson Engineering.

**Civil Consultants**

Regal Consulting Engineers.

**Electrical Consultants**

Hill Design Studio Inc.

**Landscape Consultants**

Regal Consulting Engineers.

**Mechanical Consultants**

RJC Engineers.

**Structural Consultants**

DISCLAIMER: For the purposes of this procurement process, all communications in relation to this ITT or this project must be made through the Bidding System using the "Submit a Question" link associated with this bid opportunity ("ITT Contact"), unless specifically instructed within the ITT document.

Bidders and their representatives are not permitted to contact any employees, officers, agents, elected or appointed officials or other representatives of the City, other than the ITT Contact. Failure to adhere to this rule may result in the disqualification of the bidder and the rejection of the bidder's bid.

<p><b>ARCHITECTURAL SUBCONSULTANT'S SEAL</b></p>	
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**CIVIL SUBCONSULTANT'S SEAL**

LANDSCAPE SUBCONSULTANT'S SEAL

**STRUCTURAL SUBCONSULTANT'S SEAL**

<b>MECHANICAL &amp; ELECTRICAL SUBCONSULTANT'S SEAL</b>	
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1 GENERAL

- .1 Information on existing conditions made available to bidders under this section, is included in the Bid Documents for information purposes only, and does not form part of the Contract Documents.
- .2 The Owner and Consultant assume no responsibility for the scope and accuracy of the information contained in the documents listed herein.
- .3 The Contractor shall be responsible for conducting an on-site evaluation of conditions which can be observed and for correlation of these conditions with the information included under this section.
- .4 Information contained in documents listed here may be used by the Contractor to assist in an assessment of existing conditions. Evaluation of the information shall remain the responsibility of the Contractor.

2 GEOTECHNICAL REPORT

- .1 Refer to specification Section 02 32 00 – Geotechnical Information.

END OF SECTION

1 SUMMARY OF WORK

.1 The project consists of the construction of a new one (1) storey fire station at 845 Maplevue Drive East, Barrie, Ontario.

.2 Work by Owner comprises the following:

.1 Provision of owner supplied items for GC Install.

2 WORK RESTRICTIONS

.1 Contractor's Use Of Site

.1 Use of site to the areas designated on the drawings for execution of the Work. Do not unreasonably encumber site with materials or equipment. Move stored products or equipment which interfere with operations of Owner, or other contractors. Obtain and pay for use of off-site additional storage, or work areas as required by the Work.

.2 Hours of Work

.1 Hours of work for this Contract are generally confined to regular daily business hours of 8:00am to 5:00pm, Monday to Friday. Where required by sequencing of the Work, portions of the Work may be required to be performed outside of regular daily business hours, or on weekends, but shall be performed at such times at no additional cost to the Owner.

.3 OFF SITE WORK

.1 All work beyond property lines, adjacent to the site, or beyond Extent of Contract (EOC) line is included in Contract unless noted otherwise.

END OF SECTION

- 
- 1 GENERAL
    - .1 Include all allowances listed below in the Bid Price.
    - .2 Expend Cash Allowances as directed by the Consultant.
    - .3 Each Cash Allowance will be adjusted to actual cost as defined hereunder and Contract Price will be amended accordingly by written order.
    - .4 Progress payments for work and material authorized under Cash Allowances will be made in accordance with GC 5.3 of the Contract.
    - .5 Where costs under a cash allowance exceed amount of allowance, Contractor will be compensated for excess incurred and substantiated plus allowance for overhead and profit as set out in Contract Documents.
    - .6 Include progress payments on accounts of Work authorized under cash allowances in Consultant's monthly certificate for payment.
    - .7 Prepare schedule jointly with Consultant and Contractor to show when items called for under cash allowances must be authorized by Consultant for ordering purposes so that progress of Work will not be delayed.
    - .8 Cash allowances do not include H.S.T.
  - 2 MATERIAL ALLOWANCES (SUPPLY ONLY)
    - .1 Material cash allowance shall include and provide payment for:
      - .1 Net cost of material.
      - .2 Applicable duties and taxes.
      - .3 Delivery to the Place of the Work.
    - .2 Include in the Bid Price, in addition to the material cash allowance, costs for the following:
      - .1 Handling at the Place of the Work, including unloading, uncrating, storage and hoisting.
      - .2 Protection from damage by elements or otherwise.
      - .3 Labour for installation and finishing.
      - .4 Other expenses required to complete installation.
      - .5 Overhead and profit.
  - 3 ASSEMBLY ALLOWANCES (SUPPLY AND INSTALL)
    - .1 Assembly cash allowance shall include and provide payment for:
      - .1 Net cost of material.
      - .2 Applicable duties and taxes.
      - .3 Delivery to the Place of the Work.
      - .4 Assembly contractors'/suppliers' only, expenses relating to the following:
        - .1 Handling at site, including unloading, uncrating, storage and hoisting.
        - .2 Protection from damage by elements or otherwise.
        - .3 Labour installation and finishing.
        - .4 Other expenses required to complete installation.
        - .5 Overhead and profit.

- 
- .2 Include in the Bid Price any overhead and profit or related General Contractor costs.
- 4 TESTING & LABORATORY SERVICES
- .1 Testing & Laboratory Services allowances shall include and provide payment for:
- .1 Transportation costs to and from the Place of the Work,
  - .2 Personnel & equipment required to perform tests or inspections,
  - .3 Costs of shipping & handling samples to laboratory for testing,
  - .4 Applicable duties and taxes.
- 5 ALLOWANCE AMOUNTS
- .1 The Total Cash Allowance to be included in the Stipulated Price is One-Hundred Thousand Dollars (\$100,000) in Canadian funds.
- .2 The Cash Allowance shall cover the following (in general):
- .1 Inspection & Testing - for charges from independent company(s) to provide services related to all areas of the project that require inspection and testing. \$25,000.
  - .2 Finish Hardware – Supply only of finish hardware. \$75,000.

END OF SECTION



**1 MODIFICATIONS TO CONTRACT**

- .1 Supplemental Instruction: as issued by the Consultant, consistent with the intent of the Contract Documents, and will not involve an adjustment in Contract Price or Contract Time.
- .2 Proposed Change: as issued by the Consultant, will notify the Contractor of an impending or proposed change to the Work, and will require submission of a quotation from the Contractor and all affected Subcontractors for each item noted. Submit quotation within the time period stipulated on the form, and indicate separate line items for labour and materials in each case. Work outlined in a Proposed Change must not proceed without the issuance of a Change Order signed by the Owner.
- .3 Change Directive: will be issued by the Consultant where an immediate response is required to an on-site condition. This form will authorize the Contractor to proceed with the change, with the stipulation that accurate accounts of costs be recorded, and may contain an upset cost, as agreed upon by the Owner and the Contractor.
- .4 Change Order: will be issued by the Consultant upon review and approval of quotations for a Proposed Change, or a Change Directive, and authorizes the Contractor to proceed with the change(s) proposed. A Change Order will amend the Contract Price, and/or the Contract Time.

**2 FEES FOR CHANGES IN THE WORK**

- .1 The fees (mark-ups) permitted to be applied to the Contract Price for changes to the Work shall be in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2020) as provided.
- .2 Fees (mark-ups) for Changes in the Work shall apply to all extras to the Contract Price in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2020) as provided.
- .3 Fees (mark-ups) for Changes in the Work shall only apply to credits to the Contract Price in accordance with the Supplementary Conditions of the Contract (CCDC 2 - 2020) as provided.

END OF SECTION

1 APPLICATIONS FOR PAYMENT

- .1 Applications for payment on account may be made monthly as the Work progresses, and shall be preceded by the submission of a Schedule of Values for review by the Consultant, in accordance with the Contract.
- .2 The second and all subsequent applications for payment shall include a statement based on the Schedule of Values, a statutory declaration (CCDC 9A), and a standard Workers Compensation Certificate of Clearance.

2 SCHEDULE OF VALUES

- .1 Submit Schedule of Values in spreadsheet form acceptable to the Consultant.
- .2 Identify on each Schedule of Values, the following information:
  - .1 Date of Issue
  - .2 Project name
  - .3 Owner's name
  - .4 Contractor's name
  - .5 Payment period
  - .6 Payment certificate number
- .3 Items of work listed shall include, but not be limited to, separate line items for the following:
  - .1 General Accounts
  - .2 Mobilization
  - .3 Supervision
  - .4 Bonds and Insurance
  - .5 Permits and Licenses
  - .6 Operations and Maintenance Manuals/As-Built Drawings
  - .7 All trades or portions of the Work, generally in chronological order
  - .8 Provision of other Products and/or services
  - .9 Cash Allowance expenditures
  - .10 Changes in the Work
- .4 The total Contract amount for each trade or portion of the Work shall be listed beside each item.
- .5 The Values of the Work shall be listed as to the aggregate percentage and dollar value completed, under the following major headings:
  - .1 Initial Contract Amounts for each line item,
  - .2 Progress to Date,
  - .3 Percent Complete,
  - .4 Current Invoice,
  - .5 Previous Billings,
  - .6 Contract Balance
- .6 Work shall be subtotaled under original Contract amounts, Cash Allowance expenditures, and Changes to the Work.

- .7 Final totals shall identify:
  - .1 Total amount
  - .2 Holdback deducted
  - .3 Holdback released
  - .4 Amount invoiced to date
  - .5 Net amount
  - .6 HST
  - .7 Amount due this Certificate

END OF SECTION

1 PROJECT MANAGEMENT & COORDINATION

.1 Project Coordination

.1 The Contractor is responsible for the overall coordination of the Work. Coordinate the work of all subcontractors, and provide such assistance as is necessary, including but not limited to;

- .1 Providing site dimensions and layout,
- .2 Providing temporary facilities and controls,
- .3 Scheduling subcontractors work to prevent conflicts,
- .4 Scheduling and administering regular subtrade scheduling and coordination meetings throughout progress of the Work.
- .5 Scheduling and administering regular subtrade safety meetings throughout progress of the Work.
- .6 Coordinate construction sequences and schedules including all components of the Work, including all Divisions with interdependent responsibilities.

.2 The Contractor shall facilitate production of interference drawings where necessary for coordination of the Work. Provide such interference drawings to the Consultant for review.

.2 Project Supervision

.1 The Contractor shall provide and maintain full-time supervision on site until Substantial Performance is achieved and the deficiencies have been completed or otherwise agreed with the Owner. The supervisor shall be responsible for the overall day-to-day coordination on site between subtrades.

.2 The supervisor shall coordinate the work of all subcontractors, and provide such assistance as is necessary, including but not limited to;

- .1 Layout,
- .2 Rough carpentry work for blocking, strapping, nailers, etc.

.3 Project Meetings

.1 Attend all regular bi-weekly project progress meetings throughout progress of work.

.2 Consultant shall chair regular bi-weekly project progress meetings and shall record and distribute same to Owner, Contractor and Subconsultants. Contractor shall forward to appropriate subcontractors.

.4 Project Site Administration

.1 Maintain at job site, one copy each of the following:

- .1 Contract drawings.
- .2 Project manual.
- .3 Addenda and Bid Revisions.
- .4 Reviewed shop drawings.
- .5 Change orders and other Contract modifications.
- .6 Field test and inspection reports.
- .7 Approved schedules.
- .8 Manufacturer's installation and application instructions.

**2 SCHEDULES**

- .1 Construction Progress Schedule.
  - .1 Prepare schedule in horizontal chart form, with weekly horizontal time scale identifying first/last work day of each week. Schedule must utilize "critical path" method.
  - .2 Indicate separate line for each trade or operation of the Work. Arrange trades in chronological order for commencement of that part of the Work.
  - .3 Identify projected major milestones in the course of the Work such as completion of foundation work, structure, closing in, major inspections by building officials, Substantial Performance, etc.
- .2 Submittal Schedule
  - .1 Provide schedule for submittal of all Shop Drawings, Product Data and Samples.
  - .2 Provide complete list of all manufactured products to be used in the course of the Work, including those amended by addenda.
- .3 Submission of Schedules
  - .1 Submit one copy of each schedule to the Consultant for review, prior to first progress billing. Amend schedule as required.
  - .2 Submit four (4) copies of each subsequent issue of schedules to the Consultant.
  - .3 Update schedule on a regular basis or as requested by the Consultant.

**3 ELECTRONIC FILE AGREEMENT**

- .1 Electronic files for this project will not be released until the Electronic Files Transfer Agreement, appended to this Section, has been completed and returned to the Consultant.

**4 ADDITIONAL DOCUMENTS**

- .1 Consultant may issue additional documents in the form of drawings, specifications, schedules, or written instructions to assist proper execution of the Work. These documents shall take one of the following forms as defined in the Contract;
  - .1 Supplemental Instruction: no adjustment in Contract Price or Contract Time.
  - .2 Change Order: amendment to the Contract recommended by the Consultant, and agreed upon by the Owner and the Contractor.

**5 SUBMITTAL PROCEDURES**

- .1 Submit to Consultant, all items specified for review, with reasonable promptness and in orderly sequence so as to not cause delay in the Work. Failure to submit in ample time is not considered sufficient reason for an extension of Contract Time and no claim for extension by reason of such default will be allowed.

- .2 The Contractor shall schedule a minimum of ten (10) working days in order for the Consultants to review each submission. This shall also apply to subsequent resubmissions.
- .3 Do not proceed with work affected by the submittal until review is complete.
- .4 Review all submittals prior to submission to the Consultant. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with the requirements of the Work and the Contract Documents. Submittals not stamped, signed, and dated will be returned without review.
- .5 Verify field measurements and affected adjacent work are coordinated.
- .6 Contractor's responsibility for errors and omissions in submission, or deviations from requirements of Contract Documents, is not relieved by Consultant's review of submittals.
- .7 Keep one reviewed copy of each submission on site.
- .8 Shop Drawings
  - .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by the Contractor to illustrate details of a portion of the Work.
  - .2 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of the Section under which the adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.
  - .3 Adjustments made on shop drawings by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the Work.
  - .4 Make changes in shop drawings as the Consultant may require, consistent with Contract Documents. When resubmitting, notify the Consultant in writing of any revisions other than those requested.
  - .5 Shop drawings shall be submitted electronically wherever possible. Files shall be in PDF format only.
  - .6 Shop drawings submitted by FAX, or as copies of FAX transmissions are not acceptable as shop drawings, and will not be reviewed.

- .7 Reproductions of Consultants' drawings are not acceptable for the purpose of creating Shop Drawings. Any drawings submitted for review which contain drawings or any parts of drawings produced by the Consultant, will be rejected. The Consultant will not take responsibility for any resulting delays in construction as a result of the above.
- .8 Shop drawings not submitted in the scale type of the contract documents (ie. metric for metric drawings) will not be reviewed.
- .9 Product Data Sheets
  - .1 Manufacturer's standard schematics, catalogue sheets, diagrams, schedules, performance charts, illustrations and other descriptive data are acceptable in lieu of shop drawings, where specified.
  - .2 Product Data Sheets are acceptable provided they conform to the following:
    - .1 Information not applicable to project has been deleted.
    - .2 Supplement standard information to provide additional information applicable to project.
    - .3 Show dimensions and clearances required.
    - .4 Show performance characteristics and capacities.
    - .5 Show wiring diagrams, when requested, and controls.
  - .3 Submit product data sheets or brochures for requirements requested in specification Sections and as the Consultant may reasonably request where shop drawings will not be prepared due to standardized manufacture of product.
  - .4 Submit copies of all WHMIS Data Sheets.
  - .5 Submit eight (8) copies of Product Data Sheets.
  - .6 Product data sheets submitted by FAX, or as copies of FAX transmissions will not be accepted.
- .10 Return of Submissions
  - .1 If upon review by the Consultant, no errors or omissions are discovered or if only minor corrections are made, the shop drawing transparency or one copy of the product data will be returned and fabrication and installation of Work may proceed.
  - .2 If shop drawings or data sheets are rejected, noted copy will be returned and resubmission of corrected shop drawings or data sheets through the same procedure indicated above, shall be performed before fabrication and installation of Work may proceed.
- .11 Samples
  - .1 Submit samples for review, in duplicate, in sizes requested in respective specification sections. Label samples as to origin and intended use in the Work.

- .2 Where colour, pattern or texture is criteria, submit full range of samples.
- .3 Deliver samples prepaid to Consultant's office.
- .4 Notify the Consultant in writing, at the time of submission of deviations in samples from requirements of Contract Documents.
- .5 Adjustments made on samples by the Consultant are not intended to change the Contract Price. If adjustments affect the value of Work, state such in writing to the Consultant prior to proceeding with the work.
- .6 Make changes in samples which the Consultant may require, consistent with Contract Documents.
- .7 Reviewed samples or mock-ups will become standards of workmanship and material against which installed work will be checked on project.
- .12 Submission Requirements
  - .1 Accompany submissions with transmittal letter containing:
    - .1 Date,
    - .2 Project title and number,
    - .3 Contractor's name and address,
    - .4 Drawing/page numbers of each shop drawing or data sheet,
    - .5 Identification (ie. "Structural Steel Shop Dwgs."), and
    - .6 Number of copies submitted.
  - .2 Submissions shall include (where applicable) :
    - .1 Date and revision date,
    - .2 Project title and number,
    - .3 Name of Contractor, Subcontractor(s), Supplier/Manufacturer,
    - .4 Identification of product or material,
    - .5 Relation to adjacent structure or materials,
    - .6 Field dimensions, clearly identified as such,
    - .7 Reference standards (CSA, CGSB, ASTM, etc.), and
    - .8 Contractor's stamp, initialled or signed, certifying review of submission, and verification of field measurements.
- .13 Distribution of Submittals after Review
  - .1 Distribute copies of shop drawings and product data which carry Consultant's stamp as follows (where applicable):
    - .1 Job site file (Record documents),
    - .2 General Contractor's office,
    - .3 Subcontractors, and
    - .4 Suppliers or Fabricators.

END OF SECTION



# Electronic Files Transfer Agreement

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**Architect of Record ("The Consultant"):** Salter Pilon Architecture Inc.

**Contractor ("The Contractor"):** \_\_\_\_\_

**Re ("The Owner"):** The City of Barrie

The Contractor hereby acknowledges requesting from the Consultant, electronic data containing the graphic (electronic) representation of the Architectural Drawings *as per attached list of drawings*, subject to the condition that the said drawings are to be used only for information and reference in connection with the Owner's use and occupancy of the Project. The Contractor shall be responsible for checking and verifying all dimensions, details, and quantities of materials, and for the coordination of related elements as required to facilitate complete and accurate fabrication and installation. Any omissions or discrepancies shall be reported to the Consultant. The Contractor hereby warrants to the Consultant that the files will be used solely for the development of shop drawings. The drawings shall not be used for any other purpose on this project and shall not be used on any other project either by the Contractor or by others. The Contractor further warrants not to alter the electronic data or the information contained therein, in any way except for the above-noted purposes, and acknowledges that such unauthorized use or alteration of the original work is protected in accordance with the Copyright Act and subject to the penalties prescribed therein.

The Contractor hereby acknowledges that the said electronic data contain information which may be updated or altered at any time by the Consultant, and that it is the responsibility of the Contractor to make themselves aware of these changes, in a timely manner. In the event of a conflict between the drawings issued to the Contractor and the sealed contract drawings, the sealed contract drawings shall govern.

The Contractor agrees to pay the Consultant \$0.00 per file, plus any and all applicable taxes. The fees are to cover the costs of preparation of the electronic data, and disbursements related to the preparation and shipment/forwarding of the electronic data only. By paying the fees, the Contractor has in no way purchased the drawings or any rights to the drawings or the information contained therein, and the Contractor may only alter the drawings for the purposes noted above.

The Contractor shall, to the fullest extent permitted by law, indemnify, defend and hold harmless the Consultant, and its sub-consultants from all claims, damages, losses, expenses, penalties and liabilities of any kind, including attorney's fees, arising out of, or resulting from the use of the electronic files by the

Contractor, or by third party recipients of the electronic files from the Contractor.

The Consultant believes that no licensing or copyright fees are due to others on account of the transfer of the electronic files, but to the extent any are, the Contractor will pay the appropriate fees and hold the Consultant harmless from such claims.

Any purchase order number provided by the Contractor is for Contractor's accounting purposes only. Purchase order terms and conditions are void and are not a part of this agreement.

The laws of the Province of Ontario shall govern this agreement.

The conditions and undertakings expressed herein apply to partners, employees, agents, successors, assigns and legal or other representatives of the Contractor.

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AUTHORIZED ACCEPTANCE

**by Consultant**

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*Signature*

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*Print Name and Title*

Date \_\_\_\_\_

**by Contractor**

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*Signature*

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*Print Name and Title*  
(Authorized Signing Officer)

Date \_\_\_\_\_

1 GENERAL

- .1 Provide construction photographs in accordance with procedures and submission requirements specified in this section.
- .2 Photographs shall be taken using a digital camera.

2 PROGRESS PHOTOGRAPHS

- .1 Provide 1 digital set of construction photographs, documenting progress of the Work. Submit one digital set with each monthly progress draw. Maintain one printed set on site, in clear plastic photo sleeves bound in 3-ring binder.
- .2 Submit progress photographs with each monthly progress draw, and at the following milestones;
  - .1 Completion of excavation and pouring of footings,
  - .2 Completion of foundations prior to backfilling,
  - .3 Completion of structural frame,
  - .4 Completion of rough-in of mechanical and electrical services before concealment.
  - .5 Completion of each major portion of work
  - .6 Completion of each major finish item.
- .3 Orientation of Photographs: provide photos from 4 general viewpoints, as well as specific views as required by milestones specified above, and as determined by Consultant prior to first Progress Draw.

3 FINAL PHOTOGRAPHS

- .1 Submit site copy of printed progress photographs with Operations & Maintenance Manuals at the completion of the project.
- .2 In addition to progress photographs, provide 1 digital set of images, and 2 printed sets, of final photographs of the completed project.
- .3 Orientation of Photographs: provide final photos as follows:
  - .1 General viewpoints as defined above,
  - .2 Views of all exterior elevations,
  - .3 One view from each street,
  - .4 Views of site showing parking areas and play surfaces,
  - .5 Interior views of all major spaces,
  - .6 One set of views of a typical room,
  - .7 Specific views as determined by Consultant (Max. 48 views).
- .4 Identification: Typewritten identification on 20 x 50mm white label on top left corner of all photographs indicating the following:
  - .1 Project name and number,
  - .2 Orientation,
  - .3 Date of exposure.
- .5 Photo Print Finish: matte with binding margin at one long edge.

- .6 Mounting & Binding: Final photos shall be mounted in clear plastic sleeves purpose-made for 3-ring binder storage. Bind sets individually into black, 3-ring binders, labelled on front and spine as follows:

**PROJECT RECORD PHOTOGRAPHS**

**City of Barrie  
Barrie Fire Station 6  
Completed to follow**

END OF SECTION

## **1 GENERAL**

### **1.1 SECTION INCLUDES**

- .1 Requirements for quality of work.
- .2 Requirements for for material inspection and testing.
- .3 Requirements for determination of defective materials and work.

### **1.2 REFERENCE STANDARDS**

- .1 CSA A23.1; Concrete Materials and Methods of Concrete Construction.
- .2 CSA A23.2; Methods of Test for Concrete.
- .3 CSA S16.1; Limit States Design of Steel Structures.
- .4 CSA W47.1; Certification of Companies for Fusion Welding of Steel Structures.
- .5 CSA W59; Welded Steel Construction (Metal Arc Welding).
- .6 CISC; Code of Standard Practice for Structural Steel.
- .7 OPSS; Ontario Provincial Standard Specifications.

### **1.3 REGULATORY REQUIREMENTS**

- .1 Products and services provided to complete the Work shall meet or exceed requirements of specified standards, municipal by-laws, building codes and referenced documents.

### **1.4 INDEPENDENT INSPECTION AND TESTING**

- .1 Independent Inspection and Testing Consultants will be engaged for the purpose of inspecting and/or testing individual portions of the Work. The cost of such services will be paid by Cash Allowance.

### **1.5 RESPONSIBILITIES**

- .1 Inspection and Testing Consultants
  - .1 Inspection and Testing Consultants shall;
    - .1 Provide inspection and testing specified,
    - .2 Inform the Contractor and Consultant immediately upon observance of materials, systems, or procedures not in compliance with the specifications, and
    - .3 Submit complete reports to the Contractor and the Consultant in a timely manner.
- .2 Contractor
  - .1 Contractor shall:
    - .1 Provide access to the Work for Inspection/Testing Consultants, and
    - .2 Inform the Inspection/Testing Consultants in advance of day and time required for inspection and tests.
  - .2 It is the responsibility of the General Contractor to ensure the quality control requirements of the Contract are implemented.
- .3 Consultant
  - .1 The Consultant will make final decisions on changes to the scope of work of inspection and testing that may affect the Contract Price.

- .2 When informed of any material procedure or test result that does not meet or exceed the specifications, the Consultant will respond in an expedient manner to resolve the issue.

**1.6 ACCESS TO WORK**

- .1 Allow inspection & testing companies access to the Work, as well as off site manufacturing and fabrication plants.

**1.7 REPORTS**

- .1 Submit three copies of inspection and test reports to the Consultant.
- .2 Provide copies to Subcontractor of work being inspected or tested, manufacturer or fabricator of material being inspected or tested.
- .3 Submit one copy of inspection and test reports to the Building Official having jurisdiction, where required by that official.
- .4 The cost of tests beyond those called for in the Contract Documents or beyond those required by the law of the Place of Work shall be appraised by the Consultant and may be authorized as recoverable.

**1.8 EARTHWORK**

- .1 All earthwork shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Inspection of excavations for foundations.
  - .2 Inspection of subgrade and granular fill materials.
  - .3 Inspection of backfill operations.
  - .4 Inspection and testing of backfill compaction.
  - .5 Inspection of trenching and bedding associated with underground services.
  - .6 Inspection and testing of fill and compaction associated with underground services.

**1.9 CAST-IN-PLACE CONCRETE**

- .1 All cast-in-place concrete shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Verification of materials delivered to site.
  - .2 Slump tests.
  - .3 Sampling of cylinders, and compressive strength tests.

**1.10 MASONRY MORTAR**

- .1 All masonry mortar shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Visual inspection of all materials.
  - .2 Sampling and testing of mortar cubes.

**1.11 STRUCTURAL STEEL**

- .1 All structural steel shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Confirmation that materials supplied meet specifications.
  - .2 Shop inspection during fabrication of steel.

- .3 Checking welders' CWB Certification.
- .4 Checking fabricated members against design member shapes.
- .5 Checking fabricated members against allowable sweep and camber.
- .6 Checking fabricated members against specified camber.
- .7 Visual inspection of all welded connections including spot checking of joint preparation and fit-up.
- .8 Non-destructive testing of welding.
- .9 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.
- .10 Inspection of field cutting.
- .11 Inspection and testing of all field bolted connections.
- .12 Visual inspection of all welds securing steel deck to structural steel.
- .13 Visual inspection of all bearing plate locations.

#### 1.12 STRUCTURAL STEEL STUDS

- .1 All structural steel studs shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Confirmation that materials supplied meet specifications.
  - .2 Shop inspection during fabrication.
  - .3 Checking welder' CWB Certification.
  - .4 Checking fabricated members against design member shapes.
  - .5 Visual inspection of all welded connections including spot checking of joint preparation and fit-up.
  - .6 Sample checking that tolerances are not exceeded during erection including fit-up of field welded joints.
  - .7 Inspection of all field bolted or welded connections.

#### 1.13 SPRAY-IN-PLACE INSULATION

- .1 All spray-in-place insulation shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Visual inspection of total application for defects.
  - .2 Visual inspection of all transitions and detailing at penetrations.
  - .3 Verification of applied thickness.

#### 1.14 AIR/VAPOUR BARRIERS

- .1 All building envelope air/vapour barrier components shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Visual inspection of total membrane for defects.
  - .2 Visual inspection of all transition membranes.
  - .3 Pull test to verify adhesion.

#### 1.15 SPRAY APPLIED THERMAL BARRIER

- .1 All spray applied thermal barrier shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Inspection of all spray applied thermal barrier materials to verify compliance with specifications.
  - .2 Inspection of spray applied thermal barrier application.

**1.16 ROOFING**

- .1 All roofing shall be subject to inspection as specified herein. Inspection and Testing shall include:
  - .1 Inspection of all roofing materials to verify compliance with specifications.
  - .2 Inspection of roofing application.

**1.17 FIRESTOPS AND SMOKE SEALS**

- .1 All firestopping and smoke seals shall be subject to inspection as specified herein. Inspection and Testing shall include:
  - .1 Inspection of materials to verify compliance with specifications.
  - .2 Visual inspection of all applications.

**1.18 CURTAIN WALL**

- .1 All curtain wall systems shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Site inspection of materials and installation methods.
  - .2 Shop inspection of materials and fabrication, and
  - .3 Site testing for air/water penetration.

**1.19 ASPHALT PAVING**

- .1 All asphalt paving shall be subject to inspection and testing as specified herein. Inspection and Testing shall include:
  - .1 Inspection and compaction testing of all granular base courses.
  - .2 Marshal Density testing of asphalt material.
  - .3 Compaction testing of all courses of asphalt paving.

**2 PRODUCTS**

(RESERVED)

**3 EXECUTION**

**3.1 INSPECTION AND TESTING - GENERAL**

- .1 Furnish test results and mix designs as may be requested.
- .2 The cost of tests and mix designs beyond those called for in the Contract Documents or beyond those required by the law of the Place of Work shall be appraised by the Consultant and may be authorized as recoverable.

**3.2 INSPECTION AND TESTING - PROCEDURES**

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

**3.3 QUALITY OF THE WORK**

- .1 Quality of the Work shall be first class, executed by workers experienced and skilled in the respective duties for which they are employed. Immediately notify the Consultant if required work is such as to make it impractical to produce required results.
- .2 Do not employ any unfit person or anyone unskilled in their required duties. The Consultant reserves the right to require the dismissal from the site, of workers deemed incompetent, careless, insubordinate or otherwise objectionable.

**3.4 DEFECTIVE MATERIALS AND WORK**

- .1 Refer to GC 2.4 of CCDC 2-2020 and Supplementary Conditions.
- .2 Where evidence exists, that defective work has occurred, or that work has been carried out incorporating defective products, the Consultant may have independent tests, inspections, or surveys performed in order to determine if work is defective.
- .3 Tests, inspections, or surveys carried out under these circumstances will be made at the Contractor's expense in the event of defective work, or at the Owner's expense where work is in conformance. Where tests incorporate a number of samples, payment will be assessed, by the Consultant, based on the ratio of conforming to non-conforming results. This does not include re-testing of soil compaction during placement, where evidence exists of non-conformance with the Contract documents, but rather only if re-testing is called for after completion of compaction.

END OF SECTION



**1 GENERAL**

**1 SECTION INCLUDES**

- .1 Codes and Standards.
- .2 Authority Having Jurisdiction.
- .3 Permits and Fees.
- .4 Relics, Antiquities and Human Remains.

**2 CODES AND STANDARDS**

- .1 Codes
  - .1 All construction shall conform to the Ontario Building Code, the National Building Code (NBC) and the National Fire Code (NFC) latest editions including all supplements and amendments.
  - .2 Conform to all other codes, by-laws and regulations as specified within individual sections of the specifications.
- .2 Industry Standards
  - .1 Industry Standards are specified within individual sections as applicable to those portions of the Work. The latest editions of all industry standards shall be the standards for which quality of work shall be assessed.
  - .2 Comply with all relevant codes, standards and industry-accepted practices, as specified herein, or as applicable to the Work.

**3 AUTHORITIES HAVING JURISDICTION**

- .1 The Chief Building Official of the Municipality of the Place of the Work, is the primary Authority Having Jurisdiction for compliance with all codes, by-laws and regulations as they apply to all construction.
- .2 Other Authorities Having Jurisdiction may be required to review and approve certain portions of the Work. The Chief Building Official of the Municipality of the Place of the Work, will determine the requirements for such involvement.

**4 PERMITS AND FEES**

- .1 No construction work may commence without a valid, posted Building Permit.
- .2 The Owner is responsible for obtaining all necessary information and applying for the Building Permit, including payment of associated fees.
- .3 The Contractor is responsible for applying for, and obtaining all necessary permits, licenses, or certificates required by the Work.
- .4 Authorities Having Jurisdiction may levy fees for issuing permits, licenses, or certificates under their jurisdiction. The Contractor shall pay all such fees as required, and shall include the cost of such fees in their Contract Price.
- .5 Furnish certificates and permits from other Authorities Having Jurisdiction when so requested by the Consultant.

- .6 Prior to commencement of construction, post the Building Permit at the Place of the Work.
- 5 RELICS, ANTIQUITIES AND HUMAN REMAINS
  - .1 Comply with the General Conditions of the Contract with respect to relics, antiquities, and human remains.
  - .2 Isolate and protect human remains, relics, antiquities, items of historical, archeological or scientific interest such as cornerstones, commemorative plaques, inscribed tablets and other similar objects found during the course of the Work.
  - .3 If such items are discovered in the course of construction, stop work in the immediate vicinity, and give immediate notice to the Consultant as to the nature of the discovery, and await written instructions before proceeding with work in the area.
  - .4 Resume work only after the conclusion of any inspection and evaluation by experts engaged by the Owner, and only after being given permission to do so.
  - .5 Relics, antiquities and items of historical or specific interest remain the Owner's property.

END OF SECTION

Abbreviations listed, when used in the Contract Documents, shall have the following meanings:

<b>ABBREVIATION</b>	<b>MEANING</b>
AA	ALUMINUM ASSOCIATION
AAMA	ARCHITECTURAL ALUMINUM MANUFACTURERS' ASSOCIATION
AASHO	AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS
ACI	AMERICAN CONCRETE INSTITUTE
AGA	AMERICAN GAS ASSOCIATION
AIA	AMERICAN INSTITUTE OF ARCHITECTS
AIMA	ACOUSTICAL & INSULATING MATERIALS ASSOCIATION
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISI	AMERICAN IRON AND STEEL INSTITUTE
AMCA	AIR MOVING AND CONDITIONING ASSOCIATION INC.
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATING & AIR CONDITIONING ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AWI	ARCHITECTURAL WOODWORK INSTITUTE (USA)
AWMAC	ARCHITECTURAL WOODWORK MANUFACTURERS ASSOCIATION OF CANADA
AWS	AMERICAN WELDING SOCIETY
CCA	CANADIAN CONSTRUCTION ASSOCIATION
CCRC	CANADIAN CODE FOR RESIDENTIAL CONSTRUCTION
CEC	CANADIAN ELECTRICAL CODE
CFUA	CANADIAN FIRE UNDERWRITERS ASSOCIATION
CGA	CANADIAN GAS ASSOCIATION
CGSB	CANADIAN GENERAL STANDARDS BOARD
CIQS	CANADIAN INSTITUTE OF QUANTITY SURVEYORS
CISC	CANADIAN INSTITUTE OF STEEL CONSTRUCTION
CITC	CANADIAN INSTITUTE OF TIMBER CONSTRUCTION
CLA	CANADIAN LUMBERMEN'S ASSOCIATION
CMHC	CANADA MORTGAGE & HOUSING CORPORATION
COFI	COUNCIL OF FOREST INDUSTRIES OF BRITISH COLUMBIA
CPCI	CANADIAN PRESTRESSED CONCRETE INSTITUTE
CRCA	CANADIAN ROOFING CONTRACTORS ASSOCIATION
CSA	CANADIAN STANDARDS ASSOCIATION
CSC	CONSTRUCTION SPECIFICATIONS CANADA
CSI	CONSTRUCTION SPECIFICATIONS INSTITUTE (USA)
CSPI	CORRUGATED STEEL PIPE INSTITUTE
CSSBI	CANADIAN SHEET STEEL BUILDING INSTITUTE
CUA	CANADIAN UNDERWRITERS' ASSOCIATION
CWB	CANADIAN WELDING BUREAU
CWC	CANADIAN WOOD COUNCIL
DND	DEPARTMENT OF NATIONAL DEFENCE, CANADA
FM	FACTORY MUTUAL ENGINEERING CORPORATION
FS	FEDERAL SPECIFICATION (USA)
IES	ILLUMINATING ENGINEERING SOCIETY
IGMAC	INSULATED GLASS MANUFACTURERS ASSOCIATION OF CANADA
LTIC	LAMINATED TIMBER INSTITUTE OF CANADA
MIA	MARBLE INSTITUTE OF AMERICA
MPMDD	MODIFIED PROCTOR MAXIMUM DRY DENSITY
NAAMM	NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS (USA)
NBFU	NATIONAL BOARD OF FIRE UNDERWRITERS
NBC	NATIONAL BUILDING CODE OF CANADA

NBS	NATIONAL BUREAU OF STANDARDS (USDC)
NEMA	NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
NHLA	NATIONAL HARDWOOD LUMBER ASSOCIATION (USA)
NLGA	NATIONAL LUMBER GRADES AUTHORITY
NRC	NATIONAL RESEARCH COUNCIL
OBC	ONTARIO BUILDING CODE
OHSA	OCCUPATIONAL HEALTH AND SAFETY ACT
OPSS	ONTARIO PROVINCIAL STANDARD SPECIFICATIONS
PCA	PORTLAND CEMENT ASSOCIATION
PCI	PRESTRESSED CONCRETE INSTITUTE
SDI	STEEL DECK INSTITUTE
SPMDD	STANDARD PROCTOR MAXIMUM DRY DENSITY
SSPC	STEEL STRUCTURES PAINTING COUNCIL
TTMAC	TERRAZZO, TILE & MARBLE ASSOCIATION OF CANADA
ULC	UNDERWRITERS LABORATORIES CANADA
UL	UNDERWRITERS LABORATORIES (USA)
USAS	UNITED STATES OF AMERICA STANDARDS INSTITUTE
WSIB	WORKPLACE SAFETY AND INSURANCE BOARD

END OF SECTION

1 REFERENCES

- .1 Occupational Health and Safety Act and Regulations for Construction Projects (2011) (Ontario Regulation 213/91, amended by Reg. 631/94, & Reg. 145/00).
- .2 National Fire Code of Canada (2015)
- .3 Ontario Fire Code (2007)
- .4 Ontario Building Code (2012)

2 INSTALLATION AND REMOVAL

- .1 Provide temporary utilities, facilities and controls in order to execute the work expeditiously. Remove from site all such work after use.

3 VEHICULAR ACCESS & PARKING

- .1 Provide and maintain adequate access to project site.
- .2 Build and maintain temporary access roads where indicated or required, and provide snow removal during period of work.
- .3 If authorized to use existing roads for access to project site, maintain such roads for duration of Contract and make good damage resulting from Contractor's use of roads. Maintenance shall include regular snow removal if not provided under separate contract, and regular power washing to remove mud and dirt.
- .4 Where site access for construction vehicles necessitates use of public roads, remove mud and dirt from such roads where contaminated by construction vehicles.
- .5 Traffic Control: Provide and maintain flagpersons, traffic signals, barricades and flares, lights, or lanterns as required to perform the work and protect the public.
- .6 Construction Parking
  - .1 Parking for construction equipment vehicles will be limited to the site or immediate areas of work.
  - .2 Parking for Contractors' and Subcontractors' personal vehicles will be permitted on site provided it does not constitute a safety hazard nor disrupt the performance of Work. Parking areas will be designated by the Owner.

4 TEMPORARY UTILITIES

- .1 Temporary Electricity and Lighting
  - .1 Arrange, pay for and maintain temporary electrical power supply in accordance with governing regulations and ordinances.
  - .2 Install temporary facilities for power such as pole line and underground cables to approval of local power supply authority.
  - .3 Electrical power and lighting systems installed under this contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage. Replace lamps which have been used more than a period of 3 months.

- .4 Provide temporary lighting in all areas of construction, to the minimum requirements of the Occupational Health and Safety Act, and minimum requirements specified herein.
- .2 Temporary Water Supply
  - .1 Arrange, pay for and maintain temporary water supply in accordance with governing regulations and ordinances.
  - .2 Permanent water supply system installed under this contract can be used for construction requirements provided that guarantees are not affected thereby. Make good damage.
- .3 Temporary Heating and Ventilating
  - .1 Provide and maintain all temporary heat and ventilation necessary during construction, including cost of installation, fuel, operation, attendance and maintenance. Use of direct-fired heaters discharging waste products into work areas will not be permitted unless prior approval is given by Consultant.
  - .2 Provide temporary heat and ventilation in enclosed areas as required to:
    - .1 Facilitate progress of work.
    - .2 Protect work and products against dampness and cold.
    - .3 Prevent moisture condensation on surfaces.
    - .4 Provide ambient temperatures and humidity levels for storage, installation and curing of materials.
    - .5 Provide adequate ventilation to meet health regulations for safe working environment.
  - .3 Maintain minimum temperature of 10°C or higher where construction is in progress and maintain until acceptance of structure by Consultant.
  - .4 Ventilating
    - .1 Prevent hazardous accumulation of dust, fumes, mists, vapours or gases in areas occupied during construction.
    - .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.
    - .3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.
    - .4 Ventilate storage spaces containing hazardous or volatile materials.
    - .5 Ventilate temporary sanitary facilities.
    - .6 Continue operation of ventilation and exhaust system for a time after cessation of work process, to assure removal of harmful elements.
  - .5 Maintain strict supervision or operation of temporary heating and ventilating equipment.
    - .1 Conform with applicable codes and standards.
    - .2 Enforce safe practices.
    - .3 Prevent abuse of services.
    - .4 Prevent damage to finishes.

.5 Vent direct-fired combustion units to outside.

.6 The permanent HVAC systems of the building, or portions thereof, may not be used during construction.

**5 CONSTRUCTION FACILITIES**

**.1 Field Office**

.1 Provide minimum 2400 x 4800mm office and furnish with desk, drawing layout table, filing cabinet, and coat hooks.

.2 Provide minimum 750 Lx lighting level.

.3 Heat to maintain 22°C inside temperature.

.4 Provide 2 operable windows for cross ventilation, or air condition.

**.2 Temporary Telephone and Facsimile**

.1 Provide and pay for temporary telephone and FAX machine to be installed in Field Office.

.2 Provide separate data and telephone jacks for computer hook-up.

.3 Cellular telephones are acceptable. Pay telephone is not acceptable.

**.3 Equipment, Tools and Materials Storage**

.1 Provide adequate weathertight enclosures with raised floors, for storage of materials, tools, and equipment which are subject to damage by weather.

.2 Temporary enclosures required by subtrades as workshops shall be provided by those trades.

**.4 Site Storage and Overloading**

.1 Confine the Work and the operations of employees to limits indicated by the Contract Documents. Do not unreasonably encumber the premises with products.

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

**.5 Sanitary Facilities**

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances. Post notices and take such precautions as required by local health authorities. Keep area and premises in sanitary condition. Where portable toilet facilities are provided, empty and sanitize such facilities on a weekly basis, or more frequently if required.

.2 Permanent new facilities shall not be used by the Contractor.

**6 CONSTRUCTION SAFETY MEASURES**

- .1 Observe all construction safety measures as required by the General Conditions of the Contract, the Occupational Health and Safety Act and Regulations for Construction Projects, and by all authorities having jurisdiction, provided that in case of conflict or discrepancy, the more stringent requirements shall apply.
- .2 Provide applicable spare safety equipment such as helmets, safety glasses, and harnesses, and enforce their use by Consultants, the Owner, their representatives and any authorized visitors to the site.
- .3 Provide and maintain fences, gates and locks, covered walkways, guard rails, barriers, night lights, and appropriate warning signage as required for the protection of the public, and of public and private property; as required by the General Conditions of the Contract, the Occupational Health and Safety Act and Regulations for Construction Projects, and by all authorities having jurisdiction. Erect and maintain sturdy railings around shafts, and the like, to protect workmen and the public from injury.
- .4 Workplace Hazardous Materials Information System
  - .1 Comply with all 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.
  - .2 Include copies of all WHMIS data sheets in Operations and Maintenance Manuals.

**7 CONSTRUCTION AIDS**

- .1 Falsework
  - .1 Design and construct falsework in accordance with CSA S269.1.
- .2 Scaffolding
  - .1 Design, construct and maintain scaffolding in accordance with CSA S269.2.
  - .2 Erect scaffolding independent of walls. Remove promptly when no longer required.
- .3 Hoisting
  - .1 Provide, operate and maintain hoists or cranes required for moving of workers, materials and equipment. Make financial arrangements with Subcontractors for use thereof.
  - .2 Hoists or cranes shall be operated by qualified operator.

**8 TEMPORARY BARRIERS & ENCLOSURES**

- .1 Construction Isolation Fencing
  - .1 Erect isolation fencing around perimeter of construction areas to protect the public, workers, and the public from injury.



- .2 Construction Isolation Fencing shall consist of:
  - .1 Temporary modular welded wire mesh fencing, minimum 1828 x 2440mm high, by CanFence Rentals Ltd., or equivalent.
- .2 Provide lockable gates within hoarding / fencing for access to site by workers and vehicles.
- .3 Provide barriers around trees and planting beds designated to remain. Protect from damage.
- .4 Enclosure of Structure
  - .1 Provide temporary weathertight enclosures and protection for exterior openings until permanently enclosed.
  - .2 Erect enclosures to allow access for installation of materials and working inside enclosure.
  - .3 Erect enclosures to withstand wind pressure and snow loading.
  - .4 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work area for temporary heat.
- .5 Dust Control
  - .1 Provide dust tight screens or partitions to localize dust generating activities, and for the protection of workers, or finished areas of Work.
  - .2 Dust screens shall consist of, as a minimum, 0.15mm thick polyethylene sheets secured to appropriate framing and sealed at all joints and at perimeter to prevent migration of dust.
  - .3 Maintain and relocate protection until such work is complete.
  - .4 Provide dust catching walk-off matting, at all construction entrances.

9 **TEMPORARY CONTROLS**

- .1 Drainage & Erosion Control
  - .1 Refer to Civil Drawing (C2.3).
- .2 Tree and Plant Protection
  - .1 Refer to Section 01 57 19 – Temporary Environmental Controls.
- .3 Security Measures
  - .1 Where progress of construction reaches point where building exterior is fully enclosed, provide construction cylinders for doors, and secure building against intrusion. Where installation of fixtures and equipment, or storage of materials and equipment, inside the building has begun prior to installation of exterior windows and doors, provide temporary plywood enclosures for window and door openings to prevent intrusion until permanent closures are in place.

- .4 Site Signs and Notices
  - .1 Maintain approved signs and notices in good condition for duration of project, and dispose of off site on completion of project or earlier if directed by Consultant.
  - .2 Project Sign: Provide one temporary project sign at location approved by Consultant.
  - .3 No other signs or advertisements of any description except notices regarding safety and instruction, shall be put up around the building, or site, without the approval of the Consultant.

END OF SECTION

1 REFERENCES

- .1 National Building Code of Canada (2015)
- .2 National Fire Code of Canada (2015)
- .3 Ontario Fire Code (2007)
- .4 Guidelines for Maintaining Fire Safety during Construction in Existing Buildings, (10/31/88) Ontario Ministry of the Solicitor General, Office of the Fire Marshal.
- .5 Ontario Building Code (Regulation 350/06)

2 FIRE SAFETY

- .1 Fire Fighting Equipment
  - .1 Provide and maintain in working order, ULC labelled, 9kg 4A 60BC type fire extinguishers, and locate in prominent positions to approval of authorities having jurisdiction.
- .2 Fire Department Access
  - .1 Provide and maintain fire access routes as designed, as soon as construction sequence will allow. Access routes must have compacted granular subbase, and base in place before superstructure of building may proceed.
  - .2 Construction activities must not obstruct access routes designated for fire department equipment. If necessary that existing access be obstructed or deleted, alternative access, acceptable to the fire department, must be provided prior to commencement of construction, in accordance with Ontario Building Code location and design criteria for required access routes.
- .3 Control of Combustible Materials
  - .1 The stockpiling of construction materials adjacent to the existing building must be carefully controlled in accordance with the Ontario Fire Code. Materials stored, and their proximity to, equipment used in construction may create a fire hazard. Control of combustibles on a construction site is regulated under the Occupational Health and Safety Act.
- .4 Hot Work
  - .2 Conform to the requirements of the Occupational Health and Safety Act – Regulations for Construction Projects.
  - .3 Provide all necessary guards and barriers to protect workers, property, and the public when performing hot work such as torching, cutting or coring. Protect all adjacent combustible materials.
  - .4 Provide a "Fire Watch" for a minimum of 3 hours after each instance of discontinuing hot work.

END OF SECTION

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 humankind; or degrade environment aesthetically, culturally and/or historically.
- .2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

2 SUBMITTALS

- .1 Submittals: in accordance with Submittal Procedures.
- .2 Prior to commencing construction activities or delivery of materials to Site, submit Environmental Protection Plan for review and approval by Consultant. Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.
- .3 Address topics at level of detail commensurate with environmental issue and required construction tasks.
- .4 Environmental protection plan: include:
  - .1 Name(s) of person(s) responsible for ensuring adherence to Environmental Protection Plan;
  - .2 Name(s) and qualifications of person(s) responsible for manifesting hazardous waste to be removed from Site;
  - .3 Name(s) and qualifications of person(s) responsible for training site personnel;
  - .4 Descriptions of environmental protection personnel training program;
  - .5 Erosion and sediment control plan which identifies type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial and Municipal laws and regulations;
  - .6 Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on Site;

- .7 Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff;
- .8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for marking limits of use areas including methods for protection of features to be preserved within authorized work areas;
- .9 Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance;
- .10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris;
- .11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off-site;
- .12 Contaminant prevention plan that: identifies potentially hazardous substances to be used on 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;
- .13 Waste water management plan that identifies methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water and water used in flushing of lines;
- .14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands;
- .15 Pesticide treatment plan: to be included and updated, as required.

**3 FIRES**

- .1 Fires and burning of rubbish on Site is strictly prohibited.

**4 DISPOSAL OF WASTES**

- .1 Burying of rubbish and waste materials on Site is strictly prohibited.
- .2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

**5 DRAINAGE & EROSION CONTROL**

- .1 Provide erosion and sediment control plan that identifies type and location of erosion and sediment controls to be provided. Plan: include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
- .2 Storm Water Pollution Prevention Plan (SWPPP) may be substituted for erosion and sedimentations control plan.
- .3 Provide temporary drainage and pumping as necessary to keep excavations and Site, free from water.
- .4 Do not pump water containing suspended materials into waterways, sewer or drainage systems.
- .5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.
- .6 Provide and maintain temporary drainage and pumping as necessary to keep excavations and site free from excess water.
- .7 Provide silt fencing at site perimeters and where required by local authorities to prevent contamination of adjoining properties from silt and water drainage.

**6 TREE AND PLANT PROTECTION**

- .1 Protect existing trees and plants on all adjacent properties, where in close proximity to construction activities, or where construction access passes within 3m of trees or plants, whether indicated on drawings or not.
- .2 Conform to all local By-Laws regarding tree preservation and protection.
- .3 Protect existing trees and plants on site as indicated.
- .4 Restrict tree removal to those designated by Consultant. Wrap in burlap trees and shrubs adjacent to construction work, storage areas and trucking lanes. Encase trees and shrubs with protective wood framework from grade level to height of 2134mm.
- .5 Protect roots to minimum 1m beyond dripline during excavation and site grading to prevent disturbance or damage. Avoid unnecessary traffic, dumping and storage of materials over root zones of protected trees. Minimize stripping of topsoil and vegetation.

- .6 The Minimum Tree Protection Zone will be the drip line. Within this tree protection zone there will also be no construction activity including but not limited to no root cutting, no alteration or disturbance to existing grades of any kind, no changes to the grade by adding fill, excavating or scraping, no storage of construction materials or equipment, no stockpiling of soil, debris or construction waste, & no movement or storage of heavy vehicles or equipment. Tree protection barriers must be included and priced as part of the project. For short term project (up to 2 months), standard T-bars and plastic safety fence can be used. For a longer term project, use 10 gauge chain link fence and standard T-bars. In all cases, standard T-bars should not be spaced more than 6 to 7 feet apart. These protection barriers must be erected before the project starts, must be maintained throughout the project, and taken down when final inspection and signoffs are completed.
- 7 WORK ADJACENT TO WATERWAYS/DRAINAGE DITCHES
  - .1 Do not operate construction equipment in waterways.
  - .2 Do not use waterway beds for borrow material.
  - .3 Do not dump excavated fill, waste material or debris in waterways.
  - .4 Design and construct temporary crossings to minimize erosion to waterways.
  - .5 Do not skid construction materials across waterways.
  - .6 Avoid indicated spawning beds constructing temporary crossings of waterways.
- 8 POLLUTION CONTROL
  - .1 Maintain temporary erosion and pollution control features installed under this Contract.
  - .2 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.
  - .3 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.
- 9 HISTORICAL / ARCHAEOLOGICAL ARTIFACTS
  - .1 In the event that buried archaeological remains are encountered on the property during construction activities, the Heritage Operations Unit of the Ministry of Tourism and Culture be notified immediately at (416) 326-9326.
  - .2 In the event that human remains are encountered during construction, the Contractor shall immediately contact both the Ministry of Tourism and Culture, and the Registrar or Deputy Registrar of Cemeteries at the Cemeteries Regulation Unit, Ministry of Government Services, (416) 326-8404.

10 NOTIFICATION

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

END OF SECTION



**1 PRODUCT OPTIONS**

- .1 Provide products specified under individual specification sections. Where Specification lists two or more products, or two or more manufacturers of the same product, the Contractor may select one of the listed products or manufacturers. Confirm selection of products and manufacturers when requested by the Consultant.
- .2 When only one product or manufacturer is listed in the specifications, it is intended that only that product or manufacturer is acceptable.

**2 PRODUCT SUBSTITUTION PROCEDURES**

- .1 Substitution Procedures During Construction
  - .1 Products may only be substituted during the Construction period for one or more of the following reasons:
    - .1 Insolvency of the product manufacturer.
    - .2 Inability of the manufacturer to provide the product(s) in the timeframe required to maintain the construction schedule.
    - .3 Product specified has been discontinued.
    - .4 Substitution proposed offers better performance than that specified, at no additional cost.
    - .5 Substitution offers equivalent performance to that specified, at a reduced cost to the Owner (reduction in Contract Price).
  - .2 Items 2.1.1.2, and 2.1.1.3 will require a letter from the manufacturer, confirming their inability to provide the products specified, or inability to meet the schedule.
  - .3 Items 2.1.1.4, and 2.1.1.5 will be at the discretion of the Owner.

**3 AVAILABILITY**

- .1 Immediately upon signing Contract, review Product delivery requirements, and identify lead times for supply of all Products. If lead times in supply of Products may affect the Construction Schedule, notify the Consultant in order that appropriate action may be authorized in ample time to prevent delay in performance of the Work.
- .2 The Contractor shall order Products and materials in a timely fashion so as to ensure that delivery of such Products and materials shall coincide with the Construction Schedule. Failure of the Contractor or their Subcontractors to order Products and materials in a timely fashion, shall not be cause for substitution in accordance with the criteria set out under Article 2 – Product Substitution Procedures.
- .3 In the event of failure to notify the Consultant of Product delivery problems at the commencement of the Work, and should it appear that the Work may be delayed for such reason, the Consultant reserves the right to substitute more readily available Products of similar character of their choosing, at no increase in Contract Price.

**4 REFERENCE STANDARDS**

- .1 Within the specifications, reference standards are identified. Conform to these standards, in whole or part, as specifically requested.

- .2 If there is question as to whether any product or system is in conformance with applicable standards, the Consultant reserves the right to have such products or systems tested to prove or disprove conformance.
  - .3 The cost for such testing will be born by the Owner in the event of conformance with Contract Documents or by the Contractor in the event of non-conformance.
  - .4 Conform to latest date of issue of referenced standards in effect on date of submission of bids, except where a specific date of issue is specifically noted.
- 5 **PRODUCT TRANSPORTATION & DELIVERY**
- .1 Transportation and delivery costs of Products required in the performance of the Work, are included in the Contract Price.
  - .2 Transportation and delivery costs of Products supplied by the Owner will be paid for by the Owner. Unload, handle, and store such Products on site.
  - .3 Products must be appropriately crated, skidded, boxed, shrink-wrapped, or otherwise packaged to protect such products from damage during shipment. Products which arrive at the site in a damaged condition must be rejected and returned to the supplier/manufacturer for immediate replacement.
  - .4 Advise the Owner 30 days in advance of anticipated delivery dates for materials and equipment supplied by the Owner.
- 6 **PRODUCT STORAGE, HANDLING AND PROTECTION**
- .1 Handle and store Products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with manufacturer's instructions.
  - .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 the 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 paints in a heated and ventilated room. Remove oily rags and other combustible debris from site daily. Take every precaution necessary to prevent spontaneous combustion.
  - .8 Remove and replace damaged Products at own expense and to the satisfaction of the Consultant.

**7 MANUFACTURER'S INSTRUCTIONS**

- .1 Unless otherwise indicated in the specifications, install or erect Products in accordance with manufacturer's printed 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 the specifications and manufacturer's instructions, so that Consultant may establish correct course of action.
- .3 Improper installation or erection of Products, due to failure in complying with these requirements, authorizes the Consultant to require removal, replacement where necessary, and re-installation at no increase in Contract Price.

**8 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 the affected specification Section.
- .4 Space anchors within limits of load limit or shear capacity and ensure that 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.
- .7 Obtain Consultant's approval before using explosive actuated fastening devices.

**9 QUALITY OF MATERIALS**

- .1 Products, materials, equipment and articles (referred to as Products throughout the specifications) incorporated in the Work shall be new, not damaged or defective, and of the best quality (compatible with specifications) for the purpose intended. If requested, furnish evidence as to type, source and quality of Products provided.
- .2 Products relying on uniformity of colour and pattern for appearance, such as resilient flooring, carpeting, fabrics, and vinyl wallcovering, shall be from one dye lot for the project. All products delivered to the site must be labeled as to dye lot, or production run number, as well as production date.
- .3 Defective products, whenever identified prior to the completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility, but is a 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 any dispute arise as to the quality or fitness of Products, the Consultant may request additional testing based upon the requirements of the Contract Documents, to confirm acceptability of products or materials. Refer to Article 10 - Defective Materials And Work, and Section 01 40 00.
  - .5 Unless otherwise indicated in the specifications, maintain uniformity of manufacture for any particular or like item throughout the 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.
- 10 DEFECTIVE MATERIALS AND WORK
- .1 Where evidence exists that defective work has occurred, or that work has been carried out incorporating defective products, the Consultant may have independent tests, inspections, or surveys performed in order to determine if work is defective.
  - .2 Tests, inspections, or surveys carried out under these circumstances will be made at the Contractor's expense in the event of defective work, or at the Owner's expense where work is in conformance. Where tests incorporate a number of samples, payment will be assessed, by the Consultant, based on the ratio of conforming to non-conforming results. This does not include re-testing of soil compaction during placement, where evidence exists of non-conformance with the Contract documents, but rather only if re-testing is called for after completion of compaction.
- 11 WARRANTIES & GUARANTEES
- .1 Warrant all products and labour forming part of the Work for the period specified in the Contract, unless otherwise specified herein.
  - .2 Warrant products and assemblies for the specified periods of time where in excess of the Contract Warranty, as specified within their respective sections.
  - .3 Guarantee aspects of the Work for the specified periods of time where in excess of the Contract Warranty, as specified within their respective sections.
  - .4 Warranties and Guarantees shall commence at Date of Substantial Performance of the Contract as certified by the Consultant.
  - .5 Warranties and Guarantees shall be original copies, printed on company letterhead, or on a standard company warranty certificate, bearing the name of the company.
  - .6 Within one month of the one-year warranty period, the Contractor, Consultant, and Owner shall visit the Place of the Work in order to document all outstanding deficiency or Warranty items. The Contractor shall promptly rectify all outstanding Warranty and deficiency items.

- .7 Warranties and Guarantees shall indicate:
  - .1 Name of the Principal (the Manufacturer/Subcontractor),
  - .2 Name of the Obligor (the Owner),
  - .3 Name and address of Project,
  - .4 Commencement date (Date of Substantial Performance),
  - .5 Duration of warranty or guarantee,
  - .6 Clear statement of what is included, and what if any exclusions there are,  
and
  - .7 Signature of Principal's representative having signing authority.

END OF SECTION

1 EXAMINATION

.1 Acceptance of Conditions

- .1 The General Contractor shall examine all existing or pre-determined conditions, prior to commencing work in that area, and report to the Consultant all conditions unacceptable for work to proceed. Commencement of work shall imply acceptance of conditions as is.
- .2 Subcontractors shall examine all existing or pre-determined conditions affecting their portion of the Work, prior to commencing such work, and report to the Contractor all conditions unacceptable for work to proceed. Commencement of work shall imply acceptance of conditions as is.

2 PREPARATION

.1 Field Engineering

- .1 Locate, confirm and protect control points prior to starting the Work. Preserve permanent reference points during construction.
- .2 Establish reference lines and elevations. Locate and lay out by instrumentation.

.2 Records

- .1 Maintain a complete, accurate log of control points and survey work as work progresses.

3 CUTTING AND PATCHING

.1 Submit a written request in advance, for approval of cutting or alteration which affects:

- .1 Structural integrity of any element of Project.
- .2 Integrity of weather-exposed or moisture-resistant elements.
- .3 Efficiency, maintenance, or safety of any operational element.
- .4 Visual qualities of sight-exposed elements.
- .5 Work of Owner or separate contractor.

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

.3 After uncovering, inspect conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

.4 Perform cutting, fitting and patching, including excavation and fill, to complete the Work. Perform work to avoid damage to other work.

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

.6 Cut rigid materials using power saw or core drill. Pneumatic or impact tools not allowed.

.7 Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces. At penetration of fire-rated wall, ceiling, or floor construction, completely seal voids with firestopping material, full thickness of construction element.

- .8 Refinish surfaces to match adjacent finishes; for continuous surfaces refinish to nearest intersection; for an assembly, refinish entire unit.
- .9 Provide all openings greater than 200mm in non-structural elements of work for penetrations of mechanical and electrical work. Mechanical and Electrical Subcontractors shall provide all sleeves and locations for sleeves. The cost of all cutting and patching required by Mechanical and Electrical Subcontractors shall be paid for by those trades.
- .10 Ensure that all cutting and patching work, including that by Mechanical and Electrical Subcontractors, is properly performed by the respective trades skilled in that line of work. Restore work with new products in accordance with Contract Documents.

**4 LOCATION OF EQUIPMENT AND FIXTURES**

- .1 Location of mechanical and electrical equipment, fixtures and devices indicated or specified, are to be considered as approximate. Final location of such items will be determined on site, based on integration with structural and architectural elements, and as required by coordination with other trades. In the event of a conflict, final determination of location of these items rests with the Consultant.
- .2 Prepare and submit for review by the Consultant, interference field drawings, to indicate relative position of various services and equipment, at the following locations as a minimum:
  - .1 Under all rooftop mechanical units.
  - .2 At locations of all major ductwork, piping, and conduit crossovers.
  - .3 Where ductwork passes under major structural elements.
- .3 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.
- .4 Request a review of items by Consultant once rough-in is underway, prior to final installation, and obtain approval for actual locations.

**5 CONCEALMENT**

- .1 Conceal pipes, ducts and wiring in floor, wall and ceiling construction of finished areas, except where indicated otherwise.

**6 LIGHTING FIXTURES AT SUSPENDED CEILINGS**

- .1 Ensure that secure support is provided for lighting fixtures by suspended ceilings, or by separate hangers, or by both.
- .2 Coordinate the ceiling system and lighting fixture installations to provide adequate support.
- .3 Submit affidavits with acceptable design information confirming that the installation of the suspended ceiling system and/or separate fixture hangers will provide adequate support for the lighting fixtures without exceeding specified deflection tolerances for the ceiling system.
- .4 Conform to current requirements of the Electrical Safety Authority (ESA).

7 PROTECTION OF WORK IN PROGRESS

- .1 Adequately protect Work completed or 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 Prevent overloading of any part of the building. Do not cut, drill or sleeve any load bearing structural member, unless specifically indicated, without written approval of Consultant.
- .3 Protect finished surfaces with overlays of protective materials such as Kraft paper, cardboard, or plywood, as required for individual applications to provide adequate protection.

END OF SECTION



1 GENERAL

- .1 Conduct cleaning and disposal operations to comply with local ordinances and environmental protection legislation.
- .2 Store volatile wastes in covered metal containers, and remove from premises at end of each working day.
- .3 Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.

2 CLEANING DURING CONSTRUCTION

- .1 Maintain the Work in tidy condition, free from accumulation of waste products and debris.
- .2 Remove waste material and debris from the work areas and deposit in waste container at the end of each working day.
- .3 Vacuum clean interior areas prior to start of finishing work. Maintain areas free of dust and other contaminants during finishing operations.
- .4 Individual Subcontractors are responsible for the daily clean-up and removal of debris related to, or generated by, their own work. The overall responsibility for project cleanliness rests with the Contractor.

3 WASTE MANAGEMENT

- .1 Audit, separate and dispose of construction waste generated by new construction or by demolition of existing structures in whole or in part, in accordance with Ontario Regulations 102/94 and 103/94 made under the Environmental Protection Act.
- .2 Fires, and burning of rubbish or waste on site is prohibited.
- .3 Burying of rubbish or waste materials, except as specified herein, is prohibited.
- .4 Disposal of waste or volatile materials such as mineral spirits, oil, gasoline or paint thinner into ground, waterways, or sewer systems is prohibited.
- .5 Empty waste containers on a regular basis to prevent contamination of site and adjacent properties by wind-blown dust or debris.

4 FINAL CLEANING OPERATIONS

- .1 Immediately following Date of Substantial Performance, and prior to Owner occupancy of the building or portion of the building affected by the Work, conduct full and complete final cleaning operations.
- .2 Final cleaning operations shall be performed by an experienced professional cleaning company, possessing equipment and personnel sufficient to perform full building cleaning operations.
- .3 Remove all surplus products, tools, construction machinery and equipment not required for the performance of remaining work, and thereafter remove any remaining materials, equipment, waste and debris.

- .4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.
- .5 Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .6 Cleaning operations shall include the removal of all stains, spots, scuff marks, dirt, dust, remaining labels, adhesives or other surface imperfections.
- .7 Remove all paint spots or overspray from all affected surfaces.
- .8 Clean and polish all glass and mirrors. Replace broken, scratched or disfigured glazing. Remove remaining manufacturer's and safety "X" labels.
- .9 Clean and polish all finished metal surfaces such as enamelled or stainless steel, chrome, aluminum, brass, and bronze.
- .10 Clean and polish all vitreous surfaces such as plumbing fixtures, ceramic tile, porcelain enamel, or other such materials.
- .11 Clean all ceramic tile surfaces in accordance with the manufacturer's instructions, and apply final coat of sealer where specified.
- .12 Clean inside of all millwork and cabinetry.
- .13 Vacuum, clean and dust behind grilles, louvres and screens.
- .14 Seal and wax all resilient floor surfaces as specified, and as recommended by the manufacturer.
- .15 Broom clean and spray wash all exterior paved surfaces.
- .16 Remove dirt and other disfiguration from exterior surfaces.
- .17 Clean all roofs, gutters, downspouts, areaways, drywells, and drainage systems.
- .18 Clean all equipment and fixtures to a sanitary condition, clean or replace filters of mechanical equipment.

END OF SECTION

1 INSPECTION AND DECLARATION PROCEDURES

- .1 Arrange for, conduct and document final inspections, close-out and commissioning at the completion of the Work in accordance with the procedures described in the General Conditions of the Contract, and OAA/OGCA Document 100.

2 SUBSTANTIAL PERFORMANCE

- .1 Contractor's Inspection
  - .1 Refer to OAA/OGCA Document 100 – STAGE 2.
  - .2 The Contractor and all Subcontractors shall conduct an inspection of the work, identify deficiencies and defects, and make corrections as required to conform with the Contract Documents. Notify Consultant in writing of satisfactory completion of Contractor's Inspection and that corrections have been made. Request a Consultant's Inspection.
- .2 Contractor's Application for Substantial Performance of the Work
  - .1 Refer to OAA/OGCA Document 100 – STAGE 3.
  - .2 When the Contractor has carried out the steps in Stage 2 of OAA/OGCA Document 100, and has determined that the requirements of the Contract have been substantially performed as defined by local Lien legislation, the Contractor shall make application for Substantial Performance of the Work.
  - .3 In addition to the requirements of OAA/OGCA Document 100, the following items shall accompany the Contractor's application for Substantial Performance. These items must be complete in all respects, and all verification certificates and reports having been submitted and approved by the Consultants:
    - .1 Completed (and accepted) Maintenance Manuals for all disciplines (No. of copies as specified),
    - .2 As-Built Drawings for all disciplines (No. of copies as specified),
    - .3 Mechanical, Sprinkler, and Electrical as-built CAD drawings,
    - .4 Occupancy Permit (where required by Municipality),
    - .5 Air Balance Report (legible technicians worksheets are acceptable),
    - .6 Gas fired appliances inspection,
    - .7 Plumbing Inspection,
    - .8 Domestic Water Quality Test Report,
    - .9 Sprinkler dry test verification letter stamped and signed by sprinkler design Engineer,
    - .10 Mechanical start-up reports (Boilers, HVAC Units, Chillers, Water Softeners, etc.),
    - .11 Fire Alarm verification (include legible technicians worksheets),
    - .12 Emergency Lighting verification,
    - .13 Electrical distribution system inspection,
    - .14 ESA Hydro Certificate, and
    - .15 Systems operations have been demonstrated to Owner's personnel.

- .3 Consultant's Inspection
  - .1 The Consultants shall perform an inspection of the Work to assess the validity of the Contractors application, and shall identify in separate lists, unfinished work and deficiencies. Contractor shall correct work accordingly.
- .4 Certificate of Substantial Performance
  - .1 Refer to OAA/OGCA Document 100 – STAGE 4.
  - .2 Should the Consultant concur with the Contractor's application for Substantial Performance, the Consultant shall notify the Contractor of approval of the application for Substantial Performance and issue a Certificate of Substantial Performance.
  - .3 The Contractor shall publish a copy of the Certificate of Substantial Performance in a construction trade newspaper, and shall provide the Consultant with proof of the date of publication.
- 3 LIEN PERIOD AND RELEASE OF BASIC HOLDBACK
  - .1 Refer to OAA/OGCA Document 100 – STAGE 5.
  - .2 Commencement of Lien Periods
    - .1 The day following the date of publication of Certificate of Substantial Performance shall be the date of commencement of the 60 day Lien Period prior to release of basic holdback, unless required otherwise by lien statute of the Place of the Work.
    - .2 When the Contractor has carried out the required steps in Stages 3 and 4 of OAA/OGCA Document 100, the Contractor shall make application for Release of Basic Holdback.
    - .3 The Consultant shall prepare the Certificate for Payment for release of basic holdback, and promptly upon receipt of the necessary documentation, issue the Certificate for Payment to the Owner.
- 4 FINAL INSPECTION AND PAYMENT
  - .1 Refer to OAA/OGCA Document 100 – STAGE 6.
  - .2 Submit a signed statement stating following have been performed:
    - .1 Work has been reviewed for compliance with Contract Documents,
    - .2 All deficiencies have been corrected,
    - .3 All unfinished work has been completed, and
    - .4 Work is complete and ready for Final Inspection.
  - .3 When items noted above are completed, a final inspection of the Work will be performed by the Owner, the Consultants, and the Contractor.
  - .4 If the Work is deemed to be incomplete, complete outstanding items and request a reinspection.

- .5 If the Work is deemed to be complete, the Consultant will issue a Final Certificate for Payment.
- 5 DEFICIENCY REVIEW
- .1 Following the issuance of the Certificate of Substantial Performance and prior to the Contractor's application for Final Payment and release of any monies retained as "Finishing Holdback", the Contractor shall continue to complete unfinished work and correct deficiencies. At the request of the Contractor, the Consultants shall conduct up to two general deficiency reviews during this period.
  - .2 The first review will be undertaken only if the Contractor has inspected the Work, and states in writing that the unfinished work noted in their application for Substantial Performance has been completed, and at least 50% of all deficiencies have been corrected.
  - .3 The second review will be undertaken only if the Contractor has inspected the Work, and states in writing that 90% of the deficiencies have been corrected.
  - .4 Should further review by Consultants be required due to failure of the Work to comply with Contract Documents or the criteria set out herein, the Owner will deduct amount of Consultant's compensation for reinspection services from monies owed to the Contractor.

END OF SECTION

1 REFERENCES

- .1 OAA/OGCA Document 100; OAA/OGCA Take-Over Procedures.

2 OPERATION AND MAINTENANCE MANUALS

.1 General

- .1 Prepare Operation and Maintenance Manual during the course of construction and have completed prior to Date of Substantial Performance.

.2 Submission

- .1 Maintain one copy of the Operation and Maintenance Manual volume(s) for periodic review and comment, as requested by the Consultant during the course of construction.
- .2 Submit two (2) final hard copies and one (1) USB device with PDF version of all documents of the final completed volume(s) with the application for Substantial Performance in accordance with OAA/OGCA Document 100.

.3 Format

- .1 Bind data in commercial quality, 219 x 279mm, "D" ring binders, having clear cover and spline pockets.
- .2 Identify each binder on the cover and spline with the following:  
OPERATION & MAINTENANCE MANUALS

City of Barrie  
Barrie Fire Station 6  
845 Maplevue Drive East  
Barrie, Ontario

VOLUME \_\_\_\_ OF \_\_\_\_

- .3 Provide table of contents and index tab sheets for each volume. Itemize and tabulate contents.
- .4 Provide drawings with reinforced punched binder tab, or insert into clear sleeves in folded format. Group drawings as to content, and index for quick reference.

.4 Contents - Each Volume

- .1 Table of Contents: provide title of Project, Date of submission and names:
  - .1 Addresses, and telephone numbers of Consultant and Contractor with name of responsible parties;
  - .2 Schedule of products and systems, indexed to content of volume.
- .2 For each product or system: List names, addresses and telephone numbers of sub-contractors and suppliers, including local source of supplies and replacement parts.

- .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
  - .4 Operation and Maintenance Manuals shall contain, as a minimum, the following information:
    - .1 List of Contents; cross-referenced to each Volume.
    - .2 Contact information for maintenance and repairs
    - .3 Warranty and guarantee certificates
    - .4 Equipment start-up and troubleshooting instructions
    - .5 Equipment schematics & diagrams
    - .6 Catalogue of all maintenance materials and quantities
    - .7 Complete list of Contractor, Subcontractors and suppliers, indicating name, address, telephone & fax numbers, email addresses, name of contact person and description of work done.
    - .8 Complete list of products used in the work, indicating product name and manufacturer for each listing.
    - .9 Copy of Finish Hardware List, complete with all amendments and revisions, if applicable.
    - .10 Schedule of paints and coatings. Include sufficient explanation to fully identify each surface with the applicable paint or coating used. Enclose copy of Colour Schedule.
    - .11 All "reviewed" shop drawings.
    - .12 Maintenance instructions for all finished surfaces.
    - .13 Brochures and cuts of all equipment and fixtures.
    - .14 Operating and maintenance instructions for all equipment.
    - .15 All Warranties and Guarantees required by the Specifications for this Work.
  - .5 Refer to Division 21, 22 and 23 for more specific mechanical data required beyond the description of this paragraph.
  - .6 Refer to Division 26 for more specific electrical data required beyond the description of this paragraph.
  - .7 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
  - .8 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
- 3 AS-BUILT DRAWINGS
- .1 Record information on a clean set of black line opaque drawings, provided by Owner.
  - .2 Maintain as-built drawings on site and update as construction progresses. Allow periodic review by Consultant as requested.
  - .3 Record information concurrently with construction progress. Do not conceal work until required information is recorded.

- .4 Contract drawings and shop drawings: legibly mark each item to record actual construction, including:
  - .1 Measured depths of elements of foundation in relation to finish first floor datum.
  - .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
  - .4 Field changes of dimension and detail.
  - .5 Changes made by change orders.
  - .6 Details not on original Contract Drawings.
  - .7 References to related shop drawings and modifications.
- 4 **EQUIPMENT AND SYSTEMS**
  - .1 Each Item of Equipment and Each System: include description of unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
  - .2 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
  - .3 Include installed colour coded wiring diagrams.
  - .4 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
  - .5 Maintenance Requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
  - .6 Provide servicing and lubrication schedule, and list of lubricants required.
  - .7 Include manufacturer's printed operation and maintenance instructions.
  - .8 Include sequence of operation by controls manufacturer.
  - .9 Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
  - .10 Provide installed control diagrams by controls manufacturer.
  - .11 Provide Contractor's coordination drawings, with installed colour coded piping diagrams.
  - .12 Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.



- .13 Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
  - .14 Include all test and balancing reports
  - .15 Additional requirements: As specified in individual specification sections.
- 5 MATERIALS AND FINISHES
- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
  - .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
  - .3 Moisture-protection and Weather-exposed Products: include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
  - .4 Additional Requirements: as specified in individual specifications sections.
- 6 MAINTENANCE MATERIALS, SPARE PARTS & TOOLS
- .1 Provide spare parts in quantities specified in individual specification sections. Provide identical items to those installed in the Work.
  - .2 Provide maintenance materials in quantities specified in individual specification sections. Provide identical items of same manufacturer, dye lot or production run as items in the Work.
  - .3 Provide special tools in quantities specified in individual specification sections, and tag items identifying their function and equipment or products to which they are associated.
  - .4 Receive and catalogue all items. Check inventory and include approved listings in Operations and Maintenance Manual.
  - .5 Obtain receipts for delivered products and submit prior to Substantial Performance.
  - .6 Quality
    - .1 Spare parts, maintenance materials and special tools provided shall be new, not damaged or defective, and of the same quality and manufacture as products provided in the Work.
    - .2 If requested, furnish evidence as to type, source and quality of Products provided.
    - .3 Defective products will be rejected, regardless of previous inspections. Replace products at own expense.

- .7 Delivery, Storage, And Handling
  - .1 Deliver all materials required as maintenance materials, spare parts or special tools, to the site, include shipping costs, and store as directed.
  - .2 Store spare parts, maintenance materials and special tools in a manner to prevent damage, or deterioration.
  - .3 Store in original and undamaged containers with manufacturer's seals or labels intact.
  - .4 Store materials subject to damage from severe climatic changes in a climate-controlled, weatherproof enclosure.
  - .5 Store paints and freezable materials in a moderately heated and ventilated room.
- 7 WARRANTIES AND BONDS
  - .1 Separate each warranty or bond with index tab sheets keyed to Table of Contents listing.
  - .2 List subcontractor, supplier, and manufacturer, with name, address, and telephone number of responsible principal.
  - .3 Obtain warranties and bonds, executed in duplicate by subcontractors, suppliers, and manufacturers, within ten (10) days after completion of the applicable item of work.
  - .4 Except for items put into use with Owner's permission, leave date of beginning of time of warranty until the Date of Substantial Performance is determined.
  - .5 Verify that documents are in proper form, contain full information, and are notarized. Co-execute submittals when required.
  - .6 Retain warranties and bonds for one (1) year of comprehensive material and labour warranty to be include for the entire project.

END OF SECTION

**1 GEOTECHNICAL INFORMATION**

- 1.1 A copy of the following detailed geotechnical information is appended to this Document:
- .1 Report on Geotechnical Investigation  
Propose Barrie Fire Hall Station 6 Development  
845 Maplevue Drive East  
Barrie, Ontario  
Prepared by: GEI Consultants Ltd.  
Report No.: 2203244  
Dated: November 8, 2022
- 1.2 This geotechnical information records properties of subsurface conditions and recommendations for the design of foundations, pavements and soil remediation as outlined in the information provided.
- 1.3 The geotechnical information by its nature, cannot reveal all conditions that exist or can occur on the Site. Should subsurface conditions be found to vary substantially from the report, immediately notify Consultant in writing and await instructions.
- 1.4 Contractor shall not be entitled to extra payment or extension of Contract Time for work which is required and which is reasonably inferable in the geotechnical information as being necessary.
- 1.5 In case of discrepancies between recommendations contained in geotechnical information and requirements of Contract Documents, the latter shall govern. Advise Consultant in writing of any discrepancies discovered.

END OF DOCUMENT



**Geotechnical Investigation**  
**Proposed Barrie Fire Station 6**  
**Development**

845 Mapleview Drive East, Barrie, Ontario

**Submitted to:**

City of Barrie  
157 Bradford Street  
Barrie, Ontario  
L4N 3B4

**Submitted by:**

GEI Consultants Ltd.  
647 Welham Road, Unit 14  
Barrie, Ontario, L4N 0B7  
[www.geiconsultants.com](http://www.geiconsultants.com)

November 8, 2022  
Project No. 2203244

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# 1. Introduction

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GEI Consultants (GEI) was retained by the City of Barrie (the Client) to complete a geotechnical investigation and report for the proposed Fire Station 6 development at 845 Maplevue Drive East, in the City of Barrie. A site locations plan is enclosed as Figure 1.

The City of Barrie is proposing to construct a new Barrie Fire and Emergency Service Station #6 (BFES Station # 6) to provide essential services in advance of build-out of future development areas. BFES Station #6 is planned to be located on the southwest corner of Maplevue Drive East and Prince William Way, currently identified as 845 Maplevue Drive East. The facility is anticipated to be approximately 3,000 sq. ft. in size, with a 1,500 sq. ft. garage for a total of 4,500 sq. ft. The building will be two-storeys high in some locations and a basement is also proposed. Grading plans were not available at the time of this report, but it is assumed that the ground floor slab will be just above the existing grade for purposes of this report. It is understood that the site was a former temporary Storm Water Management (SWM) pond and just prior to the geotechnical field work the pond was backfilled with engineered fill. An aerial image of the site is provided on Figure 2A and the proposed concept plan is included as Figure 2B.

The purpose of the geotechnical investigation was to assess the subsurface soil conditions at the site, and based on this information, provide geotechnical engineering recommendations in support of the proposed development. This report summarizes the borehole findings, provides design geotechnical engineering recommendations regarding available bearing capacities for foundations, slabs-on-grade, earth pressures and drainage for basements. Considerations for constructability such as soil excavation, compaction, on-site backfill suitability and temporary groundwater control are also provided.

It is noted that the recommendations provided in this report must be considered preliminary in nature due to the current uncertainty of the design for the project. As the design progresses further geotechnical review and input may be required which might necessitate the need for additional investigation and/or analysis.

GEI has also been retained to complete a hydrogeological study for the site and the findings and recommendations are provided under separate cover.

It is noted that geoenvironmental assessment, chemical testing, etc. was not part of the current scope.



## 2. Procedures and Methodology

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It is noted that all elevations in this report are metric and expressed in metres (m). All measurements are also in metric and expressed in millimetres (mm), metres (m) or kilometres (km).

Prior to the commencement of drilling activities, the borehole locations were staked in the field by GEI. Ground surface elevations of the boreholes and coordinates (referencing NAD 83 geodetic datum) were surveyed by GEI with a Topcon FC – 5000 GPS Survey unit.

Underground utilities including natural gas, electrical, telephone, water, etc. were marked out by public utility locating companies prior to drilling.

The fieldwork for the drilling program was carried out on Sept 22, 2022. Boreholes 1 to 6 were drilled to 2.0 to 6.6 m below existing grade (Elev. 248.7 to 253.9). Borehole logs are provided in Appendix A and the borehole locations are shown on Figure 2A (aerial image) and Figure 2B (proposed plan). It is noted that the boreholes were laid out and drilled based on a previous concept plan and the concept plan shown in Figure 2B is an updated concept plan.

The boreholes were advanced by a drilling subcontractor retained and supervised by GEI using a truck-mounted drill rig, hollow stem augers, and standard soil sampling equipment. Sampling was conducted using a 51 mm O.D. Split Spoon (SS) sampler. Standard Penetration Test (SPT) “N” Values (N values) were recorded for the sampled intervals as the number of blows required to drive an SS sampler 305 mm into the soil using a 63.5 kg drop hammer falling 750 mm, in accordance with ASTM D1586. In each borehole soil sampling was conducted at 0.75 m intervals for the upper 3.0 m and at 1.5 m intervals thereafter.

Monitoring wells were installed in Boreholes 1, 2, and 3 by GEI to facilitate long-term groundwater monitoring, each consisting of 50 mm diameter PVC pipe with a 1.5 m long screen and protective casing. Monitoring well construction is shown on the borehole logs in Appendix A. Boreholes without wells were backfilled in accordance with O.Reg. 903.

The GEI field staff examined, and classified characteristics of the soils encountered in the boreholes, including the presence of fill materials, groundwater observations during and upon completion of the drilling, recorded observations of borehole construction, and processed the recovered samples. All recovered soil samples were logged in the field, carefully packaged, and transported to GEI’s laboratory for more detailed examination and classification.



In GEI's laboratory, the samples were classified as to their visual and textural characteristics. Two (2) representative samples of the major soil units were selected and submitted to our laboratory for grain size analysis. Grain size results are provided in Appendix B.





## 3. Subsurface Conditions

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### 3.1 General Overview

The detailed soil profiles encountered in the boreholes are indicated on the attached borehole logs in Appendix A, and the geotechnical laboratory results are included in Appendix B. The borehole locations are shown on Figures 2A and 2B.

It should be noted that the conditions indicated on the borehole logs are for specific locations only and can vary between and beyond the locations. It should be noted that the soil boundaries indicated on the borehole logs are inferred from non-continuous sampling and observations during drilling. These boundaries are intended to reflect approximate transition zones and should not be interpreted as exact planes of geological change.

In addition, the descriptions provided in the borehole logs are inferred from a variety of factors, including visual observations of the soil samples retrieved, laboratory testing, measurements prior to and after drilling, and the drilling process itself (speed of drilling, shaking/grinding of the augers, etc.). The passage of time also may result in changes in conditions interpreted to exist at locations where sampling was conducted.

### 3.2 Stratigraphy

#### 3.2.1 *Fill*

A fill layer was encountered in all the boreholes at the surface and was penetrated at 1.5 to 3.0 m depth (Elev. 252.4 to 254.4). The fill typically consisted of silty sand to sandy silt with trace gravel. One (1) sample of the material was submitted for grain size analysis and the results are provided on Figure B1 in Appendix B. The fill was moist with moisture contents ranging from 5 to 17%. The fill had N values ranging from 5 to 38 indicating a loose to dense condition.

As noted earlier it is understood that the site was once a former temporary SWM pond and prior to the field investigation the pond/site was graded with engineered fill to the current grade. The report regarding the compaction of the engineered fill was provided to GEI for review. The report indicates that the loose/weak/poor/saturated soil was removed, and inorganic site soil was utilized as engineered fill which was placed in the pond area and the area surrounding the pond to bring the site to the surrounding grade level. The report also indicates that the engineered fill was compacted to a minimum of 98% Standard Proctor Maximum Dry Density (SPMDD).



### 3.2.2 Glacial Till

A glacial till deposit was observed under the fill in all the boreholes. The till extended to 3.0 to 4.6 m depth (Elev. 250.9 to 252.3) in Boreholes 1 to 4 and extended to the 2.0 m depth of exploration (Elev. 253.1 to 253.9) in Boreholes 5 and 6. The till matrix consisted of silty sand to sandy silt, with trace to some gravel and clay. One (1) sample of the material was submitted for grain size analysis and the results are provided on Figure B2 in Appendix B. The soil was moist, and moisture contents were 7 to 12%. N values in the material were 7 to 16 blows indicating a loose to compact condition.

### 3.2.3 Sand/Silty Sand

A lower layer of sand, locally silty sand in Borehole 4, was observed in Boreholes 1 to 4 below the till at depths of 3.0 to 4.6 m (Elev. 250.9 and 252.3) and extended to 6.6 m depth of exploration (Elev. 248.7 to 249.7). The material was wet with moisture contents of 8 to 21%. The sand or silty sand was compact to very dense with N values of 16 to greater than 100.

## 3.3 Groundwater

Unstabilized groundwater level measurements and cave measurements were taken upon the completion of drilling of each borehole as shown on the borehole logs in Appendix A. These measurements were taken to provide a rough estimate of the possible excavation and temporary groundwater control constructability considerations that may arise. Three (3) boreholes were outfitted with a monitoring well with 50 mm diameter PVC standpipe and 1.5 m long screen. Monitoring well configuration and groundwater observations are noted on the borehole logs in Appendix A. A summary of the groundwater measurements is below.

Borehole	Depth of Cave (m) / Elev.	Unstabilized Groundwater Level Depth (m) / Elev.	Depth (m) / Elev. of Groundwater Table, October 18, 2022
1	Open (6.6 / 248.9)	4.0 / 251.5	2.5 / 253.0
2	Open (6.6 / 249.7)	4.0 / 252.3	2.5 / 253.8
3	Open (6.6 / 248.7)	3.0 / 252.3	2.1 / 253.2
4	2.7 / 252.7	2.7 / 252.7	N/A
5	Open (2.0 / 253.1)	No Water	N/A
6	Open (2.0 / 253.9)	No Water	N/A

The stabilized groundwater levels were measured at 2.1 to 2.5 m depth (Elev. 253.0 to 253.7) below the existing ground surface. The groundwater is in underlying sand, controlled by the less pervious till and is under some sub-artesian pressure.



The existing sand/silty sand are permeable and allow for the free flow of groundwater when wet. The fill is semi-permeable and is expected to generally allow for the free flow of water when wet. The till is relatively impervious and is expected to allow only limited seepage.

Groundwater levels are expected to show seasonal fluctuations and vary in response to prevailing climate conditions.



## 4. Engineering Design Parameters & Analysis

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The City of Barrie is proposing to construct a new BEFS Station # 6 to provide essential services in advance of build-out of future development areas. BEFS Station #6 is planned to be located on the southwest corner of Maplevue Drive East and Prince William Way, currently identified as 845 Maplevue Drive East. The facility is anticipated to be approximately 3,000 sq. ft. in size, with a 1,500 sq. ft. garage for a total of 4,500 sq. ft. The building will be two-storeys high in some locations and a basement is also proposed. Grading plans were not available at the time of this report, but it is assumed that the ground floor slab will be just above the existing grade for purposes of this report. It is understood that the site was a former temporary Storm Water Management (SWM) pond and just prior to the geotechnical field work the pond was backfilled with engineered fill. An aerial image of the site is provided on Figure 2A and the proposed concept plan is included as Figure 2B.

It is noted that the recommendations provided in this report must be considered preliminary in nature due to the current uncertainty of the design for the project. As the design progresses further geotechnical review and input may be required which might necessitate the need for additional investigation and/or analysis.

### 4.1 Site Grading

Grading plans were not available for review at the time of this report, however it is speculated that some site grading may be required to accommodate the project. As noted above it is assumed that the ground floor slab will be slightly above existing grade (about 0.5 m above existing grade (Elev. 256.2) to allow for proper drainage), resulting in a basement about 2.5 m below existing grade (Elev. 253.7). If a basement is not incorporated, the ground floor slab is assumed to be at the same elevation as noted above.

As noted above the groundwater in the sand is under some sub-artesian pressure. In theory, in order to avoid basal instability/blow out of the base any excavation due to groundwater, excavation should be kept above Elev. 253.2 (within the till deposit). Where excavation extends below Elev. 253.2, basal instability/blow out of the base of the excavation may occur and dewatering will be required.

When grading is established, GEI should review the drawings for geotechnical requirements.

#### 4.1.1 Engineered Fill

GEI defines “engineered fill” as material that will support foundations, and which is placed and compacted in a specified and controlled manner under full-time supervision of geotechnical engineering staff.



Based on the above statement and the report supplied certifying the fill placed at the site, the existing fill at the site is considered engineered fill and does not have to be removed/replaced. Some additional grade raise may be required, and the upper 0.5 m may be weathered or become soft with ponded water before the time of construction. For these types of reasons, the following is provided.

In any location where engineered fill will be placed to raise grades or replace poor/weak soil, any topsoil, vegetation, wet/saturated/weathered soil must be fully removed down to competent engineered fill soil. The exposed subgrade soil must be proof-rolled and inspected by the geotechnical engineer to ensure all unsuitable material (e.g., organics, weak or soft soil, weathered / disturbed soil, deleterious materials) is removed from the engineered fill footprint. Any unsuitable areas must be further sub-excavated and replaced with fill compacted to targeted 100% Standard Proctor Maximum Dry Density (SPMDD), minimum 98% SPMDD in building areas and 95% SPMDD in road and servicing areas.

Once the subgrade is approved, engineered fill can be placed. Engineered fill must be placed under the full-time supervision of a geotechnical engineer as required in the Ontario Building Code. The engineered fill may consist of excavated on-site inorganic cohesionless soils provided they have been moisture conditioned to a moisture content within 2% of optimum moisture content and do not contain organics, topsoil or deleterious material. It is recommended that any imported soil consist of Granular B (OPSS.MUNI 1010) and be first used in building areas, with suitable on-site soil used in landscaped or road areas. Engineered fill must be placed in loose lifts of 200 mm or less and compacted as noted above.

Although not envisioned to be required, in wet subgrade areas, the first lift of engineered fill shall consist of 400 mm of Granular B Type II (OPSS.MUNI 1010). This will help to bridge the weaker subgrade and improve the ability to achieve the compaction specifications for subsequent engineered fill lifts.

The engineered fill must extend a minimum of 1 m out from all sides of the foundations and extend at a 1 horizontal to 1 vertical slope (1H:1V) down to the exposed subgrade. A typical detail for engineered fill pad dimensioning is included in Appendix C.

## **4.2 Foundation Design**

### **4.2.1 Foundations on Engineered Fill / Native Soil**

Based on the assumptions in the grading section (ground floor at Elev. 256.2), it is envisioned that the basement would be at about Elev. 253.7, about 2.5 m below existing grade, resulting in footings at about Elev. 253.5.



Where basements are not incorporated then exterior footings for the building are assumed to be at Elev. 254.5 (about 1.5 m below the proposed ground floor elevation) with interior footings at about Elev. 255.3.

Foundations at this site may be constructed as conventional shallow spread and strip footing foundations that bear on the existing engineered fill or native undisturbed soil and designed for a geotechnical reaction at SLS of 100 kPa (for 25 mm or less of total settlement) and a factored geotechnical reaction at ULS of 150 kPa.

Higher bearing resistance is available at depth in the sand however significant dewatering will be required to permit excavation in the sand. All footing exposed to ambient air temperature throughout the year must be provided with a minimum of 1.2 m of earth cover or equivalent insulation for frost protection (25 mm of polystyrene insulation is equivalent to 300 mm of soil cover). The minimum strip and spread footing widths to be used shall be dictated as per the Ontario Building Code, regardless of loading considerations. Footings stepped from one level to another must be at a slope not exceeding 7V:10H.

The foundation design parameters provided above are predicated on the assumption that the foundation subgrade surface is engineered fill or undisturbed native soil, and that all deleterious, softened, disturbed, organic, and caved material is removed. The foundation excavation must be done in such a way that groundwater is controlled to prevent any disturbance to the foundation base. The groundwater table must be lowered at least 1 m below the founding elevation prior to excavation to prevent disturbance to the foundation subgrade from groundwater seepage.

The foundation subgrade must be reviewed prior to concrete placement to ensure the foundation design parameters provided are applicable, and to provide remedial recommendations if necessary. If the foundation excavation will be open for a prolonged period of time, the foundation subgrade should be protected with a skim coat of lean mix concrete (applied immediately after inspection by the geotechnical engineer), to ensure that no deterioration will occur due to weather effects.



### 4.3 Basement Wall Earth Pressure Design Parameters

It is noted that basements are currently proposed.

Basement walls must be designed to resist unbalanced lateral earth pressures imparted from the weight of adjacent soils. Lateral earth pressures are calculated using the following equation:

$$P = K[\gamma h + q]$$

- where,  $P$  = the horizontal pressure at depth,  $h$  (m)  
 $K$  = the earth pressure coefficient (dimensionless)  
 $h$  = depth below surface in metres  
 $\gamma$  = the bulk unit weight of soil, (kN/m<sup>3</sup>)  
 $q$  = surcharge loading (kPa)

The above equation assumes that a drainage system is present which prevents the build up of any hydrostatic pressure behind the structure subjected to the unbalanced lateral earth pressures. If this is not the case, the equation must be revised to also incorporate the submerged unit weight of the soil multiplied by the earth pressure coefficient, in addition to the water pressure itself.

The values for use in the design of basements subjected to unbalanced lateral earth pressures at this site are as follows:

Soil Type	$\gamma$ – Bulk Unit Weight (kN/m <sup>3</sup> )	$\phi$ – Friction Angle (degrees)	Earth Pressure Coefficient (dimensionless)		
			$K_a$ – Active	$K_o$ – At-Rest	$K_p$ – Passive
Granular ‘B’ (OPSS.MUNI 1010)	21.0	32	0.31	0.47	3.25
Existing Engineered Fill/Loose to Compact Till	20.0	30	0.33	0.50	3.00

The calculation of the earth pressure coefficients is based on Rankine theory, which provides a conservative estimate as no friction between the soil and the structure is accounted for. The earth pressure coefficients provided above are only applicable for flat ground surfaces beyond the structure and will change for sloping ground surfaces.

The earth pressure coefficients referenced within the above table are a function of the friction angle of the adjacent soil, and both the degree and direction of movement of the structure subjected to unbalanced lateral earth pressures. For structures that are restrained at the top (such as basement walls), the at-rest earth pressure coefficient will apply. For structures that allow for 0.1 to 1% of movement away from the soil, the full active earth pressure coefficient

will apply. For structures that allow for 1 to 10% of movement into the soil, the full passive earth pressure coefficient will apply. The percentage movement is based on the height of the structure.

Other types of structures such as shoring walls with multiple rows of tiebacks and soil nail walls are subject to different loading conditions and must be analyzed separately.

## **4.4 Floor Slabs**

The native soils or engineered fill are suitable to support lightly loaded unreinforced concrete slabs. Topsoil, vegetation, organics, and other soil containing organics, excessive moisture, or deleterious materials are not suitable to support floor slabs.

The exposed subgrade must be proof-rolled and inspected by the geotechnical engineer. If any soft or weak subgrade areas are identified, or if there are areas containing excessive amounts of deleterious/organic material, they must be locally sub-excavated and backfilled with approved clean earth fill or imported granular material and compacted to a minimum of 98% SPMDD within 2% optimum moisture content.

All building floor slabs must be provided with a capillary moisture barrier and drainage layer. This is made by placing the concrete slab on a minimum 200 mm layer of 19 mm clear stone (OPSS.MUNI 1004) compacted by vibration to a dense state. The upper 50 mm of clear stone can be replaced with 19 mm crusher run limestone for a working surface. The clear stone and a cohesionless subgrade must be separated by a filter cloth to prevent the migration of fines into the clear stone layer which could result in loss of support for the slab. Alternatively, Granular A (OPSS.MUNI 1010) compacted to 100% SPMDD can be utilized without filter cloth.

## **4.5 Drainage**

All basement foundation walls must be provided with damp-proofing provisions in conformance to the Ontario Building Code. Backfill along the foundation wall must consist of Granular 'B' Type I (OPSS.MUNI 1010) for a minimum lateral distance of 600 mm out from the foundation wall. Alternatively, if a filtered cellular drainage media is provided adjacent to the foundation wall, the backfill may consist of common earth fill.

A perimeter drainage system must be installed that will remove any water that infiltrates into the building backfill, to ensure that any water does not infiltrate into the basement. The perimeter drains must consist of minimum 100 mm diameter perforated pipes wrapped in filter socks, sufficiently covered on all sides by 19 mm clear stone. Perimeter drains should be directed to the sump underneath the basement floor in solid pipes so as not to surcharge the underfloor drainage layer with water. Based on discussion earlier in the report, the basement or slab-on-grade levels will be above the groundwater table and underfloor drains are not





required. All sump pumps should be on emergency power for redundancy in case of a power outage. A typical basement drainage detail is included in Appendix C.

For structures that will be slab-on-grade with no basement levels, perimeter and under-slab drainage at the foundation level is not required, provided that the underside of the concrete slab is at least 200 mm above the prevailing grade of the site and the surrounding surfaces slope away from the building at a gradient of at least 2% to promote surface water run-off and to reduce groundwater infiltration adjacent to foundations. To minimize infiltration of surface water, the upper 150 mm of backfill should comprise relatively impervious/cohesive compacted soil material.

## **4.6 Site Servicing**

It is expected that the proposed fire station development will be serviced with municipal water, sanitary and storm sewers. Inverts are assumed to be about 3 m below existing grade.

### **4.6.1 Bedding**

The type of material and depth of granular bedding below the pipe will, to some extent, depend on the method of construction used by the contractor. Pipe bedding for flexible pipes should follow the requirements in Ontario Provincial Standard Drawing 802.010 or applicable municipal standards. Pipe bedding for rigid pipes should follow the requirements in Ontario Provincial Standard Drawings 802.030 to 802.032 or applicable municipal standards.

A subgrade consisting of the engineered fill or native cohesionless soils at the site will provide adequate support for pipes with the bedding requirements as laid out in the above referenced OPS drawings. Where disturbance of the trench base has occurred from groundwater seepage, construction traffic, etc., or if in-situ fill is present at the invert level, the material should be sub-excavated and replaced with suitably compacted granular fill. If weak zones are encountered, additional bedding materials and differing construction practices may be required and should be determined during construction. Any zones of peat or organic soil should be sub-excavated and replaced with approved earth fill or imported granular material compacted to 95% SPMDD. Details on temporary groundwater control are provided in Section 5.2.

Regardless of whether flexible or rigid pipes are implemented, granular bedding and cover material should consist of a well graded, free draining material, such as Granular “A” (OPSS.MUNI 1010). All granular bedding must be compacted to a minimum of 95% SPMDD.

### **4.6.2 Backfill**

Excavated inorganic fill and native cohesionless soils may be re-used as backfill in trenches, provided they are moisture conditioned so that the moisture content is within 2% of optimum. Additional soil compaction details are provided in Section 5.3. The backfill should be



compacted to a minimum of 95% SPMDD. In confined areas the layer thickness will have to be reduced to utilize smaller compaction equipment efficiently or by using granular material instead of locally sourced fill. Any backfill that is frozen, contains a high percentage of organic material (topsoil, peat, etc.) or moisture, or has otherwise unsuitable deleterious inclusion should not be used as backfill. The maximum cobble or boulder size should not exceed half of the loose lift thickness (i.e., all particles with a diameter greater than 100 mm should be removed).

Where trenches are within the traveled portions of a roadway or pavement access/driveway, backfill within the frost penetration depth of 1.2 m should consist of native, non-organic, excavated material consistent with the soils surrounding the trench. If this technique is not undertaken, then frequently problems arise with yearly differential frost heave movements between the trench backfill and the adjacent native soil. This would occur, for example, if imported granular material is used to backfill trenches which is less susceptible to frost effects compared to the native soils on site with a higher silt content (silt is highly frost-susceptible). Alternatively, if different soil is used as the backfill due to issues with achieving compaction, a frost taper of 10H:1V can be implemented to help mitigate the potential for differential settlement and frost heave.

## **4.7 Pavement Design**

### **4.7.1 Subgrade Preparation**

The grading has not been completed at this time and the subgrade soil is uncertain but likely to comprise the soil in the upper 1.0 m of the boreholes or similar site soil. Based on this the pavement subgrade will comprise material with typically moderate frost susceptibility.

The subgrades must be inspected and approved by the geotechnical engineer at the time of construction. The exposed pavement subgrade should be compacted to a minimum 95% SPMDD. If any soft or weak subgrade areas are identified, or if there are areas containing excessive amounts of moisture or deleterious/organic material, they must be locally subexcavated and backfilled with approved clean earth fill or imported granular material and compacted to a minimum of 95% SPMDD.

The long-term performance of the pavement structure is highly dependent upon the subgrade support conditions. Stringent construction control procedures must be maintained to ensure that uniform subgrade moisture and density conditions are achieved as much as possible when fill is placed, and the natural subgrade is not disturbed or weakened after it is exposed.



### 4.7.2 Drainage

Control of surface water is an important factor in achieving a good pavement life. The need for adequate subgrade drainage cannot be over-emphasized. The subgrade must be free of depressions and sloped (at a minimum grade of 2 percent) to provide effective drainage toward subgrade drains or roadside ditches. Grading adjacent to pavement areas should be designed to ensure that water is not allowed to pond adjacent to the outside edges of the pavement.

Continuous pavement subdrains should be provided along all sides of paved areas and drained into respective catch basins to facilitate drainage of the subgrade and the granular materials. The subdrain invert should be maintained at least 0.3 m below subgrade level. To minimize the problems of differential movement between the pavement and catchbasins/manhole due to frost action, the backfill around the structures should consist of free draining OPSS Granular B. Typical pavement drainage details are provided in Appendix C.

### 4.7.3 Pavement Structure

There are two different types of pavements that need to be designed for:

- Light duty: Includes driveways and parking lots which will not see frequent heavy traffic loads such as buses, delivery or fire trucks, etc., and will mostly service small vehicles such as cars or pickup trucks. In this case this design should be used for the driveway and parking lot used by the cars
- Heavy Duty: Includes driveways and parking lots which are designated fire truck routes, or will see frequent heavy traffic loads such as buses, delivery or garbage trucks, etc. In this case this design should be used for the driveway used by fire trucks.

The industry pavement design methods are based on a design life of 15 to 20 years for typical weather conditions depending on actual traffic volumes. The following pavement thickness design is provided on the above noted considerations and subgrade basis for an asphaltic concrete pavement structure:

Pavement Layer	Compaction Requirements	Minimum Component Thickness	
		Light-Duty	Heavy-Duty
<u>Surface Course Asphaltic Concrete:</u> HL3 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)	OPSS 310	40 mm	40 mm
<u>Binder Course Asphaltic Concrete:</u> HL8 (OPSS 1150) with PG 58-28 Asphalt Cement (OPSS.MUNI 1101)	OPSS 310	50 mm	80 mm



Pavement Layer	Compaction Requirements	Minimum Component Thickness	
		Light-Duty	Heavy-Duty
<u>Base Course:</u> Granular A (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM-D698)	150 mm	150 mm
<u>Subbase Course:</u> Granular B Type I or II (OPSS.MUNI 1010)	100% Standard Proctor Maximum Dry Density (ASTM- D698)	350 mm	500 mm

The granular materials should be placed in lifts 200 mm thick or less and be compacted to a minimum of 100% SPMDD for both granular base and subbase. Asphalt materials should be rolled and compacted as per OPSS 310. The granular and asphalt pavement materials and their placement should conform to OPSS 310, 501, 1010 and 1150.

Smooth transitions are required in all areas where the new pavement meets the existing asphalt surface. All longitudinal and transverse joints should meet the requirements of OPSS.MUNI 310. All longitudinal joints should be staggered between the asphalt lifts. The staggering of the longitudinal joints should be accomplished by offsetting the paving edge in the upper asphalt course by a minimum of 150 mm. Frost tapers of 10H:1V should be incorporated at the transition areas with the existing pavement.

If the pavement construction occurs in wet, winter or inclement weather, it may be necessary to provide additional subgrade support for heavy construction traffic by increasing the thickness of the granular subbase, base or both. Further, traffic areas for construction equipment may experience unstable subgrade conditions. These areas may be stabilized utilizing additional thickness of granular materials or geogrid.

It should be noted that in addition to adherence of the above pavement design recommendations, a close control on the pavement construction process will also be required in order to obtain the desired pavement life. Therefore, it is recommended that regular inspection and testing should be conducted during the pavement construction to confirm material quality, thickness, and to ensure adequate compaction.

## 5. Constructability Considerations

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### 5.1 Excavations

At this time, excavations for the project site are anticipated to be about 2.5 m for the building if a basement is incorporated (only about 1.5 m if no basement is incorporated) and 3.0 m for site servicing. Below the surficial engineered fill, excavations are anticipated to encounter the till deposit. Locally for service connections excavation may extend into the sand. Harder digging can be expected in the glacial till and dense to very dense cohesionless deposits. Cobbles and boulders should be expected in the glacial till.

Excavations must be carried out in accordance with the Occupational Health and Safety Act, Ontario Regulation 213/91 (as amended), Construction Projects, Part III - Excavations, Section 222 through 242. Where workers must enter a trench or excavation the soil must be suitably sloped and/or braced in accordance with the OHSA. These regulations designate four (4) broad classifications of soils to stipulate appropriate measures for excavation safety. If more than one soil type is encountered in an excavation, the most conservative soil type must be followed for sloping the sidewalls of the excavation. Excavations for the site should be completed considering a Type 3 soil geometry, 1H:1V from the base of the excavation, assuming that the soils are dewatered prior to excavation.

Excavation sidewalls will need to be continuously reviewed for evidence of instability and groundwater seepage, particularly following periods of heavy rain or thawing. When required, remedial action must be taken to ensure the continued stability of excavation slopes and the safety of the workers.

Minimum support system requirements for steeper excavations are stipulated in Sections 235 through 238 and 241 of the OHSA and include provisions for timbering, shoring and moveable trench boxes. To reduce the potential for instability of the trench excavations, materials excavated from the service trenches and/or other fill materials or heavy equipment should not be placed near the crest of the trench excavations.

It is important to note that soils encountered in the construction excavations may vary significantly across the site. Our preliminary soil classifications are based solely on the materials encountered in the boreholes advanced on site. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that GEI be contacted immediately to evaluate the conditions encountered.



## 5.2 Temporary Construction Groundwater Control

As noted above excavation is envisioned to extend to about 2.5 m depth for the building if a basement is incorporated (only about 1.5 m if no basement is incorporated) and 3.0 m for site servicing.

There is sub-artesian pressure in the groundwater in the sand under the till.

The lowest building basement depth discussed earlier in the report will keep the excavation above a level where issues with significant groundwater will occur. Conventional sump pumping should suffice to control groundwater seepage.

For the services connections, excavation below the recommended lowest excavation depth may be required. Dewatering or pumping from multiple keg wells may be required where the sand is encountered.

The exact scenario where certain groundwater control techniques will work are directly correlated to how coarse/fine the native soils are in an excavation, and both the lateral and vertical extent of the wet cohesionless deposits. If the groundwater table is not controlled during construction, the base of the excavations will be unstable, leading to difficulties in excavating and placement of pipes, footings or engineered fill, and providing safety for the workers.

It is recommended to carry out the work during the dry time of the year when the groundwater table is lowest, to mitigate groundwater control measures. Also reducing the size of the excavation that is open at any one time will aid in reducing groundwater control requirements.

A preliminary assessment on the amount of dewatering required for the site will depend on the amount of excavation open at any one time, the depth of excavation and if the underlying sand is encountered. A Permit-to-Take-Water (PTTW) is not likely required. Registry on the Environmental Activity and Sector Registry (EASR) system is suggested.

A hydrogeological investigation and report is also being carried out concurrently and will provide further details regarding ground water taking.

## 5.3 Compaction Specifications

Standard Proctor Maximum Dry Density the specification to indicate the degree to which soil or aggregate is compacted. To achieve the specified SPMDD as indicated in this report, all soils or aggregates must be placed in lift thicknesses no greater than 200 mm. If this is not the case, only the upper portion of the lift will be adequately compacted, and the lower portion of the lift has a high probability of not meeting compaction specifications. In addition, industry standard equipment used to determine the degree of compaction consists of nuclear



densometers. These devices have an inherent limitation in that they cannot test beyond 300 mm in depth, and so the degree of compaction beyond this depth cannot be quantitatively determined.

Along with lift thickness, ensuring that the soil or aggregate is within 2% of its optimum moisture content ensures that the specified compaction can be reached. If the soil or aggregate is too dry/wet, it is either very difficult or impossible to reach the specified compaction. This is especially true for when higher compaction specifications such as 98% and 100% SPMDD are required.

Moisture can be increased by adding water and mixing the soil prior to re-use, blending the soil with wetter material, or by importing soil to the site that is at optimum and can be readily compacted.

Moisture can be reduced by tilling or spreading out the soil to dry or blending it with drier material. In-situ moisture contents can change based on the season and local groundwater levels and can also change for stockpiled material due to precipitation. Zones of the fine-grained soil with very high moisture contents may find moisture conditioning to be difficult to accomplish.

In addition to the above compaction specifications, in any areas where compacted fill will be placed over the exposed native soil subgrade, any loose, soft, wet, organic or unstable areas should be sub-excavated, and backfilled with clean earth fill or Granular 'B' (OPSS.MUNI 1010) compacted to a minimum of 95% SPMDD. This recommendation applies to site servicing and pavement subgrades. Where structures/buildings require upfilling beneath the structure the fill should be compacted to 100% SPMDD.

## **5.4 Quality Verification Services**

On-site quality verification services are an integral part of the geotechnical design function, and for foundations, engineered fill and retaining walls, are required under the Ontario Building Code. Quality verification services are used to confirm that construction is being conducted in general conformance with the requirements as outlined in the drawings, reports and specifications prepared for the proposed development.

GEI Consultants can provide all the on-site quality verification services outlined below:

- The subgrade for shallow foundations for single-lot residential buildings may be field reviewed by the geotechnical engineer as required by the municipal regulating authority and Ontario Building Code (OBC).
- Installation of retaining structures over 1.0 m high and related backfilling operations must be field reviewed on a continuous basis by the geotechnical engineer as required in the OBC.





- Full-time monitoring, testing and inspection of engineered fill placement is required by the geotechnical engineer per the OBC.
- Part-time monitoring of the subgrade support capabilities, material quality, lift thickness, moisture content, degree of compaction, etc. is recommended for the following areas to ensure the recommendations within this report are followed and they perform adequately in the long-term;
  - Slabs-on-grade;
  - Pavement structure (granular and asphalt); and
  - Bedding/backfilling of site servicing.
- Testing of the concrete (compressive strength, slump, air content, etc.) and testing of the asphalt (asphalt content and gradation) are recommended to ensure that the quality of the materials being brought to site meet the requirements of the project.

## 5.5 Site Work

The soils found at this site may become weakened when subjected to traffic, particularly when wet. If there is site work carried out during periods of wet weather, then it can be expected that the subgrade will be disturbed unless an adequate granular working surface is provided to protect the integrity of the subgrade soils from construction traffic. Subgrade preparation works cannot be adequately accomplished during wet weather and the project must be scheduled accordingly. The disturbance caused by the traffic can result in the removal of disturbed soil and use of granular fill material for site restoration or underfloor fill that is not intrinsic to the project requirements.

The most severe loading conditions on the subgrade may occur during construction. Consequently, special provisions such as end dumping and forward spreading of earth and aggregate fills or restricted construction lanes may be required, especially if construction is carried out during unfavourable weather.

If construction proceeds during freezing weather conditions, adequate temporary frost protection for the founding subgrade and concrete must be provided. The soil at this site is susceptible to frost damage. Consideration must be given to frost effects, such as heave or softening, on exposed soil surfaces in the context of this particular project development.





## 6. Limitations and Conclusions

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### 6.1 Limitations

The recommendations and comments provided are necessarily on-going as new information of underground conditions becomes available. More specific information with respect to the conditions between samples, or the lateral and vertical extent of materials may become apparent during excavation operations. The interpretation of the borehole information must, therefore, be validated during excavation operations. Consequently, conditions not observed during this investigation may become apparent. Should this occur, GEI should be contacted to assess the situation and additional testing and reporting may be required.

GEI should be retained for a general review of the final design drawings and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, GEI will assume no responsibility for interpretation of the recommendations in the report.

The comments given in this report are intended only for the guidance of the design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc. could be greater than has been carried out for design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

This report was authorized by, and prepared by GEI for, the account of City of Barrie (as provided the PO supplied for the project). Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. GEI accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this project.



## 6.2 Conclusion

It is recognized that municipal/regional governing bodies, in their capacity as the planning and building authority under Provincial statutes, will make use of and rely upon this report, cognizant of the limitations thereof, both as are expressed and implied.

We trust this report is complete within our terms of reference, and the information presented is sufficient for your present purposes. If you have any questions, or when we may be of further assistance, please do not hesitate to contact our office.

Yours Truly,

### GEI Consultants

Prepared By:

Reviewed By:



A handwritten signature in black ink, reading "Mohammed Razeen".

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Mohammed Razeen  
Geotechnical E.I.T.

A handwritten signature in blue ink, reading "Geoffrey R. White".

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Geoffrey R. White, P.Eng.  
Geotechnical Practice Lead

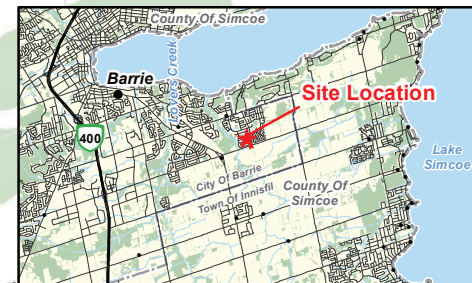
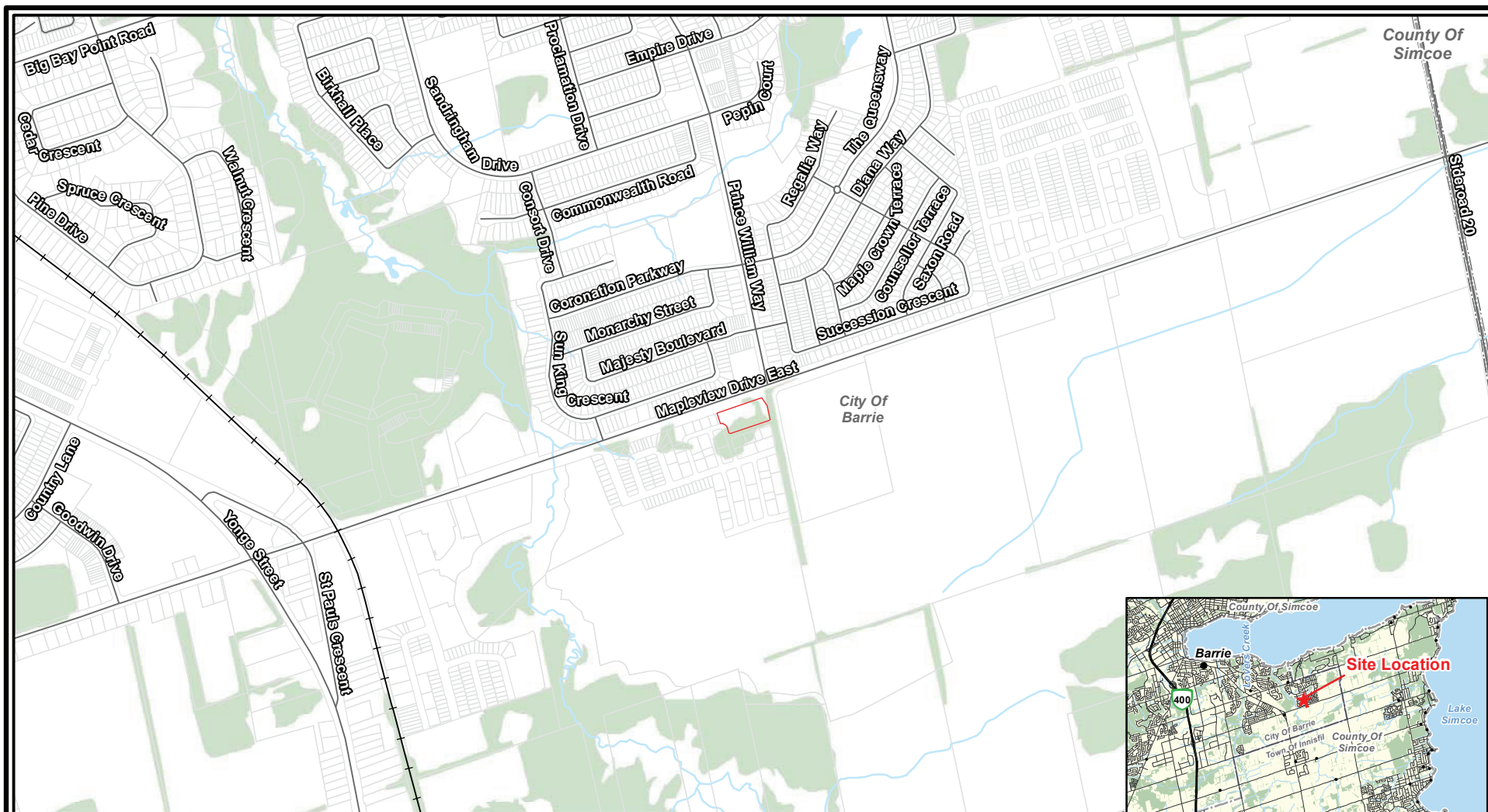
## Figures

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### Site Location Plan

### Borehole Location Plans





#### Legend

- Site Location
- Road
- Wooded Area
- Parcels
- Watercourse
- Railway
- Waterbody

**NOTES:**  
 1. Coordinate System: NAD 1983 UTM Zone 17N.  
 2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, © City of Barrie (Parcels), 2022.

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Proposed Barrie Fire Station 6  
 Development  
 Barrie, ON

City of Barrie



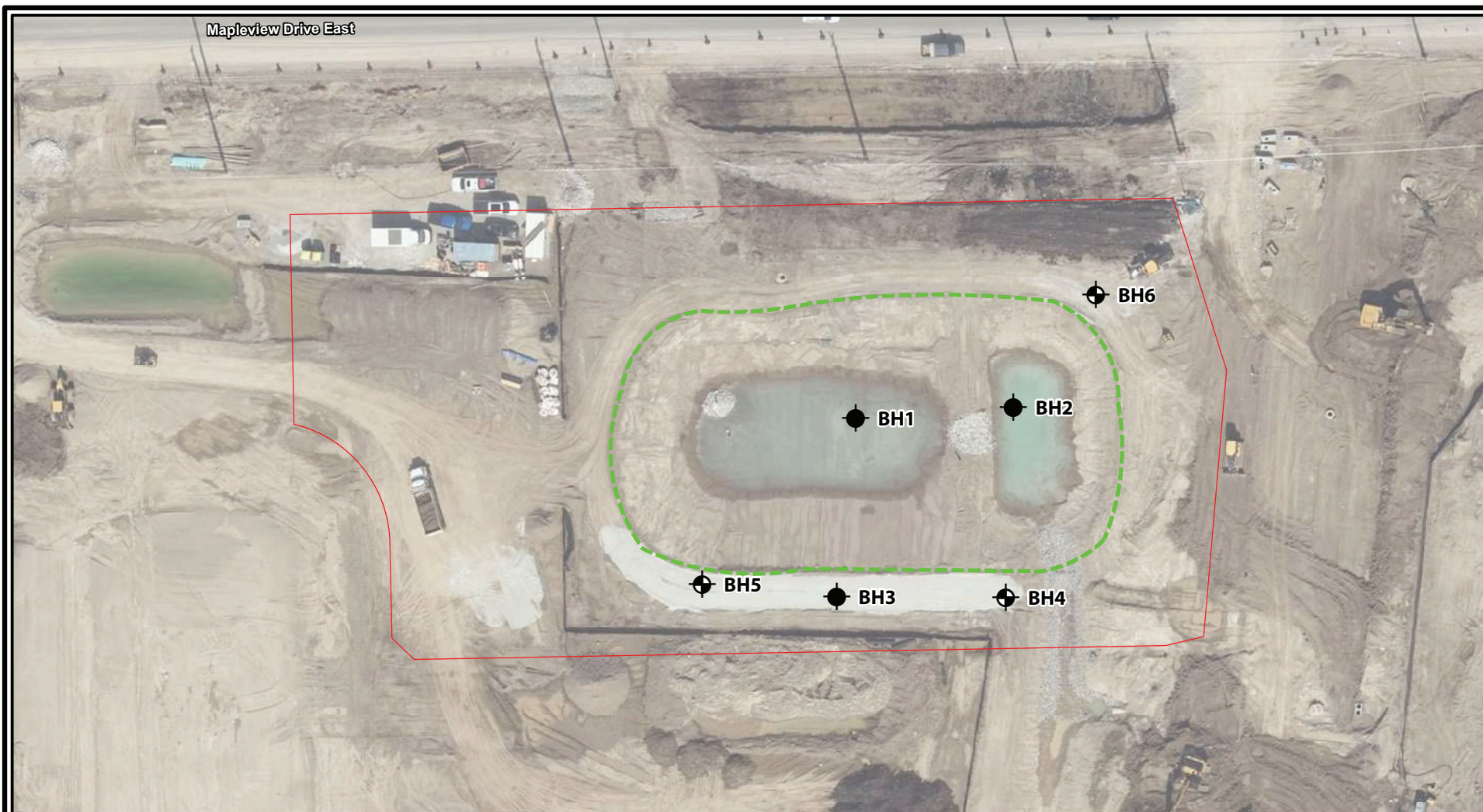
Project 2203244

SITE LOCATION PLAN

Nov. 2022

Fig. 1





#### Legend

- Site Location
- Area with Existing Engineered Fill
- Approximate Borehole Location
- Approximate Borehole/Monitoring Well Location

#### NOTES:

1. Coordinate System: NAD 1983 UTM Zone 17N.
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, © City of Barrie (Parcels), 2022.
3. Orthoimagery © First Base Solutions, 2022. Imagery taken in 2021.

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Proposed Barrie Fire Station 6  
Development  
Barrie, ON

City of Barrie

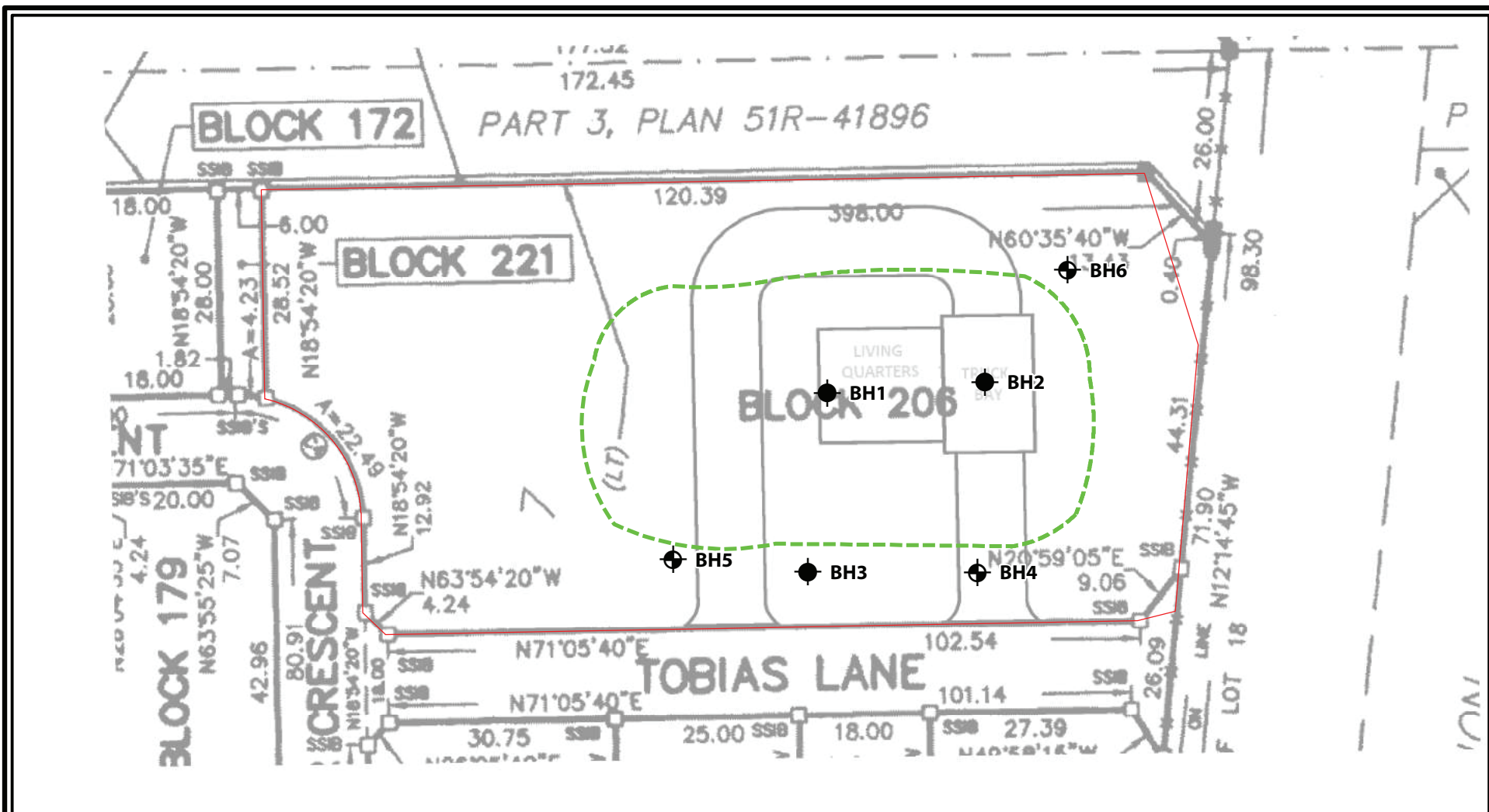


Project 2203244

BOREHOLE LOCATION PLAN  
(AERIAL)

November 2022

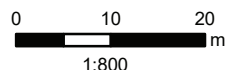
Fig. 2A



**Legend**

- Site Location
- Area with Existing Engineered Fill
- Approximate Borehole Location
- Approximate Borehole/Monitoring Well Location

**NOTES:**  
 1. Coordinate System: NAD 1983 UTM Zone 17N.  
 2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, © City of Barrie (Parcels), 2022.  
 3. Site Plan: 'Hewitt's Gate - Draft Plan of Subdivision', Jones Consulting Group (2017).



Proposed Barrie Fire Station 6  
 Development  
 Barrie, ON

City of Barrie



Project 2203244

BOREHOLE LOCATION PLAN  
 (SITE PLAN)

November 2022

Fig. 2B

# Appendix A

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## Borehole Logs

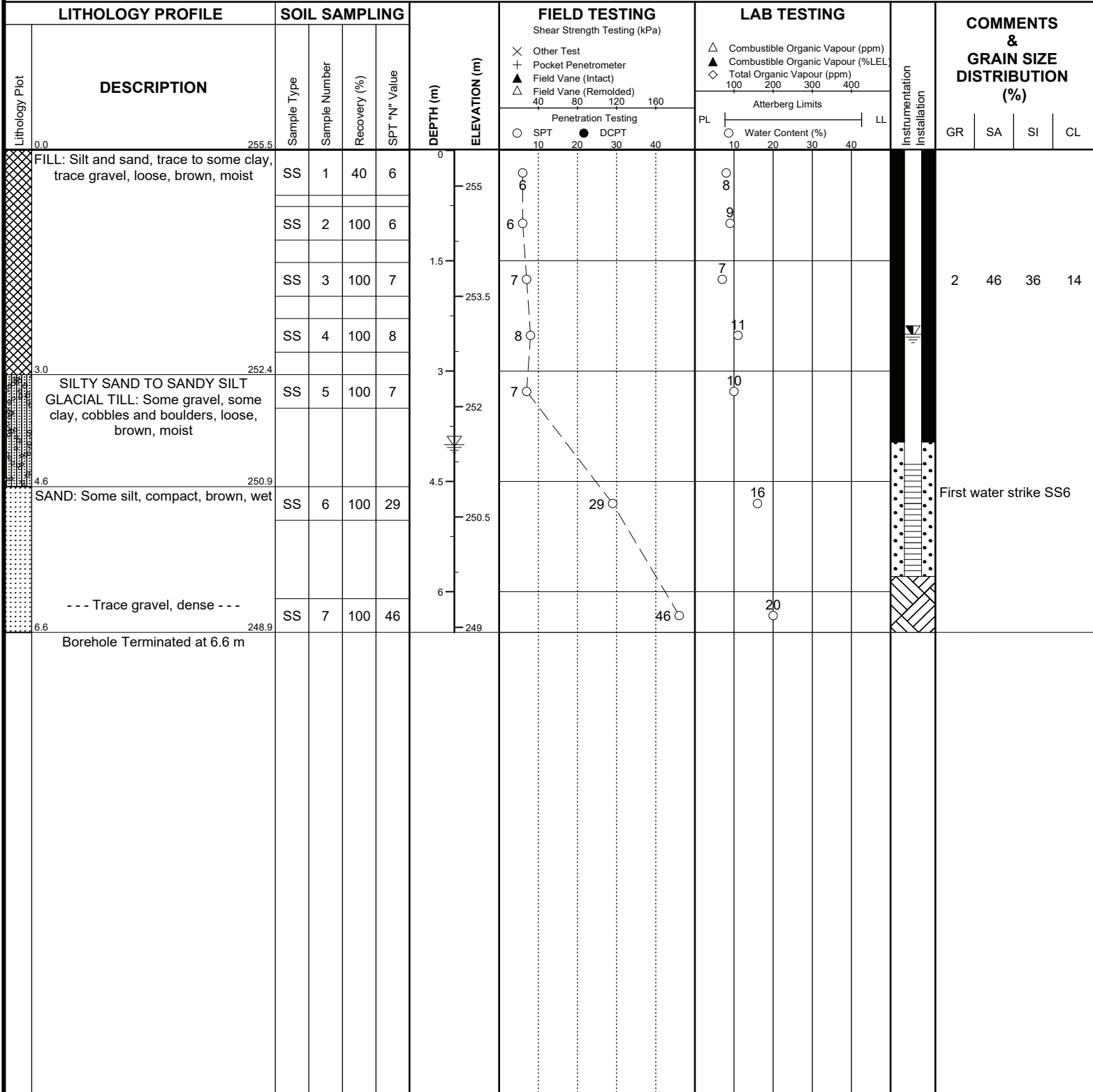


# RECORD OF BOREHOLE No. 1



Project Number: **2203244**  
 Project Client: **City of Barrie**  
 Project Name: **Proposed Firehall 6**  
 Project Location: **Barrie, ON**  
 Drilling Location: **See Borehole Location Plan**  
 Local Benchmark: \_\_\_\_\_

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Truck Mount**  
 Logged By: **BH** Northing: **4911863.7** Date Started: **Sep 22/22**  
 Reviewed By: **GRW** Easting: **610675.3** Date Completed: **Sep 22/22**





# RECORD OF BOREHOLE No. 2



Project Number: **2203244**  
 Project Client: **City of Barrie**  
 Project Name: **Proposed Firehall 6**  
 Project Location: **Barrie, ON**  
 Drilling Location: **See Borehole Location Plan**  
 Local Benchmark: \_\_\_\_\_

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Truck Mount**  
 Logged By: **BH** Northing: **4911872.0** Date Started: **Sep 22/22**  
 Reviewed By: **GRW** Easting: **610695.6** Date Completed: **Sep 22/22**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m) ELEVATION (m)		FIELD TESTING		LAB TESTING		COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits					
						Penetration Testing		Water Content (%)							

First water strike SS6

# RECORD OF BOREHOLE No. 3






Project Number: **2203244**  
 Project Client: **City of Barrie**  
 Project Name: **Proposed Firehall 6**  
 Project Location: **Barrie, ON**  
 Drilling Location: **See Borehole Location Plan**  
 Local Benchmark: \_\_\_\_\_

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Truck Mount**  
 Logged By: **BH** Northing: **4911839.1** Date Started: **Sep 22/22**  
 Reviewed By: **GRW** Easting: **610681.0** Date Completed: **Sep 22/22**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m)	ELEVATION (m)	FIELD TESTING		LAB TESTING		Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits			GR	SA	SI	CL
								Other Test	Penetration Testing	PL	LL					
								×	○	△						
								+	●	▲						
								▲	○	△						
								△	○	◇						
								40	10	100						
								80	20	200						
								120	30	300						
								160	40	400						
											</					

GEI Consultants

Drilling Method:	<u>Hollow Stem Augers</u>	Drilling Machine:	<u>Truck Mount</u>		
Logged By:	<u>BH</u>	Northing:	<u>4911846.3</u>	Date Started:	<u>Sep 22/22</u>
Reviewed By:	<u>GRW</u>	Easting:	<u>610702.2</u>	Date Completed:	<u>Sep 22/22</u>


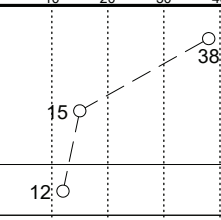
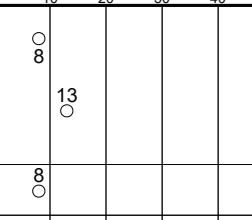
<div><b>GEI CONSULTANTS</b> 647 Welham Road, Unit 14 Barrie, Ontario L4N 0B7 T : (705) 719-7994 www.geiconsultants.com</div>	<div> Groundwater depth encountered on completion of drilling: 2.7 m.</div>	<div> Cave depth after auger removal: 2.7 m.</div>	
	<div> Groundwater depth observed on:</div>	<div>Groundwater Elevation:</div>	
	<div>Borehole details presented do not constitute a thorough understanding of all potential conditions present and require interpretative assistance from a qualified geotechnical engineer. Also, borehole information should be read in conjunction with the geotechnical report for which it was commissioned and the accompanying 'Explanation of Boring Log'.</div>		<div>Scale: <b>1 :75</b> Page: <b>1 of 1</b></div>

# RECORD OF BOREHOLE No. 5



Project Number: **2203244**  
 Project Client: **City of Barrie**  
 Project Name: **Proposed Firehall 6**  
 Project Location: **Barrie, ON**  
 Drilling Location: **See Borehole Location Plan**  
 Local Benchmark: \_\_\_\_\_

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Truck Mount**  
 Logged By: **BH** Northing: **4911835.0** Date Started: **Sep 22/22**  
 Reviewed By: **GRW** Easting: **610662.5** Date Completed: **Sep 22/22**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m) ELEVATION (m)		FIELD TESTING		LAB TESTING				Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits					GR	SA	SI	CL
						Other Test Pocket Penetrometer Field Vane (Intact) Field Vane (Remolded)	Penetration Testing SPT DCPT	Combustible Organic Vapour (ppm) Combustible Organic Vapour (%LEL) Total Organic Vapour (ppm)	Water Content (%)									
	<div>FILL: Silty sand to sandy silt, trace gravel, trace clay, dense, brown, moist</div> <div>--- Trace organics, compact ---</div> <div>SILTY SAND TO SANDY SILT</div> <div>GLACIAL TILL: Some gravel, some clay, cobbles and boulders, compact, brown, moist</div> <div>Borehole Terminated at 2.0 m</div>	SS	1	75	38	0	255											
		SS	2	100	15	1.5	253.5											
		SS	3	100	12													

# RECORD OF BOREHOLE No. 6



Project Number: **2203244**  
 Project Client: **City of Barrie**  
 Project Name: **Proposed Firehall 6**  
 Project Location: **Barrie, ON**  
 Drilling Location: **See Borehole Location Plan**  
 Local Benchmark: \_\_\_\_\_

Drilling Method: **Hollow Stem Augers** Drilling Machine: **Truck Mount**  
 Logged By: **BH** Northing: **4911890.0** Date Started: **Sep 22/22**  
 Reviewed By: **GRW** Easting: **610701.4** Date Completed: **Sep 22/22**

LITHOLOGY PROFILE		SOIL SAMPLING				DEPTH (m) ELEVATION (m)		FIELD TESTING		LAB TESTING				Instrumentation Installation	COMMENTS & GRAIN SIZE DISTRIBUTION (%)			
Lithology Plot	DESCRIPTION	Sample Type	Sample Number	Recovery (%)	SPT "N" Value			Shear Strength Testing (kPa)		Atterberg Limits					GR   SA   SI   CL			
						Other Test Pocket Penetrometer Field Vane (Intact) Field Vane (Remolded)	Penetration Testing SPT DCPT	Combustible Organic Vapour (ppm) Combustible Organic Vapour (%LEL) Total Organic Vapour (ppm)	Water Content (%)									
0.0	255.9					0	255											
	FILL: Silty sand to sandy silt, trace gravel, trace clay, dense, brown, moist	SS	1	100	38													
	--- Compact ---	SS	2	100	15													
	1.5	254.4					1.5											
2.0	253.9	SS	3	100	12													
SILTY SAND TO SANDY SILT																		
GLACIAL TILL: Some gravel, some clay, cobbles and boulders, compact, brown, moist																		
Borehole Terminated at 2.0 m																		

## Appendix B

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### Geotechnical Laboratory Testing

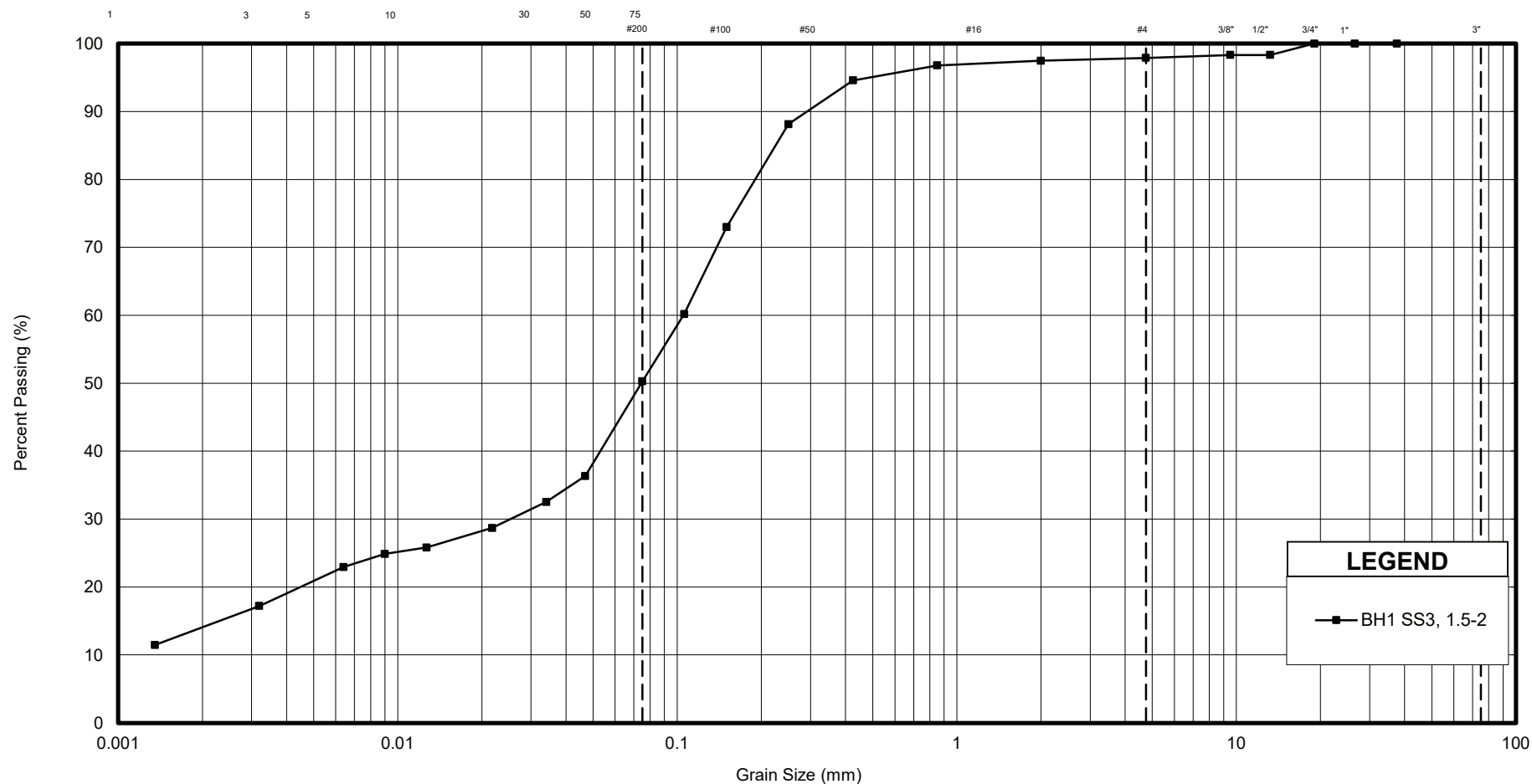


# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



## LEGEND

—■— BH1 SS3, 1.5-2

Sample	Description	Gr.	Sa.	Si.	Cl.	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>
BH1 SS3	SILT AND SAND, Some Clay, Trace Gravel	2	48	36	14	-	0.025	0.105	-	-



GRAIN SIZE DISTRIBUTION - Firehall 6 Development

**FILL: SILT AND SAND**

FIGURE No. B1

REF. No. 2203244

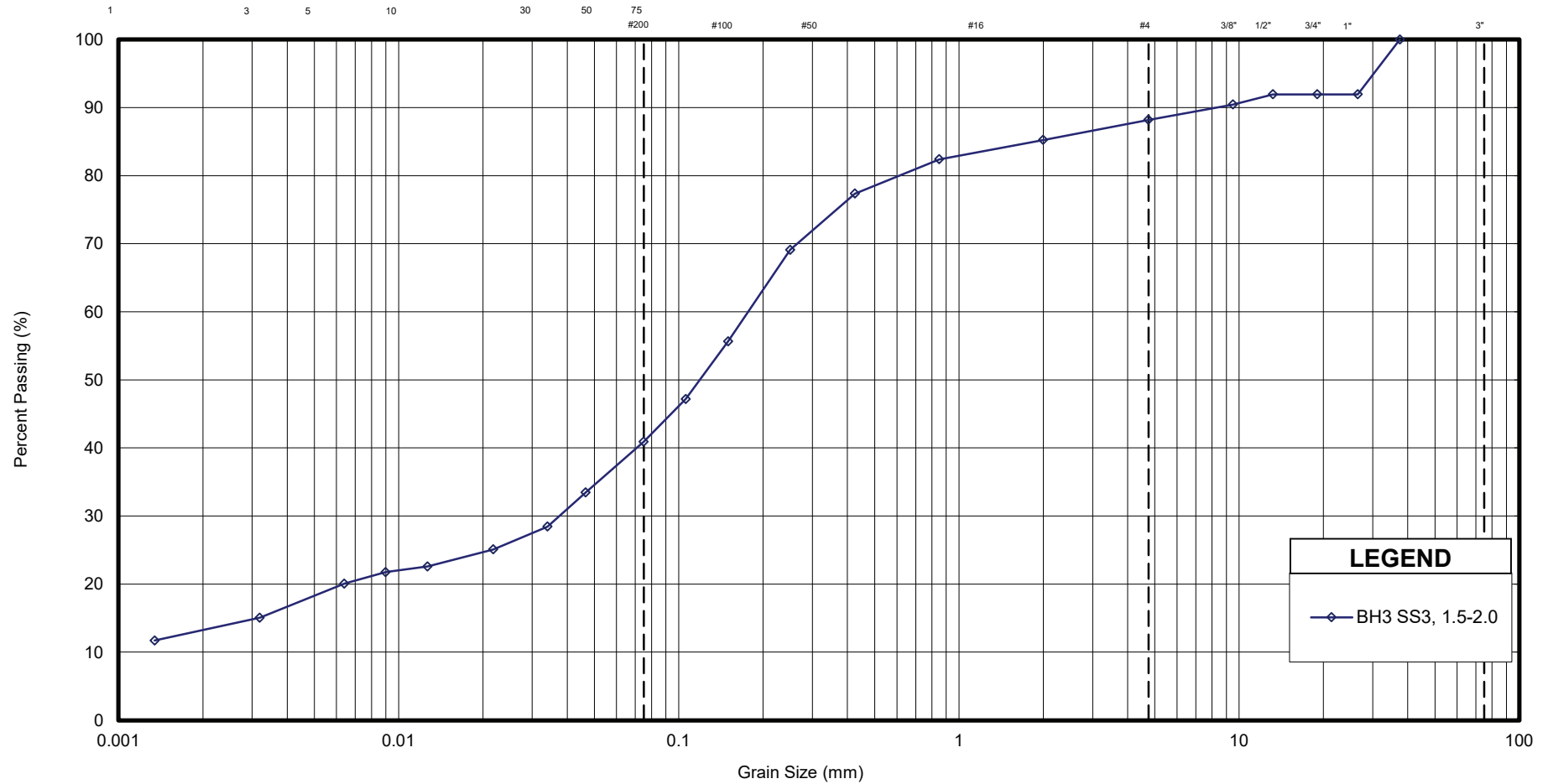
DATE November 2022

# UNIFIED SOIL CLASSIFICATION SYSTEM

CLAY AND SILT	SAND			GRAVEL	
	Fine	Medium	Coarse	Fine	Coarse

GRAIN SIZE IN MICROMETERS

SIEVE DESIGNATION (IMPERIAL)



Sample	Description	Gr.	Sa.	Si.	Cl.	D <sub>10</sub>	D <sub>30</sub>	D <sub>60</sub>	C <sub>u</sub>	C <sub>c</sub>
BH3 SS3	SILTY SAND, Some Clay, Some Gravel	12	47	28	13	-	0.037	0.177	-	-



GRAIN SIZE DISTRIBUTION - Firehall 6 Development

**GLACIAL TILL: SILTY SAND**

FIGURE No. B2

REF. No. 2203244

DATE November 2022

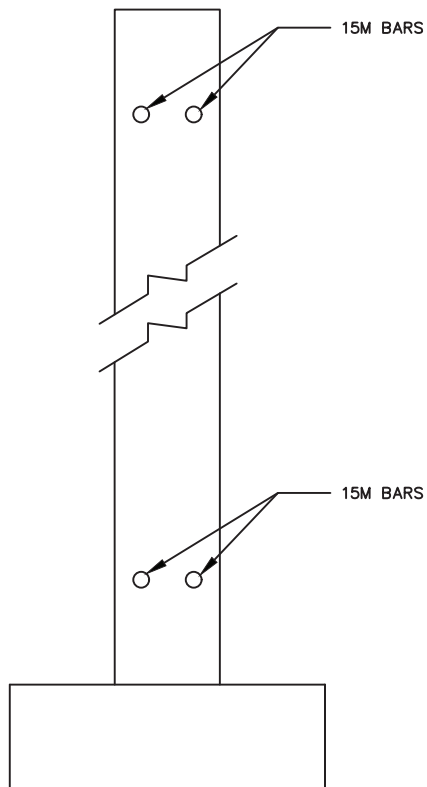


## Appendix C

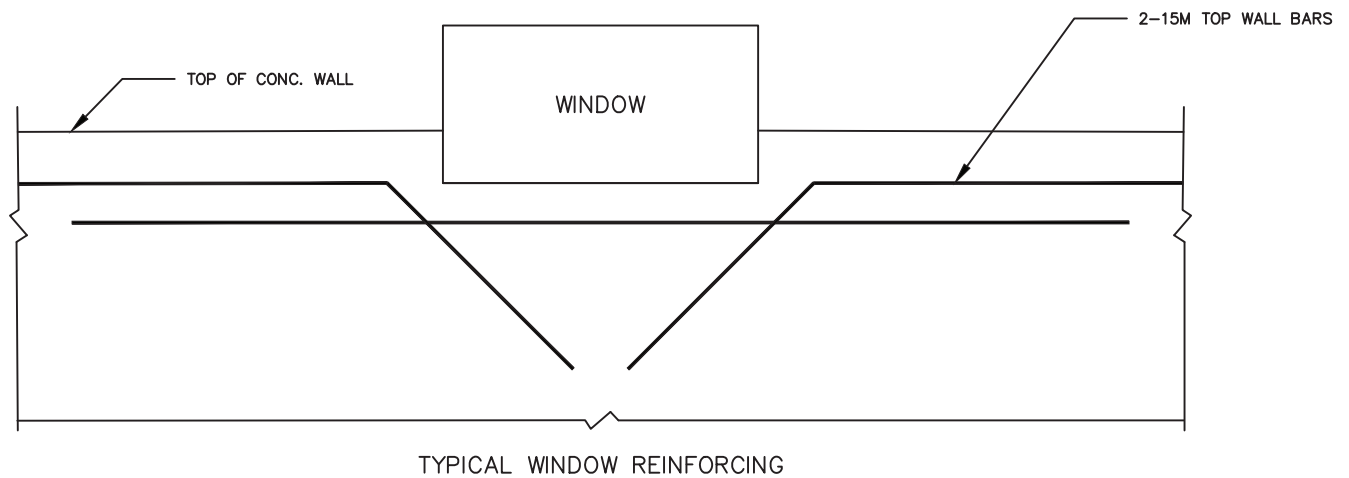
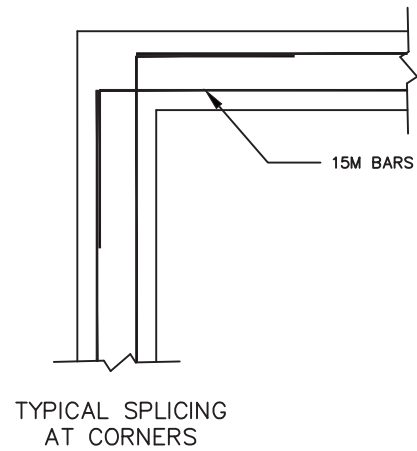
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### Typical Details





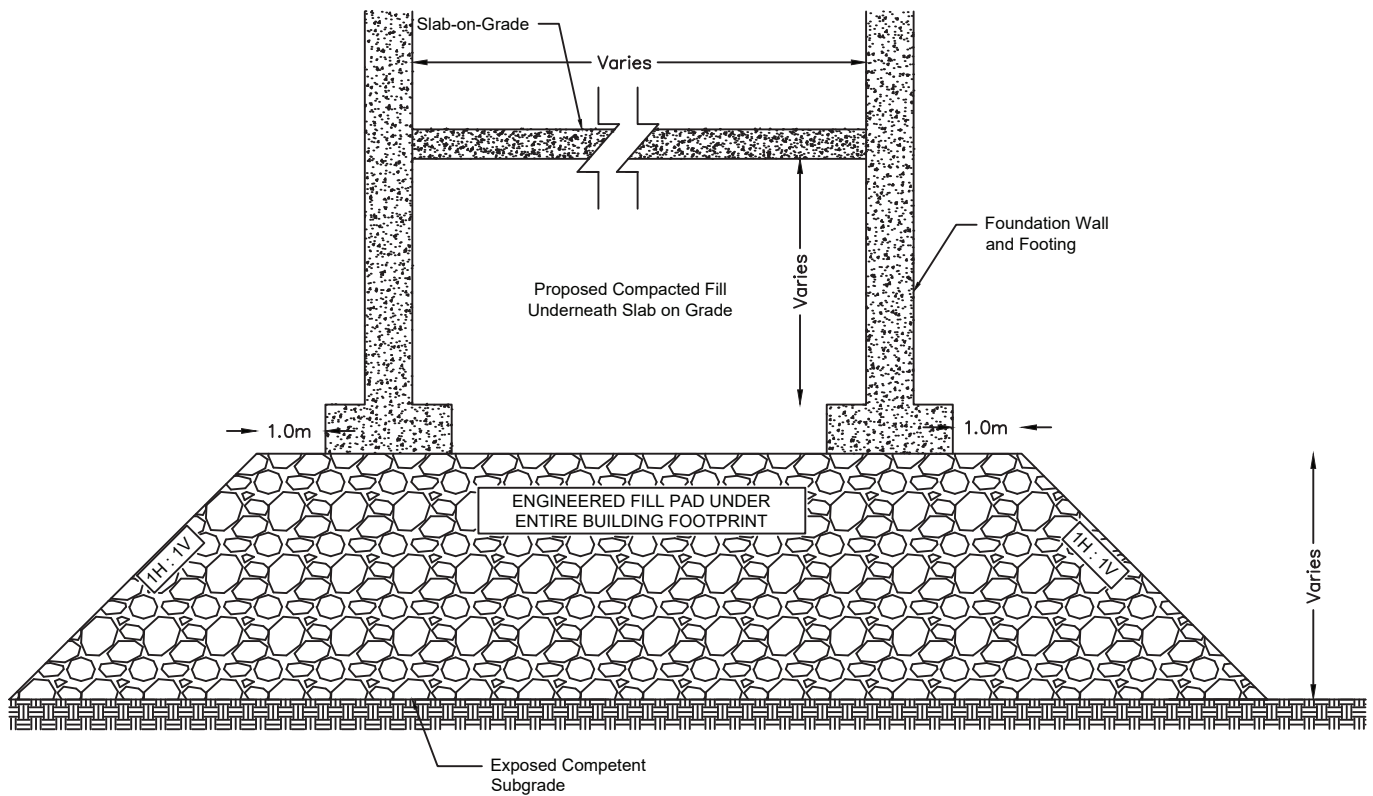
TYPICAL REINFORCED  
WALL

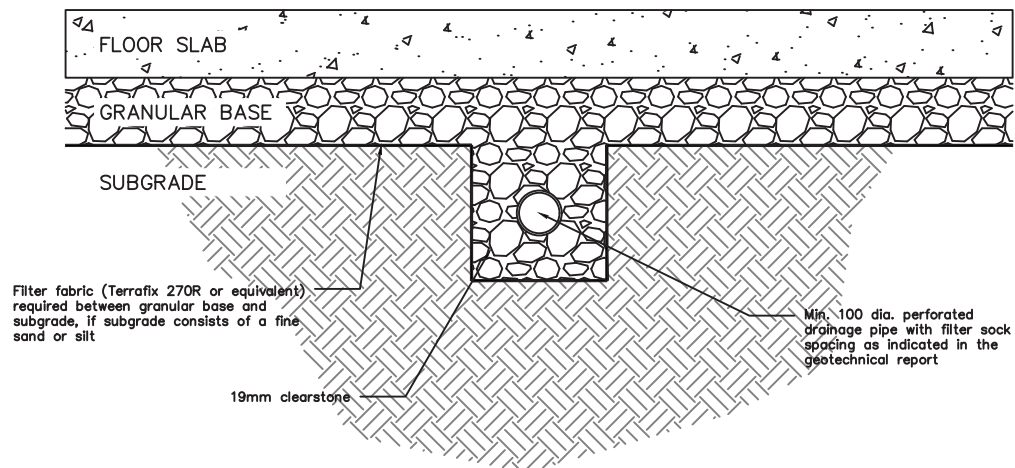
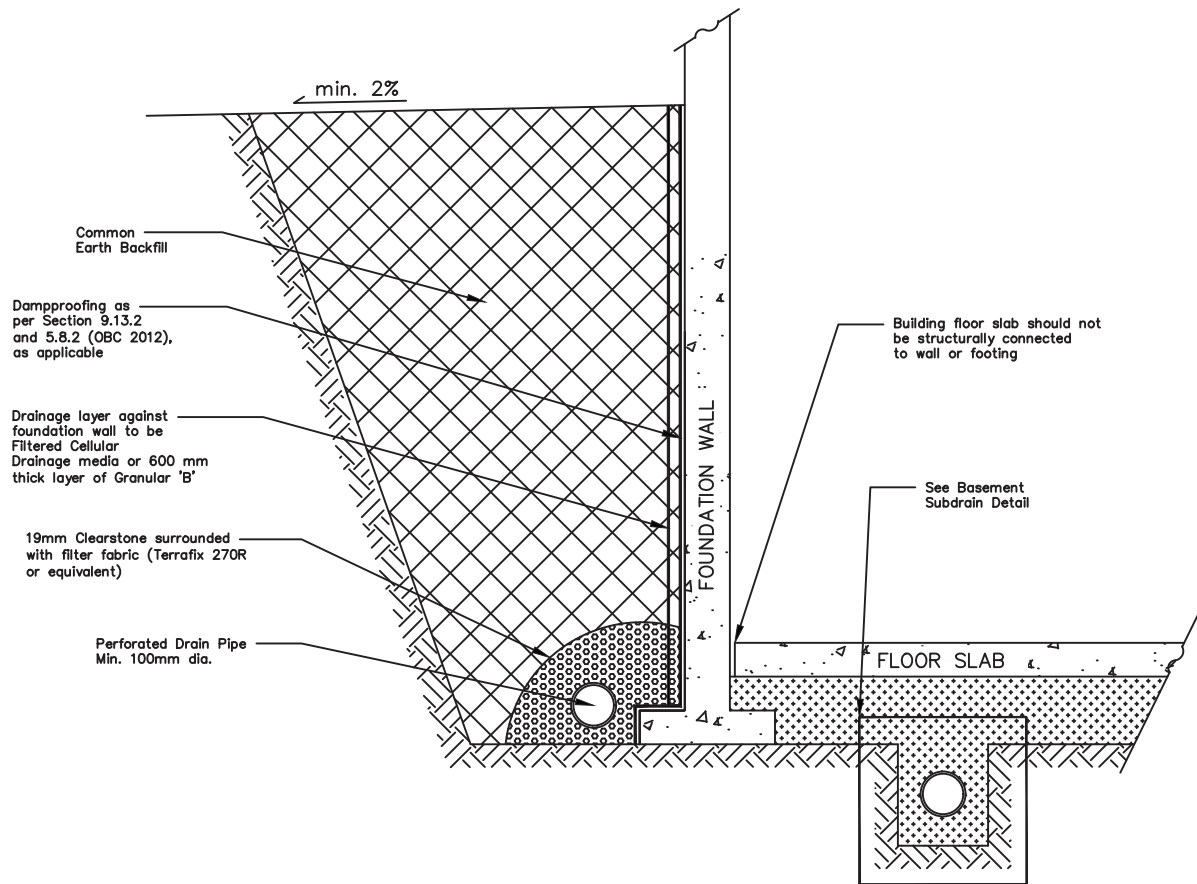


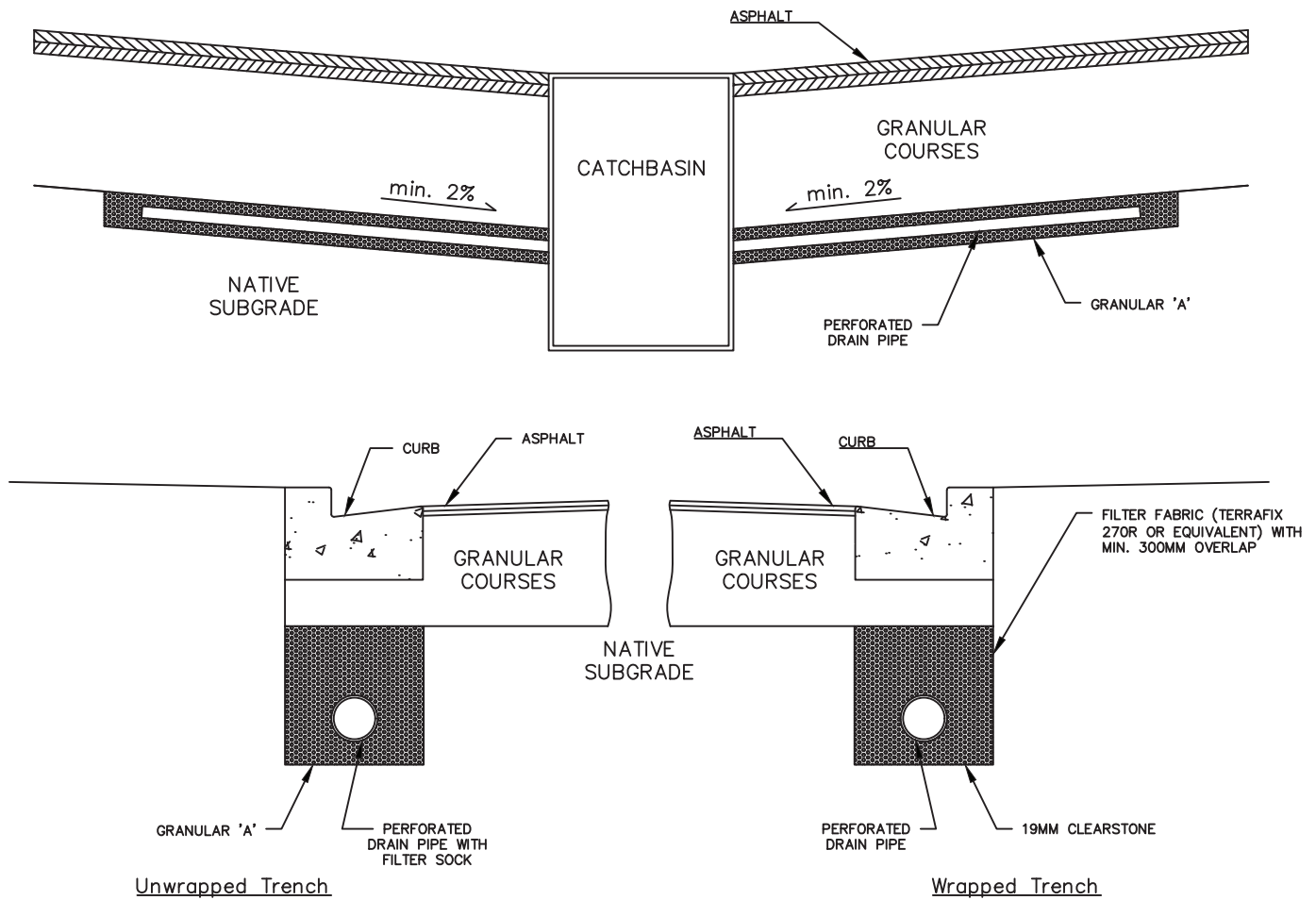
Notes:

1. Engineered Fill compacted to 98% S.P.M.D.D and inspected under the full time supervision of CEE.
2. Interior non-structural compacted fill compacted to 98% S.P.M.D.D. with recommended part-time inspection.

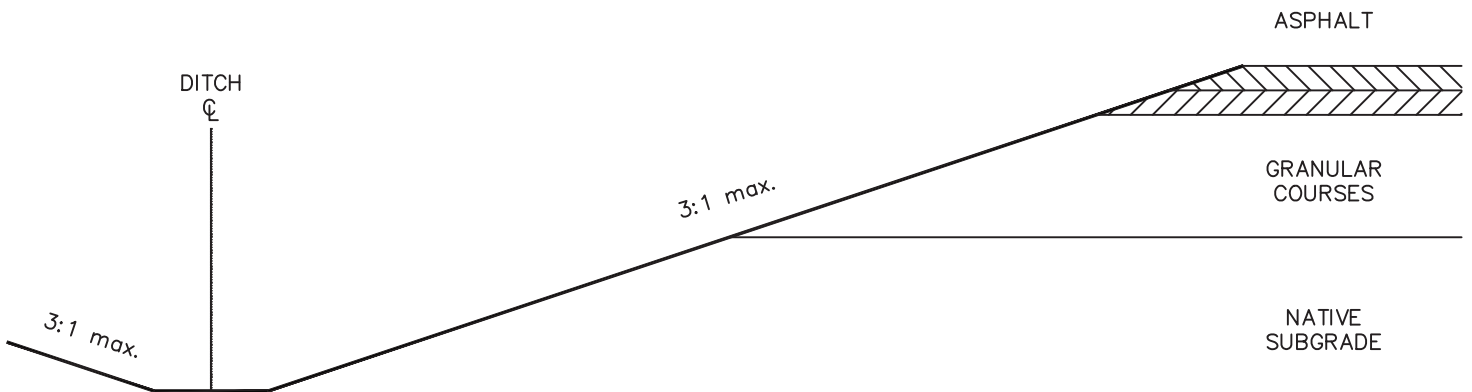
S.P.M.D.D.— Standard Proctor Maximum Dry Density







Urban Cross Sections



Rural Cross Section

1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide all labour, materials, equipment, access, cooperation, coordination, and services to allow the testing of concrete and concrete reinforcement to be carried out by a Testing Agency.
- .2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and to allow the Contractor to make appropriate allowances.
- .3 It is the responsibility of the Contractor to schedule the testing described, to coordinate construction schedules with the Testing Agency, and to cooperate with the Testing Agency in the execution of this work.
- .4 Testing required by the Contractor for the Contractor's own quality control or as noted in clause 1.6.3 will be paid for by the Contractor.

1.3 **RELATED WORK SPECIFIED ELSEWHERE**

- .1 Section 03 20 00 – Concrete Reinforcing
- .2 Section 03 30 00 – Structural Cast-in-Place Concrete

1.4 **REFERENCE STANDARDS**

- .1 Testing of concrete and reinforcement shall conform to the requirements of the following Building Code:
  - .1 Ontario Building Code - 2012 O REG 88/19
- .2 Testing of concrete and reinforcement shall conform to the requirements of the following Standards unless otherwise required by this specification:
  - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
  - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete
- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.

- .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
- .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

**1.5 DEFINITIONS - FOR THIS SECTION**

- .1 "Owner", "Contractor", and "Consultant" as per the General Conditions and Definitions.
- .2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 "Testing Agency" shall mean a third party testing and inspection agency.
- .4 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

**1.6 APPOINTMENT OF TESTING AGENCY**

- .1 A CSA-approved Testing Agency shall be appointed to test concrete, reinforcement, and grout as per this specification and shall include:
  - .1 Review of initial mix designs.
  - .2 Testing as outlined in Article 3.0.
- .2 Unless stated otherwise in Division 0 / Division 1 the Testing Agency shall be engaged by the Owner.
- .3 The Contractor shall pay for testing not covered in clause 1.6.1, which shall include but not be limited to:
  - .1 Review of Contractor-requested mix design changes.
  - .2 Any waiting time incurred by the Testing Agency in excess of 30 minutes.
  - .3 Testing required by the Contractor for stripping of formwork, such as field-cured cylinders, etc.
  - .4 Any additional costs due to overtime, shift work, holiday or weekend work, except that the Owner will pay for holiday or weekend pickup when the concrete was placed on a regular workday.
  - .5 Retesting or additional testing of concrete or reinforcement where tests have failed to meet the specified requirements.

## **1.7 SUBMITTALS**

- .1 The Contractor shall submit the following documents:
  - .1 Testing and Inspection Reports
    - .1 Reports shall be simultaneously distributed to the following parties:
      - .1 Consultant
      - .2 Contractor
      - .3 Owner
    - .2 Reports indicating defective works should be distributed immediately
    - .3 Reports shall be submitted within five (5) business days

## **2.0 Duties**

### **2.1 RESPONSIBILITY OF THE CONTRACTOR**

- .1 The Contractor shall cooperate fully with the Testing Agency.
- .2 The Contractor shall give the Testing Agency at least 24 hours prior notice of concrete placement.
- .3 It is the Contractor's responsibility to provide a finished product that meets the specification. If initial tests indicate that the concrete failed to meet the specification, the Consultant shall decide if any additional testing is necessary. This testing shall be done by a CSA-approved Testing Agency, but need not be the Owner's agency. The proposed additional testing shall have prior approval of the Consultants.
- .4 Strengths of cored samples must equal the specified strength if tested dry or 85% of specified if tested wet, with wet or dry tests as per the Standard.

### **2.2 RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY**

- .1 The Testing Agency has the authority to, and is expected to reject any concrete, including reinforcement not meeting the specifications.
- .2 All testing results and reviews performed by the Testing Agency shall be submitted as noted in section 1.7.
- .3 The Testing Agency shall immediately notify the Consultant if concrete is being placed without their notification, or if insufficient notice is provided.
- .4 Bring low 7-day, 28-day, and 56-day strength tests to the immediate attention of the Consultant and the Contractor.
- .5 At the completion of the project, the Testing Agency to provide a signed letter to the Owner, with a copy to the Consultant. The letter shall confirm that testing has been carried out as per the specifications and that the Contractor and Consultant have been notified of any deficiencies in material properties.



3.0 Testing - Concrete and Reinforcement

3.1 **GENERAL**

- .1 All strength tests shall be numbered consecutively and the cylinders marked as follows:
  - .1 7-Day Test: Marked "A".
  - .2 28-Day Test: Two cylinders marked "B" and "C".
- .2 All tests reports shall record:
  - .1 Name of Project
  - .2 Date and time of sampling
  - .3 Name of supplier
  - .4 Delivery truck number
  - .5 Batch time and discharge time
  - .6 Identification of sampling and testing technicians
  - .7 Exact location in the structure of the concrete sampled
  - .8 Design strength of concrete sampled
  - .9 Admixtures, cement type, maximum aggregate size
  - .10 Air and concrete temperature
  - .11 Slump, and air content
- .3 All field-cured cylinders shall be marked "F".
- .4 Slump tests shall be performed prior to the addition of superplasticizers.
- .5 Tests for slump and air content shall be taken with each strength test and as required by the specifications and drawings.

3.2 **REGULAR TESTING - CONCRETE**

- .1 To conform to the Standard, except each test shall consist of three cylinders - one for 7-day strength and two for 28-day strength.
- .2 Regular testing applied to all elements not listed in Clause 3.3 Full-Time Testing - Concrete.

### 3.3 FULL-TIME TESTING - CONCRETE

- .1 Full time testing shall apply to:
  - .1 Concrete specified as exposure class C-1, C-XL, or C-2 in suspended parking slab or parking slab on grade locations. (\*\*
  - .2 Concrete specified as exposure class F-1, F-2, C-XL, A-XL, C-1, A-1, and C-2 in non-parking applications.
- .2 Full time testing shall conform to the Standard and regular testing except:
  - .1 The Testing Agency shall have a representative on the job site at all times that the concrete requiring full time testing is being placed.
  - .2 Test the slump and air content from every truck and reject any concrete not within specification.
- .3 Full time testing applies for the duration of the project as follows:
  - .1 Provide full-time testing for all elements listed in 3.3.1 and for each mix type by the Supplier until the satisfactory control of the concrete mix is established by the Testing Agency.
    - .1 For slump and air content, satisfactory performance shall be established from test results on not less than 5 consecutive batches of concrete placed.
  - .2 The Testing Agency shall notify the Contractor and Structural Consultant in writing that Regular Testing can be used with a testing frequency for the mix reduced to a rate not less than 1 test every 100 cu. m. The first and last batch of concrete to be placed each day shall always be tested.
  - .3 Where Regular Testing has been initiated for a mix, the Testing Agency shall resume Full Time Testing per 3.3.2 if any test fails to satisfy the Standard, the agreed strength criteria or as directed by the Structural Consultant or Owner.
  - .4 Where a mix type has not been utilized on the project for more than 30 consecutive days, Full Time Testing shall apply until satisfactory compliance with this Standard is re-established.
  - .5 Concrete supplied from different plants or suppliers of the same mix-type shall be considered different mixes for the purposes of the testing requirements.

### 3.4 FIELD-CURED CYLINDERS

- .1 Field-cured cylinders shall be protected against wind and stored on the floor immediately below the slab they represent, unless the floor below is heated. In that case, they shall be stored on top of the slab but covered with a plywood box. The cylinders are to be undisturbed at this location until picked up by the Testing Agency. Field-cured cylinders are not to be stored in temperature-controlled containers.

**3.5 TESTING OF REINFORCING BARS AND ACCESSORIES**

- .1 The Testing Agency shall, over the duration of the project, perform at least one tensile and bend test for each bar size and mill stamp used on the project. Such testing shall comply with the applicable CSA documents. Further testing may be requested at the Consultant's discretion.
- .2 The Testing Agency will select the bars to be tested from the reinforcing supplied to the construction site, not from the suppliers' yard. The Contractor shall cut the bars to the required length and replace the shortened bars without cost to the Owner.
- .3 The Contractor shall supply mill certificates of chemical analysis in accordance with CSA G30.18R and G30.18W for all bar supplied to site.
- .4 Cut samples of mechanical splices and welded reinforcement as directed by the Consultant. Replace mechanical splices and welded reinforcement cut out for testing.
- .5 When requested, provide samples of support accessories (chairs, bolsters, spacers) that are intended to be used.

End of Section

1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide all labour, materials, equipment, and services necessary to supply, erect, and strip all formwork and falsework for poured-in-place concrete shown or indicated on the contract drawings and specifications.
- .2 Install all anchor bolts, embedded metal, inserts, hangers, reglets, dovetail anchors, etc. supplied by applicable trades for casting into concrete, and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.
- .3 Install all openings, sleeves, block-outs, etc. required by other trades and assume responsibility for correct positioning within the agreed tolerance and in accordance to drawings supplied by the trade.

1.3 **RELATED WORK SPECIFIED ELSEWHERE**

- .1 Section 03 20 00 – Concrete Reinforcing
- .2 Section 03 30 00 – Structural Cast-in-Place Concrete

1.4 **REFERENCE STANDARDS**

- .1 Concrete formwork shall conform to the requirements of the following Building Code:
  - .1 Ontario Building Code - 2012 O REG 88/19
- .2 Concrete formwork shall conform to the requirements of the following Standards unless otherwise required by this specification:
  - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
  - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete
  - .3 CSA A23.3 – Design of Concrete Structures
  - .4 CSA S269.1 – Falsework and Formwork
- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.

- .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
- .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

#### 1.5 **DEFINITIONS - FOR THIS SECTION**

- .1 "Owner", "Contractor", and "Consultant" as per the General Conditions and Definitions.
- .2 "Specialty Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

#### 1.6 **SUBMITTALS**

- .1 Shop Drawings for Formwork, Falsework, and Re-Shoring
  - .1 The structural drawings shall not be reproduced, in whole or in part, for use as shop drawings.
  - .2 When requested, submit a written proposal for review by the Consultant as to how the specified cambers are to be achieved, in the field.
  - .3 Opening information
    - .1 Submit drawings of the structure showing formed holes, recesses, and sleeving required under all Sections.
  - .4 As-Built Drawings
    - .1 Mark on a complete set of final reproducible drawings any changes, additions, or deletions that occur during construction as a result of the Contractor's work, change orders, or for any other reason.

#### 2.0 Products

##### 2.1 **GENERAL**

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

##### 2.2 **MATERIALS**

- .1 Form Material
  - .1 Exposed surfaces - High-density overlay form ply (Ainsworth 107 or preapproved equal), metal, plywood, or plywood lined. Plywood to conform to the Standard.

- 
- .2 Unexposed surfaces - metal, plywood, or wood lumber to conform to the Standard.
  - .3 Plywood and wood formwork materials shall conform to the Standard, and be free from warp and sawn straight so that lines and shapes will be accurately retained.
  - .4 Un-lined forms for unexposed surfaces shall be made with a good grade of lumber or plywood and fitted so that there will be no leakage of mortar.
  - .5 Use metal forms, plywood lined forms, or plywood forms of sufficient structural strength for exposed surfaces. Plywood for lining shall be GIS exterior grade fir plywood with waterproof glue.
  - .6 Proprietary and/or modular forming systems shall be designed such that they do not interfere with the specified placement of reinforcement or other embedded hardware and must be pre-approved by the Consultant.
- .2 Ties and Spreaders
- .1 Use metal form ties that are adjustable in length to permit tightening of forms. Use only the snap-off type of form ties, which will permit no metal within 25 mm (1") of the concrete surface after removal. Twisted wire form ties will not be accepted.
  - .2 Wood spreaders inside wall forms will not be permitted.
- .3 Form Release Agent
- .1 Use a non-staining form release agent that is compatible with any finishes/membranes specified elsewhere in the contract documents.
- .4 Void Form
- .1 Void form shall be of a deteriorating material.
- 3.0 Execution
- 3.1 **GENERAL**
- .1 All phases of concrete formwork construction shall be in accordance with the Standard unless otherwise specified herein or on the drawings. Only workers who are skilled and experienced in their trade shall do the work.
- 3.2 **LINES AND LEVELS**
- .1 Verify lines, levels, and column centers before proceeding with work and ensure that dimensions agree with drawings.
  - .2 Co-ordinate and co-operate with all other trades in forming and setting of recesses, chases, sleeves, inserts, bolts, and hangers.

### 3.3 DESIGN OF FORMWORK, FALSEWORK, AND RE-SHORING

- .1 Conform to the Standard.
- .2 Design formwork and re-shoring to safely support vertical and lateral loads until they can be supported by the structure. Design formwork for loads and lateral pressures recommended in CSA S269.1. The Contractor shall assume full responsibility for the structural adequacy of the forms to withstand all concrete, environmental, and construction loads.
- .3 Design and provide shoring and bracing to excavations and underpinning to safely withstand any lateral pressures to which they may be subjected.
- .4 See drawings for locations where reinforced concrete members are not structurally stable until walls and slabs intersecting with them have been constructed to the specified level and the concrete has reached at least 70% of the specified strength.
- .5 Design shores for these slabs and walls to safely support the total vertical and lateral loads until the walls and slabs are complete and have reached 70% of their specified strength. Design the shores so that they can be unloaded gradually.
- .6 As a minimum, the work shall conform to the Standard. Refer to "Formwork for special Architectural finishes" in CSA A23.1 for architectural concrete.
- .7 Where concrete is exposed to view, forms are to be laid out so that joints are kept to a minimum and located in an orderly and symmetrical arrangement wherever possible. Form ties shall be evenly spaced and located in straight horizontal and vertical lines. Spacing and location of form tie holes shall be detailed by the Contractor and approved by the Consultant. See also the architectural drawings and specifications for any special requirements for architectural, or exposed, concrete.
- .8 The strength and rigidity of forms shall be such that they will not leak mortar or result in visible irregularities in the finished concrete. In addition, the deflection of facing materials between studs, as well as the deflection of studs and walers, shall not exceed 0.0025 times the span.
- .9 Forms shall be constructed so that the finished concrete will conform to the shape, dimensions, and tolerances as specified in the Standard or on the structural drawing, whichever is most rigorous. They shall also incorporate the cambers specified on the structural drawings. Movement resulting from form support deflection, closure of form joints, and elastic shortening of forms and shoring must be calculated and added to the cambers indicated on the drawings. Coordination to achieve more rigorous tolerances on concrete dimensions required to accommodate the geometric tolerance of various trades and finishes (cladding, structural steel, etc.) shall be completed by the contractor.
- .10 Construct forms so that they may be dismantled and removed without damaging the concrete.
- .11 The Contractor shall submit details of the sequence and extent of formwork removal and re-shoring to the Consultant for review. Such details shall include magnitude of loads and location of all re-shores at each level. Forms shall not be removed or adjusted until the review is complete. Such review does not relieve the Contractor of responsibility for formwork and safety during construction.

- .12 Set shores on wedges or use adjustable shores so they may be removed without causing undue strains in the concrete.
- .13 Do not exceed the safe capacity of the structure with any construction or shoring loads. The safe capacity of the structure may be taken as the design live load, as indicated on the structural drawings, multiplied by the ratio of the concrete strength at the time of loading to the specified concrete strength, but not greater than 1.0.

#### 3.4 ERECTION

- .1 Sleeves and openings shown on the structural drawings must be confirmed with mechanical, electrical, and architectural drawings. Any discrepancies are to be reported to the Consultant.
- .2 Sleeves and openings not shown on the structural drawings must be approved by the Consultant.
- .3 Keep all untreated forms moist to prevent shrinkage prior to placing of concrete and wet the surface at time of placing.
- .4 Treated formwork surfaces shall have the approved form coating applied in accordance with the manufacturer's recommendations, prior to placing reinforcing steel. Remove any excess form coating. Do not apply form release agent after reinforcing steel has been placed. Ensure reinforcing steel does not come in contact with form release oil.
- .5 Erect, support, brace, and maintain formwork to safely support vertical and lateral loads until they can be supported by the structure.
- .6 All falsework erection shall be supervised by the Professional Engineer responsible for its design.
- .7 All forms shall be inspected by the Contractor prior to the concrete pour to ensure that they have been erected in conformance with the formwork shop drawings.
- .8 Construction
  - .1 Form footing sides unless footings are shown to be placed against undisturbed soil.
  - .2 Construct formwork such that hardened concrete, prior to stripping of forms, is cambered as indicated. Maintain beam depth and slab thickness from cambered surface.
  - .4 Mark building, grid, or other lines on forms to permit the accurate positioning of reinforcing steel.
  - .5 Construct templates and supports to rigidly fix reinforcing dowels in the forms prior to concreting.
  - .6 Provide suitable markers to indicate the location and configuration of continuing concrete members so that dowels can be positioned accurately in relation to their position in the continuing members.



- .7 Set anchor bolts, templates, steel connection units, hardware, or other inserts into the forms and secure them rigidly so that they do not become displaced during concreting. Set and secure these items to the tolerances specified and required in the appropriate Sections.
- .8 Build top forms on sloping concrete where required to prevent flow of the concrete out of the forms. Provide vents to top forms to permit air or bleed water to escape from the forms.
- .9 Where foundations are poured directly into fresh rock excavations, place compressible foam around foundations unless excavations are left open for more than 100 days prior to pouring.

### 3.5 TOLERANCES

- .1 The tolerances for all concrete work shall conform to the requirements of the Standard and Drawings.
- .2 Variations in building lines that result in extension of the building over lot lines or restriction lines will not be permitted.
- .3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

### 3.6 PRODUCT HANDLING

- .1 Protect formwork materials before, during, and after installation and protect installed work and materials of other trades.
- .2 In the event of damage, immediately make required repairs or replacements necessary to the approval of the Consultant at no extra cost to the Owners.

### 3.7 REMOVAL OF FORMWORK

- .1 Forms shall not be removed until concrete has attained sufficient strength that no damage to strength or continuity of concrete will occur when forms are removed. Time for formwork removal of suspended concrete shall be approved by the Consultant. See also the requirements of Article 3.2.
- .2 Prying against face of concrete to remove forms is not allowed, only wooden wedges shall be used.
- .3 Where forms are being reused, thoroughly clean and retreat them.
- .4 Removal of form ties shall be done carefully to avoid marking concrete and to allow for patching. Grout bottom of form tie hole to prevent rust staining.

### END OF SECTION

1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide all labour, materials, equipment, and services necessary to supply and install reinforcing steel work shown or indicated in all the contract drawings and specifications including accessories such as hanger bars, spirals, wire ties, support bars, chairs, spacers, supports, or other devices required to position reinforcing properly.

1.3 **RELATED WORK SPECIFIED ELSEWHERE**

- .1 Section 03 00 50 – Testing of Concrete and Reinforcement
- .2 Section 03 11 00 – Concrete Forming and Accessories
- .3 Section 03 30 00 – Structural Cast-in-Place Concrete
- .4 Section 05 12 00 – Structural Steel Framing

1.4 **REFERENCE STANDARDS**

- .1 Concrete reinforcing shall conform to the requirements of the following Building Code:
  - .1 Ontario Building Code - 2012 O REG 88/19
- .2 Concrete reinforcing shall conform to the requirements of the following Standards unless otherwise required by this specification:
  - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
  - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete
  - .3 CSA A23.3 – Design of Concrete Structures
  - .4 ASTM A1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
  - .5 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement
  - .6 CSA W47.1 – Certification of Companies for Fusion Welding of Steel
  - .7 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction
  - .8 CSA-W59 – Welded Steel Construction (Metal Arc Welding)
  - .9 Reinforcing Steel Institute of Canada (RSIC) – Manual of Standard Practice

- 
- .10 ASTM A820M – Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
  - .11 ASTM C1116M – Standard Specification for Fiber-Reinforced Concrete
  - .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
  - .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
  - .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
  - .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.
- 1.5 DEFINITIONS - FOR THIS SECTION**
- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
  - .2 “Specialty Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
  - .3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.
- 1.6 TESTING**
- .1 As per Section 03 00 50 - Testing of Concrete and Reinforcement.
- 2.0 Products**
- 2.1 GENERAL**
- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.
- 2.2 MATERIALS**
- .1 Reinforcing bars shall conform to the Standard unless otherwise specified herein or on the drawings.
  - .2 Reinforcing bars to be welded shall conform to the Standard, G30.18W.
  - .3 Reinforcing steel that is part of the seismic load-resisting system to conform to the Standard, G30.18W.
  - .4 Welded wire fabric shall conform to the Standard; size and gauges as shown on the drawings.
  - .5 Welded wire fabric for slabs shall be delivered in flat sheets.

- .6 In suspended parking slabs, bar support chairs shall be plastic or plastic coated.
- .7 Chairs, Bolsters, Bar Supports, Spacers: To CSA A23.1. In the case of concrete exposed to view or weather, the accessories shall be such that no metal is permitted to come closer than 40 mm (1-5/8") from a formed face and 50 mm (2") from a troweled surface. Use precast concrete supports for exposed concrete beams and soffits and concrete cast against soil/rock. Precast concrete supports shall be made of concrete of quality and strength at least equal to that specified for the member in which they are used.
- .8 Steel fibers shall meet the requirements of ASTM A820 Type 1, deformed fibers. Minimum ultimate tensile strength shall be 1036 MPa. Minimum aspect ratio shall be 80. Minimum fiber length shall be 60 mm. Maximum fiber diameter shall be 0.03 inches. Steel fibers shall be Dramix RC 80/60 BN manufactured by Bekaert Corporation, or approved equivalent.
- .9 Steel fiber concrete shall be proportioned as required in ASTM C1116, alternative 3, in consultation with fiber manufacturer based on the required concrete properties indicated on drawings and specifications.
- .10 Rebar End Welded to Structural Steel: LENTON Weldable Coupler as manufactured by nVent Inc. or approved alternate.

### 3.0 Execution

#### 3.1 GENERAL

- .1 All phases of concrete reinforcement work shall be in accordance with the Standards unless otherwise specified herein or on the drawings. The Contractor shall ensure that the work is executed only by workers skilled and experienced in their trade.
- .2 The Contractor shall notify the Consultant at least 24 hours before any concrete is placed in order that the Consultant may review the work.
- .3 Identify with a tag each bundle of bars with a code mark corresponding to that appearing on the bar list.
- .4 Bend reinforcement once only and at room temperature of 18°C. Do not straighten or re-bend reinforcement. Do not use bars with kinks or bends not shown on the drawings.
- .5 Replace bars that develop cracks or splits.
- .6 Non-galvanized reinforcement to be electrically isolated from galvanized steel including but not limited to reinforcement, hardware (sleeves, conduit) , embedded plates, structural steel, or window washing anchors.
- .7 Williams All-Thread - Bar must not be welded or subjected to the heat of a torch or used as a ground.

#### 3.2 FIELD BENDING

- .1 Do not field bend reinforcement except where indicated or authorized in writing by the Consultant.

- .2 When field bending is authorized, bend without heat, applying a slow and steady pressure.
- .3 Replace bars that develop cracks or splits.

### 3.3 CONSTRUCTION JOINTS IN CAST-IN-PLACE CONCRETE

- .1 Obtain acceptance from the Consultant for details of construction joints not shown.
- .2 Continue reinforcement through the joint in its normal position. Add additional reinforcement across the joint as shown or directed. Where a mechanical splice is required at a construction joint, use of the LENTON Formsaver type coupler manufactured by nVent or approved equivalent is appropriate.

### 3.4 SHOP DRAWINGS

- .1 Refer to Section 01 33 00 for submittals.
- .2 Allow at least two weeks for shop drawing review by the Structural Engineer of concrete reinforcement, bar support, and accessories. Allow sufficient time for review, correction, fabrication, shipping to site, and placement.
- .3 Clearly indicate bar sizes, grades, spacing, location and quantities of reinforcing mesh, bar supports, and accessories, mechanical splices, and identifying code marks to permit correct placement without reference to structural drawings. Include total weight of materials being installed.
- .4 Placing drawings and bar lists will be reviewed for number and size of bars only and this review shall in no way relieve the Contractor of the Contractor's responsibility for carrying out the Work in accordance with the drawings.
- .5 Substitution of imperial reinforcing sizes and grades will only be accepted if placing drawings showing imperial sizes are submitted to the Consultant for review. Approval must be obtained before any work commences.
- .6 Clearly indicate placing order of reinforcement.
- .7 Prepare sections of congested joints to avoid site issues.
- .8 Prepare reinforcement shop drawings and bar lists taking into account all openings and recesses shown on the architectural, structural, mechanical, and electrical drawings, and on the sleeving shop drawings. Reinforcement shop drawings may only be reviewed if sleeving and conduit shop drawing are submitted in parallel.
- .9 Completely dimension openings, recesses, and sleeves, and relate to suitable grid lines and elevation datum.
- .10 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias may be used by the Contractor under the following conditions:
  - .1 Copyright remains with Read Jones Christoffersen Ltd.

- .2 The drawings will only be used for shop drawings for this project and not be put to any other use.
- .3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of the Contractor's work.
- .4 References to Read Jones Christoffersen Ltd. must be deleted from the title block.
- .5 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.
- .11 Detail reinforcement in accordance with the contract documents, CSA A23.1, and detailing standards in CRSI Manual of Standard Practice.
- .12 Where 10M top bars and welded wire fabric are shown, provide adequate chairs, bolsters, or supports to ensure that these bars are not bent or displaced prior to or during the concreting operation.
- .13 Detail sections to fully illustrate placement of concrete reinforcement at areas such as openings, change of levels, spandrel, stairs, and wherever else required.
- .14 Provide large-scale detail concrete sections at areas of steel concentrations, such as at intersections of beams and columns, column splices, or wherever else required.
- .15 Indicate placing sequence for reinforcement, such as intersections of beams and beams, slabs and beams, and within slabs.
- .16 Indicate minimum clearances between reinforcement and minimum concrete cover to reinforcement.
- .17 Indicate location and embedment of dowels.
- .18 Location, number, and type of support accessories, including support bars suitably sized and spaced to rigidly support the weight of reinforcement and construction load.
- .19 Submit code marks or symbols used on reinforcement of each manufacturer so that RJC may identify grades and sizes of reinforcement.
- .20 Shop Drawings for Welding Reinforcement
  - .1 When requested, submit drawings showing, as a minimum, the following: locations, elevations, and size of welds; welding procedures and techniques; reports of chemical compositions; and verification of weldability, stamped as approved by the **Canadian Welding Bureau**.
- .21 Shop Drawings for Mechanical Splices
  - .1 Submit drawings showing, as a minimum, the following: location, elevations, and size of splices; materials; and procedures.

.22 Certificates

- .1 Reinforcing Steel from Canadian Manufacturers: When requested, provide the Consultant with certified copy of reports of reinforcing steel showing physical and chemical analysis a minimum 4 weeks prior to commencing fabrication.
- .2 Reinforcing Steel from Other than Canadian Manufacturers: When requested, provide test data from a Canadian Testing Laboratory proving that each size and grade of reinforcement proposed meets specification requirements. Reinforcement reviewed for use by the Consultant shall be identified in a manner suitable to the Consultant. Only steel that has been reviewed and accepted may be used in the project. This analysis should be provided for each heat of steel.
- .3 Provide Steel Fibers: Certification and test reports for each shipment of fibers.

.23 Substitutions

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

.24 As-Built Drawings

- .1 Mark on a complete set of final reproducible drawings any changes, additions, or deletions that occur during construction as a result of the Contractor's work, change orders, or for any other reasons.

**3.5 FABRICATION**

- .1 Fabricate all reinforcing to the Standard and contract documents.
- .2 Reinforcing bars shall be cold bent. Bars shall not be straightened or re-bent.
- .3 Colour code each bar to correspond with code mark appearing on bar list.
- .4 Steel stud assemblies for shear reinforcement shall be fabricated in accordance with ASTM A1044/A1044M.

**3.6 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- .1 Store reinforcement in a manner to prevent excessive rusting and fouling with dirt, grease, form-oil, and other bond-breaking coatings.
- .2 Reinforcement at the time concrete is placed shall be free from excessive rusting, mud, oil, or other coatings that adversely affect its bonding capacity.

**3.7 PLACING**

- .1 Reinforcing of size and shapes shown on the structural drawings shall be accurately placed in accordance with the drawings and the requirements of the Standard.

- .2 Reinforcement shall be adequately supported by chairs, spacers, support bars, hangers, or other accessories, and secured against displacement within the tolerances permitted in the Standard. Support devices contacting surfaces exposed to the exterior shall be non-corroding.
- .3 Bars that are not part of the structural design or drawings, and whose only function is supporting other reinforcing in lieu of other support accessories, shall be considered accessories.
- .4 All reinforcement shall be adequately tied and chaired to maintain it in the specified location during pouring. Lifting of reinforcing or welded wire mesh into specified position during the concrete pour will not be allowed.
- .5 Tolerances for bar placement shall be as per the Standard. Tolerances shall not be used to justify the use of chair, bolsters, or chair/support combinations that result in improper cover.
- .6 Williams All-Thread Bar must not be welded, subjected to the high heat of a torch, nor used as a ground.
- .7 Field cutting is to be done with an abrasive wheel or band saw.
- .8 Prior to concreting, accurately place reinforcement, support, and secure against displacement, as indicated on reviewed placing drawings and in accordance with CSA A23.1. Tack welding of reinforcement to secure in place will not be permitted.
- .9 Set column anchor bolts and wall dowels prior to concreting with wooden templates or other approved means.
- .10 Do not 'wet set' reinforcement into fresh concrete.
- .11 Secure reinforcement in columns and walls using sufficient spacers on each face to maintain the requisite distance between reinforcement and column or wall face and so that vertical bars are plumb.
- .12 Where continuous drop panels or slab thickenings are noted on the drawings, place bottom slab reinforcement in the bottom of the continuous drop panel or slab thickening, unless noted otherwise on the drawings.
- .13 Where toppings are placed on waterproof membranes, vapour barriers, and the like, prevent reinforcement or tie wire from contacting these items.
- .14 Ensure that longitudinal bars in beams have adequate vertical spacing between layers in accordance with the Standard.
- .15 Pre-assemble column and beam cages as necessary. Do not "spring" or bend ties and stirrups in order to place longitudinal reinforcement.
- .16 All splice locations are subject to review by the Consultant.

### 3.8 **WELDING**

- .1 Any welding of reinforcing steel shall be in accordance with the applicable Standard.



- .2 Welding of concrete reinforcement shall be performed by workers who are approved by the Canadian Welding Bureau in accordance with the Standard. Copies of the Canadian Welding Bureau approved welding procedure and certificate of current operator qualification shall be submitted to the Consultant prior to commencement of welding.
- .3 Welding to reinforcement is only permitted as indicated in the Contract Documents or with prior written approval of the Consultant.

### 3.9 CONSTRUCTION REVIEW

- .1 No concrete shall be placed until the Consultant has completed a review of reinforcement in place. The Contractor shall provide a minimum of 24 hours notice of the time when the reinforcement will be substantially in place and ready for the Consultant's review. A minimum of 6 hours is to be provided for review and any required remedial work prior to concrete placement.
- .2 The Consultant's general review during construction and inspection and testing by Independent Inspection and Testing Companies reporting to the Consultant are both undertaken to inform the Owner of the Contractor's performance and shall in no way augment the Contractor's quality control or relieve the Contractor of contractual responsibility.

### 3.10 TOLERANCES

- .1 Perform fabrication and setting so that completed work will be within the tolerances set out in CSA A23.1.
- .2 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

End of Section

1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide all labour, materials, equipment, and services necessary to supply and install cast-in-place concrete work shown or indicated in all the contract drawings and specifications including concrete toppings, bases, sumps, curbs, posts, manholes, pits, paving, sidewalks, equipment bases or curbs, grouting of baseplates, etc.
- .2 Coordinate concrete placement fully with other trades. Ensure other related work, such as inserts, dowels, sleeves, reinforcement, etc., is complete before placing concrete.

1.3 **RELATED WORK SPECIFIED ELSEWHERE**

- .1 Section 03 00 50 – Testing of Concrete and Reinforcement
- .2 Section 03 11 00 – Concrete Forming and Accessories
- .3 Section 03 20 00 – Concrete Reinforcing
- .4 Section 03 35 00 – Concrete Finishing
- .5 Section 05 12 00 – Structural Steel Framing
- .6 Section 05 31 00 – Steel Decking

1.4 **REFERENCE STANDARDS**

- .1 Concrete work shall conform to the requirements of the following Building Code:
  - .1 Ontario Building Code - 2012 O REG 88/19
- .2 Concrete work shall conform to the requirements of the following Standards unless otherwise required by this specification:
  - .1 CSA A23.1 – Concrete Materials and Methods of Concrete Construction
  - .2 CSA A23.2 – Test Methods and Standard Practices for Concrete
  - .3 CSA A23.3 – Design of Concrete Structures
  - .4 CSA S413 – Parking Structures
  - .5 CSA A3000 – Cementitious Materials Compendium
  - .6 ACI 347 – Guide to Formwork for Concrete

.7 CSA S269.1 – Falsework and Formwork

- .3 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .4 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .5 A copy of A23.1 and A23.2 shall be kept on site by the Contractor for the duration of the work and be made available for reference.
- .6 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

**1.5 DEFINITIONS - FOR THIS SECTION**

- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
- .2 “Specialty Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .3 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

**1.6 SUBMITTALS**

- .1 Keep a record at the job site showing time and place of each pour of concrete, together with a transit-mix delivery slip certifying contents of pour. Make the record available to the Owner for inspection upon request. Upon completion of this portion of work, submit placing records and delivery slips to the Owner.
- .2 Submit details of proposed methods of concrete curing and provisions for weather protection to the Consultant for review.
- .3 Submit plan locations and details of construction joints for the Consultant’s review.
- .4 Certificates
  - .1 The concrete supplier shall have a current “Certificate of Ready Mixed (or Mobile Mix) Concrete Production Facilities,” as issued by the National Ready Mixed Concrete Association (NRMCA). The certificate shall be submitted to the Consultant upon request.
  - .2 When requested, prior to beginning work and when any change in materials or source of supply is proposed, provide the following certificates prepared by an independent inspection company. The cost of this work shall be borne by the Contractor.
    - .1 Certification that all raw materials used in the production of concrete proposed for the work comply with requirements of the specifications and CSA A23.1. Specifically, the Contractor must confirm that aggregates used will not react with alkalis in the concrete to cause deleterious expansion.

- .2 Certification that compressive strength, water-cement ratio, slump, entrained air content, and other specified properties will be met using the proposed mixes.
  - .3 Certification that classes of exposure C-1, A-1, and C-XL will meet the 56-day limits specified in CSA A23.1 for the rapid chloride permeability test using the proposed mixes.
  - .4 The concrete supplier shall submit representative chloride permeability test data distributed over a period of 56 days for concrete exposure classes C-1, A-1, and C-XL with and without calcium nitrite corrosion inhibitor or any other admixture containing ionic salts.
- .3 Concrete Quality Plan
- .1 When requested, submit a complete "Concrete Quality Plan", in the format provided by the NRMCA.
  - .4 When requested and well in advance of construction, submit complete details of placing and consolidation procedures for sloping roofs, including details of construction and placing of top forms and top form panel.

## 2.0 Products

### 2.1 GENERAL

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.
- .2 Provide samples of materials upon request.

### 2.2 MATERIALS

- .1 Mixing water shall conform to the Standard.
- .2 Air entraining admixtures to the Standard.
- .3 Calcium chloride, either as a raw material or as a constituent in other admixtures, shall not be used unless approved in writing by the Consultant.
- .4 Curing compounds shall conform to the specification and shall also be compatible with specified floor hardeners, covering adhesives, and waterproofing compounds.
- .5 Grout shall be pre-approved, pre-mixed, and non-shrink conforming to the Standard. Exposed grout shall be non-staining, cement grey in colour.
- .6 Modulus of Elasticity (E): For each concrete mix design,
  - .1 the average (mean) of the Modulus of Elasticity (as measured by appropriate testing) at all times during construction is to be not less than the value shown on the structural drawings, or not less than 4,500v(f'c) MPa if no value is shown on the structural drawings.

- .2 The coefficient of variation of Modulus of Elasticity (as measured by appropriate testing) at all times during construction is to be not greater than 5%
- .7 Concrete: Normal density concrete with air-dry density of  $23 \pm 1$  kN/cu. m. Conform to CSA A23.1.
- .8 Cement Type: General Use Portland Cement (Type GU) or Low Heat of Hydration Portland Cement (Type LH) meeting the requirements of CSA A3000.
- .9 Admixture:
  - .1 Corrosion Inhibiting Admixture: Calcium nitrite based corrosion inhibitor, "DCI" or "DCI(S)" by W.R. Grace & Co. or Masterlife CI 30 by BASF Construction Chemicals (or approved alternative), shall be added at the rate of 10 L/cu. m of concrete where required on the structural drawings. The corrosion inhibitor shall contain  $30 \pm 3\%$  of calcium nitrite by weight. The selection of "DCI", "DCI(S)" or "CI 30" (or approved alternative) shall be as directed by the admixture supplier, based on anticipated placing and curing conditions and the specific concrete mix design selected.
- .10 Shrinkage Control Fibres: "Dramix" steel fibres by Bekaert or approved alternative, 60/1.05.
- .11 Bonding Agent: Use Sika Sikdur 32 epoxy bonding agent for all bonded topping installations, or approved equivalent.
- .12 Curing Compound: Conform to CSA A23.1.
- .13 Grout Beneath Base Plates: Non-shrink, non-metallic, flowable grout, In Pakt or approved alternative having a compressive strength at 28 days of at least 35 MPa (5 ksi). Where grout is exposed to view or weather, use non-ferrous grout.
- .14 Supplementary Cementing Materials (SCMs)
  - .1 It is anticipated that one or more supplementary cementing materials will have to be used in the concrete to produce a mix with acceptable fresh and hardened concrete properties and acceptable thermal characteristics during hardening. The materials will be one or more of the following:
    - .1 Granulated blast furnace slag
    - .2 Fly-ash
    - .3 Silica fume
  - .2 SCMs – fly ash, granulated blast furnace slag, or silica fume – shall comply with the requirements of CSA A23.1 and A3000.
  - .3 The supplier shall submit evidence satisfactory to the Owner to demonstrate that the storage and dispensing facilities for SCMs do not have any deleterious effects on the materials themselves. These facilities will not expose these materials to such effects as the agglomeration or balling of particles, any separation or change in effective particle size of solids in slurries, freezing and thawing, or excessive heat.

- .1 The concrete supplier shall demonstrate by appropriate tests and test results that the aggregates chosen have the potential to meet the design strength requirements specified herein.
- .2 Coarse Aggregate: Crushed rock conforming in all respects to CSA A23.1. The maximum size of the coarse aggregates shall be 20 mm but smaller maximum sizes may be used.
- .3 Fine Aggregate: Natural and conforming to CSA A23.1.

## .16 Unshrinkable Fill

- |    |   |                         |
|----|---|-------------------------|
| .1 | Cement Type   | General Use GU Portland |
| .2 | <u>Minimum</u> 24-Hour Strength   | 0.07 MPa (10 psi)       |
| .3 | <u>Maximum</u> 28-Day Strength  | 0.4 MPa (60 psi)        |
| .4 | Class of Exposure   | N/A                     |
| .5 | Size of Coarse Aggregate  | 20 mm to 40 mm          |
| .6 | Slump at Point of Discharge   | 150 mm to 200 mm        |
| .7 | Calcium chloride or pozzolanic mineral admixtures shall not be used. Air entraining admixtures may be added if desired by the Contractor. |                         |

- .17 Sealant for Exposed Separation Strips, Construction Joints, and Temporary Opening Joints: Multi-Component Polyurethane 'Sikaflex 2C-SL' by Sika, or approved alternate.

### 3.0 Execution

### 3.1 GENERAL

- .1 All phases of concrete work shall be in accordance with the Standard unless otherwise specified herein or on the drawings. The work shall be executed only by experienced and skilled workers.
- .2 The Contractor shall notify the Consultant at least 24 hours before any concrete is placed to allow the Consultant to review the work.
- .3 Prior to the initial supply of concrete to the project, the contractor must schedule a “Pre-Pour Meeting” as outlined in the Concrete Supplier’s Concrete Quality plan.

### 3.2 MIX DESIGNS

- .1 Concrete mixes shall be proportioned by the supplier to meet the compressive strength, exposure class, and other performance specifications noted in the contract documents. In addition, concrete mix design shall satisfy the transport, placing, and finishing requirements of the Contractor. All concrete shall be normal weight unless noted otherwise. Concrete types are specified in accordance with CSA A23.1 Table "Alternate methods for specifying concrete", Alternate 1.
- .2 Concrete mix design is the responsibility of the supplier, including the use of admixtures, alone or in combination. The supplier is also responsible for ensuring the plastic and hardened properties of the concrete meet the construction and specified requirements. This includes the long-term performance of the hardened mix.
- .3 Pump mix slumps shall also conform to the above.
- .4 Water/Cement ratios and air contents for exposure class shall be as per the Standard.
- .5 The proposed mixes shall be submitted to the Consultant and Testing Agency for review.
- .6 The mix designs shall note the constituents by the properties required by the structural drawings, and the structural elements for which the mix is to be used.

### 3.3 TESTING

- .1 As per Section 03 00 50 - Testing of Concrete and Reinforcement

### 3.4 PLACING OF CONCRETE

- .1 Conveying and placing of concrete is to conform to the Standard.
- .2 All concrete shall be consolidated by means of vibrators of appropriate size operated by experienced workers.
- .3 The use of vibrators to transport concrete shall not be permitted.
- .4 Cement slurry used to prime concrete pumps shall be discarded and not placed in the project.
- .5 Immediately before placing concrete, clean forms and reinforcement of foreign matter.
- .6 A maximum time limit of 120 min from the time of initial mixing to complete discharge shall be observed. Exemptions to the maximum time limit, if required, shall be agreed upon by the Engineer, Owner, and the concrete supplier prior to placement of the concrete. In some circumstances, set retarders or hydration stabilizers may be used to extend the discharge time.
- .7 During hot weather conditions, as defined by CSA A23.1, do not use concrete mixed more than 1 hour after introduction of mixing water.
- .8 Prior to pouring the concrete elements directly supported above, remove forms to such an extent to allow the Architect/Owner/Engineer to review the quality of any exposed column surface. Provide necessary protection to the exposed surfaces upon completion of review.

- .9 Remove concrete spilled onto forms around hoisting equipment before depositing concrete in these areas.
- .10 Pumping Concrete
  - .1 Pumping or pneumatic placing of concrete shall only be used if the velocity of discharge is reduced to a point where no separation or scattering of the concrete occurs, and the consistency of the mix has been designed to allow such a system with no adverse effects on the quality of concrete.
  - .2 Excess grout or mortar used to lubricate pipelines, or washout water, must not be discharged into the forms.
- .11 C-XL Concrete
  - .1 All C-XL (extended service life concrete) shall be wet cured at a temperature of at least 10°C for a period of seven consecutive days and for a time necessary to attain 70% of the specified compressive strength, whichever is greater. Wet curing shall commence immediately after placement and finishing of concrete

### 3.5 OPENINGS AND INSERTS

- .1 The Contractor shall notify all trades sufficiently in advance to ensure that provision is made for openings, inserts, and fasteners. The Contractor shall cooperate with all trades in the forming and setting of all slots, sleeves, bolts, dowels, hangers, inserts, conduits, clips, etc. Any embedded hardware may be subject to review by the Consultant.
- .2 Openings and sleeves shown on the structural drawings must be confirmed with mechanical, electrical, and architectural drawings.
- .3 Openings and sleeves not shown on the structural drawings must be approved by the Consultant.
- .4 Do not pass sleeves, ducts, pipes, or other openings through joists, beams, columns, or wall zones without written approval of the Consultant.
- .5 Do not eliminate, cut, or displace reinforcement to accommodate hardware. If inserts cannot be located as specified, obtain approval of modifications by the Consultant before placing concrete.

### 3.6 CONSTRUCTION AND CONTROL JOINTS

- .1 Construction joints shall conform to the Standard except that for horizontal joints in walls, other than retaining walls, it will be sufficient to place fresh concrete on a clean rough surface unless directed otherwise by the Consultant or otherwise noted on the structural drawings.
- .2 Joints in slabs-on-grade shall be located as indicated on the structural and/or architectural drawings. Unless noted otherwise on the drawings, a joint in the slab-on-grade may be a pour joint, trowelled joint, saw cut, or other pre-approved method. The depth of joints shall be a minimum of 1/4 of the thickness of the slab. Saw cut joints are to be completed within 12 hours of placing. Alternative joint details are to be submitted in writing to the Consultant.



- .3 For vertical joints in walls below grade, see standard detail on structural drawings. For locations, see architectural and structural drawings.
- .4 Construction joints in walls and columns shall occur at the top of slab and at the underside of slab/beam systems unless noted otherwise on the structural drawings.
- .5 Construction joints not shown in the drawings or specifications shall be subject to the approval of the Consultant. The Consultant may require keys or extra reinforcing to be provided at the Consultant's discretion with associated costs borne by the Contractor.
- .6 The existing concrete surface at construction joints shall be brought to a saturated surface dry condition immediately prior to placement of concrete.
- .7 Construction joints exposed to view may be subject to non-structural review by Consultant.
- .8 Unless noted otherwise on the drawings, control joints in walls are to be located at a maximum spacing of 9 m (30') on center and detailed as indicated on the structural drawings.
- .9 Supply and install pre-molded waterstops in construction joints where indicated on the drawings. Weld joints to make watertight. Install waterstops in accordance with manufacturer's specifications and recommendations. Waterstop procedures require approval of Consultant.
- .10 Obtain approval from RJC for location and details of construction joints not shown.
- .11 The maximum length of a concrete slab pour shall be 40 m (120'-0).
- .12 The maximum length of a concrete foundation wall pour shall be 15 m (50').
- .13 The maximum height of a concrete pour shall be 5 m (15'-0).
- .14 If the construction joint (including joints around temporary openings) will be exposed in its permanent condition, such as in a parking garage, the joint must be caulked as outlined under the Materials section.

### 3.7 CURING AND PROTECTION

- .1 Curing procedures shall be in accordance with the Standard. Alternate methods with Consultants approval, may be used providing they produce concrete that meets the contract documents.
- .2 Cold and hot weather protection shall comply with the Standard or the requirements on the structural drawings, whichever are more rigorous.
- .3 Concrete placed during extreme drying conditions shall satisfy A23.1.
- .4 (Reference Standard CSA A23.1/A23.2) Contractor shall submit a plan for curing to the Owner, for review and approval, together with other tender documents. The curing plan shall be prepared in strict accordance with the Standard, including:
  - .1 The method for protecting the concrete from evaporation of surface moisture from the fresh concrete.

- .2 The type of curing material to be used.
- .3 How the surface will be kept moist and the quality control requirements for keeping the surface moist.
- .4 The time of initiation and duration of curing.
- .5 Provisions to address potential problems such as high winds and hot and cold weather.
- .6 The limitations of access, if any, to the surfaces being cured.
- .5 (Reference Standard CSA A23.1/A23.2) All concrete mixes proportioned for C-XL class of exposure shall have Extended Curing. Concrete mixes that meet the definition of HVSCM-1 and where classes of exposure C-1, A-1, F-1, S-1, and S-2 apply shall have Extended Curing. For other exposure classifications, concrete mixes that meet the definition of HVSCM-1 or 2 shall have Additional Curing.
  - $HVSCM-1 = FA/40 + S/45 > 1.00$
  - $HVSCM-2 = FA/30 + S/35 > 1.00$where FA = fly ash (Type F, CI1, or CH content of the concrete (% mass of total cementing materials) and S = slag content of the concrete (% mass of total cementing materials)
  - Additional Curing = 7 days at > 10°C for a time necessary to attain 70% of the specified strength. When using silica fume concrete, additional curing procedures shall be used. See Standard.
  - Extended Curing = a wet-curing period of 7 days. The curing types allowed are ponding, continuous sprinkling, absorptive mat, or fabric kept continuously wet.
- .6 Contractor shall obtain the approval of the Owner for proposed means of monitoring concrete curing conditions. Contractor shall be responsible for confirming completion of curing.
- .7 Protect all concrete in accordance with CSA A23.1, the concrete supplier's requirements, and as specified herein to prevent freshly deposited concrete from freezing, being exposed to abnormally high temperatures or temperature differentials, premature drying, and moisture loss for a period of time necessary to develop the specified properties of the concrete.
- .8 Protection of Completed Work
  - .1 At all times during the work, protect exposed concrete, exposed masonry, and other exposed members from staining or becoming coated with concrete leakage due to continuing concreting operations. Members that become coated may be classed as defective by the Consultant.
  - .2 Protect exposed members from staining due to rusting of reinforcement projecting beyond construction joints.

- .3 Take suitable measures to prevent spalling and cracking damage occurring to the structure due to water freezing in expansion joints, small holes, slots, or depressions, and take suitable measures to prevent damage occurring to foundations and the like due to frost action in the soil or backfill.
- .4 Application of de-icing salts on completed work is not permitted.

### 3.8 **SLABS-ON-GRADE**

- .1 Do not place concrete slabs-on-grade until the specified sub-floor material has been placed, inspected, and approved.
- .2 Do not place concrete on a frozen sub-grade, or on one that contains frozen materials.
- .3 Do not place concrete on a sub-grade that has been frozen and thawed until the sub-grade has been reviewed by the geotechnical engineer and approved. If, in the geotechnical engineer's opinion, the bearing capacity of the sub-grade has been compromised, remove the affected materials and replace with compacted granular fill at no additional cost to the Owner.
- .4 Upon approval of the placement of the sub-floor material and setting of reinforcement, place and consolidate concrete, and finish and cure as specified herein.
- .5 Where slab-on-grade is exposed to de-icing chemicals, provide an approved sealant at the joint between the slab-on-grade and abutting surfaces.
- .6 Saw-cut slab-on-grade as shown with a maximum length between saw-cuts of 4.5 m (15' 0"). Arrange panels as shown or to the Consultant's approval.
- .7 Carry out cutting in accordance with recommendations contained in CSA A23.1, but in any event between 6 and 18 hours after placement of concrete.
- .8 After a period of at least 28 days, fill saw-cuts with mortar containing cement, sand, and latex bonding agent. Ensure that joints to be filled are clean, dry, and free of foreign matter.
- .9 Mask edges of saw-cuts as required to prevent concrete floors from becoming stained.
- .10 Construction joints may be provided in slabs-on-grade so that pours on any one day may be kept to reasonable sizes. Locate construction joints to the Consultant's approval.

### 3.9 **TOPPINGS**

- .1 Conform to CSA A23.1 and the requirements noted below unless noted otherwise in the contract documents.
- .2 Set screeds and bulkheads rigidly and accurately to prevent displacement during concreting.
- .3 Special provisions for bonded and unbonded toppings:
  - .1 The maximum pour size for bonded and unbonded toppings is to be limited to 100 sq. m.

- .2 Maintain a one-to-one length-to-width aspect ratio for all pours, where extent and geometry of topping permits.
- .3 Toppings are to be poured in a “checker board” pattern to minimize the effects of shrinkage. Adjacent sections of topping shall be poured no sooner than three days after the adjoining section was poured.
- .4 Ensure temperature of base course is 10°C minimum prior to pouring toppings.
- .5 Provide hot and cold weather protection for toppings in accordance with CSA A23.1.
- .4 Monolithic Toppings
  - .1 Monolithic toppings are constructed by applying a concrete mixture to a “freshly” poured base course that has lost all slump and bleed water prior to its final set. Alternatively, monolithic toppings can be poured with the main base course to a final thickness equal to the thickness of the base course plus the thickness of the topping.
  - .2 Where monolithic toppings are specified, place reinforcement and maintain cover requirements based on the thickness of the base slab only. Provide additional layer of reinforcement in monolithic toppings where noted on the contract documents.
- .5 Bonded Toppings
  - .1 Bonded toppings are constructed by applying the topping mixture over a hardened concrete base to which a bonding agent has been applied. By definition, bonded toppings are designed to bond to the concrete base or an existing concrete surface.
  - .2 Bond strength between topping and base course shall not be less than 1.05 MPa, per CSA A23.1.
  - .3 Base Course Finishing and Preparation
    - .1 Base courses that are to receive bonded toppings are to be finished by one of two methods:
      - .1 rough broom finish (very rough finish – amplitude  $\pm 5$  mm)
      - .2 steel trowel finish
    - .2 When a rough broom finish is provided, the slab surface is to be cleaned by high-pressure water blasting to ensure all laitance, dirt, dust, construction debris, and the like are removed prior to application of the bonding agent. Bonding agent shall be applied in strict accordance with manufacturer’s recommendations.
    - .3 When a steel trowel finish is provided, the slab is to be roughened by means of shot blasting prior to the application of the bonding agent. Ensure all laitance, dirt, dust, construction debris, and the like are removed immediately prior to the application of the bonding agent. Employ all necessary means to control dust and debris during shot blasting.

- .4 Placing and Finishing Toppings
  - .1 Place and finish the toppings in accordance with CSA A23.1.
- .5 Curing
  - .1 Continuously wet cure bonded toppings for a minimum of seven days.
- .6 Jointing
  - .1 Bonded toppings do not require special provisions with respect to jointing provided all the provisions noted above are adhered to.
  - .2 The location of joints in the topping shall match those in the base course.
- .6 Unbonded (Loose Laid) Toppings
  - .1 Unbonded or loose laid toppings are constructed by applying the topping mixture over a bond breaker and hardened concrete base, to which no bonding agent has been applied. By definition, unbonded toppings are specifically designed to not bond to the concrete base.
  - .2 Base Course Finishing and Preparation
    - .1 Base courses that are to receive unbonded or loose laid toppings are to be finished smooth by means of a steel trowel.
  - .3 Placing and Finishing Toppings
    - .1 Place toppings on bond breaker and finish the toppings in accordance with CSA A23.1.
  - .4 Curing
    - .1 Cure unbonded toppings in accordance with CSA A23.1.
  - .5 Jointing
    - .1 Unbonded toppings are to be sawcut, as per the typical detail for slabs on grade, at a maximum spacing of 3.0 m (10 ft.) in both directions, unless noted otherwise. For toppings that are to receive hard architectural floor finishes, the jointing shall be laid out in accordance with the Architect's requirements and is subject to final approval by the Architect.
- .7 All cracks in concrete toppings must be repaired by the Contractor. Extent of repair and method of crack repair must meet the requirements of flooring installation contractor and the Owner.

**3.10 MAKING GOOD**

- .1 Where directed by the Consultant, make good temporary openings left in concrete construction around pipes, ducts, and the like using a mortar of the same proportions as the surrounding work. Reinforce mortar with welded wire fabric where openings exceed 75 mm (3"). Roughen existing surfaces to receive mortar or apply suitable bonding agent such that mortar will be securely bonded to existing concrete.

**3.11 UNSHRINKABLE FILL**

- .1 Unshrinkable fill is intended for use locally in place of granular backfill below slabs-on-grade or within excavations where compaction of granular material is difficult to achieve. It is not intended for use below footings or around foundation walls, tunnels, laterally loaded caissons, etc., where vertical and/or lateral structural bearing capacities are required. Obtain written approval from the Consultant prior to using unshrinkable fill.
- .2 The unshrinkable fill material shall be placed at a slump of between 150 and 200 mm (6" and 8"). The material shall flow into the excavation so that it fills the entire space. Care shall be taken to ensure that no air is entrapped beneath horizontal projections or in other locations within the excavation.
- .3 Where bracing, shoring, and/or sheeting is used to support the sides of the excavation or to prevent movements that could damage other services or adjacent pavements, this support system shall be removed as backfilling proceeds.
- .4 If the excavation is within the travelled portion of the roadway, it shall be covered for at least 24 hours with steel plate of sufficient strength to support traffic during this period. Where road traffic is not to be accommodated, the backfilled excavation shall be covered with wooden planking or other protection for users of the road allowance until the unshrinkable fill will support the weight of an adult person.

**3.12 GROUTING BENEATH BASE PLATES**

- .1 Grout beneath plates bearing on concrete with an approved non-shrink flowable grout. Conform with the manufacturer's directions for mixing and placing grout. Completely fill voids below plates. Fill voids left by shims after shims are removed.
- .2 During cold weather, preheat base plates and footings and maintain temperature at minimum 12°C for 6 days after grouting.

**3.13 MASS CONCRETE**

- .1 Massive pours may set up temperature rises and gradients that may cause severe cracking and in extreme cases, loss of strength.
- .2 Plan and carry out concreting operations, protect and cure the concrete so as to prevent these conditions from occurring.

- .3 Design mix and employ construction procedures in accordance with CSA A23.1 such that the maximum temperature in the concrete and the maximum temperature difference from interior of mass to outside face do not exceed those specified in CSA A23.1. Use insulation or other approved techniques to achieve this.
- .4 Conduct a mat concrete test pour using the proposed mix design and a representative volume of concrete. Arrange for an inspection and testing company to install and monitor thermocouples in both the test pour and the final pour and report the temperature results achieved.
- .5 In addition to the other requirements of this and other related specification sections, adhere to the following:
  - .1 Maximum size of aggregate: 40 mm (1-1/2").
  - .2 Temperature of the concrete at the time of placing: Between 7°C and 20°C (45°F and 68°F).
- .6 Just prior to placing, bring surfaces upon or against which concrete will be placed above the freezing point.
- .7 Provide appropriate insulation and protection to the concrete surfaces for at least seven consecutive days immediately after concrete placement.
- .8 Do not remove insulation and protection until the temperature between average ambient and 75 mm (3") below the top of concrete is 30°C or less. Use a system of thermocouples placed at or below the surface of the concrete to determine concrete temperature.
- .9 Plan the entire concreting operation in advance taking into account rate of pour; size and number of high frequency vibrators; nature, capacity, and location of housing equipment; possible use of a retarder; ability to receive, place, and discharge at the planned rate; along with other considerations. Submit the plan of operation to the Consultant for review in advance, along with the concrete mix.
- .10 Arrange for an inspection and testing company to install and monitor thermocouples in both the test pour and the final pour and report the temperature results achieved.
- .11 Place concrete in maximum 450 mm (1'-6") lifts and thoroughly vibrate each layer and extend vibration into lower layers.
- .12 Advance each layer at least 6 m (20 ft.) before starting next layer.
- .13 Employ necessary procedures to keep temperature differential within concrete to 20°C or less.

**3.14 SLOPING SLABS**

- .1 In the case of sloping slabs, employ suitable concrete placing and consolidation procedures to ensure the completed concrete has the specified design characteristics, and in particular, to prevent movement of plastic concrete resulting in thickness variation, cracking, tearing, loss of bond, etc.

- .2 Upon approval of the placement of the sub-floor material, place and consolidate a uniform thickness of slab on grade concrete to within 40 mm of top. Note 50 mm (2") maximum slump. Coordinate with Section 03 20 00 the immediate placement of reinforcement on top of the first layer of concrete. Place, consolidate, finish, and cure the final 40 mm (1-1/2) thickness of slab to the tolerances specified.

### 3.15 PATCHING

- .1 Honeycombing, exposed reinforcement, and other defects shall be repaired and patched by the Contractor at the Contractor's cost to the satisfaction of the Consultant using a procedure preapproved by the Consultant. Exposed patching must also be accepted by the Consultant.
- .2 Immediately after the removal of forms, all bolts, ties, nails, or other metal not specifically required for construction purposes shall be removed or cut back to a depth of 25 mm (1") from the surface of the concrete.

### 3.16 TOLERANCES

- .1 Tolerances shall conform to the Standard or the requirements on the structural or architectural contract documents, whichever are more rigorous.
- .2 Variations in building lines that result in extension of the building over lot lines or restriction lines will not be permitted.
- .3 These tolerances are acceptable with regard to structural requirements. Interfacing tolerances may not be compatible with the above. Review and coordinate interfacing tolerances so that the various elements come together properly.

### 3.17 FINISHING - FLOORS

- .1 Finishing shall conform to CSA A23.1 - [Section 7.7](#) as a minimum. Care shall be taken during finishing to maintain the cambers specified on the structural drawings. See also the architectural drawings and specifications for additional finish requirements.
- .2 Unless noted otherwise, floor finishes shall be Class A "Conventional slab on grade and elevated floors" with and overall F-number  $F_F = 20$  and  $F_L = 15$

### 3.18 FINISHES - FORMED SURFACES

- .1 All formed surfaces shall be treated in accordance with CSA A23.1, [Section 7.10](#) as a minimum. See also architectural drawings and specifications for additional finish requirements.

### 3.19 OPENINGS THROUGH STRUCTURAL WORK

- .1 If, after any part of the structural work has been completed, it is required that additional openings be made through the structure, the Consultant shall be so informed. No opening, including cored sleeves, shall be made through completed work without authorization in writing from the Consultant.



- .2 Where the location of openings is approved, locate the reinforcement by **x-ray** or other positive means as required by the Consultant and adjust the location of the opening so that no reinforcement is cut unless specifically approved otherwise in writing by the Consultant.
- .3 In the case of precast concrete slabs, holes shall be cut or drilled only by the precast concrete fabricator.

### 3.20 REJECTION OF DEFECTIVE WORK

- .1 In the event that concrete tests do not conform to the requirements of this specification, or when conditions are such to cause doubt about the safety of the structure, testing of the structure will be undertaken at the direction of the Consultant. This may entail further concrete tests, coring, or load testing as per the Standard, or any other test the Consultant deems suitable. Such test shall be made at the expense of the Contractor and to the satisfaction of the Consultant.
- .2 Where, in the opinion of the Consultant, material or workmanship fails to meet the requirements of the specification, such work may be rejected. Work rejected shall be replaced or repaired to the approval of the Consultant and at no additional cost to the Owner.

End of Section

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for masonry work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A1064/A1064-M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
- .2 ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
- .3 CAN/CSA A82, Fired Masonry Brick Made From Clay or Shale.
- .4 CSA A165 Series, CSA Standards on Concrete Masonry Units.
- .5 CSA A179, Mortar and Grout for Unit Masonry.
- .6 CSA A370, Connectors for Masonry.
- .7 CSA A371, Masonry Construction for Buildings.
- .8 CAN/CSA A3001, Cementitious Materials for Use in Concrete.
- .9 CSA G30.18, Carbon Steel Bars for Concrete Reinforcement.
- .10 CSA S304, Design of Masonry Structures.

1.3 **DESIGN REQUIREMENTS**

- .1 Design unit masonry in accordance with following Climatic Design Data for Barrie contained in the Ontario Building Code:
  - .1 Design temperature: January 1%, July 2 1/2%.
  - .2 Hourly wind pressures: one (1) in 50 year occurrence.

1.4 **SUBMITTALS**

- .1 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating.
  - .2 Wall sections and details, reinforcing and anchors, special detailing, patterning and locations of control joints.
  - .3 Seismic anchors, supports and accessories for complete installation.
- .2 Samples:
  - .1 Submit samples in accordance with Section 01 30 00:
  - .2 Submit samples of each type and colour of masonry unit used prior to placing order.
  - .3 Submit samples of coloured mortar to match masonry samples.

- .4 Submit samples of masonry anchors, and ties.
- .5 Submit 250 x 200 mm samples of dampproof course and flashing.
- .3 Quality control submittals: Submit manufacturer's certificates stating that materials supplied are in accordance with this Specification.

## 1.5 **QUALITY ASSURANCE**

- .1 Provide plain and reinforced masonry in accordance with CSA A370, CSA A371, and CSA S304.
- .2 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for unit masonry work:
  - .1 Design of unit masonry work.
  - .2 Design of brick ties and anchors, including requirements necessary to meet seismic requirements.
  - .3 Review, stamp and sign shop drawings.
  - .4 Conduct shop and field inspections and prepare and submit inspection reports.
- .3 Cold Weather Protection:
  - .1 To CAN/CSA-A371 and as follows:
    - .1 Maintain temperature of mortar between 5°C and 50°C until batch is used or becomes stable.
    - .2 Maintain ambient temperature of masonry work and it's constituent materials between 5°C and 50°C and protect site from windchill.
    - .3 Maintain temperature of masonry above 0°C for minimum of three (3) days, after mortar is installed.
    - .4 Preheat unheated wall sections in enclosure for minimum 72 hours above 10°C, before applying mortar.
    - .5 Do not use scorched aggregate. Do not use salts or anti-freezes. Only use approved smokeless heaters.
- .4 Hot Weather Requirements:
  - .1 To CAN/CSA-A371 and as follows:
    - .1 Plan in advance for hot weather construction. Protect freshly laid masonry from drying too rapidly, by means of waterproof, non-staining coverings.
    - .2 Avoid using dry masonry in hot weather conditions. Use predampened masonry unit nominally saturated, but surface dry at time of laying. Do not dip masonry unit in bucket of water.
    - .3 Spread only enough mortar to permit soft setting of masonry units; do not over mix mortar materials; do not retemper mortar after two (2) hours of use; do not retemper pigment coloured mortar; do not spread more than 900 mm (three feet) of mortar for placement of masonry unit.

- .5 Mock-up:
  - .1 Construct one (1) mock-up panel of unit masonry construction, 1200 mm wide x 1200 mm high in a location accepted by Consultant.
  - .2 Demonstrate use of reinforcement, ties, through-wall flashing, weep holes, jointing, coursing, and sills, mortar, bonding, control joints, and workmanship.
  - .3 Mock-up may form part of Work if accepted by Consultant. Mock-ups which do not form part of Work are to be removed from Site during final cleanup, or when directed by Consultant.
  - .4 Rejected mock-ups: Correct rejected mock-ups and requested re-review by Consultant.

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

- .1 Deliver, store and handle Products in accordance with the Conditions of the Contract and as specified herein.
- .2 Remove unacceptable materials from Site and replace to acceptance of Consultant. Store materials off ground protected from wetting by rain, snow or ground water, or inter-mixture with earth or other materials. Store metal ties and reinforcement to prevent corrosion.
- .3 Do not concentrate storage of materials on any part of structure beyond design load, take particular care not to overload unsupported portions of structure which may have not attained their full design strength.
- .4 Comply with CSA A371. Do not use salt or calcium-chloride to remove ice from masonry surfaces.
- .5 Deliver mortar materials in original unbroken and undamaged packages with the maker's name and brand distinctly marked thereon. Prevent damage to units.
- .6 Keep masonry materials free from ice and frost. Keep units protected from concrete, mortar and other materials which could cause staining.

## 2 Products

### 2.1 **MASONRY UNITS**

- .1 Brick cladding (BR-#): CAN/CSA A82, Type X, Grade EG, metric jumbo, size, colour and pattern to be selected by Consultant.
  - .1 (BR-1): 79 x 257 x 90 mm, 'Canada Collection - Trinity' by Canada Brick or approved equivalent.
  - .2 (BR-2): 79 x 257 x 90 mm, 'Canada Collection - Vanier' by Canada Brick or approved equivalent.
  - .3 Provide BR-1 layout to be a mix of BR-1 Trinity (70%) and BR-2 Vanier (30%) as shown on Drawings.

- .2 Concrete block units: Lightweight units for use at all fire rated applications and block exposed to view, CSA A165 Series, 200 mm thick unless otherwise indicated on Contract Drawing, classifications as follows:
  - .1 H/15/D/M.
  - .2 SS/15/D/M.
  - .3 SF/15/D/M.
- .3 Concrete block units: Normalweight units for all non-fire rated applications and where concealed, CSA A165 Series, 250 mm thick unless otherwise indicated on Contract Drawing, classifications as follows:
  - .1 H/15/A/M.
  - .2 SS/15/A/M.
  - .3 SF/15/A/M.
- .4 Precast concrete sills and shapes: Reinforced and constructed of 27.5 MPa concrete with slopes in direction indicated. Provide drips. Dowel and hook anchors to be stainless steel. Finish: Smooth unless otherwise indicated.
- .5 Special shapes:
  - .1 Unless indicated otherwise, supply and install corner returns, bull-nosed or double bull-nosed units for exposed and external corners, bond beams, sash blocks for control joints, concrete block lintels over openings in concrete block walls and any additional special shapes as indicated.
  - .2 Provide solid masonry units where required for mechanically fastening of blocking, furring, mechanically applied finishes or where noted.
- .6 Obtain each masonry unit type from same manufacturer. Supply and install units of uniform texture and colour for each kind required.
- .7 Supply masonry units with exposed surfaces free of cracks, chips, blemishes, and broken corners.

## 2.2 ACCESSORIES

- .1 Reinforcement: CSA A370, CSA A371, and ASTM A1064/A1064-M, all components to be hot dip galvanized unless otherwise specified:
  - .1 This specification is based on products manufactured by Blok-Lok Limited. Products by Dur-O-Wal Ltd. and Fero Corporation are approved equivalent or other approved equal.
  - .2 Type 1 (single wythe): Truss type; 'Blok-Trus BL30' or approved equal.
  - .3 Type 2 (double wythe): Truss type; 'Blok-Trus BL32' or approved equal.
  - .4 Type 3 (cavity wall block back-up): Adjustable, bayonet-tie type, 1.6 mm steel plate with 4.76 mm diameter steel wire tie. 'Adjustable Veneer Anchors BL507' or approved equal.
  - .5 Type 4 (cavity wall stud back-up): Anchors fabricated from 1.5 mm plate with 4.76 mm wire, complete with screws; 'Adjustable Veneer Anchors BL607' with 'Flex-O-Lok tie' or approved equal.
  - .6 Connectors: CSA A370 and CSA S304.1.
  - .7 Reinforcing steel: CSA G30.18, Grade 400, refer to Contract Drawings for number, size, and location.

- .8 Corner reinforcing: Provide pre-manufactured 'L' and 'T' reinforcing at all corner units. Crimped metal strap ties are not acceptable for connecting intersecting walls.
- .9 Design of anchors, supports and accessories to meet seismic requirements.
- .2 Cavity wall insulation: In accordance with Section 07 21 00 .
- .3 Loose steel lintels and lateral support angles: Supplied as part of work of Section 05 50 00.
- .4 Precast concrete shapes: Fabricate to shapes and sizes shown on drawings, 35 MPa concrete in accordance with CSA A23.4, galvanized steel reinforced. Dowel and hook anchors to be stainless steel.
- .5 Dampproof course:
  - .1 Metal flashing: Prefinished metal angle flashing in accordance with Section 07 62 00, continuous strips with a 19 mm folded drip edge.
  - .2 Rubberized underlay: Adhered reinforced SBS rubberized asphalt damproof flashing over prefinished metal flashing and cut off flush with wall face as detailed on drawings; 'Blueskin TWF' by Henry or 'Airshield Thru Wall Flashing' by W.R. Meadows or approved equivalent, complete with primer and adhesive recommended by flashing manufacturer.
- .6 Control joint bond breaker: CSA A123.3; 15 lb, asphalt impregnated, non-perforated felt paper as manufactured by IKO Manufacturing Inc. or approved equivalent.
- .7 Mortar mesh: 250 mm high x thickness to suit cavity, 90% open HDPE mesh; 'Mortar Trap' by Blok-Lok Limited or 'Mortar Net' by Hohmann & Barnard, Inc or approved equivalent.
- .8 Weep hole vents:
  - .1 Flexible ultra-violet resistant polypropylene-copolymer plastic, 'Cell-Vent' by Blok-Lok, 'Mortar Maze Cell Vents' by Advanced Building Products Inc. or approved equivalent.
  - .2 Provide manufacturer recommended clear silicone adhesive for suspended applications.
  - .3 Colour: To be selected by the Consultant.

## 2.3 **MORTAR MATERIALS**

- .1 Loadbearing masonry: CSA A179, Type S, proportion method.
- .2 Interior non-loadbearing masonry: CSA A179, Type N, proportion method.
- .3 Exterior non-loadbearing masonry: CSA A179, Premixed 1-1-6 Type N, portland cement/lime, proportion method.
- .4 Cement: CAN/CSA A3001, normal Portland, Type GU. Provide white cement where required for white or light coloured mortars.

- .5 Masonry aggregate: CSA A179. Provide white aggregate where required for white or light coloured mortars.
- .6 Hydrated lime: ASTM C207, Type S.
- .7 Water: Clean potable, free from deleterious elements and free from salts that can cause efflorescence.
- .8 Concrete fill and grout: Minimum 12.5 Mpa concrete in accordance with CSA A179.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 PROTECTION

- .1 Supply and install temporary waterproof, non-staining coverings, secured against displacement, to extend over walls and down sides to protect masonry Work from snow and wind driven rain, and from drying too quickly, until masonry work is completed and protected by flashings or other permanent construction.
- .2 Supply and install non-staining, protective coverings on horizontal and vertical surfaces to protect work of this Section from damage, staining, marking, and mortar droppings.

#### 3.3 WORKMANSHIP

- .1 Perform masonry work in accordance with CSA A371 and as indicated .
- .2 Supply and install masonry work plumb, level and true to line, with vertical joints in alignment and horizontal courses level, uniform, and straight.

#### 3.4 MASONRY - GENERAL INSTALLATION

- .1 Construct masonry work as required by jurisdictional authorities.
- .2 Before commencing masonry work, verify required limitations for wall heights, wall thicknesses, openings, bond, anchorage, lateral support, and compressive strengths of masonry units and mortars.
- .3 Construct masonry fire protection and fire separations of the thickness indicated on Drawings for the fire resistant ratings as noted on Drawings, and conforming to the Fire-Performance Ratings, Appendix 'D' to the National Building Code of Canada.

- .4 Fire Separations and Fire Separations with Fire Resistance Ratings: Construct walls tightly to construction above and at perimeter, and without openings or voids. Do not reduce the thickness of walls to less than the thickness indicated on the Drawings or for the required fire resistance rating where required.
- .5 Do not butter corner units, throw mortar droppings into joints, or excessively furrow bed joints. Do not shift or tap units after mortar has taken initial set. If adjustment is necessary after mortar has started to set, remove and replace with fresh mortar.
- .6 Do not use admixtures without Consultant's written acceptance.
- .7 Tool mortar joints slightly concave with non-staining tools unless indicated otherwise. Strike joints flush in non exposed areas or where shown on Contract Drawings. Use sufficient force to press mortar tight against masonry units on both sides of joints. Remove excess, remaining mortar material and burrs.
- .8 Install masonry walls 25 mm clear of underside of steel building frames, roof or floor deck. Install masonry with a 19 mm space beneath shelf angles and install compressible filler.
- .9 Cut masonry units with a wet saw to obtain straight, clean, even, unchipped edges. Cut units as required to fit adjoining work neatly or for flush mounted electrical outlets, grilles, pipes, conduit, leaving three (3) mm maximum clearance. Use full-size units without cutting wherever possible.
- .10 Reinforce veneer walls with adjustable wall reinforcing at maximum 400 mm o.c. vertically and 600 mm o.c. horizontally. Install reinforcing in accordance with manufacturer's instructions. In veneer walls extend reinforcement from support wall, spanning cavity into exterior wythe. Place at maximum 75 mm o.c. each way around perimeter of openings, within 300 mm of openings.
- .11 Reinforce block walls with continuous wire reinforcement in every second block course. Supply and install prefabricated L and T sections. Cut, bend and lap reinforcing units as per manufacturer's printed directions for continuity at returns, offsets, pipe enclosures, and other special conditions. Bending of masonry reinforcement is not permitted.
- .12 Reinforce masonry walls with reinforcing steel as indicated on Drawings. Vertical reinforcing shall be fully grouted in masonry cores with grout.
- .13 At openings in block walls install extra reinforcement, so that first and second courses above and below openings are reinforced. Extend extra reinforcement 600 mm beyond opening in each direction.
- .14 Reinforce joint corners and intersections with strap anchors 400 mm o.c.
- .15 Do not place reinforcement across masonry wythes at control joints.
- .16 Install masonry with ten (10) mm thick joints unless indicated otherwise. Make vertical and horizontal joints equal and of uniform thickness.



- .17 Build control joints in masonry walls at intervals and in locations shown. Form joints for block walls using sash block units in accordance with details shown. Form joints for veneer walls by leaving head joints between stacked units void of mortar. Provide chase and joint with joint bond breaker full height of control joints and fill with mortar. Leave a depth of 13 mm for sealing unless otherwise shown.
- .18 Install control joints in masonry walls where indicated on drawings and at projections and changes in direction. Where control joints have not been indicated provide joints at 6100 mm o.c. for exterior walls and 9150 mm o.c. for interior walls.
- .19 If required, provide movement joints, similar to building control joints, installed between areas with different support conditions.
- .20 Supply and install solid block or metal lath under block, and fill block cells solid for lintel bearing and as required to secure built-in anchor bolts and/or anchors shown.
- .21 Do not tooth intersections of walls except as otherwise indicated.
- .22 Install weep hole vents in accordance with manufacturer's directions, in exterior wythe of masonry above dampproof courses and flashings and at tops of walls using adhesive. Space weep hole vents maximum 600 mm o.c. horizontally. Prevent weep hole vents from becoming plugged with mortar or debris.
- .23 Coordinate installation of masonry with installation of air barrier and vapour retarder to ensure continuity of these systems.
- .24 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

### 3.5 **DAMPPROOF COURSES AND FLASHING**

- .1 Install dampproof courses beneath first masonry bearing course on slabs-on-grade. Trim dampproofing to conceal it.
- .2 Install flashings in masonry in accordance with CSA A371.
- .3 Install flashings under exterior masonry bearing on foundation walls, slabs, shelf angles, and steel angles over openings and elsewhere as indicated. Where flashings occur over openings in walls extend them past openings a minimum of 200 mm and turn up minimum 150 mm at each end to create a waterproof dam to prevent water draining into cavity.
- .4 In veneer walls install flashings continuously from front edge of masonry, under outer wythe, turn up backing minimum 200 mm and provide watertight seal against support wall.
- .5 Lap dampproofing and flashing 150 mm and seal in accordance with manufacturer's instructions.

- .6 At bottom of cavity install mortar mesh to manufacturer's instructions. Apply additional mortar mesh layer as required to fill cavity thickness. Place mesh in continuous layer.
- .7 Before masonry work begins, place specified dampproofing under first course of masonry. Install continuous dampproofing with ends lapped and cut flush with exterior face of wall. Place similar dampproofing over top course.

### 3.6 **MORTAR MIXING**

- .1 Thoroughly mix mortar ingredients in proper quantities needed for immediate use to requirements of CSA A179.
- .2 Measure and batch mortar materials either by volume or weight, to accurately control and maintain proportions. Do not measure materials by shovel.
- .3 Mix mortar with maximum amount of water consistent with workability for maximum tensile bond strength within capacity of mortar.
- .4 Do not use mortar which has begun to set. Use mortar within two (2) hours after initial mixing. Re-temper mortar during two (2) hour period only as required to restore workability.

### 3.7 **BLOCK**

- .1 Lay blocks in running bond except as indicated otherwise. Align block webs vertically and install thicker ends of face shells up.
- .2 Install a full bed of mortar for first courses of masonry, for masonry units 100 mm thick and less, and between solid units. For remaining courses bed face shells, including vertical end joints, fully in mortar.
- .3 Install special shaped and sized concrete block units as indicated and as required for a complete and coordinated assembly and to minimize cut units.
- .4 Supply and install two courses of solid block beneath lintel bearing.
- .5 Stagger end joints in every course. Align joints plumb over each other in every other course.
- .6 Bond intersecting block walls in alternate courses. Where block work abuts concrete, anchor each block course to concrete.

### 3.8 **MASONRY VENEER**

- .1 Prior to installation of masonry veneer, coordinate installation of air and vapour retarder with Section 07 26 00.
- .2 Prior to installation of cavity insulation, examine air and vapour retarder and make good damage. Install cavity wall insulation in accordance with Section 07 21 00 .

- .3 Lay masonry veneer in running bond, unless indicated otherwise, and in a full bed of mortar.
- .4 Form angle corners with special shaped units; cutting of units is not permitted.
- .5 Erect exterior cavity wall construction as shown on Contract Drawings.
- .6 Install masonry veneer to prevent mortar droppings and protrusions from impeding drainage and pressure equalization of rainscreen cavities and drained walls.
- .7 Apply sufficient mortar on end of stretchers to ensure end joints are compressed full when masonry unit is pressed into place.

### 3.9 **PRECAST SHAPES**

- .1 Install dampproofing or flashings continuous under full length of precast shapes.
- .2 Install precast shapes in full mortar bed and secure units to each other with stainless steel dowels and to masonry units with stainless steel hook anchors, fully grouted.

### 3.10 **LINTELS**

- .1 Install concrete block lintels over openings in masonry except where steel lintels are indicated.
- .2 Set lintels with minimum of 200 mm uniformly distributed bearing at each end. Provide bond breaker under bearing ends.
- .3 Install reinforcing steel and concrete fill in block lintels.
- .4 Install loose steel lintels, as indicated in Contract Drawings. Centre over opening width.

### 3.11 **LATERAL SUPPORT ANGLES**

- .1 Where non load bearing unit masonry partitions meet structural elements at top of partitions, install supplied lateral supports as required by the Ontario Building Code and in accordance with Structural details. In areas where ceilings are scheduled, use 150 mm lengths of steel angle located each side of partition at 1200 mm and staggered.

### 3.12 **BUILT-IN ITEMS**

- .1 Coordinate and locate build-in items required to be built into masonry or supplied under work of other Sections including hollow metal doors, windows, lintels, sleeves, inserts, etc. Build-in items to present a neat, rigid, true and plumb installation.
- .2 Build wall openings, slots, and recesses required for ducts, grilles, pipes and other items.

- .3 Coordinate installation of conduit, outlet boxes and other mechanical and electrical built-ins with work of Divisions 21, 22, 23 and 26.
- .4 Prevent displacement of built-in items during construction. Check plumb, location and alignment frequently, as Work progresses.
- .5 Brace door jambs to maintain plumbness. Set anchors between metal frames and masonry and fill voids between hollow metal frames and masonry walls with mortar.

### 3.13 **INSTALLATION TOLERANCES**

- .1 Install masonry work to a plane flatness and exposed end tolerance of three (3) mm in 3000 mm.
- .2 Variation in Alignment from Unit to Adjacent Unit: 1.5 mm maximum.
- .3 Plumb within six (6) mm in three (3) m, or in six (6) mm in six (6) m at external corners, expansion joints, or other conspicuous lines.
- .4 Level within six (6) mm in any bay or 6 m maximum distance, and 12 mm in 12 m or more.
- .5 Located from position shown, and from related position of columns, walls, and partitions within 12 mm in any bay or six (6) m maximum distance, and 19 mm in 12 m or more.
- .6 Opening sizes within six (6) mm of designated dimension.
- .7 Column and wall cross-section dimensions within minus six (6) mm and plus 12 mm.
- .8 Joint widths to dimensions indicated or specified herein, but in no case greater than 12 mm. Variation of Mortar Joint Thickness: One (1) mm every metre.

### 3.14 **REPAIR AND POINTING**

- .1 Remove and replace masonry units which are loose, chipped, broken, cracked, marked, stained, discoloured, or otherwise damaged. Supply and install new units to match adjoining units and install in fresh mortar, and point to eliminate evidence of replacement.
- .2 During tooling of joints, enlarge any cracks, holes, or other defects, point and completely fill with mortar.
- .3 Point-up joints including corners, openings and adjacent Work for a neat, uniform appearance, properly prepared for application of sealant compounds.

### 3.15 **CLEANING**

- .1 Obtain and follow unit masonry manufacturer's written instructions for cleaning of masonry.

- .2 Clean exposed, masonry surfaces, removing excess mortar as work progresses.  
Allow mortar droppings to partially dry then dry brush with a stiff fibre brush.
- .3 Cleaning of stone work:
  - .1 Protect adjacent surfaces and other work from damage.
  - .2 Remove large particles with stiff fibre brushes without damaging surface.  
Saturate masonry with clean water and flush off loose mortar and dirt.
  - .3 Scrub with solution of 25 mL trisodium phosphate and 25 mL household detergent dissolved in one (1) L of clean water using stiff fibre brushes, then clean off immediately with clean water using hose.
  - .4 Repeat cleaning process as often as necessary to remove mortar and other stains.

END OF SECTION

1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical drawings.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide all labour, materials, equipment, access, cooperation, coordination, and services to allow the testing of structural steel, open web steel joists, structural steel deck, and welds to be carried out by a Testing Agency.
- .2 The scope of the required quality assurance testing is described in this section to inform the Contractor of the type and scope of testing on the project and to allow the Contractor to make appropriate allowances.
- .3 Testing required by the Contractor for the Contractor's own quality control or as noted in clause **Error! Reference source not found.** will be paid for by the Contractor.

1.3 **RELATED WORK SPECIFIED ELSEWHERE**

- .1 Section 05 12 00 – Structural Steel Framing
- .2 Section 05 31 00 – Steel Decking
- .3 Section 05 50 00 – Metal Fabrications
- .4 Section 05 51 00 – Metal Stairs

1.4 **REFERENCE STANDARDS**

- .1 Testing of structural steel shall conform to the requirements of the following Building Code and Reference Standards unless otherwise required by this specification:
  - .1 Building Code
    - .1 Ontario Building Code - 2012 O REG 88/19
  - .2 Reference Standards
    - .1 CSA S16 – Limit States Design of Steel Structures
    - .2 CSA W178.1 – Certification of Welding Inspection Organizations
    - .3 CSA W59 – Welded Steel Construction (Metal Arc Welding)
    - .4 CSA W47.1 – Certification of Companies for Fusion Welding of Steel Structures
    - .5 CSA G40.20 – General Requirements for Rolled or Welded Structural Quality Steel

- .6 CSA G40.21 – Structural Quality Steel
- .7 CSA S136 – North American Specification for the Design of Cold-Formed Steel Structural Members
- .8 ASTM A6/A6M – Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
- .9 CSSBI 10M – Standard for Steel Roof Deck
- .10 CSSBI 12M – Standard for Composite Steel Deck
- .11 RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts
- .12 SDI Manual of Steel Construction with Steel Deck
- .13 ASTM A653/A653M – Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .3 Galvanizing
  - .1 ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products
  - .2 ASTM A143/A143M – Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
  - .3 ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
  - .4 ASTM A384/A384M – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
  - .5 ASTM A385/A385M – Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
  - .6 ASTM E376 – Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods
  - .7 ASTM A780/A780M – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- .2 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .3 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .4 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.
- 1.5 **DEFINITIONS - FOR THIS SECTION**
  - .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
  - .2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd.

- .3 "Testing Agency" shall mean a third party testing and inspection agency.
- .4 "Non-Destructive Testing" shall mean liquid penetrant (LP), magnetic particle (MP), ultrasonic (UT), or radiographic testing (RT) as determined appropriate by the Testing Agency.
- .5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

#### 1.6 APPOINTMENT OF TESTING AGENCY

- .1 A CSA-Approved Testing Agency (approved under W178.1 - Building Category) shall be appointed to test the structural steel and connections in accordance with Part 3.0
- .2 Unless stated otherwise in Division 0 / Division 1 the Testing Agency shall be engaged by the Owner.
- .3 The Contractor shall pay for testing not covered in clause **Error! Reference source not found.**, which shall include but not be limited to:
  - .1 Testing of pre-approved connections not on the structural drawings and required by the Contractor for ease of fabrication, transportation, or erection.
  - .2 Any additional costs due to overtime, shift work, and holiday or weekend work required to meet the schedule.
  - .3 Costs for retesting or additional testing due to work having failed to meet the specified requirements.
  - .4 Non-destructive testing will be performed on samples of the work as outlined in Article 3.4 of the specification. Any repair and re-testing shall be done at the Contractor's expense.
  - .5 Deficiencies in work will trigger required additional testing.

#### 2.0 Duties

##### 2.1 RESPONSIBILITY OF THE CONTRACTOR

- .1 The Contractor shall cooperate fully with the Testing Agency. Allow free access to all parts of the work for the purpose of testing and review at all times.
- .2 Notify the Testing Agency and Structural Engineer when work is ready for review.
- .3 Prior to commencement of work, provide a schedule of shop fabrication and erection to the Testing Agency and Structural Engineer. Changes in this schedule shall be communicated to these parties in a timely fashion.
- .4 Provide a quantity takeoff of all the members in the project for use in determining the number of members required for testing. This takeoff should also indicate the divisions in which the members are to be fabricated to aid in shop inspection planning.



- .5 Provide mill certificates in accordance with the Standard, properly correlated to the elements being fabricated.
- .6 The contractor shall make available any non-destructive testing reports performed in the shop during fabrication.
- .7 The contractor shall prep all areas requiring NDE to an acceptable level. Preparation shall include, but not be limited to:
  - .1 Ultrasonic Testing (UT) to 300 mm away from the weld by grinding off weld splatter and buffing the area with a wire wheel.
  - .2 Provision of all necessary access platforms or scaffolding to allow for inspections to be carried out.
- .8 The Contractor is solely responsible to provide a finished product that meets the specifications and contract documents. Testing is not carried out for the Contractor's benefit, nor does it make the Structural Engineer or Testing Agency guarantors of the Contractor's work.

## 2.2 **RESPONSIBILITY AND DUTIES OF THE TESTING AGENCY**

- .1 The Testing Agency has the authority to, and is expected to, reject any work not meeting the specifications.
- .2 Identify the number, type, and locations of members, connections, studs, etc. to be tested and coordinate required shop and site visits.
- .3 Review the structural drawings and specifications prior to carrying out the work.
- .4 Provide testing as per the Standards and as per this specification.
- .5 Provide timely test reports to the Structural Engineer, Consultant, and Contractor.

## 3.0 Testing and Inspection

### 3.1 **GENERAL**

- .1 The Structural Engineer may reject at any time during the progress of the work a piece of material or any member which the Structural Engineer may find defective or not in accordance with the detailed drawings. This material may be rejected notwithstanding any previous acceptance, and components so rejected shall be replaced at no expense to the Owner. In case of dispute, the decision of the Structural Engineer shall be final.
- .2 If initial tests indicate that the work failed to meet specification, the Structural Engineer shall decide if any additional testing is necessary. This testing shall be done by the Owner's agency. The proposed additional testing shall have prior approval of the Structural Engineer.
- .3 Non-destructive testing operators shall have a Level II qualification as a minimum.

### 3.2 DOCUMENTS AND MATERIALS

- .1 Confirm that the fabricator and erector are certified to CSA-W47.1 and that all welders are properly qualified.
- .2 Review mill certificates for all types of material used in the project ensure they meet the requirements of 05 12 00 and forward to the Structural Engineer.
- .3 Review approved shop welding procedures.
- .4 Confirm welding consumables provided will meet the levels of strength, notch toughness and quality of the base member and that they are properly stored in shop and field.
- .5 Review bolt storage, handling, and installation procedures including pre-installation verification testing as required depending on the types of bolts or washers to be used.
  - .1 Tension Control (TC) Bolts
    - .1 Pre-installation verification must be carried out in accordance with CSA S16 to ensure that the bolts will function as intended.
  - .2 Direct Tension Indicator (DTI) Washers
    - .1 Review fabricator installation procedures.
    - .2 General review for damage to washers prior to installation.
- .6 Review all available non-destructive testing reports performed by the contractor.
- .7 Where more than one type of paint is specified, ensure that the colour of each coat of paint differs so that they can be visually identified after applications.
- .8 Obtain invoices and product data from the steel supplier for the purchase of the specified primers and paints required for the project. Circulate these documents to both the Structural and Architectural consultants.

### 3.3 VISUAL TESTING (VT) OF MEMBERS AND CONNECTIONS (WELDED OR BOLTED)

- .1 Perform visual testing of the structural components, framing and connections through a combination of shop and field visits to meet the requirements below.

Structural Framing	Total Project Minimum Sampling
Columns & Base Plates	15%
Bracing	15%
Beams & Joists (Infill members supporting roof / floor)	10%
Girders (Supporting Infill Members)	30%
Trusses & Joist Girders	50%
Moment Connections (By Member Weight)	50%
Splices	100%

Section Reinforcement & Stiffeners	30%
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- .2 The Visual Testing (VT) requirements above shall include but not be limited to verifying:
- .1 Grade markings on structural steel in fabricator's plant prior to fabrication.
  - .2 Dimensions, including cross-section, in relation to the specified members (in-house plant QC may be relied upon to perform this task assuming the testing agency is satisfied with the level of QC being carried out).
  - .3 Locations of all holes, cuts, fittings, and milling of member ends.
  - .4 Tolerances of joint preparation and fit up (bevel angle, etc.) to be in accordance with CSA S16.1, clause 28.5 Joints in Contact Bearing.
  - .5 Preheat and interpass temperatures based on the approved welding procedures.
  - .6 Snug tight bolted connections are properly compacted and brought to the snug tight condition progressing outward from the most rigid part.
  - .7 Specified beam and / or truss camber and that the cambering procedure does not reduce the member capacity.
  - .8 Erection tolerances meet the tolerances of CSA S16.
  - .9 Joist and truss erection tolerances meet CSA S16 requirements, and report twisting, sweeping, and local damage.
  - .10 Adequate joist bearing on supporting structure as detailed in the drawings.
  - .11 All truss permanent top and bottom chord bridging and end connections are complete.
  - .12 The number of headed studs per beam and that stud placement is properly offset towards the closest beam support within composite deck flutes as per the typical details.
  - .13 All steel surface preparation prior to priming and / or painting is in conformance with the requirements of the Structural and Architectural specifications.
  - .14 All steel that is exposed or in unconditioned spaces, such as canopies, parapet walls, steel lintels, shelf angles, etc., are galvanized and or painted in accordance with the contract documents.
- .3 Any defects noted during the Visual Testing (VT) work shall be reviewed using appropriate comprehensive Non-Destructive Evaluation (NDE), which shall be in addition to the requirements in clause 3.5.

**3.4 COMPREHENSIVE NDE TESTING OF CONNECTIONS (WELDED OR BOLTED)**

- .1 Perform testing of the connections through a combination of shop and field visits to meet the sampling required in Tables 1 and 2.

- .2 The requirements of Table 1 and 2 shall include but not be limited to verifying:
  - .1 At least one type of unique connection shall be tested irrespective of the sampling requirements.
  - .2 Bolt types conform to the drawings and specifications prior to start of bolting operations and that any pre-installation verification has been completed.
  - .3 All bolted connections shall be tested in accordance with CSA S16 with a minimum of two bolts tested for each pre-tensioned connection.
  - .4 For all bolted connections that are indicated as pre-tensioned or slip critical, pre-installation verification testing is performed by the inspector in cooperation with the Contractor.
  - .5 For bolted connections indicated as pre-tensioned or slip critical, the Testing Agency shall be present during installation with sufficient frequency to ensure that the pre-tensioning methods of RCSC 8.2.1, 8.2.3, or 8.2.4, as appropriate, are performed.
  - .6 When the overall length of a weld is less than 900 mm, the entire length shall be tested.
  - .7 Splices not shown on the structural drawings shall be 100% ultrasonically tested (UT) at the Contractor's expense.
- .3 Post-installation review of bolts using the following techniques:
  - .1 Conventional bolts
    - .1 Turn of the nut method marked on the washer and bolt head or calibrated torque wrench.
  - .2 Tension Control (TC) Bolts
    - .1 Post-installation should be carried out to ensure that the bolt tip is sheared off at the tension control point.
  - .3 Direct Tension Indicator (DTI) Washers
    - .1 A post-installation review shall be carried out to ensure even bearing of the connection and no obstructions are present that would cause uneven pressure to be applied to the DTI.

### 3.5 TESTING OF STEEL DECK

- .1 Provide visual testing (VT) of the steel deck gauge and connections to meet the requirements below.

Deck Type (Composite / Non-Composite)	Comments (Deck Gauge)	Individual Item Sample Size	
		Material Thickness	Connections
Non-Composite	22 Gauge	10%	30%

Deck Type (Composite / Non-Composite)	Comments (Deck Gauge)	Individual Item Sample Size	
		Material Thickness	Connections
Non-Composite	20 Gauge	10%	40%
Non-Composite	t > 20 Gauge	10%	50%
Composite	t ≤ 20 Gauge	10%	30%
Composite	t > 20 Gauge	10%	40%

- .2 Sampling of deck connections shall be done in a representative fashion to ensure equal distribution between support, seam, and edge connections.
- .3 The Visual Testing (VT) requirements above shall include but not be limited to verifying:
  - .1 The types of connections (welds) or fasteners (mechanical) and verify they meet what has been specified in the engineering drawings.
  - .2 That the welds align with the supporting structure below and proper fusion has been achieved.
  - .3 Verify that all localized deck supports have been provided at discontinuous deck ends that do not bear on structure due to framing interruptions.
  - .4 Verify the deck galvanizing as per the specifications by taking random zinc thickness measurements of 10% of supplied galvanized deck. Ensure that the areas where testing has taken place are touched up with zinc rich paint.
- .4 If the Testing Agency determines that the quality of the welds appear deficient, they shall request a weld quality control test in accordance with the SDI Manual of Steel Construction with Steel Deck. The Structural Engineer shall be immediately notified of this requirement and may request to be present at the time of the test.

### 3.6 TESTING OF HEADED STUDS AND DEFORMED BAR ANCHORS

- .1 Reinforcing bars (Rebar) butt welded to plates shall be testing as per this section, and shall be weldable grade (W) reinforcing.
- .2 Any welding of rebar shall be carried out by a welder with the appropriate qualifications.
- .3 Qualification Testing is required on a sample specimen with materials representative of the conditions used in construction prior to performing any stud welding on the project in accordance with CSA W59, Cl 6.3.
- .4 The contractor shall be responsible for the performance of qualification testing to establish a proper weld procedure. A written procedure based on this testing shall be submitted to the testing and inspection company for review and acceptance prior to the commencement of work.
- .5 Preproduction Testing: Before production welding with a particular set-up and with a given size and type of stud, and at the beginning of each day or shift's production, testing shall be performed on the first two studs that are welded. Testing requirements shall be conducted as per CSA W59 Cl 6.5.

Perform Visual Testing (VT) of the studs and anchors through a combination of shop and field visits to meet the requirements below.

Structural Framing	Minimum Total % Connection Testing
Beams & Joists	17.5%
Girders & Joist Girders	37.5%

.6 The Visual Testing requirements above shall include but not be limited to verifying:

- .1 Inspect number of studs per beam
- .2 Verifying stud placement in the deck cell is located closest to the nearest end of the beam.

Studs and anchors shall be tested by bending to an angle of 30° towards the direction of the nearest end of the member. The testing shall be completed through a combination of shop and field visits to meet the requirements below.

Structural Framing	Minimum Total % Connection Testing
Beams & Joists	1.10%
Girders & Joist Girders	1.70%

Perform destructive testing of studs and anchors through a combination of shop and field visits to meet the requirements below

Structural Framing	Minimum Total % Connection Testing
Beams & Joists	0.40%
Girders & Joist Girders	0.55%

.7 The bend (3.7.9) and destructive (3.7.11) testing shall be subject to the following additional requirements.

- .1 Studs testing to destruction shall be replaced by the contractor and retested.
- .2 Failure of the weld of any studs will be cause for rejection of the stud welding and cause for further testing at the Structural Engineer's discretion. This additional testing shall be at the Contractor's expense.
- .3 A 10% or greater failure rate at the welds of the tested studs will be cause for rejection of all studs.
- .4 Replacement of failed or rejected studs shall be at the Contractor's expense.

**TABLE 1: SINGLE PIECE MEMBERS**

Structural Framing	Minimum Total % Connection Testing
Columns & Base Plates	10%
Bracing	10%

Beams & Joists	7.5%
Girders	10%
Moment Connections	10%
Splices	100%
Section Reinforcement & Stiffeners	25%
Seismic Systems	100%

**TABLE 2: MULTI-PIECE MEMBERS**

<b>Structural Framing</b>	<b>Minimum Total % Connection Testing</b>
Trusses & Joist Girders	15%
Built-Up Tension / Compression Members	30%
Built-Up Beams / Girders	30%
Field Reinforcing Work	30%

End of Section

1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical drawings.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide all labour, materials, equipment, and services to supply, design, and erect structural steel required and/or indicated on the drawings or specified herein, including the supply of plates and/or angles for support of masonry, embedded steel parts, headed stud, mechanical couplers; deformed bar anchors, wedge anchors, and epoxy anchors that will form the connection between the structural steel, open web steel joists and masonry or concrete; and reinforcement of steel deck openings. Report any discrepancies between structural, mechanical, electrical, and architectural drawings to the Consultant and Structural Engineer immediately.
- .2 Co-ordinate with Section 03 31 00 – Concrete Framework and Section 03 20 00 – Concrete Reinforcement for the design, supply, installation, and erection of embedded steel parts.
- .3 Co-ordinate with Section 05 21 00 – Open Web Steel Joists for the design, fabrication, supply, installation, and erection of open web steel joists.
- .4 Co-ordinate with Section 05 31 00 – Steel Deck for the design, supply, and installation of headed stud shear connectors for composite beams and girders, and where required on other beams, girders, and drag struts.

1.3 **RELATED WORK SPECIFIED ELSEWHERE**

- .1 Section 03 11 00 – Concrete Forming and Accessories
- .2 Section 03 20 00 – Concrete Reinforcing
- .3 Section 03 31 00 – Structural Cast-in-Place Concrete
- .4 Section 04 20 00 – Unit Masonry
- .5 Section 05 00 50 – Testing of Structural Steel
- .6 Section 05 21 00 – Steel Joist Framing
- .7 Section 05 31 00 – Steel Decking
- .8 Section 05 50 00 – Metal Fabrications
- .9 Section 05 51 00 – Metal Stairs



.10 Section 07 81 00 – Applied Fireproofing

.11 Section 09 91 00 – Painting

#### 1.4 REFERENCE STANDARDS

.1 Structural steel shall conform to the requirements of the following Building Code and Reference Standards unless otherwise required by this specification:

.1 Building Code

.1 Ontario Building Code - 2012 O REG 88/19

.2 Reference Standards

.1 General

.1 CSA S16 – Design of Steel Structures

.2 CSA G40.20 – General Requirements for Rolled or Welded Structural Quality Steel

.3 CSA G40.21 – Structural Quality Steel

.4 ASTM A500/A500M – Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

.5 CSA S136 – North American Specification for the Design of Cold-Formed Steel Structural Members

.6 ASTM A6/A6M – Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling

.7 CISC Code of Standard Practice for Structural Steel

.8 ASTM A992/A992M – Standard Specification for Structural Steel Shapes

.9 ASTM A53 – Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

.10 ASTM F3125/F3125M – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

.11 ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat Treated 120 / 105 ksi Minimum Tensile Strength

.12 ASTM A490 – Standard Specification for Structural Bolts, Alloy Steel, Heat Treated 150 ksi Minimum Tensile Strength

.13 ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

.14 CSA W47.1 – Certification of Companies for Fusion Welding of Steel Structures

- .15 CSA W59 – Welded Steel Construction (Metal Arc Welding) (Metric version)
    - .2 Surface Preparation and Finishes
      - .1 SSPC SP-6 – Commercial Blast Cleaning
      - .2 CSA G189 – Sprayed Metal Coatings for Atmosphere Corrosion Protection.
      - .3 CISC / CPMA Standard 1-73a – A Quick-Drying One-Coat Paint for Use on Structural Steel.
      - .4 Architectural Exposed Structural Steel shall conform to Appendix I of CISC Code of Standard Practice for Structural Steel.
    - .3 Galvanizing
      - .1 CSA G164 – Hot Dip Galvanizing of Irregularly Shaped Articles
      - .2 ASTM A123/A123M – Standard Specification for Zinc (Hot-Dip Galvanizing) Coatings on Iron and Steel Products
      - .3 ASTM A143/A143M – Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
      - .4 ASTM A153/A153M – Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
      - .5 ASTM A384/A384M – Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
      - .6 ASTM A385/A385M – Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
      - .7 ASTM A780/A780M – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
      - .8 CGSB-85-GP-16M – Painting Galvanized Steel
  - .2 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
  - .3 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
  - .4 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.
- 1.5 **DEFINITIONS - FOR THIS SECTION**
- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
  - .2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd., herein also referred to as RJC.

- .3 "Specialty Structural Engineer" is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .4 "Testing Agency" shall mean the testing agency responsible to the Owner.
- .5 "Standard" and "Standards" shall mean the reference standards listed under "Reference Standards" in this section.

#### 1.6 **QUALIFICATIONS**

- .1 Fabricator, erector, and all subcontractors performing structural steel work shall be certified under the requirements of Division 1, or Division 2.1 of W47.1. Fabricator and erector shall have in place a Quality Control Program satisfying the requirements of ISO 9001-2008 or another quality control program that is acceptable to the Consultant. In any case, the Quality Control Program shall satisfy the minimum requirements specified in the contract documents.
- .2 Design calculations shall be carried out by or under the direct supervision of a qualified Specialty Structural Engineer licensed in the Province of Ontario, with a minimum of five years Canadian experience in the design of structural steel work and connections including design of weldments, as appropriate.
- .3 Engineers responsible for welding design, procedures, and practice shall be certified in accordance with CSA W47.1, section 6.1.
- .4 Specialty Structural Engineers responsible for the design of steel work, connections, and the like, shall be insured in accordance with the **Professional Engineers Ontario Act** and shall be covered under a General Liability Insurance Policy in accordance with the Provisions of the Contract.
- .5 Structural steel fabricator shall have not less than **five year(s)** experience in the fabrication of structural steel and hold the CISC Steel Structures Certification under the CISC Quality Certification Program.
- .6 Erector shall not have less than **five year(s)** experience in the erection of structural steel.

#### 1.7 **EXAMINATIONS**

- .1 All dimensions shall be taken from the drawings and verified by field measurement (including verification of interfacing with existing structures). Be responsible for the correctness of such measurements and report to the Consultant and Structural Engineer in writing all discrepancies between measurements in the field and those shown on drawings prior to commencing work. Verify location of anchor rods and embedded steel, and ensure that work prepared by other trades is at a proper elevation, on line, level, and true.

#### 1.8 **SUBMITTALS**

- .1 The Contractor shall submit the following documents:
  - .1 Any documents required as a part of section 1.6 Qualifications
  - .2 Quality Control Program (submitted prior to commencing fabrication)

- .1 Include with the tender documents a copy of fabricator's and erector's standard Quality Control Program.
- .2 Prior to commencement of the work, the Contractor, with the fabricator and erector, shall submit a complete Quality Control Program for this specific project for review by the Consultant. The fabricator and erector shall revise and resubmit the Program if required by the Consultant.
- .3 Qualifications of Fabricator
  - .1 Submit appropriate documentation for the fabricator responsible for the steel work in accordance with Section **Error! Reference source not found.**
- .4 Qualifications of Specialty Structural Engineer (submitted prior to commencing fabrication)
  - .1 Submit appropriate documentation for each Professional Engineer who will be responsible for the steel work; including the erection and design of connections, weldments (qualification of the steel fabricators and erectors for welding under Canadian Welding Bureau requirement and CSA W186), and the like, verifying the minimum qualification requirements outlined in this specification.
- .5 Proof of Insurance for Specialty Structural Engineer (submitted prior to commencing fabrication)
  - .1 Submit proof of adequate insurance coverage for each Professional Engineer who will be responsible for the steel work, connections, and the like, as outlined in this section.
- .6 Fabricator and Erector CWB Welding Qualifications and Procedures (submitted in writing prior to commencing fabrication)
  - .1 Qualification of the steel fabricators and erectors for welding under Canadian Welding Bureau requirements.
  - .2 Description of welding procedures for use on structural steel a minimum one month prior to fabrication or use.
  - .3 Ability to weld reinforcing steel to structural steel in accordance with CSA W186.
- .7 Material Properties Reports (submitted prior to commencing fabrication)
  - .1 Copies of mill test reports properly correlated to the materials used on the project. The Contractor shall also review clause 2.1.1.3 and provide reports as required in order to demonstrate conformance with the chemical content parameters.
  - .2 Manufacturer's literature and certification that shop paint, primer, coatings, and galvanization meets the performance standards specified herein and related specified work elsewhere.

- .8 Testing and Inspection Reports (submitted throughout construction)
  - .1 All non-destructive testing reports, steel testing, and weld testing reports performed in addition to the third party testing.
- .9 Shop and Erection Drawings
  - .1 Submit appropriate documentation for the fabricator responsible for the steel work in accordance with Section **Error! Reference source not found.**

#### 1.9 SHOP AND ERECTION DRAWINGS

- .1 Specialty Structural Engineer(s) responsible for the structural steel work, connections, joint systems, and the like shall either:
  - .1 Seal and sign all necessary shop drawings, or
  - .2 Submit a sealed and signed letter prior to commencement of shop drawing preparation identifying who that fabricator's engineer is that has been retained by the steel fabricator to carry out the design of steel connections, and the like AND shall submit a second letter after shop drawing preparation is complete stating that the design of the steel work, for which they are responsible, has been completed in accordance with the contract documents and relevant building codes, standards and acts. The letter shall identify what was designed by the Professional Engineer(s) and list the final shop drawings by number with dates and revision numbers.
  - .3 If the Professional Engineer(s) choose to seal and sign the shop drawings, as noted above, all shop drawings must be sealed and signed, except for erection diagrams which only contain design information (member sizes, forces, loads and the like) which is shown on the structural drawings. If any field work details, notes to the erector, or notifications are made on the erection diagrams then they must be sealed and signed.
- .2 The structural drawing, any structural models, and electronic files shall not be reproduced in whole or in part, and shall not be used to prepare shop, erection, or setting drawings. Structural models and electronic files may be used by the Contractor under the following conditions:
  - .1 Copyright remains with Read Jones Christoffersen Ltd.
  - .2 The drawings will only be used for shop drawings for this project and not be put to any other use.
  - .3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in the drawings. The Contractor assumes all risk and expenses associated with the use of structural drawings in the production of their work.
  - .4 References to Read Jones Christoffersen Ltd. must be deleted from the title block.
  - .5 The Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.
- .3 Structural drawings shall not be scaled.

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- .4 Submit structural steel connection design details shop, erection, field work details, and setting drawings for review by the Consultant.
  - .5 Connection Design Details:
    - .1 Submit "design" drawings for review summarizing the proposed connection details to be used on the project. These drawings to be prepared by or under supervision of the Specialty Structural Engineer and submitted for review before the start of shop drawing production. These design drawings shall show the complete connection and:
      - .1 How the connection assembly fits with the connected members.
      - .2 Sizes of plates, bolts, welds, etc.
      - .3 Capacities of the connection.
      - .4 Assumed eccentricities, lines of action of forces, etc.
      - .5 Submit calculations bearing the seal and signature of a qualified Specialty Structural Engineer licensed in the Province of **Ontario** for the following connections:
        - .1 Truss connections
        - .2 Hangers
        - .3 Connection where work points are not coincidental
  - .6 Erection Drawings
    - .1 Submit erection drawings for review prior to preparation of detailed shop drawings.
    - .2 Erection drawings shall be included with each submission of detailed shop drawings.
    - .3 Erection drawings shall clearly show all setting out dimensions for the structural steel frame, including dimensions that have been confirmed by site measurement. Dimensions shall be tied into relevant grid lines or reference points wherever possible.
    - .4 Well in advance of erection, submit a detailed sequence of construction method statement including procedures, methods, sequences of erection, erection bracing, shoring and guying requirements, keys assumptions and design considerations during construction and equipment proposed for use in erecting structural steel and bearing the seal and signature of a qualified licensed Specialty Structural Engineer licensed in the Province of **Ontario**.
  - .7 Shop Drawings
    - .1 Submit detailed shop drawings for all structural members that show the details necessary for the fabrication of the component parts of the structure.
    - .2 Shop drawings as a minimum, show the following:
      - .1 layout;
      - .2 member sizes;

- .3 connection details, including member cuts and copes where applicable;
  - .4 bearing details;
  - .5 splice locations and details (splices not shown on the shop drawings will be rejected);
  - .6 truss details;
  - .7 holes;
  - .8 camber;
  - .9 finishes;
  - .10 grade(s) of steel;
  - .11 bolt or threaded fastener material grade, size, and designation;
  - .12 weld type, size, extent, and if shop or field applied with AWS welding symbols as specified in the CSA W59 Appendix D and E;
  - .13 sliding expansion joint bearing pad details, including materials, size, and thickness of pads; setting out dimensions; and load capacity;
  - .14 Architectural clearance lines and finishes where connection and the like may encroach with other work.
- 
- .3 Provide a shop drawing clearly locating all anchor rods, embedded plates, baseplates, etc.
  - .4 Provide setting drawings, templates, and directions for the installation of anchor rods, plates, and other devices.
  - .5 Prior to starting erection work, submit a description of the methods, sequence of erection, and type of equipment proposed for use in erecting structural steel for review of the effects of construction loads on the remainder of the structure.
  - .6 Review of the shop drawings by the Structural Engineer is intended as an assistance to the Contractor and does not relieve the Contractor of their responsibility for the completeness or accuracy of their work and its conformance with the contract documents.
  - .7 Fabrication that commences prior to shop drawing review by the Structural Engineer is at the risk of the Contractor.
  - .8 Clearly identify on the shop drawing all revisions, changes, or modifications.
  - .9 Resubmit reviewed shop drawings where noted in the Read Jones Christoffersen Ltd.'s review stamp, or when the Contractor makes revisions for their own purposes.
  - .10 The Contractor shall perform and submit a complete survey, before steel erection commences, of position and alignment at all points where construction by other trades will support steel elements, including but not limited to pockets, embedded plates, anchor rods, rebar, and base plates. Include plan location positions relative to the building gridlines, and elevations of bearing surfaces and tops of bolts/rods relative to building Datum elevation.

- .11 The Contractor shall submit a steel erection procedure prepared by Contractor's Specialty Engineer. Procedure to include any loading and temporary connections to base building structure. Refer to temporary works on General Notes for more information. No deviation from the approved procedure will be permitted without prior written approval by the Specialty Engineer and review by RJC.
  - .12 The Contractor shall complete and submit a comprehensive survey of the as-constructed steel structure at each level adequate to assess if the structure has been built within specified tolerances. Surveys are to be submitted to the Contractor's Specialty Engineer for approval. If deviations from tolerances are found, Contractor to propose corrective measures to RJC for approval.
  - .13 Allow at least two weeks (10 working days) for shop drawing review by the Structural Engineer.
- .8 Field Work Details
- .1 Submit details for all field work in accordance with the requirements of Division 1.
  - .2 The location of field work details shall be clearly identified or referenced on the erection drawings.
  - .3 Prepare setting drawings showing dimensions and details for setting structural steel bearings, anchorages, assemblies and the like where they interface with other building components and support the work of this section.
  - .4 The steel contractor shall incorporate other trade's work as directed by the Construction Manager.
  - .5 Submit all non-prequalified welding procedures, stamped as approved by the Canadian Welding Bureau and correlated to the appropriate shop and erection drawings.
  - .6 Submit details of methods proposed to achieve and verify the specified tension to bracing members within the specified tolerance.
  - .7 Furnish Inspection Company with a copy of each shop, erection, and setting drawing bearing the Consultant's shop drawing stamp marked reviewed.

**1.10 SUPPLY OF ALTERNATE PRODUCTS**

- .1 Should the rolled sections or any other structural steel element shown on the drawings not be available or procurable, or should substitution for those sections be desired, sections of equivalent or greater mechanical properties (strength, stiffness, etc.) may be substituted if approved.

**1.11 TESTING AND FIELD REVIEW**

- .1 See Section 05 00 50 – Testing of Structural Steel.



- .2 Prior to the commencement of work, provide a schedule of shop fabrication to the Testing Agency.
- .3 The Contractor shall advise the Testing Agency of the scheduling of all shop and field work pertaining to this Project. The Contractor shall permit the testing agency full access to the fabrication shop and the site for the purpose of carrying out their work and shall provide assistance required to aid in the performance of the inspection and testing.
- .4 The Specialty Structural Engineer (or approved representative) responsible for shop drawings shall visit the site to review in place the connections and components to ensure that these connections and components substantially comply with the design drawings. The Specialty Structural Engineer shall then provide a sealed and signed letter to the Consultant and Structural Engineer to this effect.

#### 1.12 **STORAGE AND HANDLING**

- .1 The Contractor shall be responsible for the protection of all steelwork during fabrication, shipping, storage, and construction. All small bends and damage shall be reported to the Structural Engineer for instructions. Steel work that is bent, broken, or otherwise damaged shall be repaired or replaced by the Contractor prior to erection, to the satisfaction of the Structural Engineer, and at no cost to the Owner.
- .2 The Contractor shall be responsible for proper scheduling of delivery and erection for the structural steel in accordance with the construction schedule.
- .3 Store structural steel members at the site above ground on platforms, skids, or other devices so that ground dampness will not affect the bottom members of the stacks.
- .4 Steel that is stored outdoors after fabrication shall be protected from accumulations of standing water.
- .5 Other materials shall be stored in a weather tight and dry place until ready for use in the Work.
- .6 Packaged materials shall be stored in their original unbroken packages or containers.

#### 1.13 **COORDINATION WITH OTHER TRADES**

- .1 Supply all necessary instructions and drawings to other trades for setting bearing plates, anchor rods, and other members that are built in with the work of other trades. Provide punched holes for the convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply the necessary material in accordance to the construction schedule.

#### 2.0 **Products**

#### 2.1 **MATERIALS**

- .1 Structural Steel
  - .1 All steel shall be new unless otherwise indicated and be of sizes and shapes listed in the current CISC Handbook or AISC Handbook and as indicated on the drawings.

- .2 Provide only new material (including bolts) manufactured in Canada, United States, United Kingdom, or EU country mills. New materials are to be in accordance with the Referenced Standards. New materials are to be traceable and records of mill test certificates are to be provided to the Consultant by the Contractor.
- .3 Where sections identified are not available from Canada, United States, United Kingdom, or EU country mills, or where the Contractor chooses to use sections produced by other mills, provide new materials of minimum strength and minimum quality noted in the Reference Standard. For steel that is not produced by Canada, United States, United Kingdom, or EU country mills, the Contractor shall make written requests for approval of the alternate mill to the Consultant before proceeding with material procurement. The Consultant reserves the right to require physical test data, in addition to the mill test reports, proving that the steel from the proposed mill meets the specification requirements prior to approving. Steel must conform to the following:
  - .1 A total maximum boron content of 0.0008%.
  - .2 Each steel batch is to be tested to confirm the steel meets or exceeds the Reference Standards, and does not exceed the maximum boron specified in 2.1.3.1 above.
  - .3 Testing of the steel is to be performed in Canada by an ISO 17025 accredited testing laboratory.
- .4 Structural wide flange shapes (W) to conform to CSA G40.20/ G40.21 grade 345WM.
- .5 Angles (L), plates, channels (C, MC) and miscellaneous beams (S, ST, M and MT) to conform to CSA G40.20/ G40.21 grade 350W.
- .6 Square and rectangular hollow structural sections (HSS) to conform to ASTM A500 Grade C.
- .7 Round hollow structural sections (HSS) to conform to ASTM A500 Grade C.
- .8 Rolled plates and bars shall conform to CSA G40.20/ G40.21 grade 300W.
- .9 Anchor Rods: Conform to **ASTM F1554 Grade 36, 55, 105** unless otherwise noted or shown.
- .10 Bolts, Nuts and Washers: Conform to ASTM F3125. Galvanized grade 325 bolts over 22 mm (7/8") diameter shall have a dry lubricant, such as Johnson's Stick Wax #140 (or approved equivalent), on threads before installation.
- .11 High Strength Bolts: High strength bolting shall be of North American manufacture and shall conform to the provisions of the Research Council on Structural Connections (RCSC) "Specifications for Structural Joints Using High-Strength Bolts", latest edition or approved alternate as described in the above clauses.
- .2 Concrete Anchors
  - .1 Headed studs shall meet the requirements of CSA W59 Appendix H.

- .2 Types A and B shall be Nelson anchors (or pre-approved equivalent) with fluxed ends and shall meet the mechanical properties as specified in ASTM A29, Grades 1010 to 1020. Studs to be automatically end welded with suitable stud welding equipment or shop fillet welded to develop full strength of the stud. Field fillet welded studs will be rejected.
  - .3 Type C shall be deformed steel bars meeting the mechanical properties of ASTM A496 and shall be welded per the manufacturer's recommendations. Reinforcing steel bars with Lenton weldable couplers or pre-approved equal couplers to be used as specified on drawings.
  - .4 Unless noted otherwise, all studs shall be considered to be Type B and shall have a length equal to the deck profile depth plus half of the concrete topping above the high flute.
- .3 Shop Paint/Primer
- .1 Ensure that the shop primer or paint and joint filler is compatible with spray fireproofing intumescent paint and/or the top coat paint system specified, where applicable.
  - .2 Shop Paint: To CISC/CPMA 1-73a or SSPC Paint 15.
  - .3 Shop Primer: To CISC/CPMA Standard 2-75.
  - .4 Primer used in a multi-coat system where a final shop or field paint finish is to be applied shall conform to Section 09 91 00 - Painting and shall be selected and preapproved by the Architect based on surface preparation, exposure conditions and compatibility with subsequent coatings, unless noted otherwise.
  - .5 Hot Dip Galvanizing: To CSA G164, minimum zinc coating of 600 g/m<sup>2</sup>.
  - .6 Zinc-Rich Primer: Catha-Coat 302 as supplied by Devoe Coating Company (3 mils dry film thickness) or Carbozinc 11 as supplied by Carboline Company (2 to 3 mils dry film thickness or approved alternative.
  - .7 Epoxy Paint: Devran 224 HS high build epoxy coating (4 to 6 mils dry film thickness) or approved alternative.
  - .8 Zinc-Rich Touch-up Paint: Galvalite as supplied by ZRC Products Company or Galvafruid as supplied by W. R. Meadows Limited or approved alternative.
  - .9 "Corrosion Protective" Paint: Tenemec Series 394 Perimeprime or Sherwin Williams Macropoxy 646 or approved alternative. Refer to drawings for extent of steel work to receive this paint. All field-applied paints shall meet the requirements of Section 01 52 00. The maximum allowable VOC content for anti-corrosive paint is 250 g/L.

- .4 Any structural steel element outside the building envelope, within an enclosed unconditioned space, or exposed to weather shall be galvanized in accordance with CSA G164. Examples of this include, but are not limited to, canopies, cladding back-up structure, air-well, grating and supporting structure, brick support angles, and related framing materials.
- .5 Welding consumables for all processes shall be fully approved by the Canadian Welding Bureau and certified by the manufacturers as complying with the requirements of this specification. Such certificates shall be not more than two years old.
- .6 Welding electrode strengths to be equal to E49XX (E70XX) or better, and to be matched to base metal capacity.
- .7 Grout for column bases shall be non-metallic, non-expanding, and non-shrink type with a minimum strength of 35 MPa (minimum) at 28 days, unless noted otherwise on the drawings. Grout may be placed in a dry pack or flowable consistency.

## 2.2 DESIGN

- .1 General
  - .1 Design connections and the like for the loads shown or implied in accordance with requirements of S16.
  - .2 If the fabricator's engineer requires additional information or clarification to aid in the design of their work, they shall request this information in a timely and appropriate manner.
- .2 Connections
  - .1 Unless otherwise noted, the fabricator's Specialty Structural Engineer shall design and be solely responsible for all connections between all steel members, including but not limited to columns, beams, girders, trusses, and braces, and between such members as spandrel angles and beams, hangers, stiffeners, etc. and their supporting members be they steel or concrete. The design of the plates or anchors into concrete will be by the Consultant for load and required in the final building loading condition (temporary loading conditions requiring enhancements shall be by the Contractor).
  - .2 Unless otherwise noted, the fabricator's engineer shall also design and be responsible for specifying stiffeners, doubler plates, and the like required to maintain the local strength and stability of a member and where these stiffeners and doubler plates become an integral part of the connection or where they affect the connection of other steel framing members. Typical examples include but are not limited to cranked sections, moment connections between columns and beams, connections to hollow structural sections, and the like. Where connections are exposed to view, the detailing of stiffeners, double plates, and the like is subject to review by the Architect and should conform to Architectural Exposed Structural Steel referred to herein.
  - .3 Use types of shop or field connections shown, or in the absence of such indication, use most appropriate type of connections.

- .4 Design connections to safely withstand the combined primary effects of axial forces, shear, moment, and torque, and any secondary effects due to welding and bolting configurations.
- .5 Where no axial force is shown for beam-to-column connections, connect beams framing into column such that the combined capacities of the connection are able to resist a total horizontal force of 2% of the factored axial load in the column, in each direction.
- .6 Unless otherwise noted, the design of all beams and girders is based on the assumption that fastener holes through flanges will not exceed 15% of the gross flange area. If the area of holes exceeds 15%, the member size shall be altered or reinforced accordingly unless the member can be shown to have sufficient capacity to resist the factored loads with the presence of holes.
- .7 Design connections for fastening together double angles used to resist compression, tension, or bending in such a way that the slenderness ratio of any component, based on its least radius of gyration and the distance between interconnections, shall not exceed that of the built-up member.
- .8 All statically loaded bolted connections shall be designed as snug tight (ST) joints.
- .9 The following types of connections shall be designed as bearing connections but shall be pre-tensioned (PT):
  - .1 Connections for wind or seismic lateral load-resisting elements, such as those noted below or as noted on the structural drawings.
    - .1 Vertical or horizontal bracing
    - .2 Moment connections
    - .3 Truss connections
    - .4 Transfer beams
    - .5 Diaphragm collectors / struts
    - .6 All pedestrian bridge connections
  - .2 Connections where bolts are subject to tensile or tensile and shear loadings.
  - .3 Connections of all framing providing lateral support to columns in buildings over 40 m in height.
- .10 The following types of connections shall be designed as slip-critical (SC):
  - .1 Connections where slippage at the faying surfaces cannot be tolerated as noted.
  - .2 Connections subjected to fatigue or to frequent load reversals.
  - .3 Connections of members subjected to impact, cyclic, and or fatigue loading, such as those supporting crane, vehicular, or machinery loading.
  - .4 Connections with either oversized holes or slotted holes, except for those with the applied load normal (within 80 to 100 degrees) to the direction of the long dimension of the slot that are not intended to accommodate movement.

- .11 Design connections that are exposed to weather so that moisture, foreign matter, and the like cannot be trapped or gain entry to the interior of hollow built up members.
- .12 Design and detail connections so as not to encroach upon architectural clearance lines or finishes.
- .13 Where connections between beams and columns and the like result in a loss of bearing to the steel deck, design and provide support for the steel deck.
- .14 Design and provide end bearing connections of inclined members such that the bearing plane between the inclined members and their supporting members is either horizontal or vertical unless noted otherwise on the drawings.
- .15 Design connections that are to be cast into concrete to provide for the maximum deviation that can occur in erection and based upon the following:
  - .1 Specified steel erection tolerances,
  - .2 Maximum permissible tolerances in the location of inserts cast into concrete, specified in Section 03 11 00.
- .16 The connection design shall be for the forces and loads shown on the drawings and shall allow for the effects of beam deflections. Provide a minimum of two 19 mm (3/4") ASTM F3125 Grade 325 bolts or an equivalent weld for all beam-to-girder and beam-to-column connections
- .17 Provide separators for all double members in accordance with CSA S16.
- .3 Temporary Work
  - .1 The structure as shown on Contract Documents is designed to withstand the design loads only when all structural elements are installed and fully connected. Analysis of all components and assemblies under temporary configurations, including but not limited to stability, stresses, displacements, fabrication, shipping, handling, erection (at various stages), and construction loads, are the sole responsibility of the Contractor.
  - .2 Erection procedures and the design of all erection bracing and related provisions are the sole responsibility of the Contractor.
  - .3 Prepare a detailed sequence of construction method statement outlining all key assumptions and design considerations during construction.
  - .4 Coordinate the overall sequence of construction and construction schedule with the Construction Manager. Agree with Construction Manager on all key milestones and corresponding dates, as well as critical assumptions that effect the temporary stability of structure.
  - .5 Bracing members and anchor rod assemblies shown are for the finished structure and may not be adequate to resist temporary forces during construction.
  - .6 Design erection bracing to safely resist all dead loads, live loads, lateral loads, constructions loads, and other loads imposed during construction.

- .7 Design erection bracing to limit inter-storey and total drift as required for construction purposes and ensure that inter-storey drift does not exceed  $h/400$  at the floors where cladding has been installed by the cladding contractor.
    - .8 During erection, forces or reaction in the steel frame members and their connections might exceed those on which the final or permanent building design is based. Determine the magnitude of such erection forces and reactions and take such necessary measures to ensure that the safety and stability of the structure is maintained during construction.
  - .4 Trusses
    - .1 Design truss member joints to safely transmit forces shown. Unless otherwise noted, the design of truss members is based upon welded connections. If holes are made for connections, the member sizes shall be altered or reinforced if required.
    - .2 Design truss bearings, related bridging, and anchorages to safely resist minimum net uplift forces of at least 0.5 kPa or as noted in the structural drawings.
    - .3 Design and connect trusses to furnish lateral support to the chords or flanges of supporting steel members. Anchor trusses to such members and at opposite ends by connections capable of withstanding a horizontal force of not less than 2% of end reaction of truss.
    - .4 Where tie trusses are indicated, design connections to columns to safely develop 1% of column axial load, the loads shown, or 25 kN whichever is greater.
    - .5 Design anchorage of each line of bridging to abutting walls and other supporting structural steel members to safely resist forces shown, or to at least develop the ultimate capacity of the bridging members in tension.
    - .6 Design and provide end bearing connections of inclined trusses such that the bearing plane between the inclined trusses and their supporting members is horizontal.
    - .7 Design connection to trusses to safely resist horizontal forces introduced into top chords of trusses by horizontal cross-bracing shown.
  - .5 Colour Coding
    - .1 Use a colour coding technique to aid in the shop and field identification of all different grades of steel. Each member used shall bear its particular colour code as required by G40.21. Inventory controls other than colour coding may also be used, subject to agreement with the Consultant.
- 3.0 Execution
- 3.1 **FABRICATION**
- .1 Fabrication shall confirm to the requirements of CSA S16 and the reviewed shop drawings.
  - .2 Fabricated units shall be straight and true, without sharp kinks or bends, and accurate to sizes shown.

- .3 Flame cut steel columns shall have their ends milled. Steel base plates supporting columns shall be flat.
- .4 Prior to fabrication of structural steel, take field measurements where connections are to be made to existing work. Take any and all necessary field measurement.
- .5 Modify installation methods and methods for connecting to suit site conditions found and to the approval of the Consultant.
- .6 Unless noted otherwise, provide holes up to 12 mm (1/2") in diameter, as required, to permit the attachment of other materials. Ensure cross sectional area of section is not reduced by more than 10% at any point on its length.
- .7 Provide drain holes in closed sections to prevent water build-up during erection.
- .8 Provide vent and drain holes in assemblies with closed sections or closed fabricated spaces that are to be hot dipped galvanized to provide full exterior and interior galvanization. Vent and drain holes shall be provided to RJC for review prior to fabrication.
- .9 Thickness of baseplates 100 mm or greater is nominal and allows for a maximum reduction of 6 mm for milling to the requirements of CSA S16.
- .10 Visually inspect all plates and shapes for laminations. **Replace plates or shapes that contain laminations.**
- .11 Headed shear stud connectors and deformed bar anchors shall be applied in strict accordance with the manufacturer's instructions and the Standards or shop fillet welded as per the Standards. Procedural control to be in accordance with W59 as a minimum. Field fillet welds will be rejected.
- .12 Splices
  - .1 Splices in members, other than those shown, that are provided for ease of fabrication or transportation shall not be permitted without Consultant's approval.
    - .1 These connections shall be designed to develop the full strength and stiffness of the member.
    - .2 Welded splices shall be subject to non-destructive testing as directed by the Structural Engineer for which the full cost of such testing shall be borne by the Contractor.
    - .3 Bolted splices shall be designed to ensure slip is not permitted in the connection assembly so as to have the same performance as a welded splice.
- .13 Cambers
  - .1 Fabrication of rolled steel sections without specified camber shall account for any natural mill camber and/or sweep resulting from manufacturing and result in the orientation of that camber in a positive upward direction.



- .2 Provide the indicated camber to trusses, beams, and girders in such a manner as to provide a uniform parabolic profile. Ensure that the method used to provide camber does not reduce the safe load carrying capacity or cause distortion of the members.
- .3 Camber stated on the drawings is the required camber after fabrication.
- .14 Openings
  - .1 Conform to the requirements shown for location, size, reinforcement, and cutting of openings through structural steel.
  - .2 No openings through structural steel members will be permitted without the written approval of RJC.
- .15 Bending Steel Sections
  - .1 Bend sections to geometry noted on contract documents in such a manner as to provide a smooth uniform profile. Ensure that the method used to bend the steel sections does not reduce the safe load carrying capacity or cause distortion of the members.
- .16 Holes and Cutting
  - .1 All holes shall be accurately drilled or punched. Burning or drifting unfair holes will not be permitted. Holes that must be enlarged shall be reamed. Holes for the attachment of work by others shall be provided as required. Drift pins will be allowed only to bring together the several parts for connection.
  - .2 Holes shall be drilled or punched at right angles to the surface of the metal, or CNC-guided plasma or flame-cut in accordance with CISC Specifications.
  - .3 Holes shall be provided in members to permit connections to the work of other trades or contracts, as directed and located by the General Contractor.
  - .4 The use of manual gas-cutting in the shop may be used only if automatic or semi-automatic methods are not deemed practical. All burned cuts shall be ground and cleaned to remove notches. Cope for pipes and ducts as shown.
- .17 Bolts, Anchor Rods and Embedded Parts
  - .1 Drive bolts accurately into the holes without damaging the threads and heads. Bolt heads and nuts shall rest squarely against metal surfaces.
  - .2 Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, provide beveled washers to give full bearing to the thread or nut.
  - .3 Bolt threads or unfinished bolts shall be upset and non-pretensioned bolts shall be nominally tightened to prevent the nuts from backing off.

- .4 Unless noted otherwise, all high strength bolts shall be installed with full pretension using Turn-of-Nut Pretensioning, Twist-Off Type Tension Control Bolt Pretensioning, or Direct-Tension-Indicator (DTI) Pretensioning in accordance with the "Specification for Structural Joints Using High-Strength Bolts". Calibrated Wrench Pretensioning shall only be used where specifically approved by RJC.
- .5 Comply with special washer requirements of the RCSC, such as those related to slotted and oversize holes, and tapered flanges. DTI "washers" shall not be substituted for such required washers.
- .6 All high strength bolt assemblies (including Tension Control bolts and DTIs) used in pretensioned connections shall be verified in accordance with the Pre-Installation Verification section of the RCSC.
- .7 Clean and re-lubricate bolts and nuts that become dry or rusty before use, except Tension Control bolts must be re-lubricated by manufacturer.
- .8 Label and ship anchor rods and base plates in sets indicating size and locations of columns and deliver in ample time prior to the start of related concrete work. Furnish templates together with instructions for setting of anchor rods. Ascertain that anchor rods are set properly during the progress of the work.
- .9 Label and ship other embedded parts, parts with welded couplers, and the like with locations and deliver in ample time prior to the start of related concrete work. Furnish templates together with instructions for setting of embedded parts where applicable. Ascertain that embedded parts are set properly during the progress of the work.
- .18 Welding of Structural Steel
  - .1 Pre-Weld Inspection
    - .1 The surface to be welded and the filler material to be used shall be subject to inspection by quality control personnel before welding is performed.
  - .2 Method and Type
    - .1 All welding indicated on the contract drawings shall be electric arc welding and shall comply in all respects with the codes and specifications herein noted covering the specifications for design, fabrication, and inspection of welded structures and the qualifications of welders and supervisors. The heat, input, length of weld, and sequence weld and cooling process shall be controlled to prevent distortions.
    - .2 For weldments comprised of plates in more than one plane and whose configuration could cause restraint to uniform cooling of the weldment, conform to detailed welding procedures prepared by a welding expert.
    - .3 For weldments comprised of plates thicker than 38 mm, take adequate precaution to control welding and cooling processes in order to control thermal shrinkage stresses. Use stress-relieving techniques where necessary.
    - .4 Each welder's work shall be traceable.

- .19 Stiffeners
  - .1 Provide welded stiffeners in all girders, columns, and beams at points of concentrated loads where required by S16 or where specifically shown on the drawings. Fitted stiffeners shall be ground to fit closely against bearing surfaces.
  - .2 In locations of concentrated loads or bearing points shown on the drawings, these stiffeners shall be fabricated to transfer their full compressive capacity through the top and bottom flange connection through end bearing, fabricated by CISC approved methods, or by welds where the welds are designed to transfer this load.
- .20 Remove and replace any work that is not acceptable to the Consultant, when and as directed. Such operation shall not become an extra charge to the Owner.
- .21 Where roof slopes exceed 5% and do not permit flush bearing of the steel deck on the beams, provide continuous 3 mm bent plates to the pitch and necessary to ensure full bearing of the steel deck. Coordinate with the deck supplier for the locations that will require these bent plates.

### 3.2 **CLEANING AND PRIMING**

- .1 All structural steel shall have surface contamination (salts, oils, grease, drilling and cutting compounds), rust, and mill scale removed and an adequate surface profile provided in accordance with the minimum surface preparation noted in the table below.
- .2 All surface preparation should be coordinated with finishes specified by the Architect in Section 09 91 00 – Painting. Should the material data sheets require a more stringent level of surface preparation, this shall take precedence over the following minimum requirements.
- .3 Architecturally exposed structural steel (AESS) members shall be cleaned and primed when applicable in accordance and in coordination with the intumescent paint fireproofing or finished paint system procedure. Application to be coordinated with specification Section 09 91 00 – Painting and fireproofing specifications and structural documents.
- .4 The tables below do not apply for highly aggressive environments in which the structure is exposed to harmful chemicals (acidic, alkaline, oxidizing, solvents, etc.) In these cases, a paint supplier must be engaged by the Architect to provide guidance on a full paint system and an appropriate surface preparation.
- .5 Apply primers in accordance with the manufacturer's instructions.
- .6 Use paint prepared by manufacturer without thinning or adding admixtures. Execute painting on dry surfaces, free from rust, scale, or grease. Do not paint in temperatures lower than 8°C or as indicated within the paint manufacturer's specification and application procedures.
- .7 Where finish painting to parts inaccessible for finish painting after final assembly is required, apply two coats of paint during fabrication. Apply paint of two different colours so that missed areas can be detected.

.8 Interior Structural Steel

.1 The following structural steel shall be located completely within the building envelope.

Zone	Description	Exposure Conditions		Expected Finish	Minimum Surface Preparation
		Conditioned Space	Condensation		
I1	Embedded in concrete, encased in masonry, or protected by membrane	Yes	No	Bare Steel	N/A
I2	Coated in cementitious fireproofing	Yes	No	1. Bare Steel 2. Primed	1. N/A 2. CISC/CMPA 1-73a
I3	Coated in intumescent paint fireproofing	Yes	Yes / No	Per Paint Supplier	Per Paint Supplier
I2	Enclosed in architectural finishes but not exposed to condensation	Yes	No	1. Bare Steel 2. Primed	1. N/A 2. CISC/CMPA 1-73a 3. CISC/CMPA 2-75
I3	Exposed within building but not defined as AECS	Yes	No	2. Primed and Painted	SP3
I3	Enclosed in architectural finishes in areas adjacent to façade that cannot be fully conditioned and could lead to condensation	Yes	No	1. Primed 2. Primed and Painted	SP6
I4	Steel supporting members that penetrate building envelope (such as canopies, signage, etc.)	Yes / No	Yes	1. Primed and Painted 2. Galvanized	SP6
I5	Exposed in an enclosed area that is tempered or not conditioned	No	Yes	1. Primed and Painted 2. Galvanized	SP6
I6	Interior space exposed to high humidity (such as laundry facilities, foot plants, breweries, wash areas, etc.)	Yes / No	Yes	1. Primed and Painted 2. Galvanized	SP6

.2 Steel that will be non-intumescent paint fireproofed, zinc coated or galvanized, welded, receive shear studs, faying surfaces of slip resistant connections, and the underside of base plates and bearing plates steel shall not be primed unless specifically noted by the applied coating manufactures specifications.

.9 Exterior Structural Steel

Zone	Description	Expected Finish	Minimum Surface Preparation
E1	Standard exposure to exterior elements.	1. Primed and Painted 2. Galvanized	SP3

Zone	Description	Expected Finish	Minimum Surface Preparation
E2	Frequently exposed to fresh water. Involves condensation, splash, spray, or immersion.	1. Primed and Painted 2. Galvanized	SP6
E3	Frequently exposed to water with chlorides. Involves condensation, splash, spray, or immersion.	1. Primed and Painted 2. Galvanized	SP10

- .10 Provide the following touch-up for steel in an exterior exposure or which has a finish paint coat:  
After erection and after connections are completed, provide a field touch-up coat of primer to all surfaces that had no paint shop coat and have been chipped or scraped. Touch up with primer and paint all shop coat painted areas that have been chipped or scraped.
- .11 Hot Dip Galvanized Structural Steel
  - .1 When fabricating steel that is to be galvanized, it is recommended that uncoated electrodes be used wherever possible. The electrodes must still adhere to all CSA requirements referenced in previous sections.
  - .2 To ensure a high quality galvanized finish, the fabricator shall ensure that the following items are removed:
    - .1 Weld slag as well as welding flux residues
    - .2 Burrs (including those excessive rough edges derived from flame cutting)
    - .3 Heavy or probably extremely adherent type of mill scale
    - .4 Asphalt, vinyls, or epoxies
    - .5 Mill coatings like lacquers or varnishes (typically found on pipes)
    - .6 Sand, other impurities present on castings
    - .7 Thick or heavy grease or wax deposits
  - .3 The fabricator shall also avoid using the following items during the fabrication stage for steel that is to be galvanized:
    - .1 Welding rods high in silicon
    - .2 Anti-spatter sprays or materials
    - .3 Markers, crayon, or oil-based paints
  - .4 Should the fabricator desire to use the following items, they must provide a written proposal to the Structural Consultant that includes the proposed cleaning method and an approval letter from the galvanizer.
  - .5 The steel fabricator shall also be responsible for consulting each galvanizer to determine any other individual surface preparation requirements on a case-by-case basis.
  - .6 Painted materials or materials with a black lacquer coatings must first be abrasive shot blasted or wheel abraded.

- .7 In cases where members that are galvanized are to have a secondary finish applied on top, ensure that the Architect and finish supplier are consulted about post galvanizing treatments including but not limited to surface smoothing, cleaning, preparation, and profiling.
- .8 Provide the following touch-up for galvanized steel: After erection and after connections are completed, provide a field touch-up coat of **zinc-rich paint** to all surfaces that have been chipped or scraped.

### 3.3 ERECTION

- .1 At least 60 days prior to the commencing of steel erection, the Contractor shall hold a meeting to review the detailed requirements and staging for the steel erection. A detailed schedule should be developed with:
  - .1 Construction Manager
  - .2 Steel Trades (Fabricator, Deck Contractor and Erector)
  - .3 Erector's Surveyor
  - .4 Project's Surveyor
  - .5 Concrete Contractor
  - .6 Curtain wall Contractor
  - .7 All Inspection and Testing Agencies
  - .8 Consultant
  - .9 Owner's Representative
- .2 Structural steel shall be assembled and erected in accordance with the approved erection drawings and specified reference Standards.
- .3 The erector is fully responsible for erection methods, equipment, workmanship, and safety precautions.
- .4 Confirm the setting of anchor rods and bearing plates and make an instrument survey to verify the setting prior to erection of steel members.
- .2 Column Base Plates: Column base plates shall be supported and aligned on steel shims or setting bolts. After the supported members have been plumbed and properly positioned, the anchor nuts shall be tightened in preparation for grouting. Wedges and shims shall be cut off flush with the edges of plates and shall be left in place. All base plates greater than 500 mm in any dimension shall be set on steel angle seats or shim packs. Base plates longer than 900 shall be set on steel angle seats only.

- .5 Cutting or burning of baseplates to accommodate anchor rods shall be cause for rejection of baseplates. Costs associated with replacement or remedial work cause by field modifications of baseplates shall be covered by the steel fabricator.
- .6 The Contractor is responsible for providing all temporary bracing required to stabilize the work against wind, earthquake, and construction loads during all phases of the project. The timing of installation and removal of temporary bracing shall ensure the structure is true and plumb until completion of the building.
- .7 The Contractor shall be responsible for the design of all hooks, erection connections, and handling gear.
- .8 The Contractor shall ensure that all construction loads due to temporary storage of materials, erection equipment, or any other loads during the construction phase are adequately distributed so as to not exceed the capacity of any member.
- .9 Proper fit up of members in compression is critical to ensure members are loaded correctly. Tolerance for joint fit up to be in accordance with CSA S16, clause 28.5 Joints in Contact Bearing.
- .10 Temporary bolts, clips, angles, etc. used to facilitate erection shall be removed unless noted otherwise on the drawings.
  - .1 Splices: Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Splices will be permitted only where indicated on the contract drawings or the reviewed shop drawings.
  - .2 Errors: Immediately report to the Contractor any errors in shop fabrication or deformations resulting from handling and transportation that prevent the proper assembly and fitting of parts or in the erection operation. Make suggestions for corrective work and obtain approval of the method of correction. Approved corrections shall be made expeditiously and costs shall be addressed in accordance with the terms of the Contract.
- .11 Structural steel work on concrete shall be carefully located at the proper grade and rigidly secured in place using steel shims. Spaces under the steel shall then be filled with non-shrink premix grout as soon as possible, and before placing any concrete toppings or precast concrete units.
- .12 Plumb, level, and align individual members of steel work as specified in CSA S16.
- .13 The various members forming parts of complete frame or structure after being assembled shall be aligned and adjusted accurately before being fastened.
- .14 Survey: Make an accurate survey of actual column locations immediately upon the completion of every tier of steel and promptly submit same to the Consultant. Survey shall include tier below. Should column locations vary beyond the allowable tolerances, take necessary corrective measures and modify details or procedures as required and approved by the Consultant. Also survey all column splice locations every tier consistent with the axial shortening adjustments to be provided by the Consultant. Measurements to be reported to the Consultant. Vertical adjustments for column splice, such as additional shim plates or stiffener, may be required as per Engineer's directions and recommendations.

**3.4 TEMPORARY FLOORING**

- .1 Provide all temporary flooring, planking, and scaffolding necessary in connection with erection of structural steel or support of erection machinery in accordance with governing regulations and by-laws.

**3.5 WELDING**

- .1 Welding shall be done by the shielded metal-arc method in accordance with the requirements CSA W59. The welding operators shall be currently certified under CSA W47.1 for the work they are performing.
- .2 Submit, when requested, welding procedures prepared and sealed by a Specialty Structural Engineer for review.
- .3 Surfaces to be welded shall be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two or more layers, each layer shall be cleaned before the next layer is deposited. Care shall be taken to minimize stresses due to heat expansion, contraction, and distortion by using proper sequence in welding and by approved methods.
- .4 Appearance, quality of welds made, and methods of correcting defective work shall be in accordance with CSA W59.
- .5 Welding of reinforcing bars to structural steel as per CSA W186.

**3.6 COMPLETION**

- .1 The Specialty Structural Engineer responsible for the sealed shop drawings or their representative shall visit the site to review in place connections and components designed by that Specialty Structural Engineer to ensure substantial compliance with their sealed shop drawings. They shall then submit a sealed and signed letter of substantial compliance to the Consultant and Structural Engineer.
- .2 On completion of the work of this section, all protection erected in conjunction with the structural steel work shall be removed, all damage to this work and adjoining work shall be made good, and all surplus materials and debris and all tools, plant, and equipment shall be removed from the site.

End of Section



1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical drawings.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide labour, materials, equipment, and services to supply, design, and erect open web steel joists required and/or indicated on drawings or specified herein. Report discrepancies between structural, mechanical, electrical, and architectural drawings to Consultant and Structural Engineer immediately.
- .2 Co-ordinate with Section 05 12 00 – Structural Steel Framing for design, fabrication, supply, installation, and erection of structural steel and accessories.
- .3 Co-ordinate with Section 05 31 00 – Steel Deck for design, supply, and installation of headed stud shear connectors for composite beams and girders, and where required on other beams, girders, and drag struts.

1.3 **REFERENCE STANDARDS**

- .1 Structural steel shall conform to the requirements of the following Building Code and Reference Standards unless otherwise required by this specification:
  - .1 Building Code
    - .1 Ontario Building Code - 2012 O REG 88/19
  - .2 Reference Standards
    - .1 General
      - .1 CSA S16 – Design of Steel Structures
      - .2 CSA S136 – North American Specification for the Design of Cold-Formed Steel Structural Members
      - .3 CSA W47.1 – Certification of Companies for Fusion Welding of Steel Structures
      - .4 CSA W59 – Welded Steel Construction (Metal Arc Welding) (Metric version)
      - .5 CSA G40.20 – General Requirements for Rolled or Welded Structural Quality Steel
      - .6 CSA G40.21 – Structural Quality Steel
      - .7 CSA G30.18 – Carbon Steel Bars for Concrete Reinforcement

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- .8 ASTM F1554 – Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
  - .9 ASTM A193/A193M – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
  - .10 ASTM F3125/F3125M – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
  - .11 CISC / CPMA Standard 1-73a – A Quick-Drying One-Coat Paint for Use on Structural Steel.
  - .12 SSPC SP-6 – Commercial Blast Cleaning
- .2 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .3 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .4 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.
- 1.4 DEFINITIONS - FOR THIS SECTION**
- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
  - .2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd., herein also referred to as RJC.
  - .3 “Specialty Structural Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
  - .4 “Testing Agency” shall mean the testing agency responsible to the Owner.
  - .5 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.
- 1.5 QUALIFICATIONS**
- .1 Open web steel joist fabricator shall have minimum five years experience in fabrication of open web steel joists.
  - .2 Erector shall have minimum five years experience in erection of open web steel joists.
  - .3 Steel fabricators and erectors must be certified under requirements of CSA W47.1 as required by CSA S16.

- .4 Welding procedures, welders, and welding operations to be qualified in accordance with Canadian Welding Bureau Standards.

#### 1.6 EXAMINATIONS

- .1 Take dimensions from drawings and verify by field measurement. Be responsible for correctness of such measurements and report to Consultant and Structural Engineer in writing of discrepancies between field measurements and those shown on drawings prior to commencing work. Verify location of embedded steel and confirm that work prepared by other trades is at a proper elevation, on line, level, and true.

#### 1.7 SUBMITTALS

- .1 Submit, **before starting work**, written evidence of qualification of the steel fabricators and erectors for welding under Canadian Welding Bureau requirements.
- .2 Submit, **before starting work**, written evidence of ability to weld reinforcing steel to structural steel in accordance with CSA W186.
- .3 When requested, submit copies of mill test reports properly correlated to materials used on project.
- .4 Provide a schedule of fabrication to Consultant, Structural Engineer, and Testing Agency prior to commencement of fabrication.

#### 1.8 SHOP DRAWINGS

- .1 Shop drawings to show complete shop and erection details necessary for fabrication and erection of joists, including connections, splices, and location, type, size, and extent of welds. Splices not shown on shop drawings will be rejected. Indicate welds, both shop and field, by AWS Welding Symbols as specified in CSA W59 Appendix D and E.
- .2 Review of shop drawings by Structural Engineer is intended as an assistance to Contractor and does not relieve Contractor of responsibility for completeness or accuracy of work and its conformance to contract documents.
- .3 Fabrication that commences prior to shop drawing review by Structural Engineer is at risk of Contractor.
- .4 Clearly identify revisions, changes, or modifications on shop drawing.
- .5 Resubmit reviewed shop drawings where noted in Read Jones Christoffersen Ltd.'s review stamp, or when Contractor makes revisions for own purposes.
- .6 Allow at least two weeks for shop drawing review by Structural Engineer.
- .7 Structural drawings are not prepared to be used as erection or shop drawings. However, electronic files or sepias can be used by the Contractor under the following conditions:
  - .1 Copyright remains with Read Jones Christoffersen Ltd.

- .2 Drawings will only be used for shop drawings for this project and not be put to any other use.
- .3 Read Jones Christoffersen Ltd. assumes no liability for errors or omissions in drawings. Contractor assumes all risk and expenses associated with use of structural drawings in production of their work.
- .4 References to Read Jones Christoffersen Ltd. must be deleted from title block.
- .5 Contractor signs a release available from Read Jones Christoffersen Ltd. that addresses the above items in more detail.

**1.9 TESTING AND FIELD REVIEW**

- .1 See Section 05 00 50 – Testing of Structural Steel.
- .2 Prior to commencement of work, provide a schedule of shop fabrication to Testing Agency.
- .3 If requested, submit certified mill tests in accordance with the Standards.
- .4 Advise Testing Agency of scheduling of all shop and field work pertaining to this Project. Permit testing agency full access to fabrication shop and site for purpose of carrying out their work and provide assistance required to aid in performance of inspection and testing.

**1.10 STORAGE AND HANDLING**

- .1 Contractor is responsible for protection of joists during fabrication, shipping, storage, and construction. Handle steel joists at job site in a manner that prevents bending or damage of joist. Report small bends and damage to Structural Engineer for instructions. Do not use damaged joists. Replace or repair joists that are bent, broken, or otherwise damaged prior to erection, to satisfaction of Structural Engineer, and at no cost to Owner.
- .2 Co-ordinate proper scheduling for delivery and erection of joists in accordance with construction schedule.
- .3 Store joists at site above ground on platforms, skids, or other devices so that ground dampness will not affect bottom members of stacks. Do not stack joists to a height that will cause bending in bottom members.
- .4 Protect joists that are stored outdoors after fabrication from accumulations of standing water.
- .5 Store other materials in a weather tight and dry place until ready for use in Work.
- .6 Store packaged materials in their original unbroken packages or containers.

**1.11 COORDINATION WITH OTHER TRADES**

- .1 Provide punched holes for convenience of other trades in attaching wood blocking or other materials. Coordinate with drawings of other disciplines for locations and details. Supply the necessary material in accordance to construction schedule.

## 2.0 Products

### 2.1 MATERIALS

- .1 Steel shall be new unless otherwise indicated and be of sizes and shapes listed in current CISC Handbook or AISC Handbook and as indicated on drawings.
- .2 Steel to be to CSA G40.21.
- .3 Primer for interior exposure not to receive a shop or field paint finish is to be to CISC/CPMA Standard 1-73a or other pre-approved, unless noted otherwise.
- .4 Primer used in a multi-coat system where a final shop or field paint finish is to be applied is to conform to Section 09 91 00 – Painting and be selected and preapproved based on surface preparation, exposure conditions, and compatibility with subsequent coatings, unless noted otherwise.
- .5 Welding consumables for processes to be fully approved by Canadian Welding Bureau and certified by manufacturers as complying with requirements of this specification. Such certificates must be less than two years old.
- .6 Electrode strengths to be equal to E49XX (E70XX) or better.

### 2.2 DESIGN

- .1 Unless otherwise noted, open web steel joists are to be designed by Contractor to reference Standards by Specialty Structural Engineer.
- .2 Open web steel joists spliced for ease of fabrication or transportation to have splices designed to develop full strength and stiffness of member. Splices are subject to non-destructive testing as directed by Structural Engineer. Cost for such testing to be borne by Contractor.
- .3 Provide separators for double members in accordance with CSA S16.
- .4 Design of bridging for steel joists to conform to requirements of CSA S16, unless otherwise indicated on drawings. Refer to drawings for areas of non-typical joist bridging and bracing.
- .5 Design joists of depth and spacing shown on drawings and to carry loads shown on drawings in accordance with CSA S16.
- .6 Unless noted otherwise, joists shall be designed to meet the deflection requirements noted below.

#### .1 Floor Joists

Application	Loading	Limit	Max
Supporting finishes not susceptible to cracking	LL	Span / 300	25 mm
Supporting finishes susceptible to cracking	LL	Span / 360	20 mm
Supporting masonry partitions but finishes not susceptible to cracking	LL	Span / 480	20 mm
	Total	Span/320	25 mm
	LL	Span / 600	15 mm

Supporting masonry partitions but finishes not susceptible to cracking	Total	Span/320	20 mm
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.2 Roof Joists

Application	Loading	Limit	Max
Supporting finishes not susceptible to cracking	LL	Span / 300	25 mm
	Total	Span / 200	35 mm
Supporting finishes susceptible to cracking	LL	Span / 360	20 mm
	Total	Span / 240	30 mm
Industrial buildings with elastic roof coverings	LL	Span / 240	30 mm
	Total	Span / 180	40 mm
Industrial buildings with inelastic roof covering	LL	Span / 180	35 mm
	Total	Span / 120	50 mm
Industrial buildings supporting crane runways (capacity of 225 kN max)	LL	Span / 600	15 mm
Industrial buildings supporting crane runways (capacity greater than 225 kN)	LL	Span / 800	12 mm

- .7 If the joists support green roof, solar panels, or similar loads they shall be considered as dead load for the purposes of calculating deflection.
- .8 Line up openings and webs in adjacent to allow for passage of pipe, ducts, conduits, etc. Make allowance in joist design for support of pipes, ducts, conduits, etc.
- .9 Upon request by Consultant or Authority Having Jurisdiction, submit calculations and such further proof as may be necessary to show that steel joist construction conforms to requirements set forth herein, as well as municipal building bylaws.
- .10 Joist manufacturer may be required, at Structural Engineer's and Consultant's option, to demonstrate by testing or analysis, which includes effects of actual joint eccentricities, that joists provided have capacity to resist loads specified.
- .11 In addition to point loads called for in governing building code, design joists for a 1.8 kN (0.4 kip) factored additional point load at any location on top chord and bottom chord (including effects of local bending) concurrent with other design loads. Over mechanical areas, additional point loads to be 4.5 kN (1.0 kip) factored. Additional point loads noted above on each chord need not be applied concurrently with each other.
- .12 Joists shoes shall be designed for a minimum roll over force of 4.5 kN (1.0 kip) and shall be connected to the base structure for this force unless noted otherwise.
- .13 Where joists frame into both sides of a support, extend top chord of joists to center of support, unless shown otherwise.
- .14 Where joists frame into one side of a support, extend top chord of joists to far side of support, unless shown otherwise.
- .15 Provide extended ends of joists as required to support edges of roofs, floors, walls, and where shown.

- .16 Extended ends of joists to have a load-carrying capacity at least equal to loads shown on drawings.
- .17 Provide bracing as required for lateral stability of bottom chords in compression due to wind uplift, bottom chord extensions, and other effects causing compression in bottom chord.

### 3.0 Execution

#### 3.1 FABRICATION

- .1 Fabrication confirm to requirements of CSA S16 and reviewed shop drawings.
- .2 Welding to be to CSA W59.
- .3 Joist work to be executed by skilled and experienced workers.
- .4 Fabricated units to be straight, true, without sharp kinks or bends, and accurate to sizes shown.
- .5 Refer to architectural drawings for extent and location of architecturally exposed joist elements.
- .6 Provide bridging for steel joists conforming to requirements of CSA S16, unless otherwise indicated on drawings. Refer to drawings for areas of non-typical joist bridging and bracing.
- .7 Remove and replace work that is not acceptable to Consultant, when and as directed. Such operation is at own expense.
- .8 Joist and other steel members spliced for ease of fabrication are to develop full strength and stiffness of member.
- .9 Where roof slopes exceed 5% and do not permit flush bearing of steel deck on joist top chords, provide continuous 3 mm bent plates to pitch as necessary for full bearing of steel deck. Co-ordinate with deck supplier for locations that will require these bent plates.

#### 3.2 CLEANING AND PRIMING

- .1 Thoroughly clean steel of loose mill scale, loose rust, oil, or dirt.
- .2 Prime architecturally exposed joists, related framing and bridging, and exterior steel.
- .3 Do not prime joists that will be encased in concrete, fireproofed, zinc coated, galvanized, or welded.
- .4 Shop prime all other steel joists.
- .5 Clean joists that will not receive a finish paint coat and are required to be primed for interior exposure in accordance with CISC/CPMA Standard 1-73 (minimum).
- .6 Clean joists to receive a shop or field paint finish in accordance with Section 09 91 00 – Painting or SSPC-SP 6 “Commercial Blast Cleaning”, whichever produces a surface that has less rust and mill scale.

- .7 Apply primers in accordance with manufacturer's instructions.
- .8 Use paint prepared by manufacturer without thinning or adding admixtures. Execute painting on dry surfaces, free from rust, scale, or grease. Do not paint in temperatures lower than 8°C.
- .9 Where finish painting to parts inaccessible for finish painting after final assembly is required, apply two coats of paint during fabrication. Apply paint of two different colours so that missed areas can be detected.
- .10 Provide following touch up for steel in an exterior exposure or which has a finish paint coat: After erection and after connections are completed, provide a field touch-up coat of primer to surfaces that had no paint shop coat and have been chipped or scraped. Touch up with primer and paint shop coat painted areas that have been chipped or scraped.

### 3.3 ERECTION

- .1 Erector is fully responsible for erection methods, equipment, workmanship, and safety precautions.
- .2 Install temporary bracing required to stabilize work against wind, earthquake, and construction loads. Assume complete responsibility for extent and timing of removal of such bracing. Bracing members indicated on drawings are required for finished structure and not considered adequate for temporary bracing. Failure to make proper and adequate provision for stresses occurring during erection from any causes whatsoever is responsibility of Contractor.
- .3 As erection progresses, securely connect work to take care of loads, including wind and seismic during erection. Failure to make proper and adequate provisions for loads during erection is responsibility of Contractor.
- .4 Contractor is responsible for design of all hooks, erection connections, and handling gear.
- .5 Whenever piles of materials, erection equipment, or other loads are carried during erection, make proper provisions to take care of stresses resulting from same. Adequately distribute construction loads to not exceed capacity of any joist.
- .6 Assemble and erect joists and bridging in accordance with approved erection drawings and specified reference Standards.
- .7 Co-ordinate with mechanical and electrical trades prior to erection of steel joists so that joists and bridging will not interfere with installation of mechanical and electrical equipment.
- .8 Support joists at two or more points during handling and erection.
- .9 Steel joists are to bear on beams in accordance with article 2.2, but in no case shall less than 65 mm be on supporting steel members. Connect to supporting steel with a 5 mm x 30 mm long fillet weld at each side. Secure to bearing plates on masonry walls in same manner, bearing 100 mm minimum.
- .10 Plumb, level, and align individual joists as specified in CSA S16.



- .11 Remove temporary bolts, clips, angles, etc. used to facilitate erection unless noted otherwise on drawings.

#### 3.4 **JOIST BRIDGING**

- .1 Install bridging for steel joists conforming to requirements of CSA S16, unless otherwise indicated on drawings. Refer to drawings for areas of non-typical joist bridging and bracing.
- .2 Where required for stability of bottom chord, provide additional bridging. Such stability requirement to be designed by supplier using loads provided on drawings.
- .3 Butt splice architecturally exposed joist bridging and bracing and grind splices smooth to receive finish painting as specified in Architectural Finishes. Lap splices in architecturally exposed bridging are not permitted.

#### 3.5 **WELDING**

- .1 Welding shall be done by shielded metal-arc method in accordance with requirements CSA W59. Welding operators shall be currently certified under CSA W47.1 for work they are performing.
- .2 Submit for review, when requested, welding procedures prepared and sealed by a Specialty Structural Engineer.
- .3 Surfaces to be welded are to be free from loose scale, rust, paint, or other foreign matter. Where weld material is deposited in two or more layers, clean each layer before depositing next layer. Take care to minimize stresses due to heat expansion, contraction, and distortion by using proper sequence in welding and by approved methods.
- .4 Appearance, quality of welds made, and methods of correcting defective work are to be in accordance with CSA W59.

End of Section

1.0 General

1.1 **DOCUMENTS**

- .1 This section, along with the drawings, forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Drawings include architectural, mechanical, and electrical drawings.

1.2 **DESCRIPTION OF WORK INCLUDED**

- .1 Provide all labour, materials, closures, equipment, and services necessary to design, supply, fabricate, erect, and install the steel deck and field welded shear connectors to structural steel as indicated on the drawings and as hereinafter specified. Provide gauge metal formwork at all deck edges for composite deck or concrete-filled deck and reinforcement for deck openings as required herein.
- .2 Co-ordinate with Section 05 12 00 – Structural Steel Framing for design, fabrication, supply, installation, and erection of structural steel and accessories.

1.3 **RELATED WORK SPECIFIED ELSEWHERE**

- .1 Section 03 11 00 – Concrete Forming and Accessories
- .2 Section 03 20 00 – Concrete Reinforcing
- .3 Section 03 31 00 – Structural Cast-in-Place Concrete
- .4 Section 05 00 50 – Testing of Structural Steel
- .5 Section 05 12 00 – Structural Steel Framing
- .6 Section 05 12 50 – Architecturally Exposed Structural Steel
- .7 Section 05 21 00 – Steel Joist Framing
- .8 Section 05 50 00 – Metal Fabrications
- .9 Section 05 51 00 – Metal Stairs
- .10 Section 07 81 00 – Applied Fireproofing

1.4 **REFERENCE STANDARDS**

- .1 Structural steel shall conform to the requirements of the following Building Code and Reference Standards unless otherwise required by this specification:
  - .1 Building Code
    - .1 Ontario Building Code - 2012 O REG 88/19

.2 Reference Standards

- .1 CSA S136 – North American Specification for the Design of Cold-Formed Steel Structural Members
- .2 CSA W47.1 – Certification of Companies for Fusion Welding of Steel Structures
- .3 CSA W59 – Welded Steel Construction (Metal Arc Welding) (Metric version)
- .4 ASTM A653/A653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- .5 CSSBI 10M-06 - Standard for Steel Roof Deck.
- .6 CSSBI 12M-06 - Standard for Composite Steel Deck.

- .2 The revision date of all referenced codes, standards, and guidelines shall be as indicated in the above referenced Building Code. Where no reference is made within the Building Code, the latest published edition shall be used.
- .3 Where the Standard is referenced in this specification, it shall mean the documents specified in this clause and their referenced Standards.
- .4 Where there are differences between the specifications and drawings and the codes, standards, or acts, the most stringent shall govern.

1.5 **DEFINITIONS - FOR THIS SECTION**

- .1 “Owner”, “Contractor”, and “Consultant” as per the General Conditions and Definitions.
- .2 “Structural Engineer” shall mean a representative of Read Jones Christoffersen Ltd., herein also referred to as RJC.
- .3 “Specialty Structural Engineer” is a Professional Engineer registered in Ontario responsible for components designed by the Contractor and who seals and signs shop drawings.
- .4 “Testing Agency” shall mean the testing agency responsible to the Owner.
- .5 “Standard” and “Standards” shall mean the reference standards listed under “Reference Standards” in this section.

1.6 **QUALIFICATIONS**

- .1 Steel deck fabricator shall have not less than Five (5) Year(s) experience in the fabrication of steel deck and be a member of the steel deck institute.
- .2 Erector shall not have less than Five (5) Year(s) experience in the erection of steel deck.
- .3 Steel deck welders must possess current Canadian Welding Bureau Certificates of Qualification for light gauge structural welding.
- .4 Deck erectors must be certified under the requirements of CSA W47.1.

**1.7 EXAMINATIONS**

- .1 Examine and verify all necessary measurements and dimensions of previously executed work that may affect the work of this contract.
- .2 Examine surfaces which work is to be placed on or against to ensure that they are square, true, level, plumb, of correct slope or shape, and of proper surface to receive such work.
- .3 Report any discrepancies to the Consultant and Structural Engineer immediately so that instructions may be given for the necessary remedial work.
- .4 Commencement of work shall be construed as acceptance of all conditions and surfaces.

**1.8 SHOP DRAWINGS**

- .1 Submit shop drawings prepared under the supervision of a Specialty Structural Engineer. Drawings of components designed by the Contractor shall be sealed and signed by this Specialty Structural Engineer.
- .2 Shop drawings shall show the position, extent, type, and arrangement of the units, their relationship to other materials, depth, core thickness, coating thickness, connections, openings, accessories, closures, light gauge formwork and reinforcement for openings, and complete stud shear connector details for composite beams.
- .3 Shop drawings for acoustic deck shall indicate the reduction in strength and stiffness related to the acoustic perforations.
- .4 Calculations and/or test data may be requested with the shop drawings to justify deck design and shear connector design.
- .5 Show deck load capacities, including point load capacities, and for composite deck confirm that these load capacities are compatible with the zinc coating.

**1.9 TESTING AND FIELD REVIEW**

- .1 As per Section 05 00 50 – Testing of Structural Steel.

**1.10 STORAGE AND HANDLING**

- .1 Bundles of decking shall be stacked on wood blocking, clear of the ground and tilted to ensure that no water lies on the material.

**2.0 Products**

**2.1 GENERAL**

- .1 Products shall satisfy the requirements of the Standard unless otherwise specified herein or on the drawings.

## 2.2 MATERIALS

- .1 Steel deck units shall be formed of zinc-coated sheet steel minimum CSSBI 10M Grade A with a base steel nominal thickness of 0.76 mm or greater. Unless noted otherwise, zinc coatings for the following conditions shall be:
  - .1 Interior Exposure
    - .1 Floor Deck – ZF75 – Galvanneal
    - .2 Roof Deck – **ZF75 - Galvanneal**
  - .2 Exterior Exposed Deck – Z275 Galvanized.
- .2 Touch-up paint for welds shall conform to CGSB –1.181 Ready-Mixed Organic Zinc Rich Coating.
- .3 Cover plates, cell closures, etc. shall be of the same material as the deck with a minimum nominal thickness of 0.76 mm.
- .4 Deck shall conform to the depths shown on the drawings. Deck receiving composite shear studs shall have an average bottom flute width equal to twice the deck depth.
- .5 Shear stud connectors shall be Nelson headed anchors or other preapproved. Studs to be automatically end welded with suitable stud welding equipment in the field. Fillet welded studs will be rejected.
- .6 Steel deck to receive concrete topping shall be composite deck unless noted otherwise.
- .7 Steel deck that is indicated to be painted on the underside shall have factory applied, Perspectra Plus Series paint finish (ArcelorMittal Dofasco), or approved equivalent, unless otherwise specified. Painted steel deck shall be connected with mechanical fasteners that do not damage the paint finish. Painted steel deck shall not be connected with welds. Painted deck to be co-ordinated with Section 05 12 50 – Architecturally Exposed Structural Steel.
- .8 Mechanical Fasteners
  - .1 At Structural Steel Support: Hilti X-ENP-19 L15, X-EDN19 THQ12, or X-EDNK22 THQ12 or approved equal as recommended by the manufacturer for the application.
  - .2 At Structural Wood Support: 6 mm x 25 mm HHA weather-guard screws at 300 mm maximum centers at all bearing points (minimum 4 screws per sheet) for use on wood trusses.
  - .3 Deck Side Laps: No. 10 screws or Hilti S-SLC01 M HWH or S-SLC02 M HWH or approved equal, as recommended by the manufacturer for the application, are acceptable (refer to Article 3.1 for execution).

## 2.3 FABRICATION

- .1 Composite steel deck shall be formed with integral locking lugs to provide mechanical lock between concrete and steel.

- .2 Steel deck shall have interlocking male and female side laps.
- .3 Provide cell closures where required by architectural drawings and specifications at open ends of all cell runs at columns, openings, walls, etc., and where cells change direction.
- .4 For deck with concrete topping, provide necessary metal gauge formwork at the deck edges for full deck and concrete depth to prevent leaking of concrete topping. This includes, but is not limited to, edges formed by building edges, openings framed by structural steel, elevator shafts, stairwells, and around webs and flanges of columns.

## 2.4 DESIGN

- .1 Steel deck to be designed by the Contractor to the reference Standards and the loads on the drawings unless otherwise noted.
- .2 Steel deck shall span over three (3) or more supports unless prevented by the structural steel layout.
- .3 Required deck material thickness may be greater than the minimum thickness shown on the drawings.
- .4 Unless noted otherwise, metal deck shall be designed to meet the deflection requirements noted below.

### .1 Floor Deck

- .1 Support construction loading without temporary shoring and with deflection not exceeding span/180.
- .2 Deflection under live load shall be limited to span/360.

### .2 Roof Deck

Application	Loading	Limit	Max
Supporting finishes susceptible to cracking	LL	Span / 360	10 mm
	Total	Span / 240	13 mm
Supporting finishes not susceptible to cracking	LL	Span / 300	12 mm
	Total	Span / 200	15 mm
Industrial buildings with elastic roof coverings	LL	Span / 240	13 mm
	Total	Span / 180	19 mm
Industrial buildings with inelastic roof covering	LL	Span / 180	15 mm
	Total	Span / 120	25 mm

- .5 If the roof deck supports green roof, this load shall be considered as a dead load for the purposes of calculating deflection.
- .6 Unless noted otherwise, floor deck deflection under construction loading loads without temporary shoring shall be limited to Span/180.
- .7 Decking to be used as formwork shall conform to WCB formwork requirements.

- .8 Deck thickness, spacing of puddle welds or mechanical fasteners, and type and extent of side connections shall be proportioned to resist forces and loads shown on drawings, or as designated on drawings.
- .9 Where diaphragm loads are not shown on the drawings or where shear requirements are not provided, the design of the decking and its fastenings shall meet a minimum diaphragm shear requirement of 3.5 kN/m.
- .10 Shear stud connectors shall be designed for the forces indicated on the drawings. If the capacities of the individual studs are reduced because of the geometry of the particular deck profile used, provide additional studs so that the total shear transfer capacity provided is at least that indicated on the drawings.

### 3.0 Execution

#### 3.1 ERECTION

- .1 The erection of the steel deck shall be carried out by personnel experienced in the installation of steel deck.
- .2 Obtain and verify all dimensions at project site or from approved shop drawings.
- .3 The Contractor shall be solely responsible for the accuracy of such measurements and precise fitting and assembly of the finished product.
- .4 Use special care in unloading, handling, and erecting the deck to avoid bending, twisting, or otherwise distorting the panels.
- .5 The steel deck units shall be laid in accordance with the approved shop drawings.
- .6 At splice locations, steel decking shall be installed with laps sufficient to ensure that both pieces of deck are properly fastened to the supporting member. As a minimum, over supporting members with uninterrupted top surfaces, such as W-beams and channels, the lap shall be 100 mm and the welds or deck fasteners shall be at or near the centerline of the supporting members. Over supporting members with interrupted top surfaces, such as OWSJs with double angle or hat-shaped top chords, each sheet shall extend a minimum of 25 mm past the opposite edge of the joist chord, and the sheets shall not lap less than 100 mm total. In this case, the welds or deck fasteners shall be centered on the supporting surface nearer the end of the top deck sheet. See General Notes and Typical Details for clarification.
- .7 Metal closures and flashing shall be fastened in place by welding, sheet metal screws, or structural adhesive as recommended by the decking manufacturer.

- .8 Unless noted otherwise in the contract documents, the decking shall be fastened to the structural supports and interconnected at sidelaps with the minimum connection patterns:
- .1 38 mm Deck Profiles
- .1 Connect the deck to the structural support at the first, third, fifth, and seventh low corrugations (36/4 connection configuration), at 300 mm (12") maximum centres, and at each side of each sheet. Connections are to be either a minimum 19 mm (3/4") nominal diameter fusion weld or Hilti powder actuated fasteners Hilti X-ENP-19 L15, X-EDN19 THQ12, X-EDNK22 THQ12, or equivalent.
- .2 Side lap connections of adjacent nested units shall be mechanically fastened (clinched) at 600 mm (24") maximum centres, welded using a minimum 25 mm (1") nominal diameter fusion weld at 600 mm (24") maximum centres, or fastened with Hilti S-SLC01 M HWH, S-SLC02 M HWH, or equivalent at 900 mm (36") maximum centres.
- .3 Discontinuous edge (side) connections shall be either a minimum 19 mm (3/4") nominal diameter fusion weld or Hilti powder actuated fasteners Hilti X-ENP-19 L15, X-EDN19 THQ12, X-EDNK22 THQ12, or equivalent spaced at 300 mm (12") centres maximum.
- .2 76 mm Deck Profiles
- .1 Connect the deck to the structural support at the first, third, and fifth low corrugations (24/3 connection configuration), at 300 mm (12") maximum centres and at each side of each sheet. Connections are to be either a minimum 19 mm (3/4") nominal diameter fusion weld or Hilti powder actuated fasteners Hilti X-ENP-19 L15, X-EDN19 THQ12, X-EDNK22 THQ12, or equivalent.
- .2 Side lap connections of adjacent nested units shall be mechanically fastened (clinched) at 600 mm (24") maximum centres, welded using a minimum 25mm (1") nominal diameter fusion weld at 600 mm (24") maximum centres, or fastened with Hilti S-SLC01 M HWH, S-SLC02 M HWH, or equivalent at 900 mm (36") maximum centres.
- .3 Discontinuous edge (side) connections shall be either a minimum 19 mm (3/4") nominal diameter fusion weld or Hilti powder actuated fasteners Hilti X-ENP-19 L15, X-EDN19 THQ12, X-EDNK22 THQ12, or equivalent spaced at 300 mm (12") centres maximum.
- .3 All powder actuated and screw fasteners are to be installed according to the manufacturer's recommendations.
- .9 Mechanical fasteners may be substituted for welded fasteners as noted in this specification, provided written approval from RJC is received and is in accordance with execution requirements.



- .10 When mechanical fasteners have been specified in the contract documents, they may not be substituted for welded connection without written approval from RJC, and as per City of Barrie procurement documents. The substitution of mechanical fasteners will also entail a magnification of the deck diaphragm design loads provided for the mechanical fasteners. Provision is to be made by the steel deck contractor/trade for the increased design loads if a fastener substitution is desirable.
- .11 Steel deck shall be placed on the supporting steel framework and adjusted to final position before being permanently fastened. Each section shall be brought to proper bearing. If the supporting framework is not in proper alignment or at the proper level, the Contractor shall so advise the Consultant and Structural Engineer of such irregularities and shall not make final placement until corrections are made.
- .12 For steel deck that will not receive a concrete topping, immediately after the steel deck is welded in place, the steel deck surface shall be inspected, and all areas where zinc coating has been burned by welding shall be covered by a suitable zinc enriched paint, applied to the paint manufacturer's instructions.
- .13 Cut openings in metal decking at locations shown on the project drawings. These openings shall be located and dimensioned in cooperation with the various trades at the time of erecting the steel deck. Unless noted otherwise, openings up to 150 mm (6") need not be reinforced. Openings between 150 mm (6") and 400 mm (16") in size shall be reinforced by this trade, using 75 mm x 75 mm x 5.0 mm x 1200 mm (48") steel angles welded to the flutes on either side of those cut.
- .14 The Contractor shall accommodate the erection and welding sequence of the structural steel as required.
- .15 Shear stud connectors to be applied in strict accordance with manufacturer's instructions and Standards. Procedural control to be in accordance with W59 as a minimum and tested in accordance with Section 05 00 50 – Testing of Structural Steel.
- .16 Studs shall be placed in bottom flutes of steel deck on the side closest to the nearest end of the beam.
- .17 After welding studs, the ceramic ferrule shall be removed and the stud fillet visually inspected by the operator. If the fillet is less than 360° around the base of the stud, then the stud is to be hammer tested by the operator by bending the stud 30° from the vertical away from the side of no fillet. If the weld fails, the stud is to be replaced. Bent studs may be left bent.
- .18 If studs are welded to steel plates or members with temperature below 0°C, 1 stud in each 100 is to be tested by the operator by bending 30° from the vertical. This requirement is in addition to the requirements of Section 05 00 50 – Testing of Structural Steel.
- .19 No stud welding is to be done when the base metal temperature is less than -15°C, when the deck surface is wet, or when the structural steel surface below the deck is wet.
- .20 Sound absorption insulation material shall be dry prior to installation and prior to the application of the roofing membrane.

**3.2 COVER PLATES AND CLOSURES**

- .1 Furnish, install, and weld in position, sheet metal cover plates to close openings between deck sections and columns and to cover gaps where deck sections abut or change direction.
- .2 For deck with concrete topping, install all light gauge metal closures and edge strips necessary as formwork for the concrete.
- .3 Install all closures as required by the architectural drawings and specifications.

**3.3 CLEAN UP**

- .1 Steel deck cuttings, strappings, packaging material, and other debris pertaining to steel deck units shall be cleaned up.
- .2 Remove all debris and excess material at completion of erection of steel deck and leave work ready for other trades.
- .3 Touch up welds and other areas of damaged galvanizing with zinc rich paint.
- .4 Repair any defects. Leave steel deck free of all oil, grease, paint, and dirt.

End of Section

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for load-bearing metal studs work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.
- .2 ASTM A653/A653 M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .3 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .4 ASTM C1280, Standard Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing.
- .5 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.
- .6 CSA W47.1, Certification of Companies for Fusion Welding of Steel.
- .7 CSA W55.3, Certification of companies for resistance welding of steel and aluminum.
- .8 CSA W59, Welded Steel Construction (Metal Arc Welding).
- .9 CSA S136, North American Specification for the Design of Cold Formed Steel Structural Members.
- .10 Canadian Sheet Steel Building Institute CSSBI 52M, Lightweight Steel Framing Binder.

1.3 **DESIGN REQUIREMENTS**

- .1 Design load-bearing metal studs to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .2 Design load-bearing metal studs based on Limit States Design principles using factored loads and resistances. Loads and load factors to be in accordance with the National Building Code (NBC). Resistance factors to be determined in accordance with the NBC and CAN/CSA-S136-M.
- .3 Design bridging to prevent member rotation and member translation perpendicular to the minor axis. Provide for secondary stress effects due to torsion between lines of bridging.

- .4 Design load-bearing metal studs in accordance with following Climatic Design Data for Barrie contained in the Ontario Building Code:
  - .1 Design temperature: January 1%, July 2 ½%.
  - .2 Wind (Hourly wind pressures): One (1) in 50 year occurrence.
- .5 Design load-bearing metal studs for the full specified design wind load with the following deflection limits:
  - .1 Brick and stone veneer: L/720.
  - .2 Metal siding and panels: L/360.
- .6 Design load-bearing metal studs without relying on sheathing or gypsum board to resist torsion and weak axis buckling.

#### 1.4 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and system limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Wall construction, load-bearing metal stud wall system, design loads, member sizes, materials, component details, depth and gauge designation exclusive of coatings, location and spacings of framing members, connection and bracing details, bearing, anchorage, loadings, temporary bracing, welds, types and locations of mechanical fasteners, splices, permanent bracing, strapping and sheathing.
    - .2 Indicate locations, dimensions, openings and requirements of related work.
    - .3 Indicate welds by welding symbols as defined in CSA W59.
    - .4 Complete engineering design data to confirm that load-bearing metal studs meet design requirements specified.
- .3 Certificates: Prior to commencement of work, submit two (2) certified copies of load-bearing metal stud mill reports covering material properties.

#### 1.5 **QUALITY ASSURANCE**

- .1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:
  - .1 Design of load-bearing metal studs.
  - .2 Review, stamp, date and sign shop drawings and design calculations.

- .3 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed shop drawings.
  - .2 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding of structural components.
- 2 Products
- 2.1 **ACCEPTABLE MANUFACTURERS**
  - .1 Bailey Metal Products.
  - .2 Sanders Steel Inc.
  - .3 Steelform (West)/Fusion (East) Divisions of Imperial Building Products Ltd.
  - .4 Or approved equivalent.
- 2.2 **MATERIALS**
  - .1 General: All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
  - .2 Steel: to CSA S136, Grade A to D steel with Z275 zinc coating designation in accordance with ASTM A653/A653M.
  - .3 Welding materials: to CSA W59 and certified by Canadian Welding Bureau.
  - .4 Screws: pan head, self-drilling, self-tapping sheet metal screws, corrosion protected to minimum requirements of CSSBI, length to suit intended end use.
  - .5 Anchors: concrete expansion anchors or other suitable drilled type fasteners.
  - .6 Bolts, nuts, washers: hot dipped galvanized to ASTM A123, 600 g/m<sup>2</sup> zinc coating.
  - .7 Primer paint: CAN/CGSB-1.40-M or CPMA 1.73a.
  - .8 Insulation: In accordance with Section 07 21 00.
  - .9 Sill Plate Gasket: Polyethylene foam, moisture resistant, 4.8 mm thick; 'FoamSealR' by Owens Corning or approved equivalent.
  - .10 Isolation coating: Black bituminous coating, acid and alkali resistant material.
  - .11 Exterior sheathing: 12.7 mm, 'GlasRoc Brand Sheathing' with EGRG by CertainTeed Gypsum Canada, 'Securock Glass-Mat Sheathing' by CGC Inc. or 'Dens-Glass Gold' by Georgia-Pacific Canada LP or approved equivalent.

- .12 Sheathing screws: to ASTM C1002, Type S, corrosion resistant, 12.7 mm penetration into steel, complete with 38 mm diameter washers.

## 2.3 **METAL FRAMING**

- .1 Metal studs: to CAN/CSA S136, fabricated from zinc coated steel, depth as indicated. Minimum steel thickness to be 0.91 mm.
- .2 Stud tracks: fabricated from same material and finish as metal studs, depth to suit.
  - .1 Bottom track: single piece.
  - .2 Top track: two piece telescoping or single piece as required by design.
- .3 Bridging: fabricated from same material and finish as studs, 38 x 12 x 1.22 mm minimum thickness.
- .4 Angle clips: fabricated from same material and finish as studs, 38 x 38 mm x depth of metal stud, 1.22 mm minimum thickness.
- .5 Tension straps and accessories: In accordance with reviewed shop drawings and as recommended by manufacturer.

## 3 Execution

### 3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

### 3.2 **PREPARATION**

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, and other foreign matter detrimental to performance. Ensure environmental and site conditions are suitable for installation of system.

### 3.3 **INSTALLATION**

- .1 Install load-bearing metal studs in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Install sill plate gasket under bottom track at foundation wall locations and in locations indicated in accordance with manufacturer's written instructions. Butt all end and perpendicular joints tightly.
- .3 Perform work in accordance with CSSBI 52M. Perform welding in accordance with CSA W59.

- .4 Erect studs plumb, aligned and securely attached with two (2) screws minimum at each point of attachment, or welded in accordance with manufacturer's recommendations. Anchor tracks securely to structure at 800 mm o.c. maximum, unless lesser spacing prescribed on shop drawings.
- .5 For telescoping tracks install 50 mm minimum telescoping track at top of walls where required to accommodate vertical deflection. Nest top track into deflection channel a minimum of 30 mm and a maximum of 40 mm. Do not fasten tracks together. Stagger joints.
- .6 Seat studs into bottom tracks and top track. Install studs at not more than 50 mm from abutting walls, openings, and each side of corners and terminations with dissimilar materials.
- .7 Brace metal studs with horizontal internal bridging at spacing shown on reviewed shop drawings. Fasten bridging to steel clips fastened to metal studs with screws or by welding.
- .8 Frame openings in stud walls to adequately carry loads by use of additional framing members and bracing as detailed on shop drawings.
- .9 Cutouts: Limit distance from centerline of last unreinforced cutout to end of member to less than 300 mm.
- .10 Touch up welds with coat of zinc rich primer.
- .11 Erection Tolerances;
  - .1 Plumb: not to exceed 1/500th of member length.
  - .2 Camber: not to exceed 1/1000th of member length.
  - .3 Spacing: not more than three (3) mm from design spacing.
  - .4 Gap between end of stud and track web: not more than four (4) mm.
- .12 Install insulation in accordance with Section 07 21 00.
- .13 Apply isolation coating over entire contact surfaces of all dissimilar materials to prevent electrolytic action for protection from galvanic corrosion.

### 3.4 **SHEATHING INSTALLATION**

- .1 Install sheathing materials in accordance with ASTM C1280, reviewed shop drawings, and manufacturer's written instructions.
- .2 Install sheathing with long dimension perpendicular to metal studs, offset joints and butt tight, centre edges of sheathing over metal studs, mechanically fasten with specified fasteners and washers in accordance with manufacturer's instructions.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for the miscellaneous and metal fabrication work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- .2 ASTM A123, Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products.
- .3 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .4 ASTM A480/A480M-15, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet and Strip.
- .5 ASTM A276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
- .6 ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
- .7 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .8 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.
- .9 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.
- .10 CAN/CSA S16.1-M, Limit States Design of Steel Structures.
- .11 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.
- .12 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .13 CSA W48, Filler Metal and Allied Materials for Metal Arc Welding.
- .14 CSA W59-M, Welded Steel Construction (Metal Arc Welding).
- .15 CAN/CSA W117.2-M, Safety in Welding, Cutting and Allied Processes.
- .16 CAN/CGSB 1.40-M, Primer, Structural Steel, Oil Alkyd Type.
- .17 CGSB 85-GP-16M, Painting Galvanized Steel.



- .18 NAAMM, The National Association of Architectural Metal Manufacturers.
- .19 Steel Structures Painting Council (SSPC), Steel Structures Painting Manual, Vol. 2.

### 1.3 **DESIGN REQUIREMENTS**

- .1 Design details and connections, where not shown on Drawings, in accordance with CAN/CSA-S16.1 and CSA S136.1.

### 1.4 **SUBMITTALS**

- .1 Shop drawings:
  - .1 Submit shop drawings for fabrication and erection of miscellaneous and metal items in accordance with Section 01 30 00 indicating:
    - .1 Materials, core thicknesses, class of finish (AMP 555), connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
    - .2 Ensure shop drawings are of one (1) uniform size and based on field measurements.

### 1.5 **QUALITY ASSURANCE**

- .1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in work of comparable complexity and scope, to perform the following services as part of the work of this Section:
  - .1 Design metal fabrication items that are required to resist live, dead, lateral, wind, or seismic loads.
  - .2 Review, stamp, date and sign shop drawings..
- .2 Workmanship: Fabricate work of this Section to meet the required class of workmanship indicated below in accordance with NAAMM's AMP 555, Section 8.
  - .1 Class 1: for use on direct exposed to view fabricated items:
    - .1 Exposed surfaces are finished smooth without pits, mill marks, nicks, burrs, sharp edges, and scratches filled or ground off. Defects should not show when painted, polished, or finished.
    - .2 Welds should be concealed where possible. Exposed welds are ground to small radius with uniform sized cove unless otherwise noted.
    - .3 Distortions should not be visible to the eye.
    - .4 Exposed joints are fitted to a hairline finish.
- .3 Execute welding by firms certified in accordance with CSA W47.1 Division 1 or 2.1. Ensure welding operators are licensed per CSA W47.1 for types of welding required by Work.
- .4 Perform stainless steel work in accordance with NAAMM, Code of Standard Practice for the Metal Industry, Workmanship, Class 1.

2 Products

2.1 **MATERIALS**

.1 General:

- .1 All materials under work of this Section, including but not limited to, primers and paints are to have low VOC content limits.
- .2 Unless detailed or specified herein, standard products will be acceptable if construction details and installation meet intent of Drawings and Specifications.
- .3 Include all materials, products, accessories, and supplementary parts necessary to complete assembly and installation of work of this Section.
- .4 Incorporate only metals that are free from defects which impair strength or durability, or which are visible. Install only new metals of best quality, and free from rust or waves and buckles, and that are clean, straight, and with sharp defined profiles.

.2 Structural shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W. Hollow structural sections: CAN/CSA-G40.20/G40.21-M, Grade 350W, Class H.

.3 Galvanized sheet steel: ASTM A653/A653M Grade A, Z275 Commercial Quality zinc coating, size and shape as shown.

.4 Stainless steel:

- .1 Sheet and plate: ASTM A480/A480M, Type 304.
- .2 Shapes: ASTM A276, Type 304.
- .3 Finish: AISI No. 4. or X-L Blend S.
- .4 Size(s): Size as shown.

.5 Bollards (protection posts): ASTM A53/A53-M, Schedule 40 standard weight steel pipe in quantity and sizes shown.

.6 Metal grating: Galvanized steel bar grating 'Standard Tru-Weld' type 19-2 by Fisher & Ludlow or approved equivalent. Size and pattern as indicated on drawings.

.7 Welding materials: CSA W48 and CSA W59-M.

.8 Fasteners: Conforming to ASTM A307, Grade A, in areas not exposed to view, use unfinished bolts with hexagon heads and nuts. In areas exposed to view, use bolts, nuts, washers, rivets, lock washers, anchor bolts, machine screws and machine bolts Z275 zinc coated in accordance with ASTM A653/A653M. Supply bolts of lengths required to suit thickness of material being joined, but not projecting more than 6 mm beyond nut, without the use of washers.

.9 Primer paint: CAN/CGSB-1.40-M or CPMA 1.73a.

- .10 Galvanized primer paint: Inorganic zinc rich primer. For use on galvanized fabrications where touch up is to remain unpainted in finished work; Carbozinc 11WB by Carboline Company, Catha-Coat 305 by Devoe Coatings or Zinc Clad XI by Sherwin Williams or approved equivalent.
- .11 Drilled inserts: "HSL-3" by Hilti Inc. or "Dynabolt Sleeve Anchors" by ITW Construction Products or approved equivalent, heavy-duty anchors, sizes as shown.
- .12 Adhesive anchor system: 'HIT HY 200 Injectable Mortar with Hilti HAS Stainless Steel Anchor Rod System' by Hilti Ltd or by ITW Construction Products or approved equivalent, complete with all components required for a complete installation.

## 2.2 **FABRICATION**

- .1 Verify dimensions of existing Work before commencing fabrications and report any discrepancies to the Consultant.
- .2 Fit and assemble work in shop where possible. Execute work in accordance with details and reviewed shop drawings.
- .3 Use self-tapping shake-proof screws on items requiring assembly by screws or as indicated. Use screws for interior metal work. Use welded connections for exterior metal work unless otherwise found acceptable by the Consultant.
- .4 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush. Seal exterior steel fabrications against corrosion in accordance with CAN/CSA S16.1-M.
- .5 Execute shop welding to requirements specified .
- .6 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.
- .7 Assemble members without twists or open joints.
- .8 Correctly size holes for connecting work of other trades where such can be determined prior to fabrication. Where possible, show holes on shop drawings. Place holes not to cause appreciable reduction in strength of member.
- .9 Draw mechanical joints to hairline tightness and seal countersunk screw and access holes for locking screws with metal filler where these occur on exposed surfaces.

## 2.3 **FABRICATED ITEMS**

- .1 Refer to Drawings for details of metal fabrication work and related items not specifically listed in this Section.
- .2 Where work is required to be built into work of other Sections supply such members to respective Sections.

- .3 Provide miscellaneous and metal fabrications indicated on the drawings, listed below, and not indicated to be supplied under other Sections. Provide miscellaneous and metal fabrications including but not limited to the following:
- .4 Lintels: Fabricated from CAN/CSA-G40.20/G40.21-M, Grade 350W, size and location as shown, width to be not less than 25 mm less than width of wall and extend 200 mm beyond opening at each end. Unless otherwise shown, fabricate lintels in block walls of steel sections.
5. Masonry lateral support angles:
  - .1 Supply only, to Section 04 20 00 for installation, all horizontal lateral support anchors at top of non-load-bearing masonry walls.
  - .2 Refer to Structural Drawings for size and spacing of required support anchors. Provide drilled holes as required for anchorage.
  - .3 Galvanized for all exterior wall and unheated and high humidity locations.
6. Shelf Angles: Of size indicated on Drawings and as specified in structural steel specifications, with adjustable inserts for vertical adjustment and slotted holes for horizontal; galvanized.
- .7 Channel door frames: Structural channel sections, selected for trueness of web and flange, with joints welded and ground smooth. Supply bar stop and bent bar anchors for anchorage to masonry or concrete as required. Fit frames with temporary spreaders to prevent frame from springing out of shape.
- .8 Support framing for toilet partitions and cubicles: Structural channel and angle framing continuously welded and securely anchored to structure above. Design framing and anchorage to support assembly dead loads and live loads, and lateral loads attributable to misuse and vandalism. Finish: Prime painted.
- .9 Support framing for Four Fold Doors: Structural channel and angle framing continuously welded and securely anchored back to structure. Design framing and anchorage to support assembly dead loads and live loads, and lateral loads. Finish: Prime painted.
- .10 Gratings:
  - .1 Fabricate gratings to sizes shown.
  - .2 Pressure lock bars to form rigid panels of required size. Band open ends of bars.
  - .3 Make jointing in built-up sections with hairline joints in least conspicuous location. Assemble work securely and reinforce where necessary with similar fastenings. Countersink screws unless otherwise noted. Grind exposed surfaces of rolled steel shapes or fill perfectly smooth.
  - .4 Supply items that are required to be built into concrete and masonry.
  - .5 Fabricate, finish and assemble items in shop where possible, consistent with size and shipping. Minimize field assembly.
  - .6 Mitre cut metal mouldings for angles. Butt joints will not be accepted for these locations.

- .7 Provide grating access panels as indicated on drawings with heavy duty hinges, latched handle, and locking hasp.
- .11 Corner Guards: 100 x 100 x 3.0 mm, stainless steel 2000 mm high with adjustable masonry anchors welded to back at maximum 400 mm centres.
- .12 Steel ladders (interior and exterior):
  - .1 Fabricate complete with steel stiffeners, rungs, angle rails, bent plate straps or angle brackets as shown.
  - .2 Ladders in elevator pits shall extend 1220 mm high above finished floor.
  - .3 Provide safety cages around ladders where indicated on Drawings, in accordance with Ministry of Labour requirements.
  - .4 Provide safety grating at top landing of exterior ladder. Galvanized steel channel planks with serrated edges on diamond shaped openings. 'Grip Span 9-1/2" Diamond' by Fisher & Ludlow or approved equivalent.
  - .5 Finish: Hot dipped galvanized.
- .13 Hose tower platform:
  - .1 Fabricate platform complete with, but not limited to galvanized steel bar grating, guardrail and hose pegs:
    - .1 Metal grating: 6 mm thick steel plate, size and pattern as indicated on drawings.
    - .2 Guardrails, and posts:
      - .1 Design railings to withstand minimum horizontal and vertical loads as required to meet requirements of authorities having jurisdiction. In no instance shall load design of railings be less than 3.0 kN/m horizontally and 1.5 kN/m vertically.
      - .2 Close open ends of steel guardrails with 1.9 mm thick closure neatly welded. Fabricate guardrails as shown on drawings.
      - .3 Guardrail bracket: Fabricate as shown. After fabrication, galvanized bracket in accordance with ASTM A123.
    - .3 Hose pegs: Heavy duty galvanized steel.
  - .2 Finish: Hot dipped galvanized.
- .14 Bollards (protection posts):
  - .1 Provide bollards as indicated on drawings. Posts to be 250 mm diameter with a wall thickness of 8 mm. Place posts into a 1500 mm foundation, fill with 20 Mpa concrete and round top. Project pipes 1500 mm above finished grade. Finish prime coat.
  - .2 Finish: Provide paint finish in accordance with Section 09 91 00, colour to be selected by Consultant.
- .15 Vanity counter supports:
  - .1 Provide supports for vanity counters. Construct supports where indicated, conceal supports within cavity of drywall partition.
  - .2 Provide all drill holes required for concealed anchorage of counters and for anchoring to building structure.

- .16 Bench Supports:
  - .1 Supply only, for installation under work of Section 06 20 00, bench supports constructed of steel plates of sizes noted. Provide supports at maximum 609 mm centres and not less than 152 mm from ends of bench run.
  - .2 Construct supports as detailed. Provide all drill holes required for concealed anchorage of wood bench and for anchoring to building structure.
- .17 Miscellaneous steel brackets, supports and angles
  - .1 Supply and install or supply for installation by trades responsible, all loose steel brackets, supports and angles where indicated, except where such brackets, supports and angles are specified under work of other Sections. Drill for countersunk screws, expansion anchors and anchor bolts.
  - .2 Unless otherwise specified, prime paint for interior installation; galvanized finish for exterior installation.

## 2.4 **STAINLESS STEEL WORK**

- .1 Take all necessary precautions to safeguard against latent surface discolouration due to disturbance of the natural protective oxide coating of the material or to contamination from other sources.
- .2 Workmanship shall be the best standard practice for this type of work. Execute stainless steel work in accordance with the applicable instructions set forth in Atlas Stainless Steels' "Technical Data" handbook on stainless steel.
- .3 Do all stainless steel fabrication in clean shops, located away from areas where carbon steel is burnt, ground, or cut with abrasive wheels to ensure that carbon steel dust will not be embedded into the stainless steel, and as follows:
  - .1 In fabrication of stainless steel do not use tools and dies which have been used on carbon steels.
  - .2 Ensure tools and dies use for forming and cutting stainless steel are free of nicks and other damage.
  - .3 Do not use carbon grits and grinding wheels which will imbed foreign particles into stainless steel surfaces. Use only stainless steel wool when wool polishing is required.
  - .4 Stainless steel items, on which rust stains appear, shall be replaced with new fabricated material.

## 2.5 **ANCHORS AND FASTENING**

- .1 Use weld studs of size not larger than ten (10) mm for attaching miscellaneous materials and equipment to building steel. If weight of item requires larger fasteners use clips or brackets and secure by welding or through bolting.
- .2 Use self drilling expansion type concrete anchors for attaching to masonry and concrete
- .3 Do not secure items to steel deck.

- .4 Use steel beam clamps of two bolt design to transmit load to beam web. Do not use C and I clamps.

## 2.6 **WELDING**

- .1 Perform welding by electric arc process.
- .2 Execute welding to avoid damage or distortion to Work. Execute welding in accordance with following standards:
  - .1 CSA W48 - for Electrodes. If rods are used, only coated rods are allowed.
  - .2 CSA W59-M and CSA W59S1-M for design of connections and workmanship.
  - .3 CAN/CSA W117.2-M - for safety.
- .3 Thoroughly clean welded joints and expose steel for a sufficient distance to perform welding operations. Finish welds smooth. Supply continuous and ground welds which will be exposed to view and finish paint.
- .4 Test welds for conformance and remove work not meeting specified standards and replace to Consultant's acceptance.

## 2.7 **SHOP PAINTING**

- .1 Clean steel to SSPC SP6 and remove loose mill scale, weld flux and splatter.
- .2 Shop prime steel with one coat of primer paint to dry film thickness of 0.07 mm. Paint on dry surfaces, free from rust, scale, grease. Do not paint when temperature is lower than 7 deg C. Paint items under cover and leave under cover until primer is dry. Follow paint manufacturer's recommendations regarding application methods, equipment, temperature, and humidity conditions.
- .3 Shop prime galvanized steel in accordance with CGSB 85-GP-16M.
- .4 Clean but do not paint surfaces being welded in field.
- .5 Do not paint surfaces embedded in concrete, but clean as if they were to be primed.
- .6 Do not prime steel to be fireproofed or to receive intumescent paint coating.
- .7 Do not prime machine finished surfaces, but apply an effective anti-rust compound.
- .8 Take precautions to avoid damage to adjacent surfaces.



**2.8 HOT DIP GALVANIZING**

- .1 After fabrication, hot dip galvanize specific miscellaneous steel items as indicated. After galvanizing, plug relief vents air tight with appropriate aluminum plugs as suitable and required for intended metal fabricated item. Straighten shapes and assemblies true to line and plane after galvanizing. Repair damaged galvanized surfaces with zinc rich primer in accordance with manufacturer's printed directions.
- .2 Hot-dip galvanize members in accordance with requirements of the following ASTM, with minimum coating weights or thicknesses as follows:
  - .1 Rolled, pressed and forged steel shapes, plates, bars and strips: ASTM A123; average weight of zinc coating per square/metre of actual surface, for 4.8 mm and less thickness members 600 g/m<sup>2</sup> for six (6) mm and heavier members 640 g/m<sup>2</sup>.
  - .2 Iron and steel hardware: ASTM A153; minimum weight of zinc coating, in ounces per square foot of surface, in accordance with ASTM A153, Table 1 for the various classes of materials used in the Work.

**3 Execution**

**3.1 EXAMINATION**

- .1 Examine previously installed Work, upon which this Section depends, verify dimensions and condition of existing Work, and coordinate repairs, alterations, and rectification if necessary. Commencement of work of this Section is deemed to signify acceptance of existing, prior conditions.
- .2 Obtain Consultant's written approval prior to field cutting or altering of structural members.

**3.2 ERECTION**

- .1 Install metal fabrications in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Fit joints and intersecting members accurately. Make work in true planes with adequate fastenings. Build and erect work plumb, true, square, straight, level and accurate to sizes detailed, free from distortion or defects detrimental to appearance or performance.
- .3 Perform drilling of concrete and steel as required to fasten work of this Section.



**3.3 TOUCH UPS**

- .1 Paint bolt heads, washers, nuts, field welds and previously unpainted items. Touch up shop primer damaged during transit and installation, with primer to match shop primer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for rough carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- .2 ASTM A325, Specification for Bolts Quenched/Tempered Steel Nominal Thread Diameter M16 - M36 For Structural Steel Joints.
- .3 ASTM A653, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .4 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .5 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.
- .6 CAN/CSA O80 Series M, Wood Preservation.
- .7 CSA O121-M, Douglas Fir Plywood.
- .8 CAN/CSA O141, Softwood Lumber.
- .9 CSA O151-M, Canadian Softwood Plywood.
- .10 CWC, Canadian Wood Council, Wood Reference Book.
- .11 NLGA, Standard Grading Rules for Canadian Lumber, National Lumber Grades Authority

1.3 **QUALITY ASSURANCE**

- .1 Lumber identification: Grade stamp of an agency certified by the Canadian Lumber Standards Accreditation Board.
- .2 Plywood identification: Grade mark in accordance with applicable CSA standards.
- .3 Lumber quality: Carefully select individual pieces so that knots and obvious defects will not interfere with placing bolts, proper nailing or making proper connections.
- .4 Moisture Content of wood at time of construction shall be 19% maximum.

- .5 Each piece of pressure treated lumber and fire retardant treated lumber shall be shop marked with the pressure treatment brand and ULC monogram respectively, in accordance with CAN/CSA O80-M.
- 6. Dimensions of lumber shall conform to dressed sizes specified in CAN/CSA-0141 unless actual dimensions are otherwise indicated or specified.
- 7. Dimensional references to lumber on Drawings and in Specifications are to nominal sizes unless actual dimensions are indicated. Such actual dimensions shall be dry size.
- .8 Lumber defects: Discard wood with defects which will render a piece unable to serve its intended function. Lumber will be rejected by Consultant for excessive warp, twist, bow, crook, mildew, fungus, or mould, as well as for improper cutting and fitting, whether or not it has been installed.

#### 1.4 **ENVIRONMENTAL REQUIREMENTS**

- 1. When it is required that wood maintain dimensional stability and tolerances to ensure accurate installation of later work, store and install it only in dry areas, and where no further installation of moist materials is contemplated.

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

- .1 Store materials in a dry area. Cover materials with tarpaulins or polyethylene sheets to prevent moisture absorption and impairment of structural and aesthetic properties. Vent to allow air movement. Tie covering to keep in place.

### 2 Products

#### 2.1 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.
- .2 Lumber: Softwood, G4S, moisture content 19% or less at time of installation, in accordance with the following:
  - .1 Lumber shall be of same species and grade, equally seasoned and shall be processed and stamped at same mill.
  - .2 CSA O141 and NLGA Standard Grading Rules for Canadian Lumber.
  - .3 Board quality: Construction or better.
  - .4 Dimension quality:
    - .1 Structural joists, planks, and framing: No. 1 Select Structural.
    - .2 Light framing: Construction.
- .3 Plywood: CSA O121-M, G1S, T & G, standard construction, laminated with waterproof adhesive, exterior grade, Thickness as indicated on drawings.

- .4 Sheathing: Douglas Fir, CSA 0121-M or CSA O151-M; Select-Tight Face, exterior grade, T & G.
- .5 Roof lumber: NLGA, Construction grade light framing, Jack Pine, S4S, pressure treated to CAN/CSA-O80 series using copper based waterborne preservative treatment, impregnated to a net retention of four (4) kg/ m<sup>3</sup> of preservative unless otherwise specified by preservative manufacturer.
- .6 Surface applied wood preservative: Green coloured copper napthenate or 5% pentachlorophenol solution, water repellent preservative or same copper based preservative as used for shop impregnation, in accordance with CAN/CSA O80.
- .7 Fire retardant treatment of lumber and plywood (interior and protected locations): 'Dricon FRT' fire retardant treatment by Biewer Lumber or approved equivalent, conforming to ASTM E84, to provide a flame spread rating of 25 or less.
- .8 Rough hardware: Conforming to ASTM F1667; Nails, bolts, screws, anchors, expansion shields, and other fastenings required to frame and fix rough carpentry as follows:
  - .1 Nails, spikes and staples: Spiral type.
  - .2 Bolts: ASTM A325; 12.7 mm diameter minimum with nuts and washers unless noted otherwise.
  - .3 Screws: Countersunk head, full thread type.
  - .4 Proprietary fasteners: Toggle bolts, expansion shields, lag bolts, screws, inorganic fibre plugs, recommended for purpose by manufacturer.
  - .5 Galvanize rough hardware used in fire treated wood and hardware exposed to the atmosphere.
- .9 Fasteners for use in pressure treated wood: Provide hot dipped galvanized fasteners complying to ASTM A153 and connectors in accordance with ASTM A653, Class G185 for non-structural members. Provide type 304 or 316 stainless steel fasteners and connectors for use in Structural, pressure treated wood.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 GENERAL

- .1 Lay out work carefully and to accommodate work of others. Cut and fit accurately: erect in position indicated by Drawings.
- .2 Install rough carpentry to allow for expansion and contraction of the materials.

- .3 Cut work into lengths as long as practicable and with square ends. Align, level, square, plumb, and secure work permanently in place. Brace work temporarily as required. Join work only over solid backing.
- .4 Bore holes true to line and to same size as bolts. Drive bolts into place for snug fit, and use plates or washers for bolthead and nut bearings. Turn up bolts and lag screws tightly when installed, and again just before concealed by other work or at completion of Work.
- .5 Provide anchors, bolts, and inserts required for attachment of the work of this Section, to those performing the work of other Sections and who are responsible for their installation.
- .6 Do not attach work by wood plugs or blocking in concrete or masonry. Use lead shields, expansion shields, or similar methods only as approved by Consultant.

### 3.3 **MISCELLANEOUS WOODWORK**

- .1 Fit and install wood furring, strapping, grounds and blocking. Adequately size, correctly place and conceal members for finishes, fitments and for work under other Sections. Do not assume that Drawings show required work exactly or completely. Anchor wood members securely in place.
- .2 Install rough bucks, nailing strips and linings to rough openings as required for backing for frames and other work.
- .3 Except where steel supports are specifically shown, provide wood blocking and supports in metal stud partitions for fastening of item such as casework and other wall mounted accessories. Have respective trades approve the location of such wood blocking.
- .4 Bolt wood blocking or nailing strips to steel framing.
- .5 Align and plumb faces of furring and blocking to tolerance of 1:600.
- .6 Use fire retardant lumber for blocking/framing in ceiling\spaces, partitions and bulkheads.

### 3.4 **ROOF WOODWORK**

- .1 Install roof woodwork as indicated on drawings.
- .2 Fasten roof woodwork at maximum 400 mm o.c. in staggered pattern unless noted otherwise.

### 3.5 **BACKBOARDS**

- .1 Install plywood backboards, primed and painted white on both sides, with fire retardant paint.

- .2 Use minimum 19 mm thick plywood on 19 x 38 mm furring around perimeter and at maximum 300 mm intermediate spacing.

### 3.6 **FASTENERS**

- .1 Frame, anchor, fasten, tie and brace members for required strength and rigidity.
- .2 Use hot dipped galvanized fasteners for exterior work and work below grade.
- .3 Countersink bolts and bolt heads as required for clearance of other work.
- .4 Size fasteners to penetrate base member by half of fastener length minimum. Minimize splitting of wood members by staggering nails in direction of grain.
- .5 For plywood use spiral, annular or resin coated nails and staples.

### 3.7 **SURFACE-APPLIED WOOD PRESERVATIVE**

- .1 Treat raw surfaces, drilled holes and cut ends of pressure treated wood with two (2) coats of wood preservative immediately after cutting.
- .2 Apply preservative by dipping, by brush or by pouring into plugged holes to completely saturate surface.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products equipment and services necessary for the finish carpentry work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI A208.1, Particleboard.
- .2 ANSI/HPVA HP-1, Hardwood and Decorative Plywood.
- .3 ANSI/NEMA LD 3, High-Pressure Decorative Laminates.
- .4 APA - The Engineered Wood Association.
- .5 ASTM F1667, Driven Fasteners: Nails, Spikes and Staples.
- .6 Architectural Woodwork Manufacturers Association of Canada (AWMAC).
- .7 North American Architectural Woodwork Standards (NAAWS).
- .8 CAN/CSA O141, Softwood Lumber.
- .9 CSA O151-M, Canadian Softwood Plywood.
- .10 National Hardwood Lumber Association (NHLA) Rules for the Measurement and Inspection of Hardwood and Cypress.
- .11 National Lumber Grades Authority (NLGA) Standard Grading Rules for Canadian Lumber.

1.3 **SUBMITTALS**

- .1 Shop drawings: Submit shop drawings of finish carpentry work in accordance with Section 01 30 00 indicating:
  - .1 Materials, thicknesses, sizes, finishes, wood species, grades, profiles, connection attachments, shop jointing, field jointing, reinforcing, anchorage, fastener types and sizes, location of exposed fastenings, mechanical and electrical service routes, service outlets, cutout locations, and sizes.
  - .2 Include erection drawings, plans, elevations, sections, and details as applicable.

- .2 Samples: Submit samples of the following in accordance with the requirements of Section 01 30 00:
  - .1 Two (2) representative pieces of each type of wood to receive a stained or natural finish.
  - .2 Two (2) representative pieces of each type of wood finished as specified.
  - .3 Two (2) of each colour, pattern, gloss, and texture of plastic laminate, in manufacturer's standard tag size.
  - .4 Two (2) samples of laminated plastic joints, edging, cutouts and postformed profiles.
  - .5 Two (2) of each solid surface, in 100 x 75 x 12 mm samples.
  - .6 Two (2) samples of melamine surfaced board, edging and postformed profiles.
  - .7 One (1) of each item of finish carpentry hardware.

#### 1.4 **QUALITY ASSURANCE**

- .1 Execute work of this Section by member of AWMAC, with five (5) years experience in finish carpentry work of comparable complexity and scope. Submit proof of experience upon Consultant's request.
- .2 Fabricate finish carpentry work in accordance with NAAWS, Premium Quality materials and installation unless otherwise indicated. Perform work in accordance with the definition of Good Workmanship as defined in the NAAWS.
- .3 Remove and replace finish carpentry work which does not conform to the NAAWS or as amended by these Specifications.
- .4 Mock-up:
  - .1 Shop fabricate one mock-up of a base cabinet, wall cabinet, and counter top for each type of surfacing specified, complete with hardware and shop applied finishes, installed in location acceptable to Consultant.
  - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with work.
  - .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

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

- .1 Deliver, store, and handle finish carpentry in accordance with the NAAWS. Control the temperature and humidity in accordance with the NAAWS recommendations, before, during, and after finish carpentry delivery, and also during storage and installation.
- .2 Cover finished plastic laminated work with heavy kraft paper or put in cartons during shipment. Protect installed surfaces by approved means. Do not remove until immediately before final inspection.



2 Products

2.1 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, adhesives and mastics, are to have low VOC content limits.
- .2 Concealed framing lumber: Eastern Spruce, Balsam Fir, or Jack Pine, to CAN/CSA O141, NLGA, and NAAWS Custom Grade, S4S, average moisture content 7% +/- 2% at installation.
- .3 Hardwood lumber: Maple, unless otherwise indicated, to NHLA and NAAWS Premium Grade, S4S, average moisture content 7% +/- 2% at installation.
- .4 Hardwood Plywood (for cabinet frames, stretchers and blocking): Graded in accordance with AWMAC/AWI; average moisture content of 6-8%; species and grade as follows:
  - .1 Shop sanded veneer core Maple plywood, 19 mm or 25 mm thickness.
- .5 Softwood plywood for drawer body construction: Maple veneer core plywood (all laminations Maple veneer), interior grade plywood, G2S, sanded
  - .1 Quality Standard: GOST 3916.1 (Russian), Veneer Grade: BB/BB;
  - .2 Thicknesses: 12 mm (nine laminations) and 15 mm (eleven laminations)
- .6 Hardwood veneer:
  - .1 Maple unless otherwise indicated, conforming to ANSI/HPVA HP-1 having finishes and meeting grades as follows:
    - .1 Transparent finish, Grade AA.
  - .2 Face veneer cut: Rotary cut.
  - .3 Sizes, thickness, and shapes as indicated.
- .7 Shelving: 19 mm thickness for spans up to 700 mm, 25 mm thickness for longer spans, Maple hardwood core veneers, with hardwood veneer edge banding.
- .8 Cabinet Backs: Particle board core.
- .9 Plastic laminate: Provide plastic laminates conforming to ANSI/NEMA LD 3 as follows:
  - .1 Flatwork face sheet: 1.2 mm thick, heavy wear resistance.
  - .2 Vertical interior face sheets: 0.8 mm thick.
  - .3 Postformed face sheet: 0.8 mm thick.
  - .4 Backing sheet: thickness to match face sheet, high pressure laminate, manufactured by same manufacturer as face sheet.
  - .5 Plastic laminate: As manufactured by Arborite, Formica, Lamin-Art, and Lamitech HPL (Weston Premium Woods) and Wilsonart or approved equivalent.
  - .6 Colours: To the later selection of the Consultant from manufacturer's standard colour range.

10. Melamine Surfaced Particleboard: ANSI A208.1, Grade M2 particleboard with a melamine impregnated decorative paper thermofused onto the surface. Edging to be done in minimum 0.5 mm thin PVC to match melamine colour. Refer to Colour and Material Schedule for melamine type.
- .11 Particle board core (for cabinet door and drawer fronts): ANSI A208.1, Grade M2 of thickness indicated. Particleboard to be bound with waterproof adhesive and meeting the following minimum criteria:
  - .1 Density: minimum 705 kg/m<sup>3</sup>.
  - .2 Internal bond: 0.45 N/mm<sup>2</sup>.
  - .3 Modulus of rupture: 14.5 N/mm<sup>2</sup>.
  - .4 Modulus of elasticity: 2250 N/mm<sup>2</sup>.
  - .5 Face screw holding: 1000 N.
  - .6 Edge screw holding: 900 N.
- .12 Tall Storage Units: 45 mm solid core wood doors with matching stiles. Doors to be installed on 38 mm x 45 mm solid hardwood rails. Rails to be rabbeted and glued to gables.
- .13 Laminating adhesive: CSA O112 Series, water resistant type, low VOC content, selected by laminate manufacturer for intended end use.
- .14 Engineered quartz countertop: 93% crushed quartz combined with polyester resins and pigments formed into minimum 20 mm thick dense non-porous slabs with polished finish. Refer to Colour and Material Schedule for quartz colour and type.
- .15 Solid Surfacing:
  - .1 12 mm thick sheet stock, provide with bullnose edge and all cutouts as required. 'Avonite' solid surfacing or approved equivalent. Refer to Colour and Material Schedule for colour type.
  - .2 Installation and seam adhesives to be as recommended by solid surfacing manufacturer, colour matched to solid surfacing.
- .16 Wood benches: Refer to Colour and Material Schedule for wood type in sizes and thickness shown on drawings.
- .17 Draw bolts and splines: Type as recommended by fabricator.
- .18 Nails and staples: Conforming to ASTM F1667; Size and type to suit application, galvanized for exterior work, interior humid areas and for treated lumber; plain finish elsewhere.
- .19 Bolts, nuts, washers, blind fasteners, lags and screws: Size and type to suit application. Stapling is not acceptable.
- .20 Adhesive and bituminous mastic: Selected by the millwork fabricator with low VOC content.
- .21 Miscellaneous metals: In accordance with Section 05 50 00.

- .22 Finishing: In accordance with Section 09 91 00.

## 2.2 **HARDWARE**

- .1 The following hardware is the minimum quality standard for the work of this Section. Alternatives may be considered provided they are approved by Consultant prior to ordering of products.
- .2 19 mm Door Hinges: Blum Press-In 170 degree self close full overlay or Salice or approved equivalent. Hinges to be provided with factory installed knock in dowels. For quantity of hinges required per door, refer to hinge manufacturer's manual. Wood screw fastening system will not be accepted.
- .3 19 mm Door Hinge Plates: One piece plate with min. three (3) mm height adjustment. Hinge plates to be installed using pre-mounted system screws, Euro screw in five (5) mm pre-drilled hole. Wood screw fastening system will not be accepted.
- .4 19 mm Door Dampener: Blumotion 971A with Cruciform Base or Salice or approved equivalent required for all 19mm doors to allow for soft closing.
- .5 19 mm Bumpers: Polyurethane three (3) mm high X ten (10) mm diameter / minimum two (2) per door and drawer front.
- .6 Shelf Standards and Clips: KV 255 pilaster and KV 256 clip – satin nickel finish / Note: Pilasters to be fully recessed into gables.
- .7 Drawer and cabinet pulls: Refer to Colour and Material Schedule.
- .8 Coat Rods and Flanges: Richelieu # 122108140 and 1225140 or approved equivalent.
- .9 Coat Hooks in Occasional Staff Lockers: '307 C26D' by GSH or approved equivalent.
- .10 Elbow catches: Richelieu Heavy Duty Elbow Catch # 5540180 or approved equivalent / nickel finish / required at all two door units.
- .11 Drawer Slides: Accuride 45 kg (100 lbs) #3832EC or approved equivalent x length to suit. Finish C - Clear Electroplating.
- .12 Locks:
- .1 Cam locks/deadbolt locks complete with lock core by Hafele or approved equivalent, type to suit application and installation.
  - .2 Each room to be keyed alike.
  - .3 Tall storage unit door hinges and locksets, to be supplied by Hardware Supplier, installed by cabinet manufacturer.
  - .4 All cabinet doors and drawers to be lockable. Provide three keys per key code and five master keys.

- .13 Castors: 50 mm, general duty rubber swivel caster with brake and 57 kg (125 lb) weight capacity, 'Model F25086' by Richelieu or approved equivalent.
- .14 Safety release coat hook: High strength polycarbonate, screw mounted; Henkelhook or approved equivalent.

## **2.3 PLASTIC LAMINATE WORK**

- .1 Perform plastic laminate Work in accordance with AWS Quality Standards and ANSI/NEMA LD 3.
- .2 Ensure adjacent parts of continuous laminate work match in colour and pattern.
- .3 Laminate plastic laminates to core materials in accordance with manufacturer's instructions.
- .4 Fabricate core surfaces and profiles with continuous support and bond over entire surface to receive plastic laminate.
- .5 Apply plastic laminate backing sheets to balance shrinkage stresses induced by plastic laminate face sheets.
- .6 Minimize joints in plastic laminate Work; do not install joints in plastic laminate Work in less than 2400 mm o.c. Locate joints minimum 610 mm from cut-outs. Offset core and plastic laminate facing joints.
- .7 Form shaped profiles and bends as indicated, using postformed grade laminate to laminate manufacturer's instructions.
- .8 Use straight self-edging laminate strip to match adjacent colour, finish, gloss, and pattern to cover exposed edge of core material. Chamfer exposed edges uniformly at approximately 20 degrees. Do not mitre laminate edges.
- .9 Apply laminated plastic liner sheet to interior of cabinetry and where indicated.
- .10 Fabricate units by solid surfacing manufacturer's certified or approved fabricator/installer. Fabricate built-up profiles as indicated.

## **2.4 FABRICATION**

- .1 Be responsible for methods of construction and for ensuring that materials are rigidly and securely attached and will not be loosened by the work of other sections.
- .2 Coordinate locations of concealed supports and blocking with other parts of Work. Provide cutouts for outlet boxes and other fixtures.
- .3 Fabricate work in a manner which will permit expansion and contraction of the materials without visible open joints. Conceal joints and connections in wherever possible.

- .4 Set nails and countersink screws, apply wood filler to indentations, sand smooth and leave ready to receive finish.
- .5 Mitre exposed corners, no end grain shall be visible in completed installation.
- .6 Finish millwork in accordance with Section 09 91 00. Finished millwork shall be free from bruises, blemishes, mineral marks, knots, shakes and other defects and shall be selected for uniformity of colour, grain and texture.
- .7 Shop assemble finish carpentry to accommodate delivery and handling and to ensure passage through building openings.
- .8 Shop install cabinet hardware for doors, shelves and drawers. Recess shelf standards unless noted otherwise.
- .9 Fabricate sills, screens, frames and moldings to profiles shown.
- .10 Countertops:
  - .1 Core material shall be 19 mm thick particleboard with the exception of window stools and countertops with sinks installed, these shall be plywood core.
  - .2 Use draw bolts and splines in countertop joints. Maximum spacing 450 mm a.c., 76mm from edges.
  - .3 Veneer laminated plastic to core material in accordance with adhesive manufacturer's instructions. Ensure core and laminate profiles coincide to provide continuous support and bond over entire surface. Use continuous lengths up to 3050 mm.
  - .4 Keep laminate joints 305 mm from sink cutouts. Obtain Consultant's approval for locations of all laminate joints in counter tops prior to fabrication .
  - .5 Make joints where approved to hairline width. Offset joints in plastic laminate from joints in substrate.
  - .6 Provide cutouts as required for inserts, grilles, outlet boxes and other fixtures. Radius internal corners, chamfer laminate edges, and apply uncut shellac sealer to exposed edges of substrate at all cutouts.
  - .7 Nosing: 32 mm x three (3) mm PVC edge band.
  - .8 Backsplash: square-edged, as detailed on the drawings.

## 2.5 **CABINET FABRICATION**

- .1 General:
  - .1 Cabinet Components: As specified in AWMAC QSI Section 400-G as amended by the following requirements;
  - .2 Hardware: Supply hinges, drawer slides, products and materials as specified.
  - .3 Door and Drawer Fronts: Particle board core.
  - .4 Cabinet Boxes: Particle board core.
  - .5 Rails, Toe Kicks and Cabinet Bases: Hardwood veneer core.
  - .6 Backs: Particle board core.
  - .7 Blocking: Solid lumber.
  - .8 Provide Semi-Exposed surfaces in same quality and finish as Exposed parts.

- .9 Adjustable Shelf Techniques/Supports: AWMAC QSI 400B-T-9;
  - .1 Custom Grade: Adjustable shelf multiple holes (min. 5 mm diameter, single pin).
- .10 Joinery of case body members: AWMAC QSI 400B-T-10, stop-dado joints which are glued and mechanically fastened with screws.
- .11 All cabinets provided for this project shall meet or exceed the Custom requirements of AWMAC QSI 400-B-C-1 thru 6.
- .2 Wood Cabinet Construction: AWMAC QSI Section 400-G-7 (A), flush overlay style, Custom Grade as amended by the following requirements;
  - .1 Exposed and Semi-Exposed Parts (except countertops): Particle board core, minimum 19 mm thick with thermoset melamine.
  - .2 Exposed and Semi-Exposed Parts - panel edge band: lapped joint; hardwood veneer edge banding to match exposed parts.
- .3 Wall Cabinets: Finish to match base cabinets.
  - .1 Provide top and bottom filler and corner panels.
  - .2 Provide scribes and fillers with maximum 25 mm exposed dimension.
  - .3 Underside of Cabinets: Type 'B' flush (one tight line visible).
  - .4 Cabinet backs: Wall hung cabinet backs must not be relied upon to support the full weight of the cabinet and its anticipated load for hanging/mounting purposes. Method of back joinery and hanging/mounting mechanisms should transfer the load to case body members.
- .4 Shelving: AWMAC QSI 400B-T-9 Premium Grade, as amended by the following:
  - .1 Construction:
    - .1 Multiple hole configuration at 32 mm on centre, 'System 32'.
    - .2 Hardwood veneer on tops and bottoms and hardwood veneer edge banding on exposed edges to match exposed parts.
    - .3 Core: Particle board core, 19 mm thickness up to 700 mm spans, 25 mm thickness for spans greater than 700 mm.
  - .2 Provide adjustable shelves in all cabinets.
- .5 Wood doors at folding grille: 19 mm hardwood plywood with hardwood veneer, 3800 mm high x 310 wide. Provide cam lock and hinges to suit.

3 Execution

3.1 **INSTALLATION**

- .1 Install Work in accordance with AWS Quality Standards and tolerances for Architectural Woodwork. Set and secure finish carpentry in place, rigid, plumb, square, and level.
- .2 Scribe and cut as required, fit to abutting walls, and surfaces, fit properly into recesses and to accommodate columns, fixtures, outlets, or other projecting, intersecting or penetrating objects leaving a 0.8 mm gap maximum.

- .3 Coordinate cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and other fixtures, in finish carpentry. Round internal corners of cut-outs and seal exposed cores.
- .4 Form joints to conceal shrinkage.
- .5 Install draw bolts and splines in laminated plastic counter top joints at maximum spacing 450 mm o.c., and 75 mm from edge. Make joints flush, hairline butt joints.
- .6 Install finishing hardware accurately and securely in accordance with manufacturer's directions, adjust and clean.
- .7 Install prefinished millwork at locations shown on drawings. Position accurately, level, plumb straight.
- .8 Apply bituminous coating over wood framing members in contact with masonry or cementitious construction.
- .9 Melamine panels: Assemble melamine millwork using dowelled/wafered-and-glue construction. Installed melamine panels shall not show any exposed fasteners on finished/exposed surfaces.
- .10 Solid surfacing:
  - .1 Install solid surfacing in accordance with manufacturer's instructions.
  - .2 Align work plumb and level.
  - .3 Seal perimeter of fabrication to adjacent construction in accordance with Section 07 92 00.
- .11 Stone countertops:
  - .1 Construct countertops of sizes and details as noted.
  - .2 Distribute stone units of ranging colour or texture evenly over the entire installation to avoid patches or streaks, to produce a homogeneous blending of all units. If an acceptable pattern or grain direction is apparent, due to natural appearance of stone, or finishing, install units so that pattern or grain is in one direction unless otherwise directed.
  - .3 Clean stone exposed surfaces by washing with stiff fibre brush and clean water. Drench dry stones with clean water just before setting.
  - .4 Accurately and neatly cut, drill and fit stone as required for fixtures, fittings, and other appurtenances abutting or extending through stone and repair all stone after other Sections have finished.
  - .5 In cutting and fitting, the edges shall be carefully cut and ground to a perfect fit and all cutting shall be done in such a manner as not to impair the strength or appearance of the material.
  - .6 Apply grout in accordance with grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout.
  - .7 Apply two (2) coats of stone sealer to all stonework in accordance with manufacturer's written instructions.



- .12 Hardwood caps:
  - .1 Provide 13 mm thick plywood blocking mechanically fastened and glued to masonry with hardwood trim in reveal.
  - .2 Install 38 x 190 mm hardwood cap with rounded exposed edges and ends, glued and mechanically fastened to wood blocking with countersunk fasteners complete with plugs.
- .13 Benches/Storage cubicles:
  - .1 Install 400 mm deep cubicles with vertical divisions as indicated on drawings.
  - .2 Mechanically fasten to substrate with blocking and countersunk/plugged fasteners.
  - .3 Construct wood benches of sizes and details as noted.
  - .4 Anchor wood to supports in a concealed manner.
  - .5 Mitre joints at corners. Keep joints to a minimum.
  - .6 Round all corners, edges and ends.
  - .7 Install bench brackets and supports supplied under work of Section 05 50 00.
- .14 Pod Rooms (lockers, desk, beds and side tables):
  - .1 Construct pod room materials for all lockers, desk, beds and side tables where indicated and as detailed.
  - .2 Accurately and neatly cut, drill and fit wood material as required for wood framing, fixtures, fittings, and other appurtenances abutting or extending through for custom frame for a complete installation.
  - .3 Provide all drill holes required for concealed anchorage of counters and for anchoring to building structure.
  - .4 Mechanically fasten to substrate with blocking and countersunk/plugged fasteners.
  - .5 Install wood framing and materials where indicated in accordance with Drawings ensuring that it is securely fastened and true vertically and horizontally.
  - .6 Round all corners, edges and ends.
  - .7 Mitre joints at corners. Keep joints to a minimum.
  - .8 Conceal all fixings. Anchor wood to supports in a concealed manner.
  - .9 Provide all solid continuous blocking and shims required for installation. Where required, secure systems to steel supports
  - .10 Install brackets and supports for framing, supplied under work of Section 05 50 00.
- .15 Fastening:
  - .1 Coordinate wall securement, anchorage, and blocking for finish carpentry items.
  - .2 Position items of finished carpentry work accurately, level, plumb, true and fasten or anchor securely.
  - .3 Design and select fasteners to suit size and nature of components being joined. Use proprietary devices as recommended by manufacturer.
  - .4 Provide heavy duty fixture attachments for wall mounted cabinets.
  - .5 Set finishing nails to receive filler. Where screws are used to secure members, countersink screw in round cleanly cut hole and plug with wood plug to match material being secured.



- .16 Remove and replace damaged, marked, or stained finish carpentry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for the dampproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM D41/D41M, Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
- .2 ASTM D4479/D4479M, Specification for Asphalt Roof Coatings, Asbestos Free.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit manufacturer's Product data in accordance with Section 01 30 00 for each Product indicating:
    - .1 Installation details, physical properties and detailed application and installation instructions, marked as applicable to Work.
- .2 Certificates: Submit manufacturer's certification stating compliance with criteria specified and that Products are compatible.

1.4 **QUALITY ASSURANCE**

- .1 Installer's qualifications: Perform work of this Section by company approved by Product manufacturer and having five (5) years recent experience in work of comparable complexity and scope.

1.5 **SITE CONDITIONS**

- .1 Do not proceed with work when wind chill effect causes Product to set before correct curing takes place.
- .2 Supply and install temporary protection and heating to maintain air temperature and structural base temperature at dampproofing installation area above 5 °C for 24 h before, during and 24 h after installation.
- .3 Do not apply dampproofing in wet weather.
- .4 Supply and install forced air circulation during installation and curing periods for enclosed applications.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 Primer: Penetrating asphalt primer to ASTM D41, Type 2; 'HE910' by Henry Company Canada Inc. or '600 Asphalt Primer' by W. R. Meadows or approved equivalent.
- .3 Dampproofing: Cold applied, solvent based, asphalt dampproofing to ASTM D4479, Type 1; '710-11' by Henry Company Canada Inc. or '501 Foundation Coating' by W. R. Meadows or approved equivalent.
- .4 Sealing compound: Polymer modified sealing compound; 'Polybitume 570-05' by Henry Company Canada Inc. or by W. R. Meadows or approved equivalent.
- .5 Reinforcing fabric: Open weave, glass fibre reinforcing consisting of glass fibre yarn saturated with synthetic resins; 990-06 Yellow Jacket by Henry Company Canada Inc. or by W. R. Meadows or approved equivalent.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Engineer. Commencement of work of this Section means acceptance of existing conditions.
- .2 Ensure that surfaces of concrete are dry and in accordance with manufacturer's instructions before applying dampproofing material.

3.2 **PREPARATION**

- .1 Seal exterior joints between foundation walls and footings, cracks in foundation walls, and around penetrations through dampproofing with sealing compound. Apply sealing compound in accordance with manufacturer's instructions.
- .2 Prime substrates to be dampproofed in accordance with manufacturer's instructions.

3.3 **APPLICATION**

- .1 Apply dampproofing in accordance with manufacturer's instructions.
- .2 Seal exterior joints between foundation walls and footings with sealing compound before applying dampproofing.

- .3 Apply dampproofing in continuous, uniform coating to exterior side of foundation walls enclosing rooms below finished grade. Dampproof from 50 mm below finished grade level to and including tops of foundation walls and footings. Include exterior backfilled portion of interior walls where floors in adjacent rooms are at different elevations.
- .4 Brush reinforcing fabric into place overlapping fabric 50 mm at all joints with a soft bristle brush, eliminating wrinkles, air pockets or blisters and ensuring full contact.
- .5 Apply two additional coats of dampproofing and two layers of reinforcing fabric to vertical corners and construction joints for minimum width of 230 mm on each side, around penetrations and along pipes passing through walls for minimum of 230 mm.
- .6 Apply a seal coat of dampproofing over entire area at minimum one (1) l/m<sup>2</sup>

#### 3.4 **CLEAN-UP**

- .1 Clean, repair, or replace surfaces soiled or otherwise damaged in connection with work of this Section as directed by Engineer. Replace finishes or materials that cannot be cleaned to acceptance of Engineer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for sheet waterproofing work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating characteristics, performance criteria, and limitations. Indicate preparation, installation requirements and techniques, Product storage, and handling criteria.
- .2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating location and extent of system and system finish applications; system and joint sealant treatment materials, details of terminations at end of each days' work; large scale details, including relationships with adjacent construction; installation sequence and methods; connections; edge treatment at discontinuous edges; and accessories and other pertinent information required for proper and complete installations.
- .3 Samples: Submit following samples in accordance with Section 01 30 00:
  - .1 Two 300 x 300 mm samples of waterproofing membrane.
  - .2 Two samples, 300 mm long, of fastening bar.
  - .3 Two samples 300 x 300 mm of protection board.
- .4 Certification: Submit installer's certification verifying compliance with specification requirements.

1.3 **QUALITY ASSURANCE**

- .1 Qualifications: Execute work of this Section by manufacturer-approved, skilled, qualified, and experienced workers, trained in installation of work of this Section.

1.4 **SITE CONDITIONS**

- .1 Do not install the work of this Section outside of environmental ranges as recommended by manufacturer without Consultant's and Product manufacturer's written acceptance.
- .2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements before, during, and after installation.

1.5 **EXTENDED WARRANTY**

- .1 Submit an extended written warranty for sheet waterproofing work in accordance with the Conditions of the Contract, except that warranty period is extended to five (5) years from date of Substantial Performance.
  - .1 Warrant work against defects including adhesive failure, cohesive failure, waterproofing failure, and water leakage.
  - .2 Coverage: Complete replacement including effected adjacent Work.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 All components of the waterproofing system shall be supplied by one manufacturer.
- .3 Primer:
  - .1 'Aquaprime' by Henry Company Canada Inc.
  - .2 'CCW AWP' by Carlisle Coatings and Waterproofing.
  - .3 'Elastocol Stick' by Soprema.
  - .4 'Mel-Prime Primer by W. R. Meadows.
  - .5 Or approved equivalent.
- .4 Mastic:
  - .1 'Polybitume 570-05 Sealing Compound' by Henry Company Canada Inc.
  - .2 'CCW 704 Mastic' by Carlisle Coatings and Waterproofing.
  - .3 'Sopramastic 200' by Soprema
  - .4 'Pointing Mastic' by W. R. Meadows.
  - .5 Or approved equivalent.
- .5 Sheet waterproofing: 1.5 mm thick, single-ply, self adhering, self sealing, rubberised asphalt, bonded to a cross-laminated high density polyethylene film.
  - .1 'Blueskin WP 200' by Henry Company Canada Inc.
  - .2 'CCW Miradri 860/861' by Carlisle Coatings and Waterproofing.
  - .3 'Colphene 3000' by Soprema
  - .4 'Mel-Rol' by W. R. Meadows.
  - .5 Or approved equivalent.
- .6 Fastening bar: Continuous 25 mm wide x three (3) mm thick aluminum bar, predrilled for mechanical attachment.
- .7 Protection Board:
  - .1 '990-31' by Henry Company Canada Inc.
  - .2 'CCW Protection Board - V' by Carlisle Coatings and Waterproofing.
  - .3 'Sopraboard' by Soprema Inc.
  - .4 'Sealtight Vibraflex Waterproofing Protection Board' by W. R. Meadows.

.5 Or approved equivalent.

.8 Accessories: As recommended by waterproofing system manufacturer.

### 3 Execution

#### 3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that existing substrates to receive waterproofing are clean, dry, sound, smooth, and continuous.
- .3 Coordinate sealing of interruptions in, and protrusions through waterproofing membrane. Verify that other work items projecting through waterproofing membrane are in place and are securely installed.

#### 3.2 **MASTIC AND PRIMER**

- .1 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for waterproofing is achieved.
- .2 Prime substrate surfaces to receive waterproofing in accordance with manufacturer's instructions, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.
- .3 Prime surfaces. Re-prime surfaces if not covered with waterproofing membrane within four (4) hours.

#### 3.3 **WATERPROOFING**

- .1 Install mastic where required to ensure integrity of waterproofing installation at protrusions and other complex details.
- .2 Install waterproofing in accordance with manufacturer's instructions.
- .3 Lap waterproofing ends and edges 50 mm minimum. Roll waterproofing and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
- .4 Extend waterproofing as required to connect to other components of work comprising waterproofing system.
- .5 Cut and fit waterproofing as required for passage of protrusions, ensuring continuous adherence to substrate.

- .6 At end of days' work, trowel mastic water cut-off along uppermost edge of incomplete waterproofing assembly, to prevent loss of adhesion and damage waterproofing.
- .7 Supply and install continuous mechanical fastening bar to clamp waterproofing both sides of unfilled gaps, cracks, and joints.
- .8 Supply and install protection board in accordance with detailed system, and manufacturer's instructions.

#### 3.4 **REPAIR**

- .1 Repair misaligned or inadequately lapped seams, punctures, or other damage with additional ply of waterproofing sized to extend 150 mm minimum in all directions from repair edge.

END OF SECTION



1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for water repellent sealer work in accordance with the Contract Documents.
- .2 Water repellent sealer to be applied on concrete slabs on grade of parking garages and any additional areas as indicated.

1.2 **REFERENCES**

- .1 ASTM C920, Specification for Elastomeric Joint Sealants.
- .2 CSA S413, Parking Structures.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, preparation and installation requirements.
    - .2 Product transportation, storage, and handling requirements.
- .2 Reports/Certificates:
  - .1 Submit manufacturer's written acceptance of substrate prior to installation.
  - .2 Submit applicator's current certificate of approval, for installation of sealer, by the material manufacturer as proof of compliance.
  - .3 Submit letter certifying that materials proposed for use on this project meet criteria specified, are compatible with each other, and that the manufacturer had recommended the product for its intended end use.
  - .4 Submit inspection report after application of sealer.
  - .5 Submit certification from sealer manufacturer that installation meets specified and manufacturer's requirements.
  - .6 Submit a letter from the sealer manufacturer stating that the manufacturer will inspect the surface to which sealer has been applied, at the end of the first, third, and fifth years after application, and will submit a written report after each inspection to the Owner. The report shall state conditions that may adversely affect the sealer performance or cause water penetration, such as structural movement or defects, faulty construction or materials, and joint areas requiring resealing or repointing, and recommendations for corrective measures under the terms of the Warranty. This maintenance inspection shall be performed at no cost to the Owner.
- .3 Closeout submittals: Submit maintenance data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

- .4 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

#### 1.4 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five (5) years proven experience in work of similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

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

- .1 Deliver products in original factory packaging bearing identification of product, manufacturer, and batch number. Provide Material Safety Data Sheets for each product.
- .2 Store product in location protected from freezing, damage, construction activity, precipitation, and direct sunlight, in strict accordance with manufacturer's recommendations.
- .3 Prior to application, condition products in accordance with manufacturer's recommendations.
- .4 Handle all products with appropriate precautions and care as stated on Material Safety Data Sheet.

#### 1.6 **SITE CONDITIONS**

- .1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
  - .1 Ambient air and surface temperature: 5°C to 38°C
  - .2 Precipitation: None.
- .2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

**1.7 EXTENDED WARRANTY**

- .1 Submit an extended warranty for the work of this Section in accordance with General Conditions, except that warranty period is extended to five (5) years from date of Substantial Performance.
  - .1 Warrant against loss of water repellency when tested as follows:
    - .1 Modified ASTM C642 procedure: Treated concrete shall not absorb more than 0.75% water for a period of 24 hours.
    - .2 AASHTO T259: Concrete shall not absorb more than 250 ppm of chlorides at the 1 1/2 inch level over baseline conditions.
  - .2 Coverage: Complete repair of defective areas and reapplication of sealer.

**2 Products**

**2.1 MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers, sealants, sealers, and paints are to have low VOC content limits.
- .2 Water repellent sealer: Clear, penetrating, breathable, 100% active silane based sealer:
  - .1 'Protectosil BHN' by DRE Industries Inc.
  - .2 'MasterProtect H 1000' by Master Builders Solutions.
  - .3 'Pentreat 244-100' by W. R. Meadows.
  - .4 Or approved equivalent.
- .3 Sealant: ASTM C920, Type M, Grade P, Class 25; Two-part, self-levelling type, in standard colours selected.
  - .1 MasterSeal SL-2 by Master Builders Solutions.
  - .2 Sikaflex - 2C-SL by Sika Canada Inc.
  - .3 Or approved equivalent.
- .4 Primers: Type recommended by material manufacturers for various substrates, to promote adhesion and to prevent staining of adjacent surfaces for conditions encountered on project.
- .5 Joint backing: Round, solid section, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.
- .6 Bond breaker: Type recommended by material manufacturers to prevent bonding of sealant to back of recess.
- .7 Cleaning agents: As recommended by material manufacturer, harmless to substrates and adjacent finished surfaces.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.

3.2 **PREPARATION**

- .1 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.
- .2 Thoroughly clean all surfaces to receive sealer by steel shotblasting or other method approved by the manufacturer.
- .3 Rout or sawcut all cracks exceeding 1.5 mm in width and fill with sealant.

3.3 **SEALER APPLICATION**

- .1 Apply sealer in accordance with manufacturer's written instructions.
- .2 Apply sealer without dilution or alteration in any way.
- .3 Apply sealer with low pressure airless spray equipment (15 Psi) capable of flooding the surface to obtain uniform coverage and extending sealer 100 mm up walls.
- .4 Apply sealer at a minimum application rate of 4.3 m<sup>2</sup>/L.
- .5 Apply sealer by method other than spray application only at locations where overspray would affect adjacent materials.

3.4 **SEALANT APPLICATION**

- .1 Do not fill joints sooner than 30 days after concrete pours. Execute joint sealing during cool, dry ambient conditions when slab is in contracted state to minimize future joint separation.
- .2 Comply with sealant manufacturer's primer, application and temperature requirements.
- .3 Prior to sealant application, thoroughly dress and clean joints. Slightly abrade joints exposed to wheel traffic. Prime joint surfaces as required.

.4 Mask floor to edge of joints and fill joint with sealant. After initial set, prime sealant surface and refill joints with sealant as required to produce slightly convex joint surface.

.5 Apply sealant in tooled or sawn joints and at other locations indicated on drawings.

**3.5 FIELD QUALITY CONTROL**

.1 Immediately after sealing has been completed, have the sealer manufacturer's representative visit the site to inspect, test, and approve the application. Submit written inspection report to Consultant.

.2 Deficiencies in the application shall be repaired at no cost to Owner.

**3.6 PROTECTION**

.1 Prevent traffic over sealed areas, and protect work of this Section from precipitation, freezing, and debris after installation.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for the thermal insulation work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C665, Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- .2 CGSB 71-GP-24M, Flexible Adhesive for Bonding Cellular Polystyrene Insulation.
- .3 CAN/ULC-S701, Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .4 CAN/ULC-S702, Mineral Fibre Thermal Insulation for Buildings.

1.3 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating characteristics, performance criteria, and limitations. Indicate installation requirements and techniques, storage, and handling criteria and installation procedure acceptable to manufacturer.
- .2 Certification: Submit installer's certification verifying compliance with specification requirements.

1.4 **QUALITY ASSURANCE**

- .1 Qualifications: Execute work of this Section by company specializing in thermal insulation work with minimum of three (3) years, recent, documented experience, on work of comparable complexity and scope.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, adhesives are to have low VOC content limits.

2. Batt insulation:
  - .1 Batt insulation (non-rated): CAN/ULC-S702, Type 1, friction fit; 'Unfaced Thermal and Sound Control Batts' by Johns Manville, 'Pink Next Gen Fiberglas Insulation' by Owens Corning Canada or 'ComfortBatt' by Rockwool or approved equivalent.
  - .2 Batt insulation (fire-rated/acoustic): ASTM C665, Paperless, semi-rigid, spun stone wool fibre mats, of thickness as indicated on Contract Drawings, 'MinWool SAFB' by Johns Manville, 'SAFB Thermafiber' by Owens Corning Inc. or 'Rockwool AFB' by Rockwool or approved equivalent.
- .3 Cavity wall insulation (masonry cavity walls): Sprayed applied polyurethane, refer to Section 07 21 19.
- .4 Below grade insulation: CAN/ULC-S701, Type 4; Minimum RSI of 0.87, Extruded polystyrene, ship-lapped edges. Thickness: As indicated on Drawings.
  - .1 'Styrofoam SM' by Dupont de Nemours Inc.
  - .2 'Foamular C-300' by Owens Corning Canada Inc.
  - .3 Or approved equivalent.
- .5 Above grade insulation (not in cavity wall): CAN/ULC-S701, Type 3; Extruded polystyrene, square edges. Thickness: As indicated on Drawings.
- .6 Under slab insulation: Closed cell extruded polystyrene sheets in thickness as indicated on drawings. Insulation to have a compressive strength of 690 kPa. PERIMATE (XPS) by Dupont de Nemours Inc. or 'Foamular 1000' by Owens Corning Canada Inc. or approved equivalent.
- .7 Adhesive for polystyrene insulation: CGSB 71-GP-24M, Type 2, Class A, and approved by air/vapour barrier manufacturer when adhesive is in direct contact with air/vapour barrier membrane.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Ensure substrate surfaces are dry, clean, suitable to receive adhesive and free from other deleterious substances.

#### 3.2 INSTALLATION

- .1 Install thermal insulation in longest panel sizes possible in accordance with manufacturer's instructions.

- .2 Butt insulation with moderate contact and, cut and fit them tightly around other construction elements. Offset single layer vertical joints and both vertical and horizontal joints in multiple layer applications.,
- .3 Make thermal insulation continuous, maintain thermal protection continuity and secure to prevent displacement. Ensure that insulation is tight to substrate without air gaps.
- .4 Cut and fit thermal insulation tightly around electrical boxes, plumbing and heating pipes and ducts, exterior doors and windows, and other protrusions.
- .5 Leave 75 mm separation between thermal insulation and heat emitting devices such as recessed light fixtures.
- .6 Cut and trim thermal insulation neatly to fit spaces; do not compress insulation to fit. Install only thermal insulation boards which are free from chipped or broken edges.
- .7 Fill miscellaneous cavities with insulation to maintain continuity of thermal barrier. Do not compress insulation to fit.
- .8 Arrange for Consultant to review thermal insulation before it is enclosed.

### 3.3 **SECUREMENT**

- .1 Batt insulation (non-rated, fire-rated/acoustic):
  - .1 Install batt insulation in partitions, between studs, and as indicated on Contract Drawings and in accordance with the manufacturer's instructions.
  - .2 Fill stud cavities to full height of partitions and carefully cut and fit required batt insulation type around services and protrusions.
- .2 Cavity wall insulation (masonry cavity walls): Sprayed applied polyurethane, refer to Section 07 21 19.
- .3 Below grade insulation:
  - .1 Interior application: Provide 50 mm thick insulation extending 600 mm vertically along foundation wall and 100 mm thick insulation extending 1200 mm horizontally along underside of concrete floor slab. Apply suitable mastic adhesive for spot bonding insulation to foundation walls.
- .4 Underslab insulation:
  - .1 Install insulation boards in locations shown in accordance with manufacturer's instructions.
  - .2 Protect insulation board from damage by placing 200 mm layer of 19 mm crusher-run limestone over insulation board.
  - .3 In drainage trenches, place insulation board to size and location as shown in Contract Drawings, with joints butted tight.

END OF SECTION



1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for sprayed foam insulation work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Material Specification.
- .2 CAN/ULC S705.2, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density, Application.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Elevations, sections, materials, details of joint conditions, including door, window, entrance framing, flashings, and roof parapet connection.
- .3 Certificates: Submit the following certificates in accordance with Section 01 30 00:
  - .1 Applicator's current certificate of approval by CUFCA/NECA or BASF Canada's training program.
  - .2 Applicator's current certificate of approval from material manufacturer.

1.4 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that has a minimum of five years proven experience in installations of similar size and nature.
- .2 Contractor to be a certified member of the Canadian Urethane Foam Contractors Association/ National Energy Conservation Association (CUFCA/NECA) or be licensed under the BASF Canada Quality and Training Program "Raising Performance to New Heights" and in accordance with CAN/ULC S705.2 installation standard.
- .3 Provide quality assurance testing in accordance with CAN/ULC S705.2. Record daily results in a log book for Consultant's review.

- .4 Provide adhesion tests on transition membranes, in accordance with manufacturer's written instructions, at the perimeters of all openings. If the project comprises more than ten (10) openings, adhesion tests should be conducted on 15% of them. For jobs comprising ten (10) or fewer openings, 30% of these should undergo adhesion tests. Adhesion tests should be performed on the transition membranes at every tenth column or beam.
- .5 Mock-up:
  - .1 Construct mock-up of 3 m<sup>2</sup> minimum, of spray-in-place foam insulation to thickness as indicated on drawings, including one inside corner and one outside corner.
  - .2 Arrange for Consultant's review and acceptance, allow 24 hours before proceeding with work.
  - .3 When accepted, mock-up will demonstrate minimum standard for this work. Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

## 1.5 **SITE CONDITIONS**

- .1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
  - .1 Ambient air and surface temperature: 5°C to 40°C.
  - .2 Relative Humidity: Above 85%.
- .2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 48 hours before, during, and 48 hours after installation.

## 2 **Products**

### 2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Sprayed foam insulation: CAN/ULC S705.1, closed cell, medium density, polyurethane based, and utilizing an HFO blowing agent; 'Walltite CM01' by BASF, 'Sealtite One' by Carlisle, or 'Heatlok Soya HFO' by Huntsman Building Solutions or approved equivalent.
- .3 Primers: As recommended by sprayed foam insulation manufacturer.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.
- .2 Provide ventilation in area to receive sprayed foam insulation, introducing and exhausting fresh air continuously during and for 24 hours after application.
- .3 Provide temporary enclosures to prevent spray from contaminating air beyond application area, and damage from overspray and dusting on adjacent surfaces.
- .4 Supply and install temporary protection to adjacent surfaces to prevent damage resulting from work of this Section.
- .5 If required, apply primer to substrate surfaces in accordance with manufacturer's written instructions.

3.3 **SPRAY INSULATION**

- .1 Install insulation in accordance with manufacturer's written instructions and conforming to CAN/ULC S705.2.
- .2 Apply sprayed foam insulation to thickness indicated on drawings and to provide continuous air retarder in locations indicated on the Drawings. Apply insulation to within 3 mm of thickness indicated on drawings. Provide one measuring pin for every 50 m<sup>2</sup>.
- .3 Apply insulation in maximum 50 mm pass thickness, with a minimum wait time between passes as recommended by manufacturer.
- .4 Insulation to be continuous, level, plumb and uniform thickness throughout. Insulation shall be free of voids and imbedded foreign materials.

3.4 **INSPECTION AND TESTING**

- .1 Arrange for third party site-inspection by approved company. Cost of inspections shall be included in bid price.

- .2 Site inspection shall be carried out at 5%, 50% and 95% completion to verify conformance with CAN/ULC S705.2, manufacturers written instructions and this Section.
- .3 Written inspection reports shall be forwarded to Consultant within three (3) working days of test being performed.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for air/vapour barriers Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM E1643, Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
- .2 ASTM E1745, Standard Specification for Water Vapour Retarders used in contact with Soil or Granular Fill under Concrete Slabs.
- .3 CAN/CGSB 19.21-M, Sealing and Bedding Compound, Acoustical.
- .4 CAN/CGSB-51.34-M, Vapour Barrier, Polyethylene Sheet, for Use in Building Construction.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Samples: Submit following samples in accordance with Section 01 30 00:
  - .1 Two 300 x 300 mm samples of air/vapour barriers.
  - .2 Two samples, 300 mm long, of fastening bar.
  - .3 Duplicate samples of pipe and conduit boot.

1.4 **QUALITY ASSURANCE**

- .1 Mock-up:
  - .1 Construct one ten (10) m<sup>2</sup> mock-up of each type air/vapour barrier in location acceptable to Consultant indicating as a minimum one lap joint, one inside corner, one window interface, one wall electrical box, and floor pipe penetration.
  - .2 Arrange for Consultant's review and acceptance.
  - .3 Mock-up may remain as part of Work if accepted by Consultant. Remove and dispose of mock-ups which do not form part of Work.

**1.5 SITE CONDITIONS**

- .1 Do not install the Work of this Section outside of environmental ranges as recommended by manufacturer without Consultant's and Product manufacturer's written acceptance.
- .2 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements before, during, and after installation.

**2 Products**

**2.1 WALL AIR/VAPOUR BARRIER MATERIALS**

- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Membrane air/vapour barrier: 1.0 mm thick, single-ply, self adhering, self sealing, rubberised asphalt, bonded to a cross-laminated high density polyethylene film.
  - .1 'CCW 705' by Carlisle Coatings & Waterproofing.
  - .2 'Blueskin SA' by Henry Company Canada Inc.
  - .3 'Sopraseal Stick 1100 T' by Soprema.
  - .4 'Exo-Air 110' by Tremco.
  - .5 'Air-Shield" by W. R. Meadows.
  - .6 Or approved equivalent.
- .3 Primer:
  - .1 'Cav-Grip Primer' by Carlisle Coatings & Waterproofing.
  - .2 'Blueskin Adhesive' by Henry Company Canada Inc.
  - .3 'Elastocol Stick' by Soprema.
  - .4 'ExoAir Primer' by Tremco
  - .5 'Mel-Prime' by W.R. Meadows.
  - .6 Or approved equivalent.
- .4 Mastic:
  - .1 'CCW 704 Mastic' by Carlisle Coatings & Waterproofing.
  - .2 'Polybitume 570-05' by Henry Company Canada Inc.
  - .3 'Sopramastic' by Soprema.
  - .4 'Acoustical Sealant' by Tremco
  - .5 'Sealtight Pointing Mastic' by W.R. Meadows.
  - .6 Or approved equivalent.
- .5 Fastening bar: Continuous 25 mm wide x 3 mm thick aluminum bar, predrilled for mechanical attachment.
- .6 Fasteners: As specified herein or manufacturer's recommended fastener for attaching to Substrate.

## **2.2 UNDERSLAB AIR/VAPOUR BARRIER MATERIALS**

- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Air/vapour barrier (under concrete slab-on-grade): ASTM E1745, Class A, 0.38 mm (15 mil) thick. Permeance as tested after conditioning, less than 0.010 perms (gr/ft<sup>2</sup>/hr/in.hg), 0.570 ng/(Pa\*s\*m<sup>2</sup>); 'Stego Wrap Vapor Barrier' by Stego Industries or 'Perminator' by W.R. Meadows or approved equivalent.
  - .1 Joint sealing tape: High density polyethylene tape with pressure sensitive adhesive with minimum width 100 mm. Type recommended by sheet air/vapour barrier manufacturer.
  - .2 Pipe and conduit boots: Construct pipe and conduit boots from air/vapour barrier material and pressure sensitive tape as recommended by manufacturer.

## **2.3 SHEET VAPOUR RETARDER MATERIALS**

- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Sheet vapour retarder 'Super Six' Polyethylene film to CAN/CGSB-51.34, 0.15 mm (6 mil) thick, or approved equivalent.
  - .1 Joint sealing tape: Air and vapour resistant pressure sensitive adhesive tape, type recommended by sheet vapour retarder manufacturer, 50 mm wide for lap joints and perimeter seals, 25 mm wide elsewhere.
  - .2 Sealant: CAN/CGSB 19.21; One-part, non-sag, non-bleeding, non-drying, non-hardening, sealant shall remain tacky for permanent bonding to all surfaces; 'Tremco Acoustical Sealant' by Tremco Ltd. or approved equivalent.

## **3 Execution**

### **3.1 EXAMINATION AND COORDINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
- .2 Verify that existing substrates to receive air/vapour barrier are clean, dry, sound, smooth, and continuous.
- .3 Coordinate installation of air/vapour barriers with work of other Sections to achieve a air/vapour tight building envelope.

### **3.2 MEMBRANE WALL AIR/VAPOUR BARRIER INSTALLATION**

- .1 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for air/vapour barrier is achieved.

- .2 Prime substrate surfaces to receive air/vapour barrier in accordance with manufacturer's instructions, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.
- .3 Prime surfaces. Re-prime surfaces if not covered with air/vapour barrier within four (4) hours.
- .4 Install mastic where required to ensure integrity of air/vapour barrier installation at protrusions and other complex details.
- .5 Install air/vapour barrier in accordance with manufacturer's instructions in locations indicated.
- .6 Lap air/vapour barrier ends and edges 50 mm minimum. Roll air/vapour barrier and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
- .7 Extend air/vapour barrier as required to connect to other components of Work comprising air/vapour barrier system.
- .8 Cut and fit air/vapour barrier as required for passage of protrusions, ensuring continuous adherence to substrate.
- .9 At end of days' Work, trowel mastic water cut-off along uppermost edge of incomplete air/vapour barrier assembly, to prevent loss of adhesion and damage air/vapour barrier.
- .10 Supply and install continuous mechanical fastening bar to clamp air/vapour barrier both sides of unfilled gaps, cracks, and joints.

### 3.3 **UNDERSLAB AIR/VAPOUR BARRIER INSTALLATION**

- .1 Ensure services are installed and inspected prior to installation of barrier.
- .2 Install sheet air/vapour barrier under the floor slab and return up adjacent walls prior to installation of floor slab, to form a continuous air/vapour barrier in accordance with ASTM E1643 and manufacturer's written instructions.
- .3 Lap air/vapour barrier over footings and seal to foundation walls.
- .4 Overlap joints 150 mm and seal with manufacturer approved sealing tape.
- .5 Seal all penetrations (including conduits and pipes) with manufacturer's pipe boot.
- .6 Use sheets of largest practical size to minimize joints.
- .7 Inspect for continuity. Repair punctures and tears by using patches of air/vapour barrier and overlapping damaged areas by minimum 150 mm on all sides and taping with sealing tape before work is concealed.



### 3.4 **SHEET VAPOUR RETARDER INSTALLATION**

- .1 Ensure services are installed and inspected prior to installation of retarder.
- .2 Install sheet vapour retarder on the warm side of exterior wall, roof, and ceiling assemblies, prior to installation of roof insulation or interior finishes to form a continuous vapour retarder.
- .3 Use sheets of largest practical size to minimize joints.
- .4 Inspect for continuity. Repair punctures and tears with sealing tape before work is concealed.
- .5 At exterior surface openings, cut vapour retarder to form openings and ensure material is lapped and sealed to frame.
- .6 Ensure continuity of vapour retarder is maintained at junctures with other materials.
- .7 At perimeter seals, seal perimeter of sheet vapour retarder as follows:
  - .1 Apply continuous bead of sealant to substrate at perimeter of sheets.
  - .2 Lap sheet over sealant and press into sealant bead.
  - .3 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
- .8 Seal lap joints of sheet vapour retarder as follows:
  - .1 Attach first sheet to substrate.
  - .2 Apply continuous bead of sealant over solid backing at joint.
  - .3 Lap adjoining sheet minimum 150 mm and press into sealant bead.
  - .4 Ensure that no gaps exist in sealant bead. Smooth out folds and ripples occurring in sheet over sealant.
- .9 Seal electrical switch and outlet device boxes that penetrate vapour retarder as follows:
  - .1 Wrap boxes with film sheet providing minimum 300 mm perimeter lap flange.
  - .2 Apply sealant to seal edges of flange to main vapour retarder and seal wiring penetrations through box cover.

### 3.5 **FIELD QUALITY CONTROL**

- .1 Inspect air/vapour barrier continuity immediately prior to installation of subsequent construction. Repair punctures, rips and tears to ensure continuity of air/vapour barrier.
- .2 Where punctures and tears are extensive, replace entire damaged section.
- .3 Do not cover or permit to be covered any portion of air/vapour barrier until it has been inspected by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products equipment and services necessary for vapour permeable air barrier Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C920, Specification for Elastomeric Joint Sealants.

1.3 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating installation details, physical properties and detailed application and installation instructions.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Adjacent construction and typical details, dimensions, thickness, method of application, protection and penetration details.
    - .2 Location of each membrane penetration.

1.4 **QUALITY ASSURANCE**

- .1 Installer's qualifications: Perform Work of this Section by company, approved by Product manufacturer and having 5 years recent experience in Work of comparable complexity and scope.
- .2 Pre-installation meeting: Arrange with Consultant and manufacturer's representative to inspect substrates and review installation procedures 48 hours in advance of installation.

1.5 **DELIVERY, STORAGE AND HANDLING**

- 1. Protect materials from direct exposure to sunlight and physical damage.

2 Products

2.1 **MATERIALS**

- .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Vapour permeable air barrier: 23 mils thick, single-ply, self adhering membrane consisting of engineered film and permeable adhesive with poly-release film; 'Blueskin VP160' by Henry Company Canada Inc, or Cosella-Dörken Products, Inc. or VaproShield or approved equivalent.

- .3 Primer: Low VOC quick setting rubber based adhesive 'Blueskin LVC Adhesive' by Henry Company Canada Inc. or approved equivalent by Cosella-Dörken Products, Inc. or VaproShield or approved equivalent.
- .4 Sealant: ASTM C920, Type S, Grade NS, Class 25; Moisture sure, medium modulus polymer modified sealing compound 'HE925 BES' by Henry Company Canada Inc. or approved equivalent by Cosella-Dörken Products, Inc. or VaproShield or approved equivalent.

### 3 Execution

#### 3.1 **EXAMINATION**

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

#### 3.2 **APPLICATION**

- .1 Ensure surfaces to receive membrane are sound, dry, clean, and free from oil, grease, dirt, excess mortar or other contaminates.
- .2 Fill substrate voids, gaps, depressions, cracks, and joints with mastic until continuous, smooth, substrate for air barrier is achieved.
- .3 Prime substrate surfaces to receive air barrier in accordance with manufacturer's instructions, at recommended application rate, allow to dry. Vary coverage to suit surface porosity.
- .4 Prime surfaces. Re-prime surfaces if not covered with air barrier within four (4) hours.
- .5 Install mastic where required to ensure integrity of air barrier installation at protrusions and other complex details.
- .6 Install air barrier in accordance with reviewed shop drawings and manufacturer's instructions in locations indicated.
- .7 Lap air barrier ends and edges 50 mm minimum. Roll air barrier and laps for continuous adhesion over entire substrate area; use manufacturer's recommended roller.
- .8 Extend air barrier as required to connect to other components of Work comprising air barrier system.
- .9 Cut and fit air barrier as required for passage of protrusions, ensuring continuous adherence to substrate.

- .10 Seal around masonry reinforcing or ties and all penetrations with termination mastic.
- .11 At end of days' Work, trowel mastic water cut-off along uppermost edge of incomplete air barrier assembly, to prevent loss of adhesion and damage air barrier.
- .12 Do not expose air barrier to sunlight for more than 30 days prior to enclosure.

### 3.3 **FIELD QUALITY CONTROL**

- .1 Do not cover or permit to be covered any portion of the membranes until they have been inspected by the Consultant or by an inspection agency appointed by the Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for aluminum composite panel Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 2605, High Performance Organic Coatings on Architectural Extrusions and Panels.
- .2 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .3 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.
- .4 ASTM C920, Specification for Elastomeric Joint Sealants.
- .5 ASTM D1781, Standard Test Method for Climbing Drum Peel for Adhesives.
- .6 CAN/CSA-G40.20/G40.21M, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.
- .7 CSA S136, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

- .1 Design composite panels in accordance with following Climatic Design Data for Barrie contained in the Ontario Building Code:
  - .1 Design temperature: January 1%, July 2 1/2%.
  - .2 Hourly wind pressures: 1 in 50 year occurrence.
  - .3 Seismic design: Class "C".
- .2 Design aluminum composite panel system as a "dry joint system" and to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads, imposed and other loads.
- 3. Prevent rain penetration through wall system. Design system based on "Rain Screen Principle" in accordance with the National Research Council. Volume to vent ratio should not exceed 25 m. Panels should be compartmentalized at joints. Incorporate means of draining to the exterior.

4. Design aluminum composite panel system to support its own weight and the wind load, positive and negative, prevalent for the location of the building, but no less than windgust pressure calculated from National Building Code using 1-10 year probability factor. To minimize the potential for "dished" panels after loading, permanent set of the panel, measured normal to the panel surface after application and removal of the design load, must not exceed  $L/800$  of distance between supported edges of panel or distance between stiffeners where stiffeners are used. Stiffeners, where used, must not deflect more than  $L/90$  of span under load.
- .5 Design aluminum composite panel system to accommodate thermal movements of the components and structural movements to provide an installation free of oil canning, buckling, delamination, failure of joint seals, excessive stress on fasteners or any other detrimental effects.
- .6 Design aluminum composite panel system to prevent rattling and vibration of panels, overstressing of fasteners and clips, and other detrimental effects on the system.
- .7 Panel removal: System design to allow removal of individual panels within wall system.
- .8 Design miscellaneous, additional structural framing members as required to complete composite panel system, where not indicated on Contract Drawings.
- .9 The attachment face of subgirts supporting the panel system must not deflect vertically more than 3 mm due to the dead load of the panel system.

#### 1.4 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Shop drawings:
    - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
      - .1 Elevations, details, profiles, dimensions, thickness of materials, finishes, methods of joining, joint location, special shapes, methods of anchoring, anchor and clip details, types of sealants and gaskets, waterproof connections to adjoining work, details of other pertinent components of the work (i.e. windows, penetrations, membranes, etc), and compliance with design criteria and requirements of related work.
- .3 Samples: Submit two 300 x 300 mm samples of wall panels in the selected colours and finish for approval.
- .4 Closeout Submittals: Provide maintenance instructions for incorporation into Operation and Maintenance Manual, specified in section 01 78 00.

**1.5 QUALITY ASSURANCE**

- .1 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for composite panel Work:
  - .1 Design of aluminum composite panel system.
  - .2 Design of anchors, supports and accessories to meet seismic requirements.
  - .3 Review, stamp, and sign shop drawings.
  - .4 Conduct shop and field inspections and prepare and submit inspection reports.
- .2 Perform work of this Section only by a Subcontractor of recognized standing who has adequate plant, equipment, and skilled workers to perform it expeditiously, and is known to have been responsible for satisfactory installations similar to that specified during a period of at least the immediate past ten years.
- .3 Execute steel welding to CSA W59-M1989 by fabricators certified by the Canadian Welding Bureau to CSA W47.1.
- .4 Execute aluminum welding by fabricators certified by the Canadian Welding Bureau to CSA W47.2-M.
- .5 Execute finishing coatings and metal pre-treatments by applicators approved in writing by the manufacturer of the coatings and under the supervision of the manufacturer's qualified representative.
- .6 Mock-up:
  - .1 Fabricate, deliver, and erect a 1200 mm wide x 1800 mm high mock-up panel of composite panel system in location acceptable to Consultant.
  - .2 Demonstrate finish, anchoring devices, air/vapour retarder sealing, and quality of workmanship.
  - .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Handle aluminum Work in accordance with AAMA CW-10. Protect aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.
- .2 Remove and replace all damaged and unsatisfactory materials which are deemed unsuitable for use at this Section's own expense.

**1.7 EXTENDED WARRANTY**

- .1 Manufacturer's Warranty: Provide panel manufacturer's written warranty naming Owner as beneficiary and covering failure of factory-applied exterior finish on composite metal panels within the warranty period; warrant finish per ASTM D 4214 for chalk not in excess of 8 NBS units and fade not in excess of 5 NBS units. Warranty period for finish: 10 years from date Work is certified as substantially performed.

**2 Products**

**2.1 ACCEPTABLE PRODUCTS AND MANUFACTURERS**

- .1 Accumet PE by Flynn Canada Ltd.
- .2 Alpolic Panels by Exterior Technologies Group.
- .3 Or approved alternative.

**2.2 MATERIALS**

- .1 All materials under Work of this Section, including but not limited to, sealants, paints, and coatings are to have low VOC content limits.
- .2 Aluminum Composite Material: Two sheets of 0.51 mm thick aluminum alloy 3003, sandwiching a core of extruded thermoplastic formed in a continuous process without the use of glues or adhesives between dissimilar materials. Panel thickness: 4 mm. Bond integrity testing to adhere to ASTM D1781.
- .3 Finish:
  - .1 Exposed to view: Two (2) coat, coil coated fluoropolymer extrusion coating, meeting requirements of AAMA 2605, minimum thickness 1.25 mil. Colour: To be selected by Consultant.
  - .2 Concealed: Prime coat.
- .4 Structural shapes, plates, sag rods, and similar items: CAN/CSA-G40.20-G40.21-M, Grade 350W.
- .5 Vapour permeable air barrier: In accordance with Section 07 27 00.
- .6 Z-girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm thick, Z275 galvanized. Depth as indicated on Contract Drawings.
- .7 Provide all additional structural supports not shown on Drawings as required.



- .8 Thermal spacer clip system:
  - .1 Thermal spacer: 100% pultruded glass fibre and thermoset polyester resin thermal spacer complete with fastener in depth indicated on Contract Drawings; 'Cascadia Clip' by Interra Architectural Products or approved alternative.
  - .2 Fasteners for spacers and attachment to back-up construction: Corrosion resistant, types as recommended by thermal spacer manufacturer.
- .9 Fasteners: Concealed, ANSI B18.6.4, stainless steel Type 304.
- .10 Flashings, Closure Pieces, Trim, Vented Trim and Cap Flashing: Same material and colour as panels.
- .11 Clips and Panel Reinforcement: Extruded aluminum.
- .12 Sealants: ASTM C920, Type M, Grade NS, Class 25; Two-part, Polyurethane non-sag type, Sikaflex 2C-NS by Sika Canada Inc. or Dymeric 240 by Tremco Ltd. or approved equivalent. Colour: As selected by Consultant.
- .13 Joint backing: Product as recommended by siding sealant manufacturer.
- .14 Touch-up paint: as recommended by panel manufacturer.
- .15 Isolation coating: Bituminous coating, acid and alkali resistant material.

## 2.3 **FABRICATION**

- 1. Fabricate facings and concealed support members in a manner which will provide an installation free of exposed fastenings, with sufficient support and allowance for thermal movement to prevent facing distortion. Take site measurements before proceeding with production.
- .2 Fabricate components of the system at factory, ready for field installation. Include full continuous joint reveals within system.
- 3. Fabricate facings flat, true, free of marks, without visible distortion and with edges straight and true. Make all planes true, and corners square and bend of minimum radius.
- .4 Changes of plans, parallel or transverse to longitudinal axis shall be accomplished as detailed on shop drawings in the factory wherever practical and with a minimum of field fabrication.
- .5 Form panels to dimensions indicated with tolerances to accommodate expansion and contraction between panels and structure members. Accurately form shaped panels.
- 6. Provide proprietary aluminum extrusions to manufacturer's standard profiles for a complete installation. Extrusions shall be full length around panel perimeter for panel reinforcement and alignment. Intermittent clips are unacceptable.

- .7 Changes of plans, parallel or transverse to longitudinal axis shall be accomplished as detailed on shop drawings in the factory wherever practical and with a minimum of field fabrication.
- .8 Form panels to dimensions indicated with tolerances to accommodate expansion and contraction between panels and structure members. Accurately form shaped panels.
- .9 Fabricate panels with flanges on all sides.
- .10 Factory fabricate accessory and trim components ready for installation.
- .11 Joint filler strip shall be same material and colour as panels. Use of caulking at joints is not acceptable.
- .12 Plastic shims shall be used as thermal separator between extrusions and sub-girts.
- .13 Maximum allowable tolerances shall be as follows:
  - .1 Panel bow: In a concave or convex direction to be 0.5% of panel dimension width and length.
  - .2 Panel flatness: Rises and falls across the panel, (local bumps and depressions) will not be accepted.
  - .3 Panel tolerance:
    - .1 Width: 2 mm.
    - .2 Length: 4 mm.
    - .3 Thickness: 0.2 mm.
    - .4 Squareness: 5 mm maximum.

### 3 Execution

#### 3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.
- 2. Verify that backup construction is aligned for proper installation of wall panels before commencing erection.
- .3 Protect metal surfaces in contact with concrete, masonry mortar, plaster or other cementitious surface with isolation coating.

#### 3.2 **INSTALLATION**

- .1 Supply and install miscellaneous, additional structural framing members, required to complete composite panel system, where not indicated on Contract Drawings.
- .2 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

- .3 Apply isolation coating to supporting structural framing to isolate airseal liner panel and to prevent galvanic corrosion.
- .4 Supply and install air/vapour retarder in accordance with Section 07 26 00.
- .5 Erect wall panels complete with girts, clips, and fasteners, to meet design criteria. Anchor each individual panel over solid backing. Ensure that all penetrations through air/vapour barrier are sealed.
- .6 Install panels, support and anchoring system, fasteners, trim and related items to lines and elevations indicated and in strict accordance with reviewed shop/erection drawings and manufacturer's printed instructions. Carefully co-ordinate work with other Sections.
- .7 Anchor component parts to transmit wind loading and other stresses to anchorage system.
- .8 Thermal spacers and girts:
  - .1 Install thermal spacer in accordance with reviewed shop drawings and manufacturer's written instructions.
  - .2 Pre-drill concrete or concrete masonry unit substrate to 13 mm deeper than anticipated embedment depth of fastener into substrate.
  - .3 Confirm thermal clip accommodates orientation of vertical and horizontal sub-framing.
  - .4 Clip thermal spacer to Z-girt and fasten clip and girt to back-up structure, fastening through thermal spacer clip and into structure.
  - .5 Position Z-girts directly over thermal spacer before installation of fasteners.
  - .6 Completely install spacers, screws and sub-framing, prior to installing insulation.
- .9 Erect wall panel system in accordance with manufacturer's instructions and under direct supervision of the manufacturer.
- .10 Erect panels and joint filler strip in accordance with manufacturer's details to meet specified design criteria and performance. Use concealed fastening only.
- .11 Finished work shall be securely anchored, free of distortion, free of surface imperfections and uniform in colour.
- .12 Cut and flash wall penetrations.
- .13 Erect wall panels in straight lines, true, level, and plumb.
- .14 Site Tolerances: Erection tolerances apply to each individual panel and shall not be accumulative:
  - .1 Maximum deviation from vertical and horizontal alignment of erected panels 3 mm in 6 m.
  - .2 Maximum offset from alignment between adjacent wall panels: 1.5 mm.

**3.3 JOINT BACKING AND SIDING SEALANT**

- .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
- .2 Install joint backing and sealant at perimeter of composite panel system and where indicated on drawings for weathertight installation. Tool sealant to concave profile.
- .3 Seal around all openings and all other locations indicated or required to provide weathertight and watertight seal.

**3.4 REPAIR**

- .1 Remove damaged, dented, defaced, defectively finished, or tool marked components and replace with new, unless minor blemishes are approved by Consultant.
- .2 Only with approval of Consultant, refinish shop applied finishes in field with compatible materials to manufacturer's written instructions.

**3.5 CLEANING**

- .1 Remove all strippable protective film from the work as it is erected and prior to moving on to the next bay or grid.
- .2 Wash down exposed exterior surfaces using solution of mild non-acidic detergent in warm water, applied with soft clean wiping cloths.
- .3 As work progresses, remove excess sealant with recommended solvent and which will not affect metal, finished surfaces, or adjacent surfaces and materials.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for aluminum panel siding, soffit and screen work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 2605, High Performance Organic Coatings on Architectural Extrusions and Panels.
- .2 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .3 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.
- .4 ASTM C920, Specification for Elastomeric Joint Sealants.
- .5 CAN/CSA-G40.20/G40.21M, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.
- .6 CSA S136, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

- .1 Design aluminum panel work in accordance with following Climatic Design Data for Barrie contained in the Ontario Building Code:
  - .1 Design temperature: January 1%, July 2 1/2%.
  - .2 Hourly wind pressures: one (1) in 50 year occurrence.
- .2 Design aluminum panel system as a “dry joint system” and to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads, imposed and other loads.
- .3 Prevent rain penetration through system. Design system based on “Rain Screen Principle” in accordance with the National Research Council. Volume to vent ratio should not exceed 25 m. Panels should be compartmentalized at joints. Incorporate means of draining to the exterior.
- .4 Design aluminum panel system to accommodate thermal movements of the components and structural movements to provide an installation free of oil canning, buckling, delamination, failure of joint seals, excessive stress on fasteners or any other detrimental effects.
- .5 Design aluminum panel system to prevent rattling and vibration of panels, over stressing of fasteners and clips, and other detrimental effects on the system.
- .6 Panel removal: System design to allow removal of individual panels within system.

- .7 Design miscellaneous, additional structural framing members as required to complete aluminum panel system, where not indicated on Contract Drawings.
- .8 The attachment face of subgirts supporting the panel system must not deflect vertically more than three (3) mm due to the dead load of the panel system.

#### 1.4 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Shop drawings:
    - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
      - .1 Elevations, details, profiles, dimensions, thickness of materials, finishes, methods of joining, joint location, special joints, methods of anchoring, anchor and thermal clip details, types of sealants and gaskets, waterproof connections to adjoining work, details of other pertinent components of the work, and compliance with design criteria and requirements of related work.
      - .2 Seismic anchors, supports and accessories for complete installation.
  - .3 Samples:
    - .1 Submit samples in accordance with Section 01 30 00:
      - .1 600 x 600 mm samples of panel system showing fully assembled components including face sheets, sub-girts, insulation, liner panel, thermal clip and concealed sealant. Sample to be fabricated using exact colour and gauges specified.
      - .2 300 x 300 mm face sheet samples for soffits and screens.
  - .4 Closeout Submittals: Provide maintenance instructions for incorporation into Operation and Maintenance Manual, specified in Section 01 78 00.

#### 1.5 **QUALITY ASSURANCE**

- .1 Retain a licensed Professional Engineer, registered in the Province of Ontario, to perform following services for prefinished panel work:
  - .1 Design of aluminum panel system.
  - .2 Design of anchors, supports and accessories to meet seismic requirements.
  - .3 Review, stamp, and sign shop drawings.
  - .4 Conduct shop and field inspections and prepare and submit inspection reports.

- .2 Perform work of this Section only by a Subcontractor of recognized standing who has adequate plant, equipment, and skilled workers to perform it expeditiously, and is known to have been responsible for satisfactory installations similar to that specified during a period of at least the immediate past ten (10) years.
- .3 Execute steel welding to CSA W59-M by fabricators certified by the Canadian Welding Bureau to CSA W47.1.
- .4 Execute aluminum welding by fabricators certified by the Canadian Welding Bureau to CSA W47.2-M.
- .5 Execute finishing coatings and metal pre-treatments by applicators approved in writing by the manufacturer of the coatings and under the supervision of the manufacturer's qualified representative.
- .6 Mock-up:
  - .1 Fabricate, deliver, and erect a three (3) m<sup>2</sup> mm high mock-up panel of aluminum panel system in location acceptable to Consultant.
  - .2 Demonstrate full panel fabrication and installation techniques, confirm stiffness/absence of deformation, finish, anchoring devices, air barrier sealing, joint detailing and sealing, and quality of workmanship.
  - .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .7 Pre-Installation Meeting: Arrange meeting on Site to be attended by Consultant, Contractor, and panel manufacturer's representative to review installation procedures, interfaces with adjacent work, conditions under which work will be performed, inspect the surfaces to receive the vapour retarder, and installation procedures 48 hours in advance of installation.

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

- .1 Handle aluminum work in accordance with AAMA CW-10. Protect aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.
- .2 Remove and replace all damaged and unsatisfactory materials which are deemed unsuitable for use at this Section's own expense.

#### 1.7 **EXTENDED WARRANTY**

- .1 Manufacturer's Warranty: Provide panel manufacturer's written warranty naming Owner as beneficiary and covering failure of factory-applied exterior finish on prefinished metal panels within the warranty period; warrant finish per ASTM D4214 for chalk not in excess of eight (8) NBS units and fade not in excess of five (5) NBS units. Warranty period for finish: Ten (10) years from date Work is certified as substantially performed.

2 Products

2.1 **ACCEPTABLE PANEL MANUFACTURER(S)**

- .1 Aluminum Panels: Horizontal or vertical, 1.78 mm aluminum alloy panels, pre-finished panels as manufactured by Longboard Inspiring Facades or approved equivalent.

2.2 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, sealants, paints, and coatings are to have low VOC content limits.
- .2 Sheet aluminum: Aluminum Association 6061-T6 to ASTM B209.
- .3 Finish: Exposed to view: Powder coat finish complying to AAMA 2604, AkzoNobel / Interpon D2000. Colour: to be selected by Consultant. Concealed aluminum finish: Mill finish.
- .4 Structural shapes, plates, sag rods, and similar items: CAN/CSA-G40.20-G40.21-M, Grade 350W.
- .5 Air/Vapour barrier: In accordance with Section 07 26 00.
- .6 Z-girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm thick, Z275 galvanized. Depth as indicated on Contract Drawings. Z-girts to be thermally broken at mid-point of insulation thickness.
- .7 Thermal spacer: 100% pultruded glass fibre and thermoset polyester resin thermal spacer complete with fastener in depth indicated on Contract Drawings; Cascadia Clip by Interra Architectural Products or approved equivalent.
- .8 Provide all additional structural supports not shown on Drawings as required.
- .9 Seismic anchors, supports and accessories: In accordance with reviewed shop drawings.
- .10 Fasteners: Concealed, ANSI B18.6.4, stainless steel Type 304.
- .11 Flashings, Closure Pieces, Trim: Same material and colour as panels.
- .12 Spray Applied Insulation: In accordance with Section 07 21 17.
- .13 Clips and Panel Reinforcement: Extruded aluminum.
- .14 Sealant: ASTM C920, Type S, Grade NS, Class 100/50; One-part, low-modulus, moisture-curing, silicone. 'Dow Corning 790' by Dow Corning or 'Spectrem 1' by Tremco or approved equivalent. Colour as selected by Consultant. Primer as recommended by manufacturer.



- .15 Joint backing: Product as recommended by siding sealant manufacturer.
- .16 Touch-up paint: as recommended by panel manufacturer.
- .17 Isolation coating: Bituminous coating, acid and alkali resistant material.

## 2.3 **FABRICATION**

- .1 Fabricate facings and concealed support members in a manner which will provide an installation free of exposed fastenings, with sufficient support and allowance for thermal movement to prevent facing distortion. Take site measurements before proceeding with production.
- .2 Fabricate components of the system at factory, ready for field installation. Include full continuous joint reveals within system.
- 3. Fabricate facings flat, true, free of marks, without visible distortion and with edges straight and true. Make all planes true, and corners square and bend of minimum radius.
- .4 Provide proprietary aluminum extrusions to manufacturer's standard profiles for a complete installation. Extrusions shall be full length around panel perimeter for panel reinforcement and alignment. Intermittent clips are unacceptable.
- .5 Changes of plans, parallel or transverse to longitudinal axis shall be accomplished as detailed on shop drawings in the factory wherever practical and with a minimum of field fabrication.
- .6 Form panels to dimensions indicated with tolerances to accommodate expansion and contraction between panels and structure members. Accurately form shaped panels.
- .7 Fabricate panels with flanges on all sides.
- .8 Factory fabricate accessory and trim components ready for installation.
- .9 Polish smooth all exposed edges, corners and ends, free from sharp edges.
- .10 Maximum allowable tolerances shall be as follows:
  - .1 Panel bow: In a concave or convex direction to be 0.5% of panel dimension width and length.
  - .2 Panel flatness: Rises and falls across the panel, (local bumps and depressions) will not be accepted.
  - .3 Panel tolerance:
    - .1 Width: Two (2) mm.
    - .2 Length: Four (4) mm.
    - .3 Thickness: 0.2 mm.
    - .4 Squareness: Five (5) mm maximum.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that backup construction is aligned for proper installation of panels before commencing erection.
- .3 Protect metal surfaces in contact with concrete, masonry mortar, plaster or other cementitious surface and aluminum to steel surfaces with isolation coating.

3.2 **SOFFIT AND SIDING INSTALLATION**

- .1 Supply and install miscellaneous, additional structural framing members, required to complete aluminum panel system, where not indicated on Contract Drawings.
- .2 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.
- .3 Apply isolation coating to supporting structural framing to isolate airseal liner panel and to prevent galvanic corrosion.
- .4 Install air/vapour retarder in accordance with Section 07 26 00.
- .5 Install thermal spacer to substrate in accordance with manufacturer's written instructions.
- 6. Erect panels complete with girts, clips, and fasteners, to meet design criteria. Anchor each individual panel over solid backing. Ensure that all penetrations through air/vapour barrier are sealed.
- .7 Install panels, support and anchoring system, fasteners, trim and related items to lines and elevations indicated and in strict accordance with reviewed shop/erection drawings and manufacturer's printed instructions. Carefully co-ordinate work with other Sections.
- .8 Anchor component parts to transmit wind loading and other stresses to anchorage system.
- .9 Spray Applied Insulation: In accordance with Section 07 21 17.
- 10. Erect panel system in accordance with manufacturer's instructions and under direct supervision of the manufacturer.
- .11 Repair all damages and all penetrations in the installed membrane air barrier, caused by work of this Section, using the same air barrier material.

- .12 Installed panels shall not deviate from overall plane or alignment by more than 1:1000. Joints shall be hairline wherever possible or a maximum of 15 mm where indicated. Joints shall not be wavy, out of line or of different width from panel to panel.
- .13 Install all exposed work of this Section with concealed clips and fasteners. Exposed fasteners not acceptable.
- .14 Install all metal flashings within and at bottom of metal panel system.
- .15 Ensure drainage of any moisture which may occur within the system to the exterior.
- .16 Damaged panels, waviness, warp or distortion of finished work will not be accepted.
- .17 Completed installation shall be free from rattles, wind whistles, noise due to thermal movement and other noises.
- .18 Install metal materials during suitable weather conditions only.
- .19 Openings:
  - .1 Provide all openings required in preformed metal panel system.
  - .2 Provide required metal flashings around penetrations through metal panels. Ensure complete watertight seal.
- .20 Joint Backing and Sealant:
  - .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
  - .2 Install joint backing and sealant at perimeter of aluminum panel system and where indicated on drawings for weathertight installation. Tool sealant to concave profile.
  - .3 Seal around all openings and all other locations indicated or required to provide weathertight and watertight seal.

### 3.3 **SCREEN INSTALLATION**

- .1 Install screen in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Attach aluminum panels directly mounted to framing using approved concealed fasteners and clips.
- .3 Isolate aluminum from dissimilar metal to prevent galvanic action.

### 3.4 **REPAIR**

- .1 Remove damaged, dented, defaced, defectively finished, or tool marked components and replace with new, unless minor blemishes are approved by Consultant.
- .2 Only with approval of Consultant, refinish shop applied finishes in field with compatible materials to manufacturer's written instructions.

**3.5 CLEANING**

- .1 Remove all strippable protective film from the work as it is erected and prior to moving on to the next bay or grid.
- .2 Wash down exposed exterior surfaces using solution of mild non-acidic detergent in warm water, applied with soft clean wiping cloths.
- .3 As work progresses, remove excess sealant with recommended solvent and which will not affect metal, finished surfaces, or adjacent surfaces and materials.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for metal siding work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.
- .2 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .3 ASTM C553, Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- .4 ASTM C920, Specification for Elastomeric Joint Sealants.
- .5 CISC/CPMA 1.73a, A Quick-Drying One-Coat Paint for Use on Structural Steel.
- .6 CAN/CSA-G40.20/G40.21M, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels.
- .7 CSA S136, Cold Formed Steel Structural Members.
- .8 CSA S136.1, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

- .1 Design metal siding system in accordance with CSA S136, S136.1, and to withstand live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
- .2 Design metal siding system in accordance with following Climatic Design Data for Barrie contained in Ontario Building Code.
  - .1 Design Temperature: January 1%, July 2 ½%.
  - .2 Wind (Hourly Wind Pressures): 1 in 50 year occurrence.
  - .3 Seismic design: Class "C".
- .3 Design metal siding system to limit deflection under design loads, to L/240.
- .4 Design metal siding system to prevent restriction of thermal induced movement which would induce deformation such as warping, buckling, and failure of joint seals and fasteners. Design metal siding system to prevent vibration when subject to the effects of wind.
- .5 Design miscellaneous, additional structural framing members and sag rods, required to complete metal siding system, where not indicated on Contract Drawings.

#### 1.4 SUBMITTALS

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Shop drawings:
    - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
      - .1 Elevations, details, profiles, dimensions, thickness of materials, finishes, methods of joining, arrangement of sheets, joints, and seams, special shapes, methods of anchoring, anchor and clip details, types of sealants and gaskets, waterproof connections to adjoining work, details of other pertinent components of the work (i.e. windows, penetrations, membranes, etc), and compliance with design criteria and requirements of related work.
      - .2 Seismic anchors, supports and accessories for complete installation.
  - .3 Samples:
    - .1 Submit samples in accordance with Section 01 30 00:
      - .1 600 x 600 mm samples of siding system showing fully assembled components including face sheets, sub-girts, insulation, liner panel, and concealed sealant. Sample to be fabricated using exact colour and gauges specified.
- .4 Reports: Submit written field inspection and test report results after each inspection.

#### 1.5 QUALITY ASSURANCE

- .1 Retain a licensed Professional Engineer, registered in Province of Ontario, to perform following services for metal siding work:
  - .1 Design of metal siding work.
  - .2 Design of anchors, supports and accessories to meet seismic requirements.
  - .3 Review, stamp, and sign shop drawings.
  - .4 Conduct shop and field inspections and prepare and submit inspection reports.
- .2 Mock-up:
  - .1 Fabricate, deliver, and erect one full scale 3 m<sup>2</sup> high mock-up panel of metal siding construction, in location acceptable to Consultant.
  - .2 Demonstrate finish, colours, and quality of workmanship.
  - .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

- .3 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

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

- .1 Stockpile panels tilted to provide water run-off, free from ground contact on firm, level, non-staining supports extending full width of sheet and spaced not more than 450 mm apart. Cover components with opaque polyethylene sheet. Vent to allow air movement.

## 2 **Products**

### 2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, paints and sealants are to have low VOC content limits.
- .2 Metal siding: ASTM A653/A653M, Z275 galvanized steel, 0.76 mm minimum base metal thickness.
  - .1 'AD275R' by VicWest Steel, nominal 39 mm deep.
  - .2 Agway Metals Inc.
  - .3 Roll Form Group.
  - .4 Or approved equivalent
- .3 Metal siding finish: Perspectra Series coating system by ArcelorMittal Dofasco, or WeatherX by Vicwest Steel or approved equivalent. Colour as selected by Consultant.
- .4 Airseal liner panel: ASTM A653/A653M; 0.70 mm minimum base metal, Z275, galvanized steel, with interlocked male and female edge lips, factory caulked with liner sealant.
  - .1 V-Rib Liner by Canadian Metal Rolling Mills.
  - .2 L-800FR by Flynn Canada Ltd.
  - .3 L-800 Liner by Vic West Steel.
  - .4 Or approved equivalent.
- .5 Structural shapes, plates, sag rods, and similar items: CAN/CSA-G40.20-G40.21-M, Grade 300W.
- .6 Hollow structural sections: CAN/CSA-G40.20/G40.21-M Grade 350W, Class H.
- .7 Liner sealant: Type as recommended by liner manufacturer.
- .8 Airseal transition membrane: 'Perm-a-Barrier Detail Membrane' by gcp applied technologies, 'Blueskin SA' by Henry Company Canada, or 'Soprseal Stick 1100T' by Soprema Inc. or approved equivalent. Membrane to come complete with applicable primer.

- .9 Z-girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm thick, Z275 galvanized. Depth as indicated on Contract Drawings. Z-girts to be thermally broken at mid-point of insulation thickness.
- .10 Insulation: ASTM C553, 32 kg/m<sup>3</sup>, Semi-rigid mineral fibre. Thickness as indicated on Contract Drawings. Temporary adhesive: Type as recommended by insulation manufacturer.
  - .1 'Rockwool Plus MB' by Rockwool Inc.
  - .2 Johns Manville.
  - .3 Owens-Corning.
  - .4 Or approved equivalent.
- .11 Fascia, trim, closures, and flashings: Material, finish, colour, and fasteners to match siding material, 0.76 mm minimum base metal thickness minimum.
- .12 Screw fasteners: ANSI B18.6.4, stainless steel Type 304. Exposed locations: With coloured nylon heads to match metal siding.
- .13 Seismic anchors, supports and accessories: In accordance with reviewed shop drawings.
- .14 Primer paint: CISC/CPMA 1.73a
- .15 Isolation coating: Black bituminous coating, acid and alkali resistant material.
- .16 Joint backing: Product as recommended by siding sealant manufacturer.
- .17 Siding sealant: ASTM C920, Type S, Grade NS; One-part, ultra-low modulus, moisture curing silicone sealant, 'Dowsil 790' by Dow Consumer or Spectrem 1 by Tremco Ltd. or approved equivalent. Colour: As selected by Consultant.
- .18 Thermal Separation: Continuous 3 mm thick x 38 mm wide self adhering cork.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 STRUCTURAL FRAMING

- .1 Supply and install miscellaneous, additional structural framing members, required to complete metal siding system, where not indicated on Contract Drawings.



### 3.3 **AIRSEAL LINER PANEL**

- .1 Apply isolation coating to supporting structural framing to isolate airseal liner panel and to prevent galvanic corrosion.
- .2 Apply continuous beads of liner sealant on face of top and bottom supports of siding liner sheet to provide a complete seal. Ensure a complete seal is obtained between all components from back of liner panel to face of supporting members.
- .3 Install airseal liner panel to achieve continuous airseal, rigidly secured to resist design wind loading. Where possible, liner sheets to be one piece full height. Seal liner panel laps airtight with sealant.
- .4 Coordinate airseal transition to adjacent parts of Work.

### 3.4 **AIRSEAL TRANSITION MEMBRANE**

- .1 Install primer and airseal transition membrane with 150 mm overlap of metal airseal, continuously onto entire head, jamb, and sill surfaces of openings such as doors, windows, louvres and similar items, and metal siding system perimeter.
- .2 Install additional layer of airseal transition membrane to serve as flashing over openings in, and at bottom side termination of metal siding panel system.
- .3 Overlap airseal transition membrane 50 mm along sidelaps and 75 mm on end laps and lap in direction of waterflow.
- .4 Coordinate airseal transition to adjacent parts of Work.
- .5 Provide end-dams and terminations fabricated from same material as airseal transition membrane or material recommended by membrane manufacturer at sills, lintels, openings, and where horizontal surfaces intersect with vertical surfaces to ensure moisture is shed to exterior.

### 3.5 **GIRTS AND CHANNELS**

- .1 Notch Z girts and C channels as required to accommodate airseal liner panel ribs and fins and to allow drainage of cavity.
- .2 Provide thermal break between sub-girts and liner sheets. Direct metal-to-metal contact between liner sheet and exterior sheets will not be accepted.
- .3 Install Z girts, fastened through airseal liner, and into structural framing beneath. Orient Z girts to drain water from cavity.
- .4 Install C channels to frame openings such as doors, windows, and louvre openings, and orient channel webs to form heads, jambs and sills of openings.

**3.6 SIDING INSULATION**

- .1 Install siding insulation in continuous contact with airseal liner and neatly fitted between Z girts and C channels. Adhere insulation with temporary adhesive.

**3.7 FASCIA, TRIM, CLOSURES, AND FLASHINGS**

- .1 Install fascia and trim including inside and outside corners, flashing, edgings, cap strips, drips, under-sill trim, fillers, closure strips, starter strips, and window or door trim, carefully formed and profiled.

**3.8 METAL SIDING**

- .1 Install metal siding in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.
- .3 Install metal siding in one piece, full height, except as indicated otherwise.
- .4 Maintain joints in exterior siding, plumb, true to line, tight fitting, hairline joints.
- .5 Attach metal siding system components to prevent warping, buckling, and deformation induced by restriction of thermal induced movement .
- .6 Install corner pieces, closures, flashings, etc, where shown and where required. Provide formed steel closures around opening.
- .7 Bed flashings, closures, and corner pieces in sealant to provide a weathertight installation.

**3.9 JOINT BACKING AND SIDING SEALANT**

- .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
- .2 Install joint backing and sealant at siding system joints and perimeter for weathertight installation. Tool sealant to concave profile.

**3.10 TOUCH UP**

- .1 Touch up marred surfaces with air dry formulation to match pre-finished siding if approved by Consultant, otherwise remove and replace damaged metal siding.
- .2 Clean and touch up marred galvanized surfaces after installation, with zinc rich primer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for metal roofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI B18.6.4, Screws, Tapping and Metallic Drive, Inch Series, Thread Forming and Cutting.
- .2 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .3 ASTM A792-M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .4 ASTM C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
- .5 ASTM C1177M, Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
- .6 ASTM E84, Test Method for Surface Burning Characteristics of Building Materials.
- .7 CAN/CGSB-19.13-M, Sealing Compound, One Component, Elastomeric, Chemical Curing.
- .8 CAN/CSA S136-M, Cold Formed Steel Structural Members.
- .9 CAN/CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

- .1 Design metal roofing elements in accordance with CAN/CSA S136-M, S136.1-M and to withstand live, dead, lateral, wind, seismic, handling, transportation and erection loads.
- .2 Design metal roofing elements in accordance with following Climatic Design Data for Barrie contained in Ontario Building Code:
  - .1 Design temperature: January 1%, July 2 1/2%.
  - .2 Wind (Hourly wind pressures): one (1) in 50 year occurrence.
  - .3 Earthquake: Seismic Data as listed.
- .3 Design metal roofing system to limit deflection under design loads to L/240.

- .4 Design metal roofing system to prevent restriction of thermal induced movement which would induce deformation such as warping, buckling, and failure of joint seals and fasteners.
- .5 Design metal roofing system to prevent the infiltration of water into the roof system and to prevent roofing system components from vibrating due to design wind loads.
- .6 Incorporate design of snow fencing into roof design to meet design criteria specified herein. Snow fencing to be of same material and colour as roof system

#### 1.4 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Arrangements of sheets and joints, materials, thicknesses, dimensions, layouts, types and locations of supports and fasteners and special shapes.
    - .2 Relationship of panels to structural frame.
    - .3 Details of waterproofing membrane, insulation, connections, snow fencing and all other components in the system.
- .3 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00.
    - .1 Submit 300 x 300 mm samples of each sheet metal material and finish.
    - .2 Waterproofing membrane.
    - .3 Insulation.
- .4 Reports: Submit written field inspection and test report results within three (3) days after each inspection.
- .5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

**1.5 QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five (5) years proven experience in the installation of metal roofing of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Retain a Professional Engineer, licensed in Province of Ontario, with experience in metal roofing work of comparable complexity and scope to perform following services as part of work of this Section:
  - .1 Design of metal roofing and snow fencing and framing for snow fencing and attachment.
  - .2 Review, stamp, and sign shop drawings.
  - .3 Conduct shop and on-Site inspections and prepare and submit inspection reports.
- .3 Mock-up:
  - .1 Construct one full scale 1200 mm wide x 1800 mm long mock-up panel of metal roofing construction, in location acceptable to Consultant.
  - .2 Demonstrate installation of underlay board, insulation, metal roofing, finish, and quality of workmanship.
  - .3 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.
- .4 Pre-installation meeting: Arrange with manufacturer's representative, Contractor, and Consultant to inspect substrates, and to review installation procedures 48 hours in advance of installation.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Stockpile panels tilted to provide water run-off, free from ground contact on firm, level, non-staining supports extending full width of sheet and spaced not more than 450 mm apart. Cover components with opaque polyethylene sheet. Vent to allow air movement.

**1.7 EXTENDED WARRANTY**

- .1 Submit an extended warranty for metal roofing work In accordance with the General Conditions, except that the warranty is extended to 2 years from date of Substantial Performance.
  - .1 Warrant against panel warping, twisting, failure, jointing, finish failure, water penetration below waterproofing membrane and failure to drain water from rainscreen cavity.
  - .2 Coverage: Complete replacement including affected adjacent parts.

- .2 Manufacturer's Warranty: Provide metal roof manufacturer's written warranty naming Owner as beneficiary and covering all materials with all supports and accessories for a complete system and failure of factory-applied exterior finish on metal roof panels within the warranty period; warrant finish per ASTM D4214 for chalk not in excess of eight (8) NBS units and fade not in excess of five (5) NBS units. Warranty period for material and finish: Twenty-five (25) years from date Work is certified as substantially performed.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, sealants and coatings are to have low VOC content limits.
- .2 Standing seam metal: ASTM A653M; 0.61 mm (24 Ga.) minimum base metal, Z275, galvanized steel. 'CRS-38' by CR Systems or 'Tradition 150' by VicWest Steel, or by Agway Metals Inc., Roll Form Group or approved equivalent.
- .3 Metal roofing finish: Perspectra Series coating system by ArcelorMittal Dofasco, or WeatherX by Vicwest Steel or 'SMP Prepainted Steel' by Cascadia Metals Ltd. or approved equivalent. Colour as selected by Consultant.
- .4 Galvalume: ASTM A792M, AZM165 coating designation, 0.61 mm thick minimum base metal.
- .5 Steel deck: Refer to Structural Drawings and Specification for steel deck.
- .6 Deck closures: ASTM A653/A653M, Z275 hot-dip galvanized steel, 0.61 mm thick base steel thickness.
- .7 Deck reinforcements: ASTM A653/A653M, Z275 hot-dip galvanized steel, 2.0 mm thick base steel thickness.
- .8 Underlay board: ASTM C1177; six (6) mm thick, 'Dens-Deck Roof Board' by Georgia-Pacific Corp. or approved equivalent; tested to ASTM E84, 0 flame spread, 0 smoke developed, glass fibre faced both sides, silicone treated gypsum core. 1200 mm wide sheets x maximum practical lengths to minimize end joints.
- .9 Waterproof membrane: 1.0 mm thick composite sheet comprised of SBS modified bitumen with woven polyethylene reinforcement; 'CCW 300 HT' by Carlisle Coatings and Waterproofing, 'Lastobond Shield HT' by Soprema, 'Platinum HT SA' by FT Synthetics, or by Henry Company Canada or approved equivalent. Primer recommended by membrane manufacturer.
- .10 Drainage mat: 7.6 mm thick, 'Viper CDR Vent' by Keene or approved equivalent.

- .11 Z girts and C channels: CAN/CSA S136-M; Minimum 1.2 mm, Z275 galvanized Z girts and C channels. Depth: As indicated on Contract Drawings.
- .12 Seam clips: ASTM A653M; Z275 galvanized steel, thermal clip system.
- .13 Insulation: ASTM C612, 96 kg/m<sup>3</sup>, Semi-rigid mineral fibre. Thickness as indicated on Contract Drawings. Temporary adhesive: As recommended by insulation manufacturer.
  - .1 'Rockboard 60' by Rockwool Inc.
  - .2 Owens Corning Canada Inc.
  - .3 Or approved equivalent
- .14 Fascia, trim, closure, and flashings: Material, finish, colour, hidden fastener and thickness to match metal roofing material.
- .15 Snow fencing: Fabricated from galvanized steel and prefinished to match metal roof; 'Snow Fence' by TRA Snow Fences Inc., 'Snow Guard' by Vicwest, or approved equivalent.
- .16 Screw fasteners: Hot dipped galvanized steel fasteners. All fasteners to be concealed and hidden. Fasteners to be complete with coloured heads to match metal roofing.
- .17 Sealant: CAN/CGSB-19.13-M. Primer as recommended by sealant manufacturer.

## 2.2 **FABRICATION**

- .1 Fabricate roof components in accordance with reviewed shop drawings factory-ready for field installation.
- .2 Fabricate individual metal roofing panels in maximum lengths.
- .3 Fabricate metal roofing panels square, true and accurate to size, free from distortion and other defects detrimental to appearance or performance.
- .4 Notch Z girts and C channels as required to allow for drainage of rainscreen cavity.

## 3 Execution

### 3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

### 3.2 **STEEL DECK**

- .1 Install steel deck in accordance with CSA S136 and manufacturers written instructions ensuring it is securely fastened with minimum bearing on structural support equal to depth of steel roof deck profile.
- .2 Fasten steel roof deck to structural supports with a maximum fastener spacing along bearing supports of 400 mm or two flute spacings, whichever is less.
- .3 Provide arc spot welds with a nominal 20 mm top diameter.
- .4 Mechanically fasten side laps of adjacent units at maximum 900 mm. Provide closer spacing where required by design.
- .5 Provide deck closures and reinforcing as required for design loads.

### 3.3 **UNDERLAY BOARD**

- .1 Stagger underlay board joints at least 25% of full board length. Orient long side of boards perpendicular to metal deck flutes. Locate end joints over supporting ribs of metal deck.
- .2 Do not install imperfect, damaged or damp boards. Butt boards together with no spaces between boards.
- .3 Screw fasten underlay board to metal deck substrate at 600 mm o.c. and continuously around perimeter of each board at 300 mm o.c.. Maintain 15 mm minimum from edge of board to centre of screw.

### 3.4 **WATERPROOF/AIRSEAL MEMBRANE**

- .1 Install primer and waterproof membrane continuously over underlay board, in accordance with manufacturer's instructions.
- .2 Overlap waterproof membrane 50 mm along sidelaps and 75 mm on end laps and lap in direction of waterflow.
- .3 Coordinate airseal transition to adjacent parts of work.

### 3.5 **GIRTS AND CHANNELS**

- .1 Install Z girts, fastened through waterproof membrane and into structural framing beneath. Orient Z girts to drain water from rainscreen cavity.
- .2 Frame roofing system edges, with C channels and orient channel webs to face outwards.



**3.6 METAL ROOF INSULATION**

- .1 Prior to installation of insulation, examine waterproofing membrane and make good damage.
- .2 Install metal roof insulation in continuous contact with waterproof membrane and fitted between Z girts and C channels. Butt boards together with no spaces between boards. Areas of insulation system having voids will be rejected.
- .3 When cutting insulation board, cut completely through board thickness and trim to provide plain butt joints. Do not break or tear insulation board to fit detail.

**3.7 FASCIA, TRIM, CLOSURES, AND FLASHINGS**

- .1 Form and profile fascia and trim including inside and outside corners, flashing, edgings, cap strips, drips, fillers, closure strips, and starter strips in accordance with the drawings.
- .2 Flashings to utilize a "S" locking joint for concealed fastening.
- .3 Cut neat holes in metal roofing to accommodate roof penetrations and install flashing for a watertight installation.

**3.8 METAL ROOFING (STANDING SEAM)**

- .1 Install metal roofing in accordance with reviewed shop drawings and manufacturer's written instructions. Used concealed fasteners unless otherwise approved by the Consultant.
- .2 Install seam clips spaced as indicated on reviewed shop drawings to comply with design criteria. Secure cleats with two fasteners each minimum, into Z girts or metal deck.
- .3 Apply sheet metal roofing beginning at eaves. Loose lock pans to valley flashing and edge strips at eaves and gable rakes.
- .4 Fold lower ends of seams at eaves over at 45° angle. Terminate standing seams at ridge and hips by turning down in tapered fold.
- .5 Install metal roofing panels in one piece, for entire slope, except as indicated otherwise. In locations that roof panels cannot be installed in one piece, provide 100 mm starter strip to join the panels together. Provide a continuous sealant bead under starter strip.
- .6 Metal roof panels terminating at eaves or valleys shall not have a raw metal edge or exposed fasteners. Fold panel ends and install in accordance with reviewed shop drawings.

- .7 Insert metal roof panels terminating at hips or ridges into concealed metal closures. Metal closures shall allow for expansion of the metal roof panel and also act as a starter strip for hip or ridge flashings.
- .8 Install valley sheets not exceeding three (3) m in length. Shingle lap joints 150 mm in direction of flow. Extend valley sheet minimum 150 mm under roofing sheets. Double fold valley and roofing sheets and secure at 450 mm oc.
- .9 Install snow fencing in accordance with manufacturer's instructions and reviewed shop drawings.
- .10 Tapered roof panels to be one piece.
- .11 Apply isolation coating to metal surfaces in contact with concrete or mortar.
- .12 Remove and replace damaged metal roofing. Do not touch-up damaged panels.

### 3.9 **SEALANT**

- .1 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other work. Sealing work consists of bedding between members where possible. Dry tool sealant to concave profile where exposed.

### 3.10 **CLEANING AND TOUCH-UP**

- .1 Clean exposed finished surfaces of complete installation free of dirt, grease and smudges.
- .2 Touch-up scratches with air dry formulation of coating system to match original factory finish.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for flashing and sheet metal Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM C920, Specification for Elastomeric Joint Sealants.
- .3 CRCA Roofing Manual, Canadian Roofing Contractors Association.
- .4 Canadian Steel Sheet Building Institute (CSSBI) Bulletin No. 9, Core and Maintenance of Pre-finished Sheet Steel Building Products.

1.3 **SUBMITTALS**

- .1 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Proposed method of shaping, forming, jointing.
    - .2 Fastening, and application of flashing and sheet metal Work.
- .2 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00:
    - .1 50 x 50 mm samples of sheet metal material, colour and finish.
    - .2 Representative sample section of prepainted metal flashing illustrating S locking jointing method, minimum 600 mm long.

1.4 **QUALITY ASSURANCE**

- .1 Mock-Up:
  - .1 Fabricate mock-up in minimum 2400 mm length with reviewed materials, approved methods including joints, seams, expansion joints, starter strips and fasteners.
  - .2 Mock-up, if accepted, shall represent the minimum standard for Work. Mock-up may form part of finished Work.
- .2 Flashing and Sheet Metal Work shall be executed in accordance with SMACNA Architectural Sheet Metal Manual - 1993 (Addendum No. 1 - October 31, 1997), by skilled trades having a minimum of five (5) years related experience.

1.5      **WARRANTY**

- .1      Contractor must extend the Warranty on replaced parts and workmanship for a period of two (2) years from date of acceptance of replacement parts and workmanship. Defects will include but will not be limited to leaking, failure to stay in place, lifting, deformation and breaking of weathertight seals.
- .2      Provide all additional Warranties that may be available from manufacturer.

2      Products

2.1      **MATERIALS**

- .1      All materials under Work of this Section, including but not limited to, sealants and paints are to have low VOC content limits.
- .2      Prepainted sheet steel: ASTM A653/A653M; Classification LFQ, Grade A, Z275 zinc coating designation, minimum base metal thickness of 0.71 mm (24 gauge), commercial quality, prefinished with Perspectra Series coating system by U.S. Steel Canada, or WeatherX by Vicwest Steel or approved equivalent. Colour as selected by Consultant.
- .3      Plastic cement: Trowel grade asphalt mastic.
- .4      Sealant: ASTM C920, Type S, Grade NS, Class 25; High-performance, medium-modulus, one-part, neutral-cure silicone sealant. 'CWS' by Dow Corning or approved equivalent.
- .5      Cleats and starter strips: Starter strips to be continuous, of same material as flashing used, 1.2 mm thick. Minimum 100 mm wide face or as detailed and to be continuous.
- .6      Fasteners: Flat head roofing nails of length, type and thickness suitable for metal flashing application.
- .7      Washers: of same material as sheet metal, one (1) mm thick with rubber packings.
- .8      Touch-up paint: Same colour and material as prepainted sheet steel, as recommended by prefinished coating manufacturer.

2.2      **FABRICATION**

- .1      Shop fabricate flashing, sheet metal and trim in accordance with requirements of SMACNA, CRCA and the Contract Documents. Form sheet metal on bending brake, shaping, trimming and hand seaming on bench.

- .2 Brake-form sections square, true, and accurate to size. Flashings shall be free from distortion, oil canning, twists, buckles, discolouration and other defects detrimental to appearance and performance.
- .3 Hem exposed edges 13 mm minimum on underside for appearance and stiffness. Mitre and seal corners with sealant.
- .4 Form joints with 'S-locks' and make allowances for movement. Mitre and form standing seams at all corners. Make allowance for movement at joints.
- .5 Fabricate copings, cap flashings, counter flashings and starter strips, scuppers, fascia and miscellaneous flashings to details shown and where required.
- .6 Fabricate metal in 2400 mm maximum lengths with an unbroken face less than 225 mm. Form flashings with an exposed unbroken face exceeding 225 mm and a girth greater than 610 mm in 1220 mm maximum lengths.
- .7 Provide an 'S-Lock' joint at all end joints and at all horizontal joints between the cap flashing and the vertical flashing and between the vertical flashing and base counter flashing.
- .8 Provide double locking standing seam at interior and exterior corners where flashings meet.
- .9 Scuppers:
  - .1 Form scuppers from prefinished steel sheet metal.
  - .2 Sizes and profiles as indicated.
  - .3 Provide necessary fastenings.
  - .4 Provide Zurn Z198 cast metal parapet scupper sleeve with collar clamp or approved equivalent where indicated on drawings.
- .10 Sheet metal coming in contact with a metal of a different type must be back painted with two (2) coats of isolation coating.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

#### 3.2 FLASHING INSTALLATION

- .1 Install coping flashings, curb counter flashings, starter strips, scuppers, and miscellaneous flashings to details shown on the Contract Drawings and in accordance with CRCA.

- .2 Use concealed fasteners. Exposed fasteners such as pop rivets are not allowed.
- .3 Install continuous starter strips to present a true, non-waving, leading edge. Anchor to back-up for a rigid, secure installation.
- .4 Counterflash bituminous flashings at intersections of roof with vertical surfaces and curbs. Flash joints using S-lock forming tight fit over hook strips.
- .5 Make end joints using an S lock joint. Execute by inserting end coping length in 25 mm deep S lock formed in end of adjacent length. Extend concealed portion of S lock 25 mm outwards and nail to substrate. Face nailing of joints will not be permitted.
- .6 Seal where necessary to form weathertight seal between flashing and adjoining surfaces and between flashing and other Work. Sealing Work consists of bedding between members where possible. Tool sealant to concave profile where exposed.
- .7 Insert metal flashing under cap flashing to form weathertight junction.
- .8 Caulk flashing at cap flashing with sealant.
- .9 Install pans, where shown around items projecting through roof membrane.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary to protect spray applied foam insulation not otherwise concealed within masonry or gypsum clad wall assemblies with a spray applied thermal barrier in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 CAN4 S124, Standard Methods of Test for the Evaluation of Protective Coverings for Foamed Plastics.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Certification:
    - .1 Submit certified documentation for each worker performing Work of this Section, to substantiate five (5) years minimum of experience in sprayed thermal barrier installation.
    - .2 Submit installer's and Product manufacturer's certification verifying compliance with Contract Documents.
    - .3 For assemblies not tested and rated in accordance with CAN4 S124, submit proposals based on related designs using accepted thermal barrier design criteria.

1.4 **QUALITY ASSURANCE**

- .1 Qualifications: Execute Work of this Section by manufacturer-approved, skilled, qualified, and experienced workers, trained in installation of Work of this Section.

1.5 **SITE CONDITIONS**

- .1 Maintain a 5°C air and substrate temperature for 24 hours before, during, and 24 hours after application in accordance with manufacturer's instructions.
- .2 Ventilate to dry thermal barrier. In enclosed areas circulate interior air and exhaust to the exterior.
- .3 Protect adjacent surfaces and equipment around application areas from overspray, marring or damage. Clean, polish or replace materials damaged to acceptance of Engineer.

2 Products

2.1 **MATERIALS**

- .1 All materials under Work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 Primer/bonding agent: As recommended by spray thermal barrier manufacturer.
- .3 Thermal Barrier: CAN4 S124, Spray applied, single component cementitious thermal barrier with a density of 370 to 380 kg/m<sup>3</sup>:
  - .1 'A/D Cementitious Thermal Barrier' by A/D Fire Protection Systems Inc.
  - .2 'Monokote Z-3306' by Grace Construction Products.
  - .3 Or approved equivalent.
- .4 Water: Clean, free from organic and mineral impurities which would be harmful to application.

2.2 **MIXING**

- .1 Mix Products in accordance with manufacturer's instructions.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Engineer. Commencement of Work means acceptance of existing conditions.
- .2 Verify that substrates are compatible and have suitable bonding characteristics to receive thermal barrier.
- .3 Ensure that items required to penetrate thermal barrier are placed before installation of thermal barrier.
- .4 Ensure that ducts, piping, equipments, or other items which would interfere with application of thermal barrier are not positioned until thermal barrier is completed.

3.2 **APPLICATION**

- .1 Use temporary enclosures to prevent spray from contaminating air beyond application area. Protect adjacent surfaces and equipment from damage by overspray, fall-out, and dusting of thermal barrier material. Protect walls, windows, floors and other surfaces around areas to be fireproofed, from marring or damage.
- .2 Clean surfaces to be fireproofed of any foreign matter which would affect adhesion.



- .3 Apply primer as recommended by thermal barrier manufacturer for the particular substrate to be fireproofed.
- .4 Apply thermal barrier in separate coats in accordance with the manufacturer's instructions to total thickness required to achieve fire ratings shown on the Contract Drawings. Comply with accepted ULC or WHI design.
- .5 Maintain continuity of thermal barrier without gaps or voids. Board tamp or trowel thermal barrier before curing.
- .6 Repair thermal barrier damaged by other trades, to acceptance of Consultant.

**3.3 FIELD QUALITY CONTROL**

- .1 Perform field tests required by authorities having jurisdiction.

**3.4 CLEANING UP**

- .1 Clean exposed wall, ceiling or other surfaces of thermal barrier materials to the acceptance of Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for intumescent fireproofing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM D2240, Standard Test Method for Rubber Property - Durometer Hardness.
- .2 ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- .3 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- .4 ASTM E761, Standard test method for Compressive Strength of Sprayed Fire-Resistive Materials Applied to Structural Members.
- .5 AWCI, Association of the Wall and Ceiling Industries - International.
- .6 AWCI Technical Manual 12-B, Standard Practice for the Testing and Inspection of Field Applied Thin-Film Intumescent Fire-Resistive Materials; an Annotated Guide.
- .7 Technical Manual 12-B, 'Standard Practice for the Testing and Inspection of Field Applied Thin-Film Intumescent Fire-Resistive Materials by Association of the Wall and Ceiling Industry (AWCI)
- .8 ULC, Underwriter's Laboratories of Canada.

1.3 **SYSTEM DESCRIPTION**

- .1 Provide intumescent fireproofing to provide a fire resistance rating of 60 minutes for all columns and items indicated on drawings.

1.4 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data for each material used in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00.
    - .1 Two 150 x 300 mm samples of intumescent fireproofing applied to three (3) mm steel plate cut back to show primer, intumescent coating and topcoat demonstrating colour and finish for Consultant approval.

- .3 Certificates: Submit ULC certification for designs of fire resistive coating application to substrate materials required and test reports showing compliance with specified physical performance characteristics and physical properties.

## 1.5 **QUALITY ASSURANCE**

- .1 Installers qualifications:
  - .1 Perform work of this Section by a company that has a minimum of five (5) years proven experience in the installation of intumescent fireproof coatings on project of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Inspection and Testing:
  - .1 An independent testing laboratory/company may be selected by the Consultant to test random samples as applied, to verify thickness of thin-film intumescent fire-resistive coating in accordance with AWCI Technical Manual 12-B. Inspection shall be carried out prior to application of topcoat.
  - .2 Correct deficiencies and have such corrected work approved by Inspection/Testing Company before work is continued.

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

- .1 Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Ship, store and deliver at temperatures not less than 50°F (10°C); protect from freezing.
- .2 Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

## 1.7 **SITE CONDITIONS**

- .1 Do not install work of this Section outside of following environmental ranges without Consultant's and Product manufacturer's written acceptance:
  - .1 Ambient air and surface temperature: 10°C minimum.
  - .2 Precipitation: None.
  - .3 Relative Humidity: 40-60%.
- .2 Do not install work of this Section outside of environmental ranges as recommended by the intumescent coating manufacturer without the Consultant's and Product manufacturer's written acceptance.
- .3 Supply and install temporary protection and facilities to maintain Product manufacturer's, and above specified environmental requirements for 24 hours before, during, and 24 hours after installation.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, coatings are to have low VOC content limits.
- .2 Intumescent fireproofing system: 'A/D Firefilm III System' by A/D Fire Protection Systems, 'Sprayfilm' by Cafco or by StonCor or approved equivalent, consisting of the following components.
  - .1 Primer: Recommended by manufacturer for substrate being fireproofed.
  - .2 Intumescent coating: A/D Firefilm III, conforming to:
    - .1 Hardness (Shore "D"): Durometer D65-70 in accordance with ASTM D2240.
    - .2 Surface Burning Characteristics: Class "A", in accordance with ASTM E84.
    - .3 Density 1425 kg/m<sup>2</sup>.
    - .4 Bond strength: 861 kPa in accordance with ASTM D4541.
    - .5 Compressive strength: 5.2 MPa at 10 % deformation, in accordance with ASTM E761.
  - .3 Top coat: A/D TC-55 Sealer. Colour: Clear.
- .3 Intumescent fireproofing system: Two component, epoxy based, thermally activated, subliming coating. Intumescent coating system to include primer, intumescent coating, and top coat as indicated below.
  - .1 'Thermo-Lag 3000-SA' by A/D Fire Protection Systems or approved equivalent by Cafco or approved equivalent manufacturer that meets or exceeds the specifications.
  - .2 Primer: Recommended by manufacturer for substrate being fireproofed.
  - .3 Intumescent coating: Provide first and final coat of 'Thermo-Lag 3000-SA' by A/D Fire Protection Systems or approved equivalent, meeting the following criteria:
    - .1 VOC content: 0.53 lbs/gal.
    - .2 Density: 1313 kg/cm. (82 pcf) conforming to ASTM E605.
    - .3 Hardness (Shore "D"): Durometer of 55 in accordance with ASTM D2240.
    - .4 Surface Burning Characteristics: Flame Spread: 0, Smoke Development: 0-20, Class "A", in accordance with ASTM E84.
    - .5 Bond Strength: 2.73 MPa (57,000 psf) in accordance with ASTM E736.
    - .6 Compressive strength: 19.65 MPa (2,850 psi) in accordance with ASTM E761.
  - .4 Top coat: Top coat as approved by intumescent film manufacturer for intended application. Colour to be selected by Consultant.

2.2 **MIXES**

- .1 Mix intumescent fireproof coating components in accordance with manufacturer's written instructions.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Verify that all clips, hangers, sleeves and similar devices have been attached. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **PREPARATION**

- .1 Protect work of other trades against overspray and make good at own expense any such damage. Provide adequate covering by drop cloths, masting or tarpaulins to surfaces, or on fitments in contact with, or adjacent to, surfaces to be fireproofed.
- .2 Clean surfaces, to be fireproofed, free of dust, grease, oils, etc. in accordance with manufacturer's recommendations. Ensure surfaces are free of any extraneous matter which could be detrimental to a satisfactory and acceptable finish.
- .3 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to performance. Obtain manufacturer's approval of substrate in writing, submit copy to Consultant.
- .4 Prime surfaces to be fireproofed with specified primer in accordance with manufacturer's recommendations.
- .5 Inspect primed surfaces to be fireproofed for gouges, marks, pinholes, nibs, etc. Properly prepare same by patching, filling, smoothing or any other surface preparation necessary to ensure a satisfactory surface finish.
- .6 Ensure written confirmation is received from steel fabricators of the specific surface preparation procedures and primers used for the application of fireproofing materials to ascertain compatibility with work of this Section:
  - .1 Verify that substrate surfaces are ready to receive work. Commercial blast cleaning (SSPC SP6) is required for minimum surface preparation. Weld flashes should be ground smooth prior to commencement of application. Select primer from manufacturer's list of approved primers.

3.3 **APPLICATION**

- .1 Install intumescent fireproofing in accordance with manufacturer's written instructions.
- .2 Install intumescent fireproofing at the proper consistency to ensure a satisfactory surface finish.
- .3 Use-up materials within shelf life period recommended by manufacturer.
- .4 Ensure finished work is uniform as to sheen, gloss, colour, and texture.

- .5 Patching: Patch and repair any fire resistive coating that has been damaged in accordance with patching recommendations of material manufacturer. If coating becomes damaged, rebuild thickness by spray or brush. Fill small areas with trowel. When dry, smooth and finish to match adjacent surfaces.

#### 3.4 **FIELD QUALITY CONTROL**

- .1 Perform field tests as required by Authorities having Jurisdiction. Tests to be carried out as outlined in Technical Manual 12-B by AWCI.

#### 3.5 **CLEANING**

- .1 Remove temporary coverings and protection of adjacent work areas. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions. Remove and legally dispose of construction debris.
- .2 Work will not be considered complete until all spatters, drippings, smears and overspray have been cleaned and removed to the satisfaction of Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for firestopping and smoke seals work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C303, Standard Test Method for Dimensions and Density of Preformed Block and Board-Type Thermal Insulation.
- .2 ASTM C920, Standard Specification for Elastomeric Joint Sealants.
- .3 ASTM C1104, Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
- .4 ASTM E814, Test Method for Fire Tests of Through-Penetration Fire Stops.
- .5 ASTM E2174, Standard Practice for On-Site Inspection of Installed Fire Stops.
- .6 CAN/ULC S102, Surface Burning Characteristics of Building Materials and Assemblies.
- .7 CAN/ULC S114, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
- .8 CAN/ULC S115, Standard Method of Fire Tests of Firestop Systems.
- .9 CAN/ULC S129, Standard Method Of Test For Smoulder Resistance Of Insulation (Basket Method).
- .10 CAN/ULC S702, Thermal Insulation, Mineral Fibre for Buildings.

1.3 **DEFINITIONS**

- .1 Fire Separation: A construction assembly, plane or device, either vertical or horizontal, which is required to prevent the passage of fire and smoke for a prescribed period of time. Proof of compliance to required time rating shall be by ULC, Warnock Hersey (or similar approved) certification or shall be as listed in the Ontario Building Code Supplementary Standard SB-2.
- .2 Smoke Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time but is required to prevent the passage of smoke. A "Smoke Separation" is also known as a "Fire Separation with No Rating" or a "Zero Hour Rated Separation".
- .3 Non-Rated Separation: A construction assembly, plane or device, either vertical or horizontal, which is not required to prevent the passage of fire for a prescribed period of time and is not required to prevent the passage of smoke.

**1.4 SYSTEM DESCRIPTION**

- .1 Firestopping and smoke seals: ULC or Intertek Testing Services listed Products and systems in accordance with CAN/ULC S115 suitable to actual application and installation conditions.
- .2 Firestop applications that exist for which no ULC or cUL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar ULC or cUL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineer judgment drawings must follow requirements set forth by the International Firestop Council.
- .3 Firestop and smoke seal system shall achieve a fire resistance rating and smoke seal rating equal to that of assemblies into which they are installed.
- .4 Provide smoke sealants over firestopping materials or combination smoke seal/firestop seal material to form air tight barriers to retard the passage of gas and smoke.
- .5 Firestopping and smoke seals located at movement joints shall be designed with movement capability.
- .6 Firestopping and smoke seals within mechanical and electrical assemblies shall be provided as part of the work of Divisions 21, 22, 23, 26, 27, and 28 respectively.

**1.5 SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate cUL or ULC reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
    - .3 Submit firestop and smoke seal manufacturer's Product data for materials and prefabricated devices, including manufacturer's printed installation instructions.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Fire rated and smoke sealed systems for each typical application.
    - .2 Construction details, accurately reflecting actual job conditions.
    - .3 ULC or Intertek Testing assembly listing.
    - .4 Each floor and wall assembly requiring firestop system with each corresponding ULC firestop system.



- .3 Certification:
  - .1 Submit certified documentation from manufacturer for each worker performing work of this Section.
  - .2 Submit installer's and Product manufacturer's certification verifying compliance with the Contract Documents and conformance with ASTM E814 and CAN/ULC S115.

## 1.6 **QUALITY ASSURANCE**

- .1 Installers qualifications: Perform work of this Section by a company that has a minimum of five (5) years proven experience in the installation of firestopping and smoke seal work of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Manufacturer's direct representative and/or fire protection specialist shall be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures conforming to manufacturer's written recommendations published in their literature and drawing details.
- .3 Pre-construction meetings: Arrange with manufacturer's representative, Contractor, Consultant and Field Engineer to determine responsibility for handling such issues as FT rated partitions, firestop custom details, compatibility, mixed penetrations, and to review installation procedures 48 hours in advance of installation.

## 1.7 **DELIVERY STORAGE AND HANDLING**

- .1 Deliver materials to Place of Work in manufacturer's unopened containers, containing classification label with labels intact and legible at time of use.
- .2 Do not use damaged or adulterated materials exceeding their expiry date.

## 1.8 **SITE CONDITIONS**

- .1 Conform to manufacturer's requirements and maintain a minimum temperature of 5<sup>0</sup> C for a minimum period of 24 h before application, during, and until application is fully cured.
- .2 Maintain sealant at a minimum 18° C for best workability.

## 2 **Products**

### 2.1 **ACCEPTABLE MANUFACTURERS**

- .1 Acceptable manufacturers of rated systems include:
  - .1 3M
  - .2 Hilti Canada Corporation.
  - .3 Specified Technologies Inc. (STI Firestop)
  - .4 Tremco Ltd.

- .5 Or approved equivalent.

## 2.2 **GENERAL SYSTEM REQUIREMENTS**

- .1 All materials under work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
- .2 Do not use Products containing asbestos.
- .3 Firestopping components shall not contain volatile solvents or require special application to protect plastic pipe from firestopping compound.
- .4 Provide smoke seal sealant in following colours:
  - .1 Grey or white in finished areas.
  - .2 Red in unfinished areas.
- .5 Smoke sealant for overhead and vertical joints for floor to be self-levelling and non-sagging sealant.
- .6 Smoke sealant at vertical through penetrations in areas with floor drains shall be waterproof type.

## 2.3 **MATERIALS**

- .1 Following materials have been provided for convenience. Contractor shall provide complete system with all components and accessories as required for fire resistant and smoke seal installation.
- .2 Firestop sealant: single component, low modulus, silicone rubber, moisture curing sealant to ASTM C920, ULC labelled to CAN/ULC S115.
- .3 Pre-Installed firestop devices for use with non-combustible and combustible pipes, conduit and/or cable bundles penetrating concrete floors and walls.
  - .1 Cast-in place firestop device complete with aerator adaptor when used in conjunction with aerator system. Model CP 680-P by Hilti or approved equivalent.
  - .2 Cast-in place firestop device for use with noncombustible penetrants. Model CP 680-M by Hilti or approved equivalent.
  - .3 Speed sleeve for use with cable penetrations. Model CP 653 by Hilti or approved equivalent.
  - .4 Firestop block. Model CFS-BL by Hilti or approved equivalent.
- .4 Re-penetrable, round cable management devices for use with new or existing cable bundles penetrating walls:
  - .1 Speed sleeve with integrated smoke seal fabric membrane. Model CP 653 by Hilti or approved equivalent.
  - .2 Firestop Sleeve. Model CFS-SL SK by Hilti or approved equivalent.
  - .3 Retrofit sleeve for use with existing cable bundles. Model CFS-SL RK by Hilti or approved equivalent.

- .4 Gangplate for use with multiple cable management devices. Model CFS-SL GP by Hilti or approved equivalent.
- .5 Gangplate Cap for use at blank openings in gangplate for future penetrations. Model CFS-SL GP CAP by Hilti or approved equivalent.
- .5 Firestop insulation: to CAN/ULC S702, Type 2; mineral fibre manufactured from rock or slag, suitable for manual application.
  - .1 Density: Minimum 64 kg/m<sup>3</sup> when tested to ASTM C303.
  - .2 Combustibility: Noncombustible to CAN/ULC S114.
  - .3 Melt temperature: >1175 degrees C.
  - .4 Surface burning characteristics: to CAN/ULC S102, maximum flame spread of 0, smoke developed of 0.
  - .5 Moisture Absorption: 0.04 percent when tested to ASTM C1104.
  - .6 Smoulder Resistance: 0.01 percent when tested to CAN/ULC S129.
- .6 Damming, back-up, supports, and anchorage: In accordance with manufacturer's fire rated systems and to acceptance of authorities having jurisdiction.
- .7 Primer: As recommended by firestopping sealant manufacturer.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that substrates and surfaces to receive firestopping and smoke seals are clean, dry, and frost free.

#### 3.2 PREPARATION

- .1 Prepare, modify, and adjust void sizes, proportions, and conditions to conform to fire rated and smoke sealed assembly requirements such as assembly opening size and dimensional restrictions.
- .2 Clean surfaces to remove material detrimental to bond including dust, paint, rust, oil, grease, moisture, frost and other foreign matter to manufacturers recommendations.
- .3 Mask adjacent surfaces to avoid spillage and over-coating of adjacent surfaces. Remove stains from adjacent surfaces.

#### 3.3 INSTALLATION

- .1 Install firestopping and smoke seal systems in accordance with reviewed Shop Drawings, manufacturer's instructions and fire rated assembly to establish continuity and integrity of fire separations.

- .2 Install firestop insulation in compacted thicknesses required by ULC design. Compress insulation approximately 50 percent.
- .3 Install primers as recommended by firestop and smoke seal Product manufacturers.
- .4 Install temporary forming, damming, back-up as required, remove after materials have achieved initial cure and will resist displacement.
- .5 Install firestop and smoke seal filler in horizontal joints providing 25% compression fit.
- .6 Use resilient, elastomeric firestopping and smoke seal systems in following locations:
  - .1 Openings and sleeves for future use.
  - .2 Penetration systems subject to vibration or thermal movement.
  - .3 Penetration systems in acoustical containment enclosures.
- .7 Trowel and tool exposed firestop and smoke seal. Product surfaces to uniform, smooth finish.
- .8 Seal joints to ensure an air and water resistant seal capable of withstanding compressions and extensions due to thermal wind or seismic joint movement.
- .9 Taped joints will not be acceptable.
- .10 Repair damaged firestopped and smoke sealed surfaces to acceptance of Consultant.
- .11 Identify each firestop and smoke seal penetration assembly with permanent label listing following:
  - .1 Assembly and rating in hours.
  - .2 Date of installation.
  - .3 Installing company's name and telephone number.
- .12 Do not cover materials until full cure has taken place.

#### 3.4 **INSPECTION AND TESTING**

- .1 Inspection of through-penetration firestopping shall be performed in accordance with ASTM E2174 to ensure that firestopping and smoke seals have been installed in accordance with Contract documents and to tested and listed firestop system.

#### 3.5 **CLEAN-UP**

- .1 Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.
- .2 Remove excess materials and debris immediately after application.

**3.6 SCHEDULE OF FIRESTOP AND SMOKE SEAL LOCATIONS**

- .1 Following firestop and smoke seal location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of work of this Section. Generally provide systems with required fire and smoke ratings at following locations:
- .1 Gaps at intersections of fire-resistance rated walls and partitions.
  - .2 Control and sway joints in fire-resistance rated walls and partitions.
  - .3 Gaps at top of fire-resistance rated partitions and walls.
  - .4 Penetrations through fire-resistance rated walls and partitions including but not limited to mechanical and electrical services and openings and sleeves for future use.
  - .5 Penetrations through fire-resistance rated floor slabs, ceilings, and roofs.
  - .6 Gaps at edge of floor slabs at exterior walls.
  - .7 Perimeter of retaining angles on rigid ducts greater than 0.012 m<sup>2</sup>, firestopping material between retaining angle and fire separation and between retaining angle and duct, on each side of fire separation.
  - .8 Where indicated on drawings.
  - .9 At non-rated assemblies that require a smoke seal.
  - .10 Where required by Ontario Building Code.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for sealant Work in accordance with the Contract Documents.
- .2 Work of this Section does not include sealants in firestopping and smoke sealed assemblies.
- .3 Work of this Section does not include sealant work identified in individual specification sections.

1.2 **REFERENCES**

- .1 ASTM C834, Specification for Latex Sealants.
- .2 ASTM C920, Specification for Elastomeric Joint Sealants.
- .3 ASTM C1330, Specification for Cylindrical Sealant Backing for Use with Cold Liquid Applied Sealants.

1.3 **SUBMITTALS**

- .1 Product data: Submit copies of Product data in accordance with Section 01 30 00 describing type, composition and recommendations or directions for surface preparation, material preparation and material installation.
- .2 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00.
    - .1 Two samples of sealant/caulking, for colour selection.
    - .2 Two samples of back-up material and primer for physical characteristics.

1.4 **QUALITY ASSURANCE**

- .1 Qualifications: Work of this Section shall be executed by trained applicators approved by sealant manufacturer and having a minimum of 5 years proven experience.

1.5 **SITE CONDITIONS**

- .1 Do not install materials when ambient air temperature is less than 5 °C, when recesses are wet or damp, or to manufacturer's recommendations.

1.6 **DELIVERY, STORAGE AND HANDLING**

- .1 Arrange delivery of materials in original, unopened packages with labels intact, including batch number, and ensure that on-site storage is kept to a minimum. Do not store materials on site where there exists any danger of damage from moisture, direct sunlight, freezing and other contaminants.

2 Products

2.1 **MATERIALS**

- .1 General:
  - .1 All materials under Work of this Section, including but not limited to, primers and sealants are to have low VOC content limits.
  - .2 Use materials as received from manufacturers, without additives or adulterations. Use one manufacturer's Product for each kind of Product specified.
- .2 Sealant **Type 1**: ASTM C920, Type M, Grade NS, Class 50; Multi-Component, polyurethane sealant, in standard colours selected.
  - .1 'Dowsil CWS' by Dow Consumer Solutions.
  - .2 'Dymeric 240' by Tremco.
  - .3 Or approved equivalent.
- .3 Sealant **Type 2**: ASTM C920, Type S, Grade NS, Class 25; One-Component, polyurethane sealant, in standard colours selected.
  - .1 'Dowsil CWS' by Dow Consumer Solutions.
  - .2 'Dymonic' by Tremco.
  - .3 'Novalink' by Chemlink Advanced Architectural Products.
  - .4 Or approved equivalent.
- .4 Sealant **Type 3**: ASTM C834; Pure acrylic siliconized sealant; in standard white colour (paintable).
  - .1 '950A Siliconized Acrylic Latex Caulk' by Sherwin Williams.
  - .2 'Tremflex 834 Silconized Sealant' by Tremco Ltd.
  - .3 Or approved equivalent.
- .5 Sealant **Type 4**: ASTM C920, Type S, Grade NS; One-part mildew-resistant silicone, in standard colours selected.
  - .1 'Dowsil 786 Mildew Resistant Silicone Sealant' by Dow Consumer Solutions.
  - .2 'Tremsil 200 Silicone Sealant' by Tremco Ltd.
  - .3 Or approved equivalent.
- .6 Sealant **Type 5**: ASTM C920, Type S, Grade NS, Class 50; One-part neutral-cure silicone, in standard colours selected.
  - .1 'Dowsil 795 Weather Sealant' by Dow Consumer Solutions.
  - .2 'Spectrum 2' by Tremco Ltd.
  - .3 Or approved equivalent.

- .7 Sealant **Type 6**: Acoustical sealant in accordance with Section 09 21 16.
- .8 Sealant **Type 7**: ASTM C920, Type S, Grade NS, Class 50; One-part neutral-cure, low modulus silicone, in standard colours selected.
  - .1 'Dowsil 791 Sealant' by Dow Consumer Solutions.
  - .2 'Spectrum 3' by Tremco Ltd.
  - .3 Or approved equivalent.

## 2.2 ACCESSORIES

- .1 Primers: Type recommended by material manufacturers for various substrates, primers to prevent staining of adjacent surfaces encountered on project.
- .2 Joint backing: ASTM C1330; Round, solid section, closed cell, skinned surface, soft polyethylene foam gasket stock, compatible with primer and sealant materials, 30 to 50% oversized, Shore A hardness of 20, tensile strength 140 to 200 kPa. Bond breaker type surface.
- .3 Bond breaker: Type recommended by material manufacturers.
- .4 Void filler around the window frames to be one part expanding polyurethane foam.
- .5 Cleaning agents: As recommended by material manufacturer, non-staining, harmless to substrates and adjacent finished surfaces.

## 2.3 MIXING

- .1 Follow manufacturers instructions on mixing, shelf and pot life.

## 3 Execution

### 3.1 PREPARATION

- .1 Prepare joints to receive sealants to manufacturer's instructions. Ensure that joints are clean and dry and ferrous surfaces are free from rust and oil.
- .2 Clean recesses to receive sealant, to be free of dirt, dust, loose material, oil, grease, form release agents and other substances detrimental to sealant's performance.
  - .1 Remove lacquer or other protective coatings from metal surfaces, without damaging metal finish, using oil-free solvents. Remove rust, mill scale and coatings from ferrous metals by wire brush, grinding or sand blasting.
  - .2 Ensure recess is dry.
  - .3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings. Remove incompatible coatings as required.
- .3 Ensure that all materials in contact with sealant are compatible. Test substrate for adhesion.



- .4 Depth of recess: Maintain depth to  $\frac{1}{2}$  joint width up to a maximum of 13 mm and not less than six (6) mm at centre of joint. For greater depth, use joint backing under. Where recess is less than specified depth, cut back surface of recess to specified recess depth.
- .5 Install polyethylene backing rod in joints six (6) mm or more in width. Roll backing rod into joint. Do not stretch or bend backing rod. Install bond breaker to back of recess.
- .6 Prime sides of recess, in accordance with sealant manufacturer's instructions.
- .7 Condition products for use in accordance with manufacturer's recommendations.

### 3.2 **INSTALLATION**

- .1 Apply sealant immediately after adjoining Work is in condition to receive such Work. Apply sealant in continuous bead using gun with correctly sized nozzle. Use sufficient pressure to evenly fill joint.
- .2 Ensure sealant has full uniform contact with, and adhesion to, side surfaces of recess. Superficial painting with skin bead is not acceptable. Tool sealant to smooth surface, free from ridges, wrinkles, sags, air pockets, embedded impurities, dirt, stains or other defects.
  - .1 At recesses in angular surfaces, finish sealant with flat profile, flush with face of material at each side.
  - .2 At recesses in flush surfaces, finish compound with concave face, flush with face of material at each side.
- .3 Make sealant bead uniform in colour.
- .4 Cure sealants in accordance with sealant manufacturer's instructions. Do not cover up sealants until proper curing has taken place.
- .5 Immediately remove excess compound or droppings which would set up or become difficult to remove from adjacent finished surfaces, using recommended cleaners, as work progresses. Do not use scrapers, chemicals or other tools which could damage finished surfaces. Remove defective sealant.
- .6 Clean recesses and re-apply sealant.
- .7 Remove masking tape immediately after joints have been sealed and tooled.

### 3.3 **CLEANING**

- .1 Clean surfaces adjacent to joints, remove sealant smears or other soiling resulting from application of sealants. At metal surfaces, remove residue. Do not mar or damage finishes on materials adjacent to joints. Repair or replace marred or damaged materials.

### 3.4 SCHEDULE OF LOCATIONS

- .1 Following sealant location schedule is included for convenience and may not be complete. Examine Contract Drawings and other specification sections and determine entire extent of Work of this Section. Generally seal following locations:
  - .1 Concrete, masonry, wood and stone to metal.
  - .2 Wood to masonry, concrete and stone.
  - .3 Metal to metal.
  - .4 All dissimilar materials.
- .2 Sealant **Type 1 or Type 2:**
  - .1 Interior joints between dissimilar materials.
  - .2 Interior joints at perimeter of all built-in equipment.
  - .3 Interior joints at perimeter of metal door and window frames.
- .3 Sealant **Type 3:**
  - .1 Interior non-movement joints 6mm or less for painting (painter's caulk).
- .4 Sealant **Type 4:**
  - .1 Interior joints where mildew resistance is required.
  - .2 Interior joints at perimeter of all plumbing fixtures.
  - .3 Interior joints between counter backsplash and wall surfaces.
- .5 Sealant **Type 5:**
  - .1 Glass to glass joints.
  - .2 Glass to metal joints.
  - .3 Metal to metal curtain wall joints.
  - .4 Interior face of metal panel joints.
- .6 Sealant **Type 6:**
  - .1 Perimeter of all gypsum board partitions where sound insulation is indicated.
  - .2 All vapour barrier seams and seals.
- .7 Sealant **Type 7:**
  - .1 Exterior joints between dissimilar building veneer materials.
  - .2 Exterior control joints in building veneers.
  - .3 Exterior joints at perimeter of all door and window frames.
  - .4 Exterior joints in metal panel systems.

END OF SECTION



1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for metal door and frame work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM A924/A924M, Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- .3 ASTM E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- .4 CAN4/ULC-S104M, Standard Method for Fire Test of Door Assemblies.
- .5 CAN4/ULC-S105M, Standard Specification for Fire Door Frames, Meeting the Performance Required by CAN4/ULC-S104M.
- .6 CAN/CGSB-1.198, Cementitious Primer, (for Galvanized Surfaces).
- .7 CGSB 41-GP-19Ma, Rigid Vinyl Extrusions for Windows and Doors.
- .8 CAN/ULC-S702, Thermal Insulation, Mineral Fibre for Buildings.
- .9 CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures.
- .10 CSA W59-M, Welded Steel Construction (Metal Arc Welding).
- .11 CSDMA, Canadian Steel Door Manufacturer's Association.
- .12 NFPA 80, Standard for Fire Doors and Other Opening Protectives.
- .13 NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

1.3 **DESIGN REQUIREMENTS**

- .1 Design exterior frame assemblies to accommodate expansion and contraction when subjected to minimum and maximum surface temperature of -35°C to 35°C.
- .2 Maximum deflection for exterior metal doors under wind load of 1.2 kPa not to exceed 1/175th of span.

**1.4 SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating door and frame construction.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 for each type of door and frame indicating:
    - .1 Thickness and type of steel.
    - .2 Thickness and type of core.
    - .3 Thickness and type of steel stiffeners and location of them within the door.
    - .4 Thickness and type of metal facing on edges of door and method of fastening.
    - .5 Location of mortises, reinforcement, anchorages, joining, welding, sleeving, exposed fasteners, openings and arrangement for hardware.
  - .2 Include schedule identifying each unit with door marks and numbers relating to numbering on Contract Drawings and in door schedule. Indicate doors and frames to be fire rated.

**1.5 QUALITY ASSURANCE**

- .1 Perform work in accordance with requirements by a member of the Canadian Steel Door Manufacturer's Association (CSDMA).
- .2 Label and list fire rated doors and frames by an organization acceptable to authorities having jurisdiction and accredited by the Standards Council of Canada in conformance with CAN4/ULC-S104M and CAN4/ULC-S105M for ratings indicated, Labelling shall be in accordance with NFPA 80.

**2 Products**

**2.1 ACCEPTABLE MANUFACTURERS**

- .1 Baron Metal Industries Inc.
- .2 Daybar Industries Limited
- .3 Fleming Doors Products.
- .4 Steelcraft.
- .5 Vision Hollow Metal Limited.
- .6 Or approved equivalent.

## 2.2 MATERIALS

- .1 General: All materials under work of this Section, including but not limited to, primers are to have low VOC content limits.
- .2 Steel: ASTM A924/A924M, Class 1; Commercial grade steel, hot dip galvanized to ASTM A653/A653M, ZF120 galvanized coating.
- .3 Minimum base steel thickness:
  - .1 Frames 1.6 mm
  - .2 Typical doors 1.6 mm
  - .3 Interior stiffeners 0.9 mm
  - .4 Lock/strike reinforcements 1.6 mm
  - .5 Hinge reinforcements 2.7 mm
  - .6 All other reinforcement 1.6 mm
  - .7 Top and bottom channels 1.2 mm
  - .8 Glazing stops 0.9 mm
  - .9 Guard boxes 0.9 mm
  - .10 Jamb spreaders 0.9 mm
- .4 Top caps and thermal breaks: CGSB 41-GP-19Ma; Rigid PVC extrusions.
- .5 Primer: CAN/CGSB 1.198.
- .6 Core material:
  - .1 Interior doors: Mineral fibre insulation with a minimum face density of 24 kg/m<sup>3</sup> (1.5 lbs/ft<sup>3</sup>).
  - .2 Exterior doors: Rigid poly/isocyanurate, closed cell insulation, 32 kg/m<sup>3</sup> (2.0 lbs/ft<sup>3</sup>), thermal value: RSI 1.9.
  - .3 Fire rated doors: Mineral fibre insulation to CAN/ULC S702, Type 1A; 24 kg/m<sup>3</sup> (1.5 lbs/ft<sup>3</sup>).
- .7 Screws: Stainless steel screws with countersunk flat head.
- .8 Door silencers: Type 6-180, black neoprene.
- .9 Frame anchors:
  - .1 Frames in masonry: 1.2 mm minimum, adjustable T-strap jamb anchors.
  - .2 Frames in steel stud partitions: 0.9 mm minimum steel anchors of suitable design securely welded inside each jamb.
  - .3 Labeled frames: In accordance with ULC requirements.
- .10 Floor anchors: 1.6 mm minimum adjustable floor clip angles with two (2) holes for anchorage to floor.
- .11 Labels for fire doors and door frame: Brass plate, riveted to door and door frame.
- .12 Glass and glazing: In accordance with Section 08 80 00.

## 2.3 FABRICATION

- .1 General
  - .1 Fabricate doors and frames in accordance with reviewed shop drawings.
  - .2 Welding: CSA W59-M to produce a finished unit with no visible seams or joints, square, true and free of distortion.
  - .3 Welding: Continuous unless specified otherwise. Execute welding by a firm fully acceptable to the Canadian Welding Bureau to requirements of CSA W47.1.
  - .4 Form profiles accurately to details shown on Contract Drawings.
  - .5 Ream and remove burrs from drilled and punched holes.
  - .6 Grind welded corners and joints to a flat plane and fill with metallic filler and sand to a uniform smooth finish. Apply one coat of primer.
  - .7 Provide weather strip for exterior doors in accordance with Section 08 70 00 and door manufacturer.
- .2 Frames, windows, and screens:
  - .1 Fabricate frames of welded construction. Cut mitres and joints accurately and weld continuously on inside of frame profile. Exterior frames to be thermally broken.
  - .2 Construct large frame sections with provision for on Site assembly to suit Site conditions.
  - .3 Blank, reinforce, drill and tap frames for mortised, templated hardware. Protect mortised cut-outs with guard boxes.
  - .4 Reinforce frames where required for surface mounted hardware.
  - .5 Reinforce frames over 1200 mm wide with roll formed steel channels or hollow structural sections specified in Section 05 50 00 and as indicated on drawings.
  - .6 Furnish exterior door frames with a continuously welded integral steel weather drip at head of frame.
  - .7 Prepare each door opening for single stud rubber door silencers, 3 for single door openings located in strike jamb, and 2 for double door openings located in head.
  - .8 Install 2 channel or angle spreaders per frame, to ensure correct frame alignment. Install stiffener plates or spreaders between frame trim where required, to prevent bending of trim and to maintain alignment when setting in place.
  - .9 Form channel glazing stops minimum 16 mm height, accurately cut, mitred, fitted and fastened to frame sections with stainless steel counter-sunk, flat head screws spaced at maximum 450 mm throughout and 50 mm from each end.
  - .10 Provide the following requirements for electrified frame applications:
    - .1 Low voltage wire conduit for required electrified hardware devices.
    - .2 Junction boxes for all frame mounted electrified hardware devices, complete with required connectors to in frame low voltage wire conduit.

- .3 Anchorage:
  - .1 Anchor units to floor and wall construction. Locate each wall anchor immediately above or below each hinge reinforcement on hinge jamb and directly opposite on strike jamb, minimum number of anchors for each jamb:
    - .1 Frames up to 2285 mm 3 anchors.
    - .2 Frames from 2285 mm to 2440 mm 4 anchors.
  - .2 Where frames are to be set in masonry or concrete, supply adjustable anchors to trade installing frame.
  - .3 Fabricate frames for installation in steel stud partitions with steel anchors of suitable design, minimum number of anchors for each jamb :
    - .1 Frames up to 2285 mm height 4 anchors.
    - .2 Frames 2285 mm to 2440 mm 5 anchors.
- .4 General Door Requirements:
  - .1 Hollow steel construction, flush swing type, of sizes to conform to details, schedules and reviewed shop drawings with provisions for cut-outs for glass and grilles and reinforced to receive hardware fastenings.
  - .2 Blank, reinforce, drill and tap doors for mortised, templated hardware. Where required, reinforce doors for surface mounted hardware and door closers.
  - .3 Reinforce oversized doors with steel channels and plates specified in Section 05 50 00 and as indicated on drawings.
  - .4 Where openings are required, form integral cut-outs with framing, glass stop moldings and division bars.
  - .5 Install grilles to fit tight and secure into openings.
  - .6 Bevel both stiles of single doors 1 in 16.
  - .7 Provide the following requirements for electrified door applications:
    - .1 In door low voltage wire raceways.
    - .2 Steel astragals for hollow metal doors.
    - .3 Reinforcement for all door mounted electrified hardware devices as required and as indicated on Contract Drawings.
- .5 Interior Doors:
  - .1 Supply and install inverted, recessed, mechanically interlocked with tack welded channels at top and bottom of doors.
  - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.
  - .3 Fill hollow space within door and vertical stiffeners from top to bottom with mineral fibre batt insulation.
- .6 Exterior Doors:
  - .1 Supply and install inverted, recessed, mechanically interlocked with tack welded channels at top and bottom of doors.
  - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure no filler is used in joints.
  - .3 Fill void between door faces with polyisocyanurate insulation as specified, thermally bonded to door skins.



- .7 Fire Rated Doors:
  - .1 Supply and install inverted, recessed, spot welded channels at top and bottom of doors. Supply and install steel flush top caps on exterior doors.
  - .2 Fabricate doors with joints between front and back panels meeting on stile edges. Make joints mechanically interlocked and tack welded for entire height of door. After welding has been completed, grind joints smooth to match metal. Ensure that no filler is used in joints.
  - .3 Fabricate doors to achieve fire rating as indicated on drawings and in accordance with ULC. Provide ULC label on door at hinged edge midway between top hinge and head of door.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 HOLLOW METAL DOOR, AND FRAME INSTALLATION

- .1 Install hollow metal doors, frames, windows, and screens in accordance with reviewed shop drawings, manufacturer's written instructions and to meet CSDMA requirements.
- .2 Install hollow metal doors, frames, windows, and screens plumb, square, level, secure, and at correct elevation.
- .3 Install doors clear of floor finishes, and with the correct rebate opening for the door installation. Install door silencers.
- .4 Secure anchorages and connections to adjacent construction. Brace frames rigidly in position while building-in. Remove temporary steel shipping jamb spreaders. Install wood spreaders at third points of frame rebate height to maintain frame width. Supply and install vertical supports as indicated on drawings for openings over 1200 mm in width. Remove wood spreaders after frames have been built-in.
- .5 Allow for structural deflection and prevent structural loads from being transmitted to hollow metal frames.
- .6 Touch-up areas where galvanized coating has been removed or damaged with primer.
- .7 Fire rated doors: Install fire rated doors and frames in accordance with requirements of NFPA 80.

**3.3            ADJUSTING AND CLEANING**

- .1      Adjust doors for smooth and balanced door movement.
- .2      Clean doors, frames, windows and screens.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for four fold doors Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A36/A36M, Specification for Carbon Structural Steel.

1.3 **DESIGN REQUIREMENTS**

- .1 Design folding door to withstand a windload condition of 20 lbs./sq. ft. (88 mph) at standard pressure and temperature.
- .2 Folding door shall not exceed a maximum allowable deflection of 1/120 of the span.

1.4 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), Product characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating elevations, sections, details, required clearances, materials, operating components, dimensions, gauges, and finishes.
  - .3 Closeout submittals: Submit operation, maintenance, cleaning instructions for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.5 **QUALITY ASSURANCE**

- .1 Furnish each folding door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components. Furnish folding doors by one manufacturer for the entire project.
- .2 Inserts and Anchorages: Furnish fasteners and spacers as required to facilitate installation. If special requirements are necessary, coordinate those requirements with the general Contractor.

1.6 **WARRANTY**

- .1 Manufacturer shall warrant all folding doors against defects in material and workmanship for three (3) years from date of acceptance.

2 Products

2.1 **ACCEPTABLE PRODUCTS AND MANUFACTURERS**

- .1 'Model FF300 Glazed Four-Fold Doors' by Door Engineering.
- .2 Or approved equivalent.

2.2 **MATERIALS**

- .1 Structural Steel: ASTM A36/A36M.
- .2 Steel Sheets: Steel sheets of commercial quality, complying with ASTM A366/A366M cold-rolled steel sheet, or A569/A569M hot-rolled steel sheet.
- .3 Hardware: Manufacturer's standard components.
- .4 Fasteners: As recommended by door manufacturer.
- .5 Door panels and framing: Provide minimum 14-gauge structural steel tube framing with minimum 14-gauge steel sheet on exterior and interior faces. Sheetting shall be formed on vertical edges with no visible welds on panel faces. All frames and framing members shall be true to dimension and square in all directions, no door shall be bowed or warped. Door shall not be out of line, vertically or horizontally. Exposed welds shall be ground smooth and flush. Fabricate door size as indicated on drawings.
- .6 Door finish:
  - .1 Fire Station Apparatus Bay: Custom powder coated to match PPG Duranar Sunstorm Coating 'Red'.
  - .2 Training Apparatus Bay: Red.
- .7 Surface Mounted Tube Frame: Supply pre-hung tube frame system designed to anchor to masonry wall construction or weld to steel structure. All hinges, track supports and operator supports shall be factory attached.
- .8 Operating Hardware: Hardware shall include guide tracks and brackets, trolleys, center guides, not less than three pairs of jamb and fold hinges per opening and all bolts, nuts, fasteners, etc. necessary for complete installation and operation. Jamb hinges shall be dual shear and have two thrust bearings and two needle bearings. Jamb hinges shall be gusseted. Fold hinges shall be dual shear with two thrust bearings. All bearings shall be completely concealed within the hinge barrel. All hinge pins shall be minimum 19 mm diameter hardened steel.
- .9 Weather stripping: Cloth-inserted neoprene bulb installed weather-tight. Weather stripping shall be retained continuously.
- .10 Vision Panels: 6 mm clear tempered glazing; 'Energy Advantage' by Pilkington or approved equivalent with low emissivity coating on surface #2, of the size, shape and location as noted on the drawings. 25 mm total insulated glass unit thickness.

## 2.3 OPERATORS

- .1 Each Four-Fold door shall be operated by an overhead mounted electro-mechanical drive unit designed for high cycle operation. Operator consists of an electric motor, gear reducer, and rotating drive arm. Door shall be operated in accordance with Manufacturer's written instructions.
- .2 Electric Controls: Controls shall be furnished by the door manufacturer and shall be complete for each door and built in accordance with the latest NEMA standards.
- .3 Operation (interior): Remote pushbutton stations, surface mounted, in location shown, with "OPEN-STOP-CLOSE" designations on pushbuttons in English.
- .4 Radio Control: Portable transmitter to signal operator to open, close or stop door.
- .5 Photo sensors and timer: UL approved, self monitoring operator to open door when object is sensed and a timer-to-close function to close door at a programmable time from five (5) seconds to one (1) hour.

## 3 Execution

### 3.1 EXAMINATION

- .1 Verify condition and dimensions of steel hanger system, installed by Section 05 50 00, and other Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

### 3.2 INSTALLATION

- .1 Install door and operating equipment complete with necessary hardware, jamb and head mould strips, anchors, inserts, hangers and equipment supports in accordance with final shop drawings, manufacturer's product data and as specified herein.
  - .1 Secure guides to walls, plumb, level and true to line. Anchor guides at spacings indicated on approved shop drawings.
  - .2 Provide additional support as necessary for attachment of guides, brackets and door and operator mechanisms to interfacing surfaces.
- .2 Connect and adjust electrical components and operating hardware accordingly.
- .3 Touch-up paint on frame and other painted surfaces in accordance with painting Section 09 91 00.
- .4 Upon completion of installation, including work by other trades, lubricate, test and adjust doors to operate in accordance with manufacturer's product data. Final adjustments shall be made by manufacturer's authorized representative.
- .5 Protect finished installations until date of Substantial Completion. Repair damage to door panel, hardware and operators.

**3.3 CLEANING**

- .1 Upon completion of work of this section, remove strippable coatings, clean, materials, adjust operations and lubricate as required to obtain optimum performance.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for electrically operated glazed sectional overhead door Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- .2 ANSI, H35.1M Alloy and Temper Designation Systems for Aluminum (Metric).
- .3 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .4 ASTM B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .5 CSA C22.1, Canadian Electrical Code, Part 1, Safety Standards for Electrical Installations.
- .6 CAN/CSA-G40.20/G40.21-M, General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steels.
- .7 CAN/CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.
- .8 CSA S136.1-M, Commentary on CAN/CSA S136-M, Cold Formed Steel Structural Members.

1.3 **DESIGN REQUIREMENTS**

- .1 Design door assembly for climatic design data for location of work and to withstand wind loads in closed position of 1 kPa positive and 0.6 kPa negative. Maximum deflection under full design load to be 1/240 of opening width.
- .2 Calculate properties of steel sections and allowable stresses used in determination of structural performance in accordance with CSA S136.1-M.
- .3 Design door assembly to withstand minimum 100,000 cycles per annum, and 20 years total life cycle.
- .4 Design electrical components for doors in accordance with CSA C22.1 and the Ontario Hydro Electrical Safety Code.

**1.4 SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standards, characteristics, limitations, and trouble-shooting protocol.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Elevations, materials, sections and details, operating components, dimensions, gauges, glazing, hardware, accessories, finishes, and service rating.
    - .2 Complete electrical wiring diagrams including electrical schematics and sequence of operation.
    - .3 Complete engineering design data to confirm that door meets design criteria specified.
- .3 Closeout submittals:
  - .1 Submit following for each Product for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00:
    - .1 Identification: Manufacturing name, type, year, and serial number.
    - .2 Performance criteria and maintenance data.
    - .3 Operating instructions and precautions.
    - .4 Safety precautions.
    - .5 Component parts availability including names and addresses of spare part suppliers.
    - .6 Lubrication schedule indicating lubrication points and type of lubricant recommended.

**1.5 QUALITY ASSURANCE**

- .1 Retain a Professional Engineer, licensed in the Province of Ontario, with experience in Work of comparable complexity and scope, to perform the following services as part of the Work of this Section :
  - .1 Design overhead doors to resist live, dead, lateral, wind, or seismic loads.
  - .2 Review, stamp, and sign shop drawings.

**1.6 EXTENDED WARRANTY**

- .1 Submit a extended warranty for Work of this Section in accordance with the Conditions of the Contract, except that warranty period is extended to 3 years from date of Substantial Performance.
  - .1 Warrant against failure to meet design criteria and specified requirements.
  - .2 Coverage: Complete replacement including affected adjacent Work.



2 Products

2.1 **ACCEPTABLE PRODUCTS AND MANUFACTURERS**

- .1 Model Insulated (C175) Sectional Overhead Doors with Aluminum framed Full View Panels by Service Door Industries.
- .2 Or approved equivalent.

2.2 **MATERIALS**

- .1 Aluminum extrusions: ASTM B211 and ANSI H35.1 AA6063 alloy, T6 temper.
- .2 Aluminum sheet: ASTM B209 and ANSI H35.1 AA1100 aluminum alloy, H14 temper, minimum 1.0 mm aluminum sheet.
- .3 Steel angles, shapes, plates, and similar items: CAN/CSA-G40.20/G40.21-M, Grade 350W.
- .4 Galvanized steel sheet: commercial quality to ASTM A653/A653M with Z275 zinc coating.
- .5 Insulated sections: Structural quality hot-dipped galvanized steel with polyurethane core sandwich type construction, thermal break and to incorporate the use of two continuous replaceable factory installed gaskets. Sections shall have a minimum thermal insulating value of R16 (RSI 2.81).
- .6 Insulation: Cavity shall be filled with continuous process, formed-in-place, CFC and HCFC free rigid polyurethane core, interior and exterior skins shall feature thermal break.
- .7 Glazing: 12.7 mm thick insulated glass unit consisting of two panes of 3 mm thick tempered glass with 6.7 mm thick air space, warm edge spacers and Low E coating to 2<sup>nd</sup> surface.
- .8 Weather stripping: Heavy duty, factory installed continuous top seal to seal against header, continuous co-polymer joint bulb seal between sections and vinyl bulb shaped astragal on the bottom edge of the door. Dual durometer vinyl jamb weather seal, bolted to the continuous adjustable mounting angle (ADCA).
- .9 Trusses: Provide adequate number of galvanized steel reinforcing trusses to meet the wind loading.

2.3 **STANDARD OPERATING HARDWARE**

- .1 Track: Lift hardware as indicated on drawings with 75 mm size minimum 2.3 mm core thickness galvanized steel track.
- .2 Track Supports: 2.3 mm core thickness continuous galvanized steel angle track supports.

- .3 Spring counter balance: Heavy duty oil tempered torsion spring with manufacturers standard brackets.
  - .1 Drum: 133 mm diameter die cast aluminum.
  - .2 Shaft: 40 mm diameter solid steel.
- .4 Top roller carrier: Galvanized steel minimum 2.3 mm thick, adjustable.
- .5 Rollers: Full floating, grease packed hardened steel, ball bearing minimum 75 mm diameter, stamped tire.
- .6 Roller brackets: Adjustable, galvanized steel, minimum 2.5 mm thick.
- .7 Hinges: standard duty industrial 2.3 mm thick galvanized steel.
- .8 Cable: minimum 4 mm diameter multi-strand galvanized steel aircraft cable with a safety factor of 8:1.
- .9 Lock: manufacturer's standard interior mounted slide lock.

#### 2.4 **SPRINGLESS SAFE-DRIVE OPERATING SYSTEM**

- .1 Track: Lift hardware as indicated on drawings with 80 mm size minimum 2.75 mm core thickness galvanized steel track.
- .2 Track Hangers: 32 mm x 32 mm x 2 mm galvanized steel angles.
- .3 Vertical track mounting: Adjustable Continuous Track Angle (ADCA) bolted type, field adjustable, sloped to ensure weather tight seal, shall be fabricated from 2.4 mm commercially galvanized steel,
- .4 Rollers: UHMW nylon rollers, 76 mm diameter, with sealed ball bearings, 11 mm diameter roller axles and both inner and outer ball races of hardened steel..
- .5 Roller brackets: Fabricated from 3.1 mm zinc plated steel.
- .6 Hinges: standard duty industrial 2.75 mm thick zinc plated steel.
- .7 Track Guards: Continuous 4.5 mm x 1524 mm high, chamfered 45 degree at top, gray prime finish.
- .8 Bumper springs shall be installed at the end of each horizontal track to stop door over travel.

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**2.5 ELECTRICAL**

- .1 Electrical jack shaft side mounted type operator for standard operating doors and direct drive type electric operator, shaft mounted for springless safe-drive operating doors. Operator to include motors, speed reducers with all gears running in oil, sheaves, racks, levers, cables and brake, disconnect switches, reversing starters, controls, and all conduit and wiring to make all connections required to complete the Work.
- .2 Provide operator with floor level disconnect device to allow for manual operation in event of power failure. Equip operator with electrical interlock switch to disconnect power to operator when in manual operation and Built-in chain hoist for manual operation in event of power failure.
- .3 Electrical motors, controller units, remote pushbutton stations, relays and other electrical components: to CSA approval with CSA enclosure type 1.
- .4 Power supply: 120 V, 3 phase, 60 Hz.
- .5 Motor: Minimum 0.375 kW to maximum 0.560 kW to suite design.
- .6 Operation: Remote pushbutton stations, surface mounted, in location shown, with "OPEN-STOP-CLOSE" designations on pushbuttons in English.
- .7 Exterior push buttons: Mushroom style exterior button to close door, interlinked with card reading system. Provide one per door, surface mounted, in location shown.
- .8 Radio Control: Portable transmitter to signal operator to open, close or stop door.
- .9 Vehicle Detection and Sensing Unit
  - .1 System to consist of detector unit working in conjunction with sensing loop to activate door when vehicle enters or exits.
  - .2 Vehicle detector: Manufacturers standard unit for use in temperature range of -40°C to 71°C.
  - .3 System to automatically self-tune after initial setting.
  - .4 Include protection against interference or damage by lightning or other electrical influence. Minimum protection to include loop fuse, zener diode over-voltage protection, neon flash over protection and line filter.
- .10 Safety switch: combination roll rubber with limit switches for full length of bottom rail of bottom section of door, to reverse door to open position when coming in contact with object on closing cycle.
- .11 Door speed: Minimum 300 mm per second.
- .12 Control transformer: for 24 V AC control voltage.

**2.6 FABRICATION**

- .1 Verify dimensions of existing Work before commencing fabrications and report discrepancies to Consultant.
- .2 Fabricate Work in accordance with Contract Drawings and reviewed shop drawings. Fabricate, fit and assemble Work in shop where possible.
- .3 Fabricate Work free from defects impairing function, appearance, strength and durability.
- .4 Join stiles and rails with self tapping screws. Reinforce doors as required to meet design criteria.
- .5 Panels and glazing to be encased in vinyl channels and held in place with a snap in retainer.

**2.7 FINISHES**

- .1 Extrusion and sheet finish:
  - .1 Fire Station Apparatus Bay: Custom powder coated to match PPG Duranar Sunstorm Coating 'Silverstorm - UC106685F'.
  - .2 Training Apparatus Bay: Satin nickel finish.
- .2 Steel: Hot dip galvanized in accordance with CAN/CSA G164-M.

**3 Execution**

**3.1 INSTALLATION**

- .1 Install doors in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Use anchorage devices to securely fasten unit assembly to wall construction and building and building framing without distortion or stress.
- .3 Fit and align assembly including hardware; level and plumb, to provide smooth operation. Install door to fit tight at all edges of jambs and heads of frames.
- .4 Install operator including electrical motors, controller units, pushbutton stations, vehicle sensing unit, remote operators, relays and other electrical equipment required for door operation in accordance with CSA C22.1 and Ontario Hydro Electrical Safety Code.
- .5 Coordinate the installation of a magnetic loop with Division 26.
- .6 Lubricate and adjust door operating components to ensure smooth opening and closing of doors.
- .7 Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 92 00.

- .8 Touch-up doors and hardware after installation to the satisfaction of the Consultant.
- .9 Adjust weatherstripping to form a weathertight seal.
- .10 Apply isolation coating at 0.8 mm dry film thickness to prevent corrosive or electrolytic action between dissimilar materials.

### 3.2 **ERECTION TOLERANCES**

- .1 Maintain dimensional tolerances and alignment with adjacent work and as follows:
  - .1 Maximum variation and alignment from plum: 1.5 mm.
  - .2 Maximum variation from level: 1.5 mm.
  - .3 Longitudinal or diagonal warp: Plus or minus 3 mm per 3 m straight edge.

### 3.3 **FIELD QUALITY CONTROL**

- .1 Testing: Test operate door and demonstrate the operation of same to the satisfaction of the Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, tool, equipment and services necessary for Aluminum work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 501, Methods of Test for Exterior Walls.
- .2 AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels - Series: Components, Coatings and Finishes.
- .3 AAMA CW-10, Care and Handling of Architectural Aluminum from Shop to Site.
- .4 AAMA CW-DG-1, Aluminum Curtain Wall Design Guide Manual.
- .5 AAMA/WDMA/CSA 101/I.S.2/A440, Standard Specification for Windows, Doors, and Unit Skylights.
- .6 ANSI H35.1M, Alloy and Temper Designation Systems for Aluminum (Metric).
- .7 ASTM A167, Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
- .8 ASTM B209M, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- .9 ASTM B221M, Specification for Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles and Tubes.
- .10 ASTM C920, Specification for Elastomeric Joint Sealants.
- .11 ASTM E283, Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
- .12 ASTM E330, Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- .13 ASTM E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
- .14 ASTM E783, Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.

- .15 ASTM E1105, 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.
- .16 ASTM F738M, Specification for Stainless Steel Metric Bolts, Screws, and Studs.
- .17 CAN/CGSB 1.108-M, Bituminous Solvent Type Paint.
- .18 CAN/ULC S702, Thermal Insulation, Mineral Fibre, for Buildings.
- .19 CAN/ULC S705.1, Standard for Thermal Insulation - Spray Applied Rigid Polyurethane Foam, Medium Density - Material Third Edition.
- .20 NFRC 100, Procedure for Determining Fenestration Product U-factors.
- .21 NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.

### 1.3 **DEFINITION(S)**

- .1 Aluminum work: Shall mean aluminum curtainwall, windows, entrances, vestibules, doors, and framing mentioned in Part 2 of this Specification Section.

### 1.4 **DESIGN REQUIREMENTS**

- .1 Design Aluminum work to meet requirements of AAMA/WDMA/CSA 101/I.S.2/A440, AAMA CW-DG-1, ASTM E283, ASTM E330, ASTM E331, NFRC 100, NFRC 200 and to meet performance and energy requirements specified herein and as required by authorities having jurisdiction.
- .2 Design Aluminum work in accordance with following Climatic Design Data for Barrie contained in the Ontario Building Code:
  - .1 Design temperature: January 1%, July 2 1/2% .
  - .2 Hourly wind pressures: One (1) in 50 year occurrence.
  - .3 Seismic design: Class "C".
- .3 Design complete aluminum window systems, including glazing, to meet the following performance criteria:
  - .1 U-factor: Maximum to follow.
  - .2 SHGC: Maximum to follow.
- .4 Design complete aluminum entrance door systems, including glazing, to meet the following performance criteria:
  - .1 U-factor: Maximum to follow.
  - .2 SHGC: Maximum to follow.

- .5 Design Aluminum work to accommodate following without producing detrimental effect:
  - .1 Cyclic 40°C daily thermal swing of components.
  - .2 Cyclic, dynamic loading and release of loads such as wind loads.
  - .3 13 mm vertical deflection in supporting structure and movement of supporting structure due to live, dead load, and creep or deflections, seismic load, sway displacement and similar items.
- .6 Design to prevent accumulation of condensate on interior side of Aluminum work framing under the following service conditions:
  - .1 Interior summer temperature: 21°C.
  - .2 Interior winter temperature: 21°C.
  - .3 Exterior temperature: -20°C.
  - .4 Interior RH: 35%.
- .7 Restrict air infiltration/exfiltration, through Aluminum work in accordance with ASTM E283 at pressure differential as indicated:
  - .1 Curtainwalls and entrance assemblies: 0.003 L/s m<sup>2</sup> at differential of 300 Pa.
  - .2 Doors (per door): 2.78 m<sup>3</sup>/h m per linear metre of crack at differential of 75 Pa.
- .8 Design and detail controlled drainage path to actively discharge water, which enters into or forms within Aluminum work, to exterior; prevent accumulation or storage of water within Aluminum work. Prevent water from entering interior when tested in accordance with ASTM E331 at a pressure differential of 700 Pa..
- .9 Design and detail air barrier, vapour retarder, and rainscreen products and assemblies into continuous and integrated Aluminum work envelope. Optimize Aluminum work design to align envelope layers and to minimize thermal bridges.
- .10 Prevent deflection and permanent or progressive glazing displacement. Restrict horizontal and vertical mullion deflection to less than L/175 and 19 mm maximum for heights under 4115 mm and L/240 and 25 mm maximum for heights over 4115 mm.
- .11 When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span in accordance with ASTM E330.
- .12 Design anchorage inserts for installation as part of other Sections of work. Design anchorage assemblies to accommodate construction and installation tolerances.
- .13 Provide all reinforcing within aluminum members as required by design and OBC to provide structurally sound assembly. In any case, mullion size shall not be increased due to provision of reinforcing.



- .14 Design Aluminum work and connections to substrate where the bottom of the Aluminum work extends to a point below 1070 mm above finished floor level and separates a floor level from an adjacent interconnected space to withstand the required guard and handrail loads in accordance with the OBC and applicable local regulations. When requested by Consultant, provide a letter signed and sealed by a Professional Engineer certifying that the Aluminum work conforms to the OBC requirements.
- .15 Design operable windows within reach of occupants with limiting stops conforming to requirements of OBC.

## 1.5 SUBMITTALS

- .1 Shop drawings:
  - .1 Submit shop drawings for mock-ups and Aluminum Work in accordance with Section 01 30 00 indicating:
    - .1 Plans, sections, details, type of extrusions, profiles, finishes, panels, spandrels, operating components, doors, related flashings, closures, fillers, and end caps, and sealants.
    - .2 Products and glazing types.
    - .3 Calculations or modelling confirming Aluminum work conforms to specified performance and energy requirements.
    - .4 Structural integrity of Aluminum work, anchorage inserts, and system installation tolerances.
    - .5 Section and hardware reinforcement, anchorage, assembly fixings.
    - .6 Detailing, locations, and allowances for movement, expansion, contraction
    - .7 Air barrier and vapour retarder continuity and path of cavity drainage and air pressure equalization.
    - .8 Seismic anchors, supports and accessories for complete installation.
- .2 Samples:
  - .1 Submit two samples of following in accordance with Section 01 30 00.
    - .1 250 mm long samples of each type of extrusion and finish.
    - .2 250 x 200 mm samples of insulating glass unit.
    - .3 One complete corner detail of door frame, glazing, and finish for each door type.
    - .4 Each door hardware item for Consultant's approval.
    - .5 250 x 200 mm sample of aluminum panel.
    - .6 200 x 200 mm sample of insect screen for operable windows for Consultant's approval of fibreglass mesh.
- .3 Reports:
  - .1 Submit substantiating engineering data, and independent test results of pre-tested, Aluminum work to substantiate compliance with the design criteria including air leakage and water penetration conforming to ASTM E283 and ASTM E331.

- .2 Engineering data demonstrating compliance with test procedures outlined in AAMA 501 including as a minimum air leakage resistance, static pressure water penetration resistance, dynamic pressure water penetration resistance, wind load resistance, vertical live load deflection movement and lateral (horizontal) movement, and condensation resistance.
- .3 Submit documentation to substantiate ten(10) years of experience in Aluminum work manufacture and installation of similar size and nature.
- .4 Close-out submittals: Submit Aluminum work data for incorporation into the Operations and Maintenance Manual as part of Section 01 78 00.
- .5 Extended warranties: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

## 1.6 **QUALITY ASSURANCE**

- .1 Retain a Professional Engineer, licensed in Province of Ontario, with experience in Aluminum work of comparable complexity and scope to perform the following services as part of the work of this Section:
  - .1 Design of Aluminum work.
  - .2 Design of anchors, supports and accessories to meet seismic requirements.
  - .3 Review, stamp, and sign shop drawings.
  - .4 Conduct on-Site inspections and prepare and submit inspection reports. Number and frequency of inspection to be sufficient to satisfy Engineer that Window Wall Work is being fabricated and installed in accordance with reviewed shop drawings and design intent.
- .2 Shop mock-up:
  - .1 Provide one, full scale mock-up in shop of Aluminum work for shop testing, including air leakage, water penetration, and deflection in accordance with AAMA/WDMA/CSA 101/I.S.2/A440,, AAMA 501, ASTM E283, ASTM E330, and ASTM E331. If a test fails, additional testing may be required by Consultant to ensure performance of Aluminum Work at no additional cost to Owner.
  - .2 Demonstrate conformance to specified design requirements.
  - .3 Mock-up shall show full range of Products, finishes, textures, quality of fabrication, and workmanship including, but not limited to, framing members, glazing units, anchorage, opening units, doors and transitions to adjoining assemblies and materials.
- .3 Site mock-up:
  - .1 Provide one full scale in-situ mock-up for testing of air and water infiltration to AAMA 501, ASTM E783 and ASTM E1105 to the satisfaction of an Consultant. If a test fails, additional testing may be required by Consultant to ensure performance of Aluminum Work at no additional cost to Owner.
  - .2 Deliver and erect one, full scale mock-up of Aluminum work assembly, in location acceptable to Consultant.
  - .3 Demonstrate conformance to specified design requirements.

- .4 Demonstrate installation procedures, finished look and quality of workmanship including, but not limited to, framing members, glazing units, anchorage, opening units, doors and transitions to adjoining assemblies and materials.
- .5 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

.4 Pre-installation meetings:

- .1 Mock-ups: Prior to installation of mock-ups, arrange meeting at the shop and on Site to be attended by Consultant, Contractor, and window wall Engineer and site superintendent to inspect substrates, and to review installation procedures 48 hours in advance of installation.
- .2 Site: Prior to installation of window wall, arrange meeting at the Site to be attended by Consultant, Contractor, and window wall Engineer and site superintendent to inspect substrates, and to review installation procedures two (2) weeks in advance of installation.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver, store, and handle Aluminum Work in accordance with AAMA CW-10 and manufacturer's written recommendations.
- .2 Protect aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather. Do not remove before final cleaning of building.

**1.8 EXTENDED WARRANTY**

- .1 Aluminum work: Submit an extended warranty for Aluminum work in accordance with General Conditions, except that warranty period is extended to five (5) years from date of Substantial Performance.
  - .1 Warrant against failure to meet the design criteria and requirements such as interior leakage, frame condensation.
  - .2 Coverage: Labour and materials to repair or replace Aluminum Work as required to correct deficient work and meet specified requirements including affected adjacent work.
- .2 Glazing:
  - .1 Provide a ten (10) year warranty, commencing from date of Substantial Performance, against defects in the insulating glass units and warrant them to be free from material obstruction of vision as a result of dust or film formation on the internal glass surfaces by any cause, under normal design conditions. Warrant the following:
    - .1 The insulating glass units shall be free from condensation, fogging material obstruction of vision as a result of dust or film formation on the internal glass surfaces by any cause under design conditions.
    - .2 The insulating glass units shall not change their mechanical design properties and shall not in any way deteriorate, degrade, delaminate or change their visual appearance.

- .3 The glass units will not break due to thermal shock and temperature differential due to inherent glass faults, other than extrinsic glass breakage.
  - .4 Internal fogging shall be deemed to occur when light transmission of the glass is reduced by 5% in any 50 mm x 50 mm area.
  - .5 Failure will be deemed to occur when the internal dew point exceeds -40oC in a 21oC ambient temperature (when tested in accordance with ASTM E576).
  - .2 Warrant that glazing work is water and weather tight and free from distortion; that glazing materials will not deteriorate from exposure to the atmosphere and weather, will not be displaced, and will be free from permanent deformation under load; and that glass and insulating glass units will not be broken, cracked or scratched by causes resulting from defects in material, workmanship or design of glazing installation.
  - .3 Cracked or scratched glass, shrinking, cracking, staining, hardening, sagging of glazing materials; loosening or rattling of glass; and leaking of glazed joints will be considered defective work.
  - .4 Warranty shall provide for the removal of defective Products, replacement with new Products conforming to the specifications, and restoration of work damaged by removal and replacement including labour and installation costs.
3. Manufacturer's finish Warranty: Provide manufacturer's written warranty naming Owner as beneficiary and covering finish degradation or failure of factory-applied exterior fluoropolymer finish on Aluminum work within the warranty period; warrant finish per AAMA 2605 for colour fade less than 5 units, maximum chalk rating of eight (8), and greater than 30% gloss retention. Warranty period for finish: five (5) years from date Work is certified as substantially performed.

## 2 Products

### 2.1 **ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)**

- .1 All Aluminum work systems and components are to be provided by a single manufacturer to ensure a single source of responsibility for the Work of this Section.
- .2 Curtain wall: 'HP3252 Series' by CRL / U.S. Aluminum or by Oldcastle Building Envelope or approved equivalent. Reinforcing in curtain wall mullions as required to maintain mullion size as detailed.
- .3 Exterior entrance system:
  - .1 Aluminum entrance framing: In accordance with 2.1.1, Curtainwall.
  - .2 Aluminum doors: 'ThermaPorte 7700' by Alumatic Limited, 'Insulclad Doors' by Kawneer Company Canada Limited or by US Aluminum (C.R. Lawrence) or approved equivalent.

- .4 Interior vestibule framing:
  - .1 Aluminum entrance framing: '1800 Series' by Alumicor Limited or 'Trifab VG 451' by Kawneer Company Canada Limited or by US Aluminum (C.R. Lawrence) or approved equivalent
  - .2 Aluminum doors: 'Canadiana' by Alumicor Limited, 'Standard Entrances' by Kawneer Company Canada Limited or by US Aluminum (C.R. Lawrence) or approved equivalent.

## 2.2 MATERIALS

- .1 All materials under work of this Section, including but not limited to, sealants are to have low VOC content limits.
- .2 Aluminum extrusions and channels: ASTM B221 and ANSI H35.1 AA6063 alloy, T6 temper.
  - .1 Profile and dimensions: Refer to Contract Drawings.
  - .2 Thermal breaks in frame members: Vertically aligned with glazing.
- .3 Aluminum sheet: ASTM B209 and ANSI H35.1 AA1100 aluminum alloy, H14 temper, minimum 2.38 mm thickness for all sheet widths.
- .4 Reinforcements and anchors: ASTM A167, Type 304 to AISI No. 2B finish. Size as shown.
- .5 Glass and glazing materials: As specified in Section 08 80 00.
- .6 Airseal and Aluminum Work sealant: ASTM C920, Type S, Grade NS, Class 100/50; One-part, low-modulus, moisture-curing, silicone. 'Dow Corning 790' by Dow Corning; 'Spectrem 1' by Tremco or approved equivalent. Verify compatibility with insulating glass unit manufacturer's secondary sealant. Colour as selected by Consultant. Primer as recommended by manufacturer.
- .7 Frame sealant: Type as recommended by the Aluminum work manufacturer.
- .8 Joint backing: Closed cell foam polyethylene rod, outsized minimum 30-50% larger than joint width and compatible with joint sealant. Product as recommended by sealant manufacturer.
- .9 Airseal transition membrane: To match products provided under Section 07 26 00 - Air/Vapour Barriers.
- .10 Anchors, clips, and angles: Extruded aluminum or stainless steel.
- .11 Shims and blocking for frame: Rigid plastic, wood is not permitted.
- .12 Flashings, closures and trim: 1.0 mm minimum aluminum sheet, finish to match Aluminum Work extrusion finish.
- .13 Screws, bolts and other fasteners: ASTM F738M; Stainless Steel Type 304.

- .14 Seismic anchors, supports and accessories: In accordance with reviewed shop drawings.
- .15 Isolation coating: CAN/CGSB-1.108-M; Bitumastic coating, acid and alkali resistant material.
- .16 Foam Insulation: One component polyurethane foam-in-place moisture cured caulking sealant insulation, 16 kg per m3 to 32 kg per m3 density; injected from prepackaged pressurized containers for installation within closures and fillers; foam shall be CFC free. Enerfoam by Dow Chemical Canada Inc. or approved equivalent.
- .17 Window hardware: Manufacturer's standard heavy duty corrosion resistant hardware.
- .18 Door hardware: Supplied by others, installed by this Section.
- .19 Weatherstripping: Durable, non-absorbing material resistant to deterioration by aging and weathering. Weather stripping shall provide complete air-tight seal at jambs and head of opening. Adapt weatherstripping as required to maintain required performance and provide any/all necessary accessories.

## 2.3 **FABRICATION**

- .1 Fabricate sections true to detail, free from defects impairing appearance, strength and durability. Fabricate extrusions with sharp, well defined corners.
- .2 Fabricate Aluminum work in accordance with reviewed shop drawings and manufacturer's written instructions.
- .3 Fabricate, fit, and secure framing joints and corners accurately, with flush surfaces, and hairline joints. Apply frame sealant at joints to provide continuity of water and air barrier.
- .4 Conceal anchors, reinforcement and attachments from view. Fabricate reinforcement in accordance with design requirements.
- .5 Do not expose manufacturer's identification labels on aluminum assemblies.
- .6 Fabricate continuous sill flashings with intermediate anchor clips, and joint reinforcing, form to profile shown. Fabricate filler and closure pieces as necessary for a complete and weather tight installation.
- .7 Certify aluminum windows as complying with the AAMA/WDMA/CSA 101/I.S.2/A440 design criteria and requirements using an easily removable label located on the inside face of glazing.
- .8 Fabricate doors and frames complete with internal reinforcements, cut-outs, and recesses to accommodate finish hardware. Reinforce cut-outs to assure adequate strength.

- .9 Fabricate Aluminum work closures and trim from aluminum sheet. Form to profile shown. Make weathertight.
- .10 Double weatherstrip windows and doors. Install weatherstripping in specially extruded ports and secure to prevent shrinkage or movement.
- .11 Fabricate glazing recess with drainage to exterior.

## 2.4 **ALUMINUM DOORS**

- .1 Fabricate doors of welded construction.
- .2 Glazing stop: Aluminum, square, snap-on type, designed for glazing system.

## 2.5 **FINISH**

- .1 Extrusion finish: Four coat finish with barrier coat 'Duranar XL' by PPG or approved equivalent in accordance with AAMA 2605. Colour: to be selected by Consultant.
- .2 Mullion cap finish: Four coat finish with barrier coat 'Duranar XL' by PPG or approved equivalent in accordance with AAMA 2605. Colour: to be selected by Consultant.
- .3 Doors: Four coat finish with barrier coat 'Duranar XL' by PPG or approved equivalent in accordance with AAMA 2605. Colour: to be selected by Consultant.
- .4 Panel and sheet finish: As indicated on drawings to match adjacent extrusion finish.

## 3 Execution

### 3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

### 3.2 **INSTALLATION**

- .1 Install Aluminum Work in accordance with reviewed shop drawings, manufacturer's written instructions, and CAN/CSA-A440-M/A440.1-M.
- .2 Install Work of this Section securely, in correct location, level, square, plumb, at proper elevations, free of warp or twist.
- .3 Apply isolation coating at 0.8 mm dry film thickness to prevent corrosive or electrolytic action between dissimilar materials such as aluminum to concrete, masonry, galvanized steel and similar conditions.
- .4 Install flashings, closures, and trim pieces.



- .5 Fill voids between aluminum framing and adjacent construction with foam insulation.
- .6 Install sills in maximum lengths possible. For sills over 1200 mm in length, maintain three (3) mm to six (6) mm space at each end.
- .7 Refer to Contract Drawings for glazing type locations. Install glazing in accordance with Section 08 80 00.
- .8 Install aluminum door weatherstripping at door frame perimeter. Install weatherstripping throughout entire length and width of doors at jambs and heads.
- .9 Install doors and hardware to manufacturers' written instructions. Clean and adjust hardware for correct performance.
- .10 Install hardware in accordance with hardware templates.
- .11 Adjust fixed and operable hardware for correct clearances and function.
- .12 Remove damaged or unacceptable Products and assemblies from Site and replace to Consultant's acceptance.
- .13 Install glass presence markers, in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.

### 3.3 **ERECTION TOLERANCES**

- .1 Tolerances: Non-cumulative.
  - .1 Maximum variation from plumb: 1.5 mm/3 m non-cumulative or 12 mm/30 m, whichever is less.
  - .2 Maximum misalignment of two adjoining members abutting in plane: 0.8 mm.
  - .3 Vertical and horizontal positions: +/- 3 mm.
  - .4 Racking of face: Six (6) mm, nil in elevation.
  - .5 Operable components: Consistent with smooth operation and weatherproof performance.
  - .6 Maximum perimeter sealant joint between Aluminum Work and adjacent construction: 13 mm.

### 3.4 **GLAZING PERIMETER AIRSEAL**

- .1 Install glazing perimeter airseal at entire perimeter of each insulating glass unit to achieve an airseal from insulating glass unit to curtain wall frame. Do not obstruct path of cavity drainage and air pressure equalization.
- .2 Perform sealant work in accordance with manufacturer's written requirements.



**3.5 AIRSEAL TRANSITION MEMBRANE**

- .1 Install primer and airseal transition membrane in accordance with manufacturer's instructions. Install airseal transition membrane into extrusion reglet as indicated on drawings. If there is no extrusion reglet, mechanically fasten airseal transition membrane to frame with batten bar fastened at 150 mm o.c.
- .2 Overlap airseal transition membrane 75 mm minimum and lap in direction of waterflow.
- .3 Coordinate airseal transition to adjacent parts of Work.

**3.6 JOINT BACKING AND ALUMINUM WORK SEALANT**

- .1 Prepare substrate surface and mask as recommended by sealant manufacturer.
- .2 Install joint backing and sealant at Aluminum Work and perimeter joints for weather tight installation in accordance with sealant manufacturer's instructions. Tool sealant. Remove excess sealant.
- .3 Seal joints between windows and window sills with sealant. Bed sill expansion joint cover plates and drip deflectors in sealant. Seal between sill upstand and window-frame. Seal butt joints in continuous sills.

**3.7 ADJUSTING**

- .1 Adjust operable units to move smoothly, with proper tension, throughout their full range of motion and to fit tightly when closed and locked.
- .2 Lubricate hardware in accordance with manufacturer's instructions.
- .3 Ensure that weatherstripping makes weathertight contact and does not cause binding to affect closing and locking.

**3.8 CLEANING**

- .1 Maintain Aluminum Work, inside and outside, in clean condition throughout construction period.
- .2 Remove labels, protective material, and glass presence markers from prefinished surfaces.
- .3 Remove CAN/CSA-A440-M/A440.1-M certification labeling when directed by Consultant, in writing.

- .4 Wash Aluminum Work with solution of mild detergent in warm water, with particular attention to recesses and corners. Wipe surfaces clean and dry.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for finish hardware work in accordance with the Contract Documents.
- .2 Supply only of door hardware will be handled by a cash allowance specified in Division 1.

1.2 **REFERENCES**

- .1 BHMA, Builders Hardware Manufacturing Association.
- .2 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

1.3 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating compliance with reference standards, transportation, storage, handling and installation requirements.
- .2 Shop Drawings:
  - .1 Submit Shop Drawings and three (3) complete hardware lists in accordance with Section 01 30 00 indicating:
    - .1 Door locations, sizes, hardware manufacturer's catalogue numbers, finish symbols and quantities required.
    - .2 Locations and mounting heights of each type of hardware.
  - .2 Supply templates and required information to door and frame manufacturer to enable accurate sizes, locations of cut-outs and reinforcement for hardware.
  - .3 Submit templates to required trade to arrange for provisions for accurate setting and fitting of hardware.
- .3 Samples:
  - .1 Submit two (2) samples in accordance with Section 01 30 00 of each item that is different from hardware specified and include manufacturer's parts lists and installation instructions.
  - .2 Submit hardware component samples illustrating style, colour and finish. Tag samples identifying applicable Specification article number, brand name and number, finish, building location, date and catalogue number.
  - .3 Do not order hardware until samples have been accepted. Submit new samples to replace rejected samples. Supply hardware and finishes identical to each accepted sample.
- .4 Closeout submittals:
  - .1 Submit the following in accordance with Section 01 78 00 for each Product for incorporation into Operation and Maintenance Manual:
    - .1 Maintenance data.
    - .2 Operating instructions and safety precautions.
    - .3 Parts list with name and address of supplier.

- .4 Lubrication schedule and type of lubricant recommended.
- .5 Keys, tools and special devices.
- .6 Inspection procedures related to preventive maintenance.

#### 1.4 **QUALITY ASSURANCE**

- .1 General:
  - .1 Manufacturers: Companies specializing in manufacturing door hardware and registered with BHMA.
  - .2 Hardware supplier: Company specializing in supplying commercial door hardware and acceptable to manufacturer.
- .2 Certifications:
  - .1 Employ an Architectural Hardware Consultant to prepare hardware schedule and inspect completed installation and certify that hardware has been installed in accordance with manufacturer's printed instructions, Authorities having Jurisdiction and as specified.
  - .2 Submit manufacturer's certificate that finish hardware and fire rated hardware meets specified requirements.

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

- .1 Be responsible for packaging of hardware, on a set by set basis. As material is received from various manufacturers identify it to correspond to Hardware List symbols.
- .2 Label packages legibly, indicating manufacturer's number, types, sizes, opening number and Hardware List reference number. Wrap hardware and include in package, screws, bolts and fastening necessary for correct installation. If hardware package is not complete, pay additional charges incurred by installer.
- .3 Deliver hardware to Site packaged, labelled and cross-referenced to hardware list for each item and its scheduled installation location.
- .4 Accept Products of this Section on Site and ensure that each item is undamaged.
- .5 Catalogue and store hardware in secure area.

### 2 **Products**

#### 2.1 **GENERAL**

- .1 Aluminum door hardware: Supplied and installed under the work of Section 08 44 00.

- .2 Carefully check and verify Hardware List against Contract Drawings to ensure that hardware listed can be used as specified. Inform Consultant of concerns regarding quality, quantity, operation or function of hardware selected:
  - .1 Verify hand of doors, examine details on Contract Drawings and at Site to ensure hardware supplied can be correctly installed and is correct for work as constructed.
  - .2 Select hardware in accordance with applicable codes and regulations and to approval of local Fire Marshal.
  - .3 Replace and pay for defective hardware including hardware which was incorrectly selected, and remedial and installation costs.
- .3 Ensure that hardware selected will function correctly, meets Contract requirements and Ontario Building Code and authorities having jurisdiction.
- .4 Ensure that each hardware item is of same type, design and by same manufacturer.
- .5 Manufacturer's names or trade marks are not permitted on exposed surfaces of hardware.
- .6 Include in packing slip a list of parts, name of supplier and door number in which lock is to be installed.
- .7 Hardware for fire rated and labelled door and frame assemblies: ULC listed or as accepted by authorities having jurisdiction.
- .8 Fire rated assemblies:
  - .1 Hardware: Selected and installed in accordance with applicable codes and regulations, NFPA-80 and to approval of Ontario Fire Marshal.
  - .2 Fire rated doors: ULC labelled hardware. Submit written certification of conformance to ULC requirements for each type of hardware prior to delivery.
  - .3 Locksets and latchsets on fire rated doors: 19 mm throw minimum.

## 2.2 ACCESSORIES

- .1 Items to be attached to masonry or concrete with expandable shields, lag screws, bolts or other fastening devices as required. Exposed screws: Stainless steel, Phillips or Robertson heads.

## 2.3 FINISHES

- .1 Metal finishes: Free from defects, clean, unstained and of a uniform colour for each type of finish required. Exposed surfaces and anchors: Specified finish symbol of item.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

- .1 Install hardware in accordance with reviewed Shop Drawings, manufacturer's installation instructions, and applicable Codes and regulations.
- .2 Install hardware in accordance with hardware templates.
- .3 Adjust fixed and operable hardware for correct clearances and function.
- .4 Mount hardware measured from finished floor to centre of hardware, unless indicated otherwise or required by Code:
  - .1 Top hinge: 250 mm from head of door to top.
  - .2 Bottom hinge: 265 mm from finished floor to bottom of hinge.
  - .3 Intermediate hinge: Equal distance between top and bottom hinge.
  - .4 Locksets, latchsets: 1000 mm.
  - .5 Panic device crossbar: 1000 mm.
  - .6 Push plates: 1100 mm to bottom of plates.
  - .7 Guard bars: 1100 mm.
  - .8 Door pulls: 1100 mm to bottom of pulls.
  - .9 Blank strike: 1450 mm.
  - .10 Blank fronts: 1450 mm.
- .5 Include for supply and installation of wiring for electric strikes from electrical junction box to electric strike hardware.
- .6 Locate door stops to contact doors 75 mm from latch edge.
- .7 Install hardware and trim square and plumb to doors.
- .8 Replace wrappings for hardware provided by manufacturer after installation.
- .9 Safeguard keys to keep them out of unauthorized hands, tag them with door number, and deliver them to person designated by Consultant at building completion.

3.3 **FIELD QUALITY CONTROL**

- .1 Have hardware inspected after installation by hardware supplier's representative, obtain certification in writing that hardware has been supplied and installed in accordance with Specifications and hardware manufacturer's instructions and is functioning correctly.

- .2 Inspect fire rated openings to ensure they are installed in compliance with NFPA 80 requirements and Authorities having Jurisdiction.
- .3 Test access control system and electrified hardware devices for proper operation. Verify electric door release hardware operates properly upon activation of fire alarm system.

### 3.4 **ADJUSTING**

- .1 Verify under work of this Section, that installed hardware functions properly.
- .2 Adjust hardware so that latches and locks operate smoothly and without binding, and closers act positively with the least possible resistance in use. Lubricate hardware if required by manufacturer's instructions.
- .3 Adjust doors with self closing devices or automatic closing devices for proper operation after the HVAC system is balanced and adjusted. Verify spring power of non sized door closers is properly adjusted.

### 3.5 **CLEANING**

- .1 Remove wrappings at completion of the Project and clean hardware in accordance with manufacturer's instructions.

### 3.6 **HARDWARE GROUPS/SCHEDULE**

- .1 Hardware groups/schedule: Refer to hardware groups/schedule appended to this Section.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, tool, equipment and services necessary for automatic door equipment work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI/BHMA A156.19, Power Assist and Low-Energy Power-Operated Doors.

1.3 **DESIGN REQUIREMENTS**

- .1 Design handicap door system comprising of low energy power operator with optional push and go door system as defined in ANSI/BHMA A156.19.
- .2 Design system operator to activate if one push button from either side of door is pushed. Actuated door shall open slowly to back check (80°) in three (3) to six (6) seconds and to full open position in four (4) to seven (7) seconds. Door shall remain open for period set to suit requirements (period of 5 to 30 seconds). After time delay door shall close by spring in door operator from 90° to 10° in 3 to 6 seconds from 10° to fully closed in 1-1/2 to two (2) seconds.

1.4 **SUBMITTALS**

- .1 Product data: Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, trouble-shooting protocol, transportation, storage, handling and installation requirements.
- .2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating all connections, attachments, reinforcing, anchorage and location of exposed fastenings.

2 Products

2.1 **ACCEPTABLE MANUFACTURER(S) AND SYSTEM(S)**

- .1 Heavy Duty Door Operator: Design is based on self contained, low pressure electro-hydraulic power. Operator to be as manufactured by one of the following:
  - .1 PowerSwing by Assa Abloy Entrance Systems Canada (Besam).
  - .2 Magic Force by Stanley Canada Inc.
  - .3 Or approved equivalent.
- .2 Door operating equipment shall be complete with electro mechanical motor gear box. Provide three (3) position (off-on) switch. System shall operate between -30 deg C and 50 deg C.



## 2.2 REQUIREMENTS

- .1 Functional Requirements:
  - .1 Equipment shall be designed to operate swing doors up to weight of 100 kg.
  - .2 Opening Speed:
    - .1 Door shall be field adjusted to back check as required in Table 1 of ANSI/BHMA A156.19.
    - .2 Opening speed to fully open shall be four (4) seconds or longer.
- .2 Hold Open: Door shall be field adjusted to remain fully open for not less than five (5) seconds or more than 30 seconds.
- .3 Closing Speed:
  - .1 Doors shall be field adjusted to close 90° to 10° in 3 seconds or longer as required in Table 1 of ANSI/BHMA A156.19.
  - .2 Doors shall close from 10° to fully closed in not less than 1.5 seconds.
  - .3 Force required to prevent door from opening or closing shall not exceed 7 kg applied 25 mm from latch edge of door at any point in opening or closing cycle.
  - .4 During power failure, doors shall open with manual pressure not exceeding 11.3 kg at point 25 mm from latch edge of door.
  - .5 Doors shall be equipped with signs visible from either side, instructing user as to operation and function of door.
- .4 Requirements:
  - .1 Provide header complete with full housing, finish shall match door frame finish.
  - .2 Locations of automatic door operators to conform to requirements of the Ontario Building Code (OBC).
  - .3 Operator shall be activated by 150 mm diameter stainless steel push button switches on either sides as indicated.
  - .4 Switches shall bear universal handicap logo visible to all types of traffic.

## 3 Execution

### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

### 3.2 INSTALLATION

- .1 Install automatic door operators, controls and accessories for doors indicated in accordance with reviewed shop drawings and manufacturer written instructions.

- .2 Installation of automatic door operators to be in accordance with requirements of the Ontario Building Code (OBC).
- .3 Doors shall operate manually as though equipped with manual door closers, without damage to automatic door components, in event of power failure or in event of power termination.
- .4 Co-ordinate this work with Section 08 44 00.
- .5 Power supply to each door operator and wiring shall be provided by Division 26 - Electrical. Make connections at operators and at control panel and supply and install each electrical work between operators and activating controls. Comply with requirements of Division 26 - Electrical. All wiring shall be concealed and where exposed shall be run in conduit. Location of exposed wiring shall be subject to Consultant's approval.

### 3.3 **ADJUSTMENT AND CLEANING**

- .1 Test and adjust operators and controls smooth and proper operation.
- .2 Upon completion of Work of this Section, remove from Site all debris, equipment and excess material resulting from Work of this Section.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment, tools, and services necessary for glass and glazing work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM C1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
- .2 ASTM C1376, Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass.
- .3 ASTM C1503, Standard Specification for Silvered Flat Glass Mirror.
- .4 ASTM D2240, Test Method for Rubber Property - Durometer Hardness.
- .5 ASTM E2190, Standard Specification for Insulating Glass Unit Performance and Evaluation.
- .6 CAN/CGSB-12.1-M, Tempered or Laminated Safety Glass.
- .7 CAN/CGSB-12.8, Insulating Glass Units.
- .8 Glass Association of North America (GANA) Glazing Manual.
- .9 NFPA 80, Standard for Fire Doors and Other Opening Protectives.

1.3 **DESIGN REQUIREMENTS**

- .1 Glass design:
  - .1 Design glass using a probability of breakage of eight (8) lites per 1000 at the first application of design load.
  - .2 Perform stress analysis. Design units to accommodate live, dead, lateral, wind, seismic, handling, transportation, and erection loads.
  - .3 Perform a thermal stress analysis on each glass unit with Low-E coating and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.
  - .4 Perform a thermal stress analysis on each insulating thermal unit and provide heat strengthening and/or tempered units as necessary to prevent thermal breakage.
  - .5 Where required, design glazing units so as not to allow thermal stress fracture due to heat build-up behind insulating units.
  - .6 Roller wave:
    - .1 Heat treated flat glass to be by horizontal (roller hearth) process with inherent roller wave distortion parallel to the bottom edge of the glass as installed.

- .2 Maximum peak to valley roller wave 0.08 mm in the central area and 0.20 mm within 267 mm of the leading and trailing edge or 100 millidiopter over 95% of the glass surface.
- .3 Maximum bow and warp 0.79 mm per 300 mm.
- .4 Roll distortion is to run parallel to the width dimension when installed in the building.
- .7 Coordinate with applicable Sections as required to meet intended energy and performance requirements for insulating glass units.

.2 Limit glass deflection to flexural limit of glass with full recovery of glazing materials.

.3 Utilize inner light of multiple light sealed units for continuity of air and vapour seal.

#### 1.4 **SUBMITTALS**

- .1 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating as a minimum:
    - .1 Fabrication and erection of glazing elements indicating materials, thicknesses, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details, and accessories.
- .2 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00.
  - .2 Submit one sample of each type of glass.
    - .1 300 x 300 mm of each type of insulating glass unit, complete with each different Low-E coating.
    - .2 300 x 300 mm of tempered glass.
    - .3 300 x 300 mm of laminated glass.
    - .4 300 x 300 mm of each colour of spandrel glass.
    - .5 300 x 300 mm of mirror.
    - .6 300 x 300 mm of glass film.
- .3 Certificates: Submit manufacturer's certification that glass and glazing materials are compatible.
- .4 IGMAC Compliance Audit: Submit in accordance with Section 01 30 00, a written certification of successful completion of a Compliance Audit within the last six months.
- .5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.

**1.5 QUALITY ASSURANCE**

- .1 Insulating glass unit fabricators shall be a certified member of the Fenestration and Glazing Industry Alliance (FGIA). FGIA members must participate in the certification program and shall have successfully passed a Compliance Audit within the last six months.
- .2 Installers qualifications: Perform work of this Section by a company that has a minimum of five (5) years proven experience in the installation of glazing units of a similar size and nature.

**1.6 SITE CONDITIONS**

- .1 Glaze with compounds, sealants, or tapes only when glazing surfaces are at temperatures over 4°C, and when positive that no moisture is accumulating on them from rain, mist, or condensation.
- .2 When temperature of glazing surfaces is below 4°C, obtain from Consultant and material manufacturer approval of glazing methods and protective measures which will be used during glazing operations.

**1.7 EXTENDED WARRANTY**

- .1 In accordance with Section 08 44 00.

**2 Products**

**2.1 ACCEPTABLE MANUFACTURERS**

- .1 Glass manufacturers:
  - .1 AGC Flat Glass.
  - .2 Cardinal Glass Industries.
  - .3 Guardian Industries.
  - .4 Viracon Inc.
  - .5 Vitro Architectural Glass (formerly PPG Industries Ltd.)
  - .6 Or approved equivalent.

**2.2 MATERIALS**

- .1 General:
  - .1 All materials under work of this Section, including but not limited to, primers, coatings, sealers, sealants, adhesives and cleaners are to have low VOC content limits.
  - .2 All coatings of a similar type shall be applied in a single production run to ensure colour match.
  - .3 Edges of glass shall be free from spalls, flake chips or rough chips which would be either visible or compromise the adhesion of the exterior weather seal or reduce the strength of glass when subjected to temperature differentials.

- .2 Tempered glass (**TGL**): CAN/CGSB-12.1-M, Type 2, Class B, Category II, clear, minimum 6 mm thick.
- .3 Fire rated glass (**FRGL**): 20 min. to 3 hr. fire rating tested to ULC CAN4 S104-M and ULC CAN4 S106-M, 5 mm thick or as otherwise noted on Door Schedule with appropriate labelling stating fire rating and approval, clear polished glass. Firelite Plus by Nippon Electric Glass Company Ltd. or approved equivalent.
- .4 Laminated glass (**LGL**): to CAN/CGSB-12.1, Category II, consisting of top layer of 3 mm thick clear tempered glass, 0.8 mm thick clear PVB interlayer, and bottom layer of 3 mm thick clear tempered glass. Heat strengthening and/or tempered laminated glass as necessary to prevent thermal breakage.
- .5 Spandrel glass (**SGL**): ASTM C1048, Condition B, 6 mm thick tempered glass, with water-based silicone emulsion coating applied to backside, 'Opaci-Coat 300' by ICD High Performance Coatings or approved equivalent. Colour: To the later selection of the Consultant.
- .6 Heat strengthened glass (**HSGL**): CAN/CGSB-12.3-M; clear float glass, glazing quality, heat strengthened in accordance with ASTM C 1048, Kind HS, 17.5 mm thick unless indicated otherwise.
- .7 Silvered mirror glass (**MGL**):
  - .1 to ASTM C1503, 6 mm thick, laminated safety mirror glass fabricated with polished plate or float glass. Mirror backing shall be resistant to sulphur and hydrogen sulphide fumes. Polish and round all corners of mirrors.
  - .2 Mirror attachment accessories:
    - .1 Mirror adhesive: Chemically compatible with mirror coating and wall substrate.
    - .2 Mirror frames: Stainless steel.
    - .3 Stainless steel clips.
- .8 Insulating glass units:
  - .1 To CAN/CGSB-12.8-M, ASTM E2190 and IGMA requirements utilizing approved stainless steel edge spacer. Dual seal with a PIB primary seal and silicone secondary seal.
  - .2 To comply with IGMA labelling requirements to be considered certified. Materials, excluding the glass, shall be from the same manufacturer as those employed for the certification of the insulating glass units.
- .9 Argon gas: 100% pure. Argon gas to be used to fill air space at all insulated glass units.
- .10 Low-E coating (Soft coat): ASTM C1376, high performance sputtered low-E coating. Provide insulating glass units with low-E coating edge deletion and low-E coating. Apply low-E coating to second surface unless otherwise indicated. 'EnergySelect 36' by AGC Flat Glass, 'Cardinal LoE-272' by Cardinal Glass Industries or 'SN 68' by Guardian Industries or approved equivalent.

- .11 Glazing and rebate primers, sealants, sealers, and cleaners: Compatible with each other. Type as recommended by sealant, spline, and glass manufacturer.
- .12 Glazing sealant: Silicone sealant as recommended by glazing manufacturer. Verify compatibility with insulating glass unit secondary sealant.
- .13 Heel & toe bead: Silicone sealant as recommended by glazing manufacturer.
- .14 Glazing gasket: 'Visionstrip' or Polyshim II' by Tremco Ltd. or approved equivalent, glazing seal, size as recommended by manufacturer.
- .15 Glazing tape: 'Polyshim II' by Tremco or approved equivalent glazing tape EPDM shim.
- .16 Glazing splines: EPDM or neoprene, extruded shape to suit glazing channel retaining slot, colour as selected.
- .17 Setting blocks (regular): EPDM, 80 - 90 Shore A durometer hardness to ASTM D2240, sized to suit glazing method, glass unit weight and area.
- .18 Edge blocks: EPDM, 60-70 Shore A Durometer hardness, self adhesive on face, sized with 3 mm clearance from glass edge and spanning glass thickness(es).
- .19 Glass presence markers: Easily removable, non-residue depositing.
- .20 Screws, bolts and fasteners: Type 304 stainless steel.

## 2.3 **GLAZING AND FILM SCHEDULE**

- .1 General: Glass types shall be as indicated on Drawings and below unless otherwise required due to thermal stress analysis.
- .2 GL-1 (IG units): 6 mm clear tempered glass interior lite, argon filled air space, 6 mm clear tempered glass exterior lite with low-E coating on surface #2. Standard throughout unless noted otherwise. 25 mm overall thickness.
- .3 GL-2: 7 mm clear laminated safety glass interior lite, argon filled air space, 6 mm clear tempered glass exterior lite with low-E coating on surface #2. Standard throughout unless noted otherwise. 25 mm overall thickness.
- .4 GL-3: 6 mm clear tempered glass.

## 2.4 **FABRICATION**

- .1 Verify glazing dimensions on Site.
- .2 Clearly label each glass lite with maker's name and glass type. Ensure labels are easily removable, non-residue depositing type. Do not remove labels until after Work is accepted by Consultant.

- .3 Fabricate glazing not less than three (3) mm smaller than rebate size in either dimension; allow for edge spacers, shims, and setting blocks as necessary.
- .4 Work shall have smooth finished surfaces free from distortion and defects detrimental to appearance and performance.
- .5 Carefully make and fit details. Take special care with exposed finished work to produce a neat and correct appearance to the Consultant's acceptance.
- .6 Grind and polish a 1.5 mm arris to both edges of exposed glazing at locations where glazing is not encapsulated in framing and where edges are exposed to occupants.
- .7 Fabricate argon filled thermal units with air space filled minimum 90% with argon gas.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that openings for glazing are correctly sized and within tolerance.
- .3 Verify that surfaces of glazing channels or recesses are clean, free of obstructions, and ready to receive glazing.
- .4 Laminated glass edges shall be completely covered by tape to protect against sealants and water if required by manufacturer.

#### 3.2 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.

#### 3.3 INSTALLATION

- .1 Provide glazing in accordance with FGIA recommendations. Provide continuous contact between glazing tapes and gasket to the glazing.
- .2 Install glazing to the work of Sections 05 50 00, 06 20 00, 08 11 13, 08 35 00, and 08 44 00.



- .3 Provide neat, straight sight lines. Trim excess glazing tape flush with top of stops and fixed leg of frames.
- .4 Remove protective coatings, glazing stops, clean rebate and glass contact surfaces with solvent, wipe dry.
- .5 Apply primer/sealer to contact surfaces, prior to glazing.
- .6 Apply glazing tape as per manufacturer's instructions including recommended corner sealant.
- .7 Use setting blocks at 1/4 points and spacers to centre glass unit in frame.
- .8 Install glazing in accordance with reviewed shop drawings and manufacturer's written instructions. Install glazing with full contact and adhesion at perimeter. Maintain edge clearance recommended by glass manufacturer.
- .9 Apply a continuous heel bead of sealant around perimeter of inboard lite of the sealed unit and the metal framing.
- .10 Re-install glazing stops ensuring continuous contact and rattle-free installation. Do not distort glass. Trim tape protruding more than two (2) mm above stop.
- .11 Install glazing gasket in accordance with manufacturer's recommendations.
- .12 Do not cut or abrade tempered, heat treated, or coated glass.
- .13 Install glass presence markers in two cross stripes extending from diagonal corners. Maintain markers until final clean-up.
- .14 Remove, dispose of, and replace broken, cut, abraded glass, and defective glass including but not limited to production dimples, roller wave or marks, tong marks, chips, cracks, etc.
- .15 Exterior glass: Glaze units with gasket on exterior side and glazing tape on interior side. Seal gap between glazing and stop with sealant to depth equal to bite of frame. Apply cap head of sealant along void between stop and glazing, to uniform line, flush with sight line. Tool or wipe sealant surface smooth.
- .16 Interior glass: Glaze interior glass using glazing gasket glazing tape.
- .17 Glass film
  - .1 Install glass film with adhesive, applied in accordance with film manufacturer's instructions.
  - .2 Place without air bubbles, creases or visible distortion.
  - .3 Fit tight to glass perimeter with razor cut edge.

- .18 Mirrors:
  - .1 Install mirrors in one (1) single piece in sizes indicated without joints.
  - .2 Set mirrors with adhesive and clips, applied in accordance with manufacturer's instructions.
  - .3 Where indicated, provide continuous metal trim along all mirror edges, with mitred corners and concealed fastenings.

#### 3.4 **CLEANING**

- .1 Immediately remove sealant and compound droppings from finished surfaces.
- .2 Remove labels, protective material, and glass presence markers from prefinished surfaces.
- .3 Clean glass surfaces with cleaning agents and methods in accordance with Manufacturer's written instructions.
- .4 Do not wash glass film for 30 days after installation.
- .5 Do not use bristle brushes on glass film.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for gypsum board work.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM C475, Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- .3 ASTM C645, Specification for Nonstructural Steel Framing Members.
- .4 ASTM C754, Specification for Steel Framing Members to Receive Screw-Attached Gypsum Board.
- .5 ASTM C834, Standard Specification for Latex Sealants.
- .6 ASTM C840, Specification for Application and Finishing of Gypsum Board.
- .7 ASTM C1002, Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- .8 ASTM C1396, Specification for Gypsum Board.
- .9 ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.3 **DESIGN REQUIREMENTS**

- .1 Design gypsum board wall and ceiling systems with a maximum deflection of  $l/360$ .
- .2 Design ceiling suspension system in accordance with manufacturer's printed directions and ASTM C754.
- .3 Design ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.
- .4 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
- .5 Design suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures.

- .6 Design subframing as necessary to accommodate, and to circumvent, conflicts and interferences where ducts or other equipment prevent the regular spacing of hangers.
- .7 Design wall framing system and reinforce as necessary to accommodate and support items attached to and supported by wall framing system.
- .8 Design wall framing system for wall assemblies with a height greater than 3000 mm and those assemblies incorporating non-standard gypsum board assemblies including, but not limited to, abuse resistant gypsum board, and large format tile applications.

#### 1.4 **REGULATORY REQUIREMENTS**

- .1 Provide fire separations and fire protection exactly as specified in test design specification that validates the specified rating. Verify that work specified in other Sections, as a part of the entire assembly, meets applicable validating test design specification.

#### 1.5 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop Drawings:
  - .1 Submit Shop Drawings in accordance with Section 01 30 00 indicating:
    - .1 Wall assemblies, suspension systems, adjacent construction, elevations, sections and details, dimensions, thickness, finishes and relationship to adjacent construction.
    - .2 Framing and blocking for items being supported of wall systems.
    - .3 Fire rated designs.
- .3 Certifications: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

#### 1.6 **QUALITY ASSURANCE**

- .1 Qualifications: Execute the work of this Section by skilled, qualified, and experienced workers trained in the installation of the work of this Section.

- .2 Retain a Professional Engineer, licensed in Province of Ontario, with experience in work of comparable complexity and scope, to perform following services as part of work of this Section:
  - .1 Design of wall systems with height greater than 3000 mm and at non-standard gypsum board assemblies including, but not limited to, assemblies incorporating abuse resistant gypsum board, and large format tile applications.
  - .2 Design of suspended gypsum board assemblies.
  - .3 Review, stamp, and sign Shop Drawings and design calculations.
  - .4 Conduct shop and on-site inspections, prepare and submit written inspection reports verifying that this part of Work is in accordance with Contract Documents and reviewed Shop Drawings.

## 1.7 **SITE CONDITIONS**

- .1 Do not begin work of this Section until:
  - .1 Mechanical and electrical work above the ceiling is complete.
  - .2 Substrate and ambient temperature is above 15°C.
  - .3 Relative humidity is below 80 %.
  - .4 Ventilation is adequate to remove excess moisture.
- .2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and 24 h after installation.

## 2 **Products**

### 2.1 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, sealants, adhesives, and primers are to have low VOC content limits.
- .2 Steel framing: ASTM C754; ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
  - .1 Bailey Metal Products Limited
  - .2 Corus Metal Profiles
  - .3 Or approved equivalent.
- .3 Steel studs and track runners: ASTM C645; Galvanized steel studs and runners, 32 mm wide x depth as indicated on Contract Drawings. Formed from galvanized steel sheet, thicknesses as follows:
  - .1 Studs less than 3000 mm: Minimum 0.53 mm (25 ga.).
  - .2 Studs greater than 3000 mm and non-standard assemblies: Minimum 0.91 mm (20 ga.), unless stud thickness of greater thickness is required to accommodate intended loading, spans, or conditions.
  - .3 Track runners and ancillary components to match stud thickness.

- .4 Main carrying channels: ASTM C645; Formed from galvanized steel sheet, 38 x 19 mm cold rolled, channels.
- .5 Resilient channel: ASTM C645; 0.5 mm thick galvanized metal, 57 mm wide x 12 mm deep for walls and ceiling to reduce sound transmission.
- .6 Furring channels: ASTM C645; Formed from galvanized steel sheet, 22 mm winged flange type, cold rolled.
- .7 Furring channels (hat type): ASTM C645; 0.5 mm base steel thickness, galvanized. 70 mm wide x 22 mm deep hat shaped channel.
- .8 Heavy duty furring channels: ASTM C645; 0.9 mm steel thickness, galvanized hat shaped channel with a wider and deeper size as required by manufacturers.
- .9 Hanger wires: 4.1 mm minimum diameter galvanized pencil rod.
- .10 Tie wire: 1.6 mm thick minimum diameter, soft annealed, galvanized steel wire.
- .11 Corner bead, casing bead, and special shapes: Formed from 0.6 mm thick minimum, galvanized steel sheet, designed to be concealed by joint compound.
- .12 Deflection track: ASTM C 645 top runner with 50.8-mm- deep flanges, in thickness indicated for studs and in width to accommodate depth of studs.
- .13 Deflection track (fire rated): Provide 25 mm deep leg deflection track where indicated on rated walls. 'Fire Trak Shadowline' by Fire Trak Corporation or approved equivalent.
- .14 Ceiling clips: Hot dip galvanized partition attachment clips, in square and reveal edge; 'PAC 15 Series' to match grid system by CGC Inc. or approved equivalent.
- .15 Gaskets (acoustic partitions): Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 3.2 mm thick, in width to suit steel stud size.
- .16 Control joint strip: Roll formed from galvanized steel sheet, with a tape protected recess, 6 mm wide x 11 mm deep.
- .17 Screw fasteners: ASTM C1002 Type S; Corrosion resistant.
- .18 Concrete anchors: tie wire sleeve anchors, 'Redi-Drive Anchors' by ITW Red Head or approved equivalent.
- .19 Insulation: In accordance with Section 07 21 00.

- .20 Standard sealants:
  - .1 Acoustic sealant (non-rated): Non-hardening acoustic sealant for use at non-rated assemblies, ASTM C834; Lightweight, acrylic, mould resistant sealant, paintable. 'Lightweight Smoke and Acoustic Sealant CS-S SA Light' by Hilti or approved equivalent.
  - .2 Fire-rated sealant: Non-hardening sealant for use at fire-rated assemblies: CAN/ULC-S102; Acrylic based firestop sealant, colour: red or white as selected by Consultant. 'Flexible Firestop Sealant CP606' by Hilti or approved equivalent.
  - .3 Fire-rated seal: Non-hardening seal for use at fire-rated assemblies: CAN/ULC-S102; Flexible seal for installation between top track and substrate. 'Firestop Top Track Seal CFS-TTS' by Hilti or approved equivalent.
  - .4 Standard sealants: In accordance with Section 07 92 00.
- .21 Polyethylene vapour retarder: In accordance with Section 07 26 00.
- .22 Vibration isolation ceiling hangers: unit shall consist of a steel spring in series with a neoprene isolating element. Model W30N manufactured by Mason Industries Inc., or by PAC International or approved equivalent. Provide hangers to ensure that working load does not exceed 2/3 of solid load. Design hangers to tolerate 30 deg. misalignment.
- .23 Fire rated gypsum board: ASTM C1396; gypsum board 15.9 mm thick of maximum practical lengths to minimize end joints, unless indicated otherwise. Furnish Type X Board by Certainteed Gypsum Canada, CGC Inc., or Georgia-Pacific Canada LP or approved equivalent.
- .24 Abuse Resistant Panels: ASTM C1396; 15.9 mm thick unless indicated otherwise on drawings; 'Abuse Resistant' by Certainteed Gypsum Canada, 'Sheetrock AR' by CGC Inc. or 'ToughRock' by Georgia-Pacific Canada LP or approved equivalent.
- .25 Moisture, mould, and abuse resistant panels: 15.9 mm thick unless indicated otherwise on drawings; 'AirRenew Extreme Impact Resistant with M2Tech' by Certainteed Gypsum Canada, 'Sheetrock Mold Tough AR' by CGC Inc. or 'DensArmor Plus Abuse-Resistant Interior Panel' by Georgia-Pacific Canada LP or approved equivalent.
- .26 Tile Backer: Water resistant tile backer board meeting ASTM C1178 or ASTM C1278, thickness as indicated. 'Diamondback Tile Backer' by Certainteed Gypsum Canada, 'Fiberock Aqua-Tough Underlayment' by CGC Inc. or 'Dens Shield' by Georgia-Pacific Canada LP or approved equivalent.
- .27 Primer: Where indicated by board manufacturer, provide primer as required to achieve finishes as defined in ASTM C840.
- .28 Joint reinforcing tape:
  - .1 Standard gypsum board: ASTM C475; 50 mm wide x 0.25 mm thick, perforated paper, with chamfered edges.

- .2 Moisture resistant and tile backer boards: ASTM C475; fibreglass mat joint tape as recommended by board manufacturer to suit location.
- .29 Bonding adhesive: Type for purpose intended and as recommended and approved by manufacturer.
- .30 Joint and patching compound: ASTM C475; Asbestos-free, supplied by manufacturer of gypsum board used.
- .31 Fast setting patching compound: ASTM C475; Asbestos-free, Sheetrock or Durabond by CGC Inc., 'Moisture and Mold Resistant Setting Compound with M2Tech' by Certainteed Gypsum Canada or approved equivalent.
- .32 Access doors: Supplied by other Sections for installation as part of the work of this Section.

### 3 Execution

#### 3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 **SUSPENSION FRAMING**

- .1 Install ceiling systems in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.
- .3 Install vibration isolation hangers at all locations where indicated in strict accordance with manufacturer's printed instructions.
- .4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.
- .5 Install additional hangers at lighting fixture and ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.
- .6 Install main carrying channels transverse to structural framing members. Lap main carrying channels 200 mm minimum at splices and wire each end with two loops and prevent clustering or lining-up of splices.



- .7 Install furring channels at 400 mm o.c., not less than 25 mm, and not more than 150 mm from perimeter walls, at openings, at interruptions in ceiling continuity, and at change in plane. Install furring channels to a tolerance of three (3) mm maximum in 3600 mm.
- .8 Install additional main carrying and furring channels to frame and to reinforce openings such as recessed lighting fixtures, access hatches, ceiling grilles, outlet boxes, ventilating outlets and similar items.

### 3.3 **STEEL STUDS AND FURRING**

- .1 Install steel studs and furring in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install steel stud partitions to underside of structure unless indicated otherwise.
- .3 Install track runners at floors, ceilings, and underside of structure; align track runners accurately and secure to structure at 600 mm centres maximum.
- .4 Install double top track runner assembly to prevent the transmission of structural loads to steel studs.
- .5 Install steel studs vertically at 400 mm o.c., unless otherwise indicated, and not more than 50 mm from abutting walls, at openings, and at each side of corners. Install studs securely to track runners.
- .6 Schedule and coordinate steel framing installation with mechanical and electrical services installation.
- .7 Install full height, double studs at door and service openings, fastened together and stiffened back to the structure to prevent vibration when doors close.
- .8 Provide double studs boxed together at all openings, sill, head and jambs and at door jambs, fastened together and stiffened back to the structure to prevent vibration. At each opening exceeding 900 mm in width double studs shall be 20 ga. extending to structure above, and adequately anchored at each end. Provide steel studs above and below openings spaced at 400 mm oc maximum. All metal stud partitions above doors and screens over 1220 mm wide shall be secured to structure over and reinforced with sway bracing to stabilize walls to prevent lateral movement.
- .9 Erect three studs at corner and intermediate intersections of partitions. Space 50 mm apart and brace together with wired 19 mm channels.

- .10 Stiffen partitions over 2440 mm high or 3000 mm long, or both, with horizontal bracing extended for full length of partitions. Provide one line of bracing in partitions. Space lines to provide equal unbraced panels. Provide bracing for portions of partitions over door openings in partitions over 3000 mm high, and bracing both above and below openings in partitions located no greater than 150 mm from top and bottom of opening, and extending two stud spaces beyond each edge of opening for both doors and windows. Wire tie or weld bracing to studs.
- .11 Frame control joints using back to back double studs at abutting structural elements, at dissimilar backup interface, at dissimilar walls and ceilings, at structural expansion and control joints, at door and other openings, and at 9000 mm maximum spacing in continuous runs. Install control joint strips and secure in place.
- .12 Install additional support framing at openings and cutouts for built-in equipment, upper cabinet support, access panels and similar items.
- .13 Attach to framing adequate steel reinforcing members or an 18 ga. steel stud mounted horizontally and notched around furring members to support the load of, and to withstand the withdrawal and shear forces imposed by, items installed upon the work of this Section. Such items include, but are not restricted to, coat hooks, washroom accessories, handrail anchors, rub rails, grab bars, guards, wall-hung cabinets and fittings, shelving, curtain and drape tracks; Owner supplied equipment; and minor mechanical and electrical work. Heavy mechanical and electrical equipment shall be self-supporting in Divisions 21, 22, 23 and 26.
- .14 Provide for support and incorporation of flush-mounted and recessed mechanical and electrical equipment and fixtures only after consultation and verification of methods with those performing the work of Divisions 21, 22, 23 and 26.
- .15 Install cross bracing in accordance with the steel stud manufacturer's recommendations.

#### 3.4 **FIRE RATED ASSEMBLIES**

- .1 Install Products in fire rated assemblies in strict accordance with reviewed Shop Drawings and applicable tested and approved designs required by Authorities Having Jurisdiction.
- .2 Install firestop fill material behind fire rated acoustical sealant and provide firestop identification tag.
- .3 Stiffen fire rated walls over 3.66 m high, where linear length of wall is greater than 2.44 m between perpendicular wall supports, with diagonal bracing above the ceiling extending perpendicular to wall at a 45° angle to structure above. Locate diagonal bracing at maximum 2.44 m o.c.
- .4 Where double layers of gypsum board are shown, and required for fire rating, screw first layer to studs and furring and laminate the second layer to the first using joint filler as an adhesive. Stagger joints between first and second layers.

**3.5 INSULATION**

- .1 Install non-rated and fire-rated/acoustic insulation as required for Work of this Project in accordance with Section 07 21 00.

**3.6 ACOUSTICAL SEALANT**

- .1 Install acoustical sealant to acoustically insulated partitions in accordance with the manufacturer's instructions and Contract Drawings.
- .2 Install acoustical sealant under floor runner track, at partition perimeter both sides and at openings, cut-outs, and penetrations, concealed from view in the final installation.
- .3 Smooth acoustical sealant with trowel prior to skin forming.

**3.7 GYPSUM BOARD**

- .1 Comply with ASTM C840. Install gypsum board in accordance with reviewed Shop Drawings and manufacturer's written instructions.
- .2 Install gypsum board vertically or horizontally, whichever results in fewer end joints. Locate end joints over supporting members.
- .3 Install gypsum board in lightly butted contact at edges and ends and with 1.6 mm maximum open space between boards; do not force gypsum board into place. Do not install imperfect, damaged or damp boards.
- .4 Install gypsum board butting paired tapered edge joints, and mill-cut or field-cut end joints; do not place tapered edges against cut edges or ends.
- .5 Install vertical joints minimum 300 mm from the jamb lines of openings and stagger vertical joints over different studs on opposite sides of partitions.
- .6 Do not locate joints within 200 mm of corners or openings, except where control joints occur at jamb lines or where openings occur adjacent to corners. Where necessary, place a single vertical joint over the centre of wide openings.
- .7 Install gypsum board over concrete and concrete masonry units with adhesive as recommended by gypsum board manufacturer where indicated on Drawings.
- .8 Cut, drill and patch gypsum board as may be necessary to accommodate the work of other trades.
- 9. Fire Separations:
  - .1 Construct gypsum board assemblies, where located, in accordance with tested assemblies to obtain required or indicated fire rated assemblies. As a minimum fire separations shall consist of metal framing covered on both sides by fire-rated gypsum board.

- .2 Install assemblies tightly to enclosing constructions to maintain integrity of the separations. Install casing beads at all perimeter edges.

### 3.8 **CORNER, CASING BEADS AND TRIM**

- .1 Corner reinforcing bead: Install along all external angles, erect plumb, level and with a minimum of joints. Secure with screws at 225 mm o.c. apply filler over flanges flush with nose of the bead and extending at least 75 mm onto surface of board each side of corner. When filler dries, apply a thin coat of topping cement and blend onto adjoining surfaces.
- .2 Casing bead: Install where wallboard butts against a surface having no trim concealing the juncture and where shown on drawings. Erect casing beads plumb or level, with minimum joints, and secure with screws at 300 mm o.c. apply filler over flange flush with bead and extending at least 75 mm onto surface of board. When dry, apply a thin coat of topping cement and blend onto adjoining surfaces.
- .3 Recess channels and trim: Install recess channels and special metal trim where shown. Secure to substrate. Provide casing beads full height on wallboard edges at recess channels and metal trim.

### 3.9 **JOINT TAPING AND FINISHING**

- .1 Install reinforcing tape and a minimum of 3 coats of joint compound over gypsum board joints, metal trim and accessories, and screw fasteners in accordance with the gypsum board manufacturer's instructions.
- .2 Fill gaps between ,and any imperfections in, gypsum boards with joint compound, allow to dry, and sand smooth ready for painting.
- .3 Install finished gypsum board work smooth, seamless, plumb, true, flush, and with square, plumb, and neat corners.
- .4 Finish gypsum board in accordance with ASTM C840 to the following grades:
  - .1 Level 0: No taping, finishing, or accessories required. Use above suspended ceilings and within other concealed spaces, unless the assembly is fire rated, sound rated, sound or smoke controlled, or unless the space serves as an air plenum.
  - .2 Level 1: At joints and interior angles embed tape in joint compound. Leave surface free of excess joint compound. Tool marks and ridges are acceptable. Use above suspended ceilings and within other concealed spaces if the gypsum board assembly is fire rated, sound rated, sound or smoke controlled, or the space serves as an air plenum.
  - .3 Level 2: At joints and interior angles embed tape in joint compound with one separate coat of joint compound applied over joints, angles, fastener heads, and accessories. Use for water resistant gypsum board indicated for use as a substrate for ceramic tile.

- .4 Level 3: At joints and interior angles embed tape in joint compound with two separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use where heavy grade wall coverings are the final decoration.
- .5 Level 4: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply joint compound smooth and free of tool marks and ridges. Use for all locations except those indicated for other finish levels.
- .6 Level 5: At joints and interior angles embed tape in joint compound with three separate coats of joint compound applied over all joints, angles, fastener heads, and accessories. Apply a thin skim coat of joint compound, or a material manufactured especially for this purpose, to the entire surface. Leave surface smooth and free of tool marks and ridges. Use where semi-gloss or gloss finish coatings are the final decoration.

### 3.10 **ACCESS DOORS**

- .1 Install access doors, supplied as part of other parts of the work, in accordance with manufacturer's written instructions.

### 3.11 **SITE TOLERANCES**

- .1 Install metal support systems to ensure that, within a tolerance of +3 mm and -1.5 mm for plaster thickness, finish surfaces will be flat within three (3) mm under a three (3) m straightedge, and with no variation greater than 1.5 mm in any running 300 mm, and that surface planes shall be within three (3) mm of dimensioned location.

### 3.12 **REPAIR**

- .1 Make good cut-outs for services and other work, fill in defective joints, holes and other depressions with joint compound.
- .2 Make good defective work, and ensure that surfaces are smooth, evenly textured and within specified tolerances to receive finish treatments.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for tile work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ANSI A108/A118/A136.1, Installation of Ceramic Tile.
- .2 ANSI A137.1, Specifications for Ceramic Tile.
- .3 ASTM C144, Specification for Aggregate for Masonry Mortar.
- .4 ASTM C920, Specification for Elastomeric Joint Sealants.
- .5 CAN/CSA A3000, Cementitious Materials Compendium.
- .6 TTMAC Specification Guide 09 30 00 Tile Installation Manual.
- .7 TTMAC, Maintenance Guide.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and warranties.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Tile layout, patterns, and colour arrangement.
    - .2 Perimeter conditions, junctions with dissimilar materials.
    - .3 Setting details.
- .3 Samples:
  - .1 Submit following sample panels in accordance with Section 01 30 00.
    - .1 Each colour, texture, size, and pattern of tile.
    - .2 Adhere tile samples to 400 x 400 x 12.5 mm thick cement board complete with selected grout colour in joints.

- .4 Certificates: Submit manufacturer's certificates stating that materials supplied are in accordance with this specification.
- .5 Extended warranty: Submit extended warranty signed and registered by the manufacturer providing the warranty in the name of the Owner for the timeframe and coverage specified in this Section.
- .6 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

#### 1.4 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that is a member in good standing of the Terrazzo Tile and Marble Association of Canada with proven, acceptable experience on installations of similar complexity and scope.

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

- .1 Deliver materials in adequate crates or containers with manufacturer's name and product description clearly marked.
- .2 Handle and store tiles in a manner to avoid chipping, breakage or the instruction of foreign matter. Take precautions to protect the mortar and grout admixtures from freezing or from excessive heat.

#### 1.6 **SITE CONDITIONS**

- .1 Do not install work of this Section outside of the following environmental ranges without the Consultant's and Product manufacturer's written acceptance:
  - .1 Ambient air and surface temperature: 15<sup>0</sup>C to 45<sup>0</sup>C.
  - .2 Precipitation: None.
- .2 Install temporary protection and facilities to maintain the Product manufacturer's, and specified, environmental requirements for seven (7) Days before, during, and seven (7) Days after installation.

#### 1.7 **MAINTENANCE**

- .1 Submit extra tile amounting to 3% of gross area covered, allowing proportionately for each pattern and type specified and which are part of the same Production run as installed Products. Store maintenance Products as directed by the Consultant.

2 Products

2.1 **MATERIALS**

- .1 General: All materials under work of this Section, including but not limited to, sealants, adhesives, and sealers are to have low VOC content limits.
- .2 Tile (PT-#):
  - .1 To CAN/CGSB-75.1-M.
  - .2 Supply coves, caps, inside and outside corners and bullnose tile as required.
  - .3 Where unfinished tile edge is exposed, supply cap to Consultant's selection.
  - .4 Colour and style to be selected by Consultant.
  - .5 Locations: As per Room Finish Schedule.
- .3 Tile Base: Base tile to match floor tile.

2.2 **ACCESSORIES**

- .1 Metal trims and caps: Metal trims with trapezoid anchoring leg by Schluter or approved equivalent. Profiles, materials and finish as indicated on Colour and Material Schedule.
- .2 Cement: CAN/CSA A3000, Type GU.
- .3 Sand: ASTM C144.
- .4 Water: Potable and free of minerals and other contaminants which are detrimental to mortar and grout mixes.
- .5 Flexible thin-set mortar: ANSI A108/A118/A136.1; ServoStar 3000 Flex White by Kiesel or approved equivalent.
- .6 Medium bed mortar: to ANSI A118.4; Servoflex-Trio-schnell SuperTec by Kiesel or approved equivalent.
- .7 Thick bed sloped topping: Factory mixed blend of portland cement and aggregates with latex admix. as manufactured by Kiesel or approved equivalent.
- .8 Primer: To meet specified requirements of adhesive manufacturer.
- .9 Cleaner: In accordance with TTMAC's requirements and as recommended by tile manufacturer.
- .10 Grout:
  - .1 Joint widths 1 mm - 10 mm for walls and floors: Fast-setting, flexible, water and dirt repellant grout; Servoperl Royal Schnell by Kiesel or approved equivalent.
  - .2 Joint widths 3 mm - 25 mm for walls and floors: Universal flexible sanded grout; Servoflex F by Kiesel or approved equivalent.



- .3 Grout colour: To be selected by the Consultant from the manufacturer's full colour range.
- .11 Joint backing: Round, closed cell, foam rod, oversized by 30% to 50%, Shore A hardness of 20, tensile strength 140 to 200 kPa.
- .12 Sealer: CAN/CGSB-25.20, penetrating, type as recommended by tile manufacturer.
- .13 Tile sealant: In accordance with Section 07 92 00.

## 2.3 **MIXES**

- .1 Levelling bed mix:
  - .1 1 part Portland cement.
  - .2 4 parts sand.
  - .3 1 part water (including polymer additive), adjusted for water content of sand.
  - .4 1/10 part polymer additive.

## 3 Execution

### 3.1 **SURFACE PREPARATION**

- .1 Clean and dry surfaces thoroughly. Remove oil, wax, grease, dust, dirt, paint, tar, primers, form release agents, curing compound, and other foreign material from substrate surfaces which may prevent or reduce adhesion.
- .2 Neutralize any trace of strong acids or alkali from the substrate.

### 3.2 **CONTROL JOINTS**

- .1 Provide control, expansion and isolation joints in accordance with TTMAC specification 301MJ and as indicated on drawings. Install in locations indicated on drawings and specified herein.
- .2 Continue control, construction, and cold joints in the structural substrate up through the tile finish, and align with mortar joints where possible. Review joint locations on Site with the Consultant.
- .3 Install joint widths to match grout joint widths, except where a minimum width is indicated.
- .4 Install control joints in the following typical locations:
  - .1 Aligned over changes in type of substrate.
  - .2 At the restraining perimeters such as walls and columns.
  - .3 Interior areas (not subject to sunlight): Six (6) mm minimum width, at 7320 mm o.c. maximum.
  - .4 Interior areas (subject to sunlight): Six (6) mm minimum width, at 3660 mm o.c. maximum.
  - .5 As indicated on the Contract Drawings.

- .5 Seal control joints in accordance with Section 07 92 00.

### 3.3 **LEVELLING BED**

- .1 Install a levelling bed on uneven substrate surfaces, level and plumb substrates in accordance with the following tolerances:
  - .1 Vertical surfaces: Three (3) mm in 2.4 m maximum .
  - .2 Horizontal surfaces: Six (6) mm in three (3) m from finished levels of the surface, or better.
- .2 Clean structural substrate control joints and blow-clean with compressed air. Grout fill control joints flush to slab with levelling bed.
- .3 Provide slopes to drains in washrooms and as indicated on drawings.

### 3.4 **GENERAL INSTALLATION REQUIREMENTS**

- .1 Install tiles in accordance with manufacturer's instructions and TTMAC Specification Guide 09300 Tile Installation Manual. Manufacturer's installation instructions govern over TTMAC Installation Manual.
- .2 Lay out Work to produce a symmetrical pattern with minimum amount of cutting. Ensure cut tile at room perimeter and at joints is not less than ½ full size.
- .3 Install trim to be placed under tile in locations indicated on Drawings.
- .4 Set tiles in place and rap or beat with a beating block as necessary to ensure a proper bond and to level surface. Align tile for uniform joints and allow to set until firm. Clean excess mortar from surface of tile with a wet cloth or sponge while mortar is fresh.
- .5 Ensure following minimum mortar contact coverage to back of tiles. Contact must be evenly distributed to give full support of the tile.
  - .1 98% for large format (305 mm x 305 mm or greater) interior applications.
  - .2 90% for non-large format interior applications.
- .6 Adjust joints between units uniform, plumb, straight, even, and true, with adjacent tile flush. Align grout joints in both directions unless indicated otherwise.
- .7 Align floor and base grout joints.
- .8 Install tile accessory fittings for a complete and fully coordinated tile assembly.
- .9 Do not place tile, trim, and accessories over control, expansion, or isolation joints. Stop materials in either side on joints and provide control, expansion and isolation joints as specified.

- .10 Cut and fit tile neatly around piping, fittings, joints, projections and around recesses items e.g. washroom accessories. Where surface mounted equipment and accessories are installed on tile surfaces, extend tile over surfaces. Cut edges smooth, even, and free from chipping; chipped and broken edges are not acceptable.
- .11 Do not proceed with grouting until minimum 48 hours after tile has set, to prevent displacement of tiles.
- .12 Apply grout in accordance with grout manufacturer's directions to produce watertight, filled joints without voids, cracks and excess grout. Thoroughly compact and tool floor grout. Finish grout flush to edge thickness of tile and remove excess grout with soft burlap or sponge moistened with clean water.

### 3.5 **CLEANING**

- .1 Clean off excess grout with soft burlap or sponge moistened with clean water.
- .2 Polish tile after grout has cured in accordance with TTMAC recommendations in the Maintenance Guide; do not use acid for cleaning.
- .3 Apply 2 coats of sealer to unglazed floor tile in accordance with sealer manufacturer's printed directions.
- .4 Re-point joints after cleaning as required to eliminate imperfections, then re-clean as necessary. Avoid scratching tile surfaces.

### 3.6 **JOINT BACKING AND TILE SEALANT**

- .1 Install joint backing under sealant as necessary.
- .2 Install tile sealant around piping and fittings extending through tiled surfaces.
- .3 Seal tile control joints.
- .4 Seal internal tile to tile junctions. Tool to a smooth, flush surface, free from air bubbles and contamination.

### 3.7 **PROTECTION**

- .1 Prevent traffic over tiled areas, and protect tiled assemblies from weather, freezing, and water immersion, for 72 hours minimum, after final installation.
- .2 Prevent direct impact, vibration and heavy hammering on adjacent and opposite walls for 24 hours minimum, after final installation.

- .3 Cover work temporarily with building paper properly lapped and taped at joints until work has been approved by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for acoustical ceilings work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .2 ASTM C635, Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- .3 ASTM C636, Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels.
- .4 ASTM C645, Specification for Non-Load Bearing (Axial) Steel Studs, Runners (Tracks), and Rigid Furring Channels for Screw Application of Gypsum Board.
- .5 ASTM E1264, Classification for Acoustical Ceiling Products.

1.3 **DESIGN REQUIREMENTS**

- .1 Design acoustical ceiling system in accordance with following Climatic Design Data for Barrie contained in the Ontario Building Code:
  - .1 Design temperature: January 1%, July 2 1/2%.
  - .2 Hourly wind pressures: 1 in 50 year occurrence.
  - .3 Seismic design: Class "C".
- .2 Design acoustical ceiling suspension system and anchors in accordance with specified Seismic Design requirements.
- .3 Design ceiling suspension systems in accordance with ASTM C636 and manufacturer's printed directions.
- .4 Design tile ceiling system for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority. Acoustic panel system is not designed to carry the weight of electrical equipment.
- .5 Design hanger anchor and entire suspension system static loading not to exceed 25% of their ultimate capacity including lighting fixture dead loads.
- .6 Design tile suspension system to support weight of mechanical and electrical items such as air handling boots and lighting fixtures, and with adequate support to allow rotation/relocation of light fixtures. Acoustic panel system is not designed to carry the weight of mechanical and electrical equipment.

- .7 Design subframing as necessary to accommodate, to avoid conflicts and interferences where ducts or equipment prevent regular spacing of hangers.

#### 1.4 **SUBMITTALS**

- .1 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Suspension system layout including hangers and supports for acoustic tile system.
    - .2 Acoustic panel system including suspension system, hangers, supports and panel sizes and locations.
    - .3 Conditions at abutting, intersecting, and penetrating construction.
    - .4 Dimensioned locations of lighting fixtures, diffusers, sprinkler heads and other items that pierce the ceiling plane.
    - .5 Seismic anchors, supports and accessories for complete installation.
- .2 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00:
    - .1 One full-size sample of each type of tile panels to be used.
    - .2 One of each type of suspension system members.
- .3 Certificates: Submit written certification stating that suspended ceiling system is designed for adequate support of electrical fixtures as required by the current bulletin of the Electrical Safety Authority.

#### 1.5 **QUALITY ASSURANCE**

- .1 Mock-up:
  - .1 Construct one 3 m<sup>2</sup> mock-up for each type of ceiling system incorporating typical light fixture and other typical mechanical and electrical fixtures.
  - .2 Test the adequacy of the suspension system to support the fixtures without deflection of ceiling or failure of hanging wire anchorage. Supply copy of Test Results to Consultant.
  - .3 Change materials and installation methods if tests indicate proposed system is inadequate and re-test as necessary until system approved.
  - .4 Give early notice to Consultant and Mechanical and Electrical Trades and co-operate with them in selecting suitable location for sample ceiling and timing of installation and test.
  - .5 Do not commence general installation work until sample ceiling approved, then install ceiling to conform with approved samples.
  - .6 Mock-up may form part of final Work, if acceptable to Consultant. Remove and dispose of mock-ups which do not form part of Work.

#### 1.6 **SITE CONDITIONS**

- .1 Do not install the work of this Section until:
  - .1 Mechanical and electrical work above the ceiling is complete.
  - .2 Relative humidity is below 80 %.
  - .3 Ventilation is adequate to remove excess moisture.

- .4 Areas are closed and protected against weather, and maintained at no less than 10°C.

- .2 Install temporary protection and facilities to maintain Product manufacturer's, and above specification, environmental requirements 24 h before, during, and after installation.

## 1.7 **MAINTENANCE**

- .1 Submit extra acoustic ceilings amounting to 2% of gross ceiling area, allowing proportionately for each pattern and type specified to nearest full carton. Submit Products which are part of same production run as installed Products. Store maintenance Products as directed by Consultant.

## 1.8 **DELIVERY, STORAGE AND HANDLING**

- .1 Transport, handle and store material in manner to prevent warp, twist, damage to panel edges and surfaces in accordance with Manufacturer's recommendations.
- .2 Any warped and/or damaged panels and trim shall be rejected and be replaced by new, straight, undamaged and acceptable material at no cost to Owner.
- .3 Bent, twisted or otherwise damaged Tee grid suspension components shall not be used under any circumstances. Replace such damaged items with new undamaged material at no additional cost to Owner.
- .4 Store material in warm, dry place away from water and the elements. Protect against undue loading stresses and shock.
- .5 All packaged material shall be delivered in original manufacturers wrappers and containers with labels and seals intact. All cartons shall bear U.L. label.

## 2 **Products**

### 2.1 **MATERIALS**

- .1 Galvanized steel sheet: ASTM A653/A653-M, Z275; cold rolled, galvanized steel sheet.
- .2 Main carrying channels: ASTM C645; Channels formed from galvanized steel sheet, 38 x 19 mm cold rolled.
- .3 Subframing: ASTM C645; Channels formed from galvanized steel sheet, dimensions and spans as required.
- .4 Hangers: 2.6 mm minimum diameter, galvanized steel wire.
- .5 Tie wire: 1.6 mm minimum diameter, soft annealed galvanized steel wire.
- .6 Concrete anchors: tie wire sleeve anchors, 'Redi-Drive Anchors' by ITW Red Head or approved equivalent.

- .7 Seismic anchors and supports: Provide wall moulding, seismic clips and perimeter hanger wires as required and in accordance with reviewed shop drawings.
- .8 Wall mouldings and accessories, including but not limited to, corner caps, edge mouldings, panel hold over clip, metal closures, and trim. Finish and colour: same as main tees.
- .9 Exposed main, cross tees, and relocatable cross tees: ASTM C635, 38 mm high steel, bulb tee design double steel web, rectangular single spans without exceeding a deflection of 1/360 of the span. Splices to be integral and reversible; cross tee interlocking into main tee. Colour and finish: Manufacturer's standard white.
  - .1 Suspension system:
    - .1 Armstrong World Industries Inc.
    - .2 CGC Inc.
    - .3 Certainteed Ceilings Canada.
    - .4 Rockfon/Chicago Metallic.
    - .5 Or approved equivalent.
- .10 Acoustic tiles for suspended ceiling system: To be selected by Consultant.
- .11 Wall mouldings: To match acoustical ceiling suspension system.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 SUSPENSION SYSTEM

- .1 Coordinate locations and openings of mechanical and electrical services support, and penetration through the acoustical ceilings. Coordinate field conditions, clearances, measurements, and mechanical and electrical services testing and commissioning, above the acoustical ceilings.
- .2 Install hanger wires plumb and securely anchored to the building structural framing, independent of walls, pipes, ducts, and metal deck; install additional framing and hangers to bridge interference items.
- .3 Install acoustical ceiling systems in accordance with manufacturer's written instructions, reviewed shop drawings, and ASTM C636, listed in order of precedence.
- .4 Install hanger wires at 1200 mm maximum centres along carrying channels, not less than 25 mm, and not more than 150 mm from channel ends.



- .5 Install additional hangers at lighting fixture and air distribution ductwork locations. Do not attach hanger wires to mechanical or electrical equipment. Do not support mechanical and electrical fixtures and fitting on ceiling without the ceiling manufacturer's written acceptance.
- .6 Install acoustical ceiling suspension system to a tolerance of 1:1200 of span and 0.4 mm maximum between adjacent metal members. Tolerances are not cumulative. Refer to Electrical Contract Drawings for fixture layout.
- .7 Do not bend or twist hangers as a means of levelling. Form double loops tightly and lock to prevent vertical movement or rotation within the loop.
- .8 Install edge moulding at intersection of ceiling and vertical surfaces.
- .9 Centre acoustical ceiling suspension systems on room axis; install equal border pieces. Install hangers onto the ends of main tee runners at not more than 150 mm from ends of runners, adjacent and perpendicular to walls.
- .10 Support the suspension system independently of walls, columns, ducts, pipes and conduits.
- .11 Install main runners in maximum available lengths. Layout joints in suspension members to avoid the perimeters of recessed fixtures. Lock grid members to form a rigid assembly. Install additional tee, suspension system framing around recessed fixtures, diffusers, grilles and other items for a complete assembly.
- .12 Install seismic anchors, supports and accessories in accordance with reviewed shop drawings.

### 3.3 **ACOUSTIC LAY-IN TILES**

- .1 Install acoustic tile in grid system openings supported by bottom flanges of members. Provide special shapes and sizes to provide a complete installation by cutting tile to fit into openings. Fit tile moderately tight between upright legs of members.
- .2 Carefully cut and trim acoustic tiles to accommodate items piercing the finished ceiling plane.
- .3 Remove and replace acoustic tiles with broken edges, or damaged, marked, discoloured, soiled, or stained faces.

### 3.4 **ADJUSTMENTS AND CLEANING**

- .1 Clean soiled or discoloured surfaces of exposed work on completion of work.
- .2 Replace components which are visibly damaged, marred or uncleanable.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for resilient base work and accessories in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM F1861, Specification for Resilient Wall Base.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Samples: Submit two 250 mm long samples of resilient base in accordance with Section 01 30 00.
  - .3 Closeout submittals: Submit maintenance and cleaning data for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **SITE CONDITIONS**

- .1 Maintain air temperature and structural base temperature at installation area above 20°C for 48 hr before, during and 48 hr after installation.
- .2 Store materials for two (2) days prior to installation in area of work to achieve temperature stability.
- .3 Do not install base in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.
- .4 Provide adequate ventilation during installation.

1.5 **MAINTENANCE**

- .1 Submit extra 5% or to nearest full roll of each colour, pattern and type of base required for maintenance use. Identify each carton. Store where directed.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers, and adhesives are to have low VOC content limits.
- .2 Rubber base (RB-1): ASTM F1861,
  - .1 ASTM F1861, Type TP, Group 1, rubber wall base, approximately 100 mm high x 3 mm thick, coved profile, in lengths as long as possible including premoulded end stops and inner and outer corners. Colour: As selected by Consultant. 'Traditional Wall Base' by Tarkett or approved equivalent.
  - .2 Locations: Refer to Room Finish Schedule for rubber base colours and types.
- .3 Reducing edge strips, transition strips, thresholds and accessories: Refer to Colour and Material Schedule.
- .4 Primers and adhesives: Low VOC, waterproof, recommended by base manufacturer for specific material on applicable substrate, above, at or below grade.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this Section.

3.2 **RESILIENT BASE APPLICATION**

- .1 Install resilient base in accordance with manufacturer's written instructions.
- .2 Lay out base to keep number of joints at minimum.
- .3 Prior to installing base, fill cracks and irregularities with a filler recommended by base manufacturer.
- .4 Set base in adhesive using a three (3) kg hand roller, against wall and floor surfaces.
- .5 Install straight and level to variation of 1:1000.
- .6 Scribe and fit to door frames and other obstructions.
- .7 Cope internal corners.

**3.3 CLEANING**

- .1 Forty-eight hours after installation, clean resilient base surfaces with a mild soap solution approved by finish manufacturer.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for resilient sheet flooring work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM D2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine.
- .2 ASTM F710, Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
- .3 ASTM F970, Standard Test Method for Static Load Limit.
- .4 ASTM F1516, Standard Practice for Sealing Seams of Resilient Floor Products by the Heat Weld Method.
- .5 ASTM F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
- .6 ASTM F2170, Standard Test Method for Determining Relative Humidity in Concrete Slabs Using in-situ Probes.
- .7 ASTM F2034, Standard Specification for Sheet Linoleum Floor Covering.
- .8 CAN/ULC-S102.2-M, Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings, and Miscellaneous Materials and Assemblies.
- .9 ISO 717-2, Acoustics - Rating of Sound Insulation in Buildings and of Building Elements - Part 2: Impact Sound Insulation.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 30 00.

- .3 Samples:
  - .1 Submit samples in accordance with Section 01 30 00:
    - .1 Two 250 x 200 mm samples of each type of sheet material and colour.
    - .2 Two 250 mm long samples of each accessory and colour.
- .4 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 78 00.

#### 1.4 **SITE CONDITIONS**

- .1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hr before, during and 48 hr after installation.
- .2 Store materials for two (2) days prior to installation in area of Work to achieve temperature stability.
- .3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.
- .4 Provide adequate ventilation during installation.

#### 1.5 **MAINTENANCE**

- .1 Submit extra 5% or to nearest full roll of each colour, pattern and type of flooring material required for maintenance use. Identify each roll. Store where directed. Submit maintenance material in one piece and of same production run as installed materials.

### 2 **Products**

#### 2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, primers and adhesives are to have low VOC content limits.
- .2 Linoleum sheet flooring (LINO-1):
  - .1 Conforming to ASTM F2034, Type 1, 2.5 mm thick, homogeneous resilient flooring, made from natural ingredients, mixed and calendared onto a natural jute backing.
  - .2 Flame spread: 150 to CAN/ULC-S102.2-M.
  - .3 Smoke developed: 160 to CAN/ULC-S102.2-M.
  - .4 Impact sound reduction: when tested to ISO 717/2, 6 dB.
  - .5 Slip resistance: Static coefficient of slip resistance meets or exceeds 0.6 when tested in accordance with ASTM D2047.
  - .6 Static load limit: 450 pounds per square inch when tested in accordance with ASTM F970.
  - .7 Colour: To be selected by Consultant.

- .8 Locations: Refer to Finish Room Schedule.
- .9 Acceptable products and manufacturers: 'Marmoleum' by Forbo Flooring or approved equivalent.
- .3 Base and accessories: In accordance with Section 09 65 00.
- .4 Welding rod: type recommended by flooring manufacturer to complement flooring.
- .5 Primers and adhesives: Low VOC, waterproof, of types recommended by flooring manufacturer for specific material on applicable substrate, above, on or below grade.
- .6 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.
- .7 Concrete skim coat compound: High-performance, rapid-setting cement based skim coating compound. 'Ultra SkimCoat' by Mapei or approved equivalent for filling minor voids and leveling existing substrate.
- .8 Stain sealer and polish: Type recommended by flooring manufacturer.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Ensure concrete floors meet the following minimum requirements and requirements of the flooring manufacturer. If there is a conflict between these requirements and those of the flooring manufacturer, the more stringent shall apply.
  - .1 Internal Relative Humidity Test: Perform internal relative humidity testing in accordance with ASTM F2170. Results shall not exceed 80% RH.
  - .2 Moisture Test: Moisture emissions from concrete subfloors (cured for a minimum of 28 days) must not exceed 3 lbs per 1000sf per 24 hours (1.4 kg H<sub>2</sub>O/24 hr/93 m<sup>2</sup>) for acrylic adhesive and 5lbs for polyurethane adhesive via the Calcium Chloride Test Method (ASTM F1869).
  - .3 The pH level of the subfloor surface shall not be higher than 9.9. If higher, subfloor must be neutralized.
- .3 Ensure that sub-floors have been provided as specified without holes, protrusions, cracks, depressions or other major defects.
- .4 Ensure that control joints have been filled and levelled.
- .5 Defective work resulting from application to unsatisfactory surfaces will be considered the responsibility of those performing the work of this Section.

**3.2 SUBFLOOR TREATMENT**

- .1 Flooring shall be installed over subfloors conforming to ASTM F710 for concrete.
- .2 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .3 Apply sub-floor filler to low spots and cracks to achieve floor level to a tolerance of 1:1000, allow to cure.
- .4 Meet ASTM F710 Standard for Concrete or other monolithic floors.
- .5 Clean and remove all deleterious materials from surfaces to receive this work in accordance with the adhesive manufacturer's recommendations.
- .6 Prime concrete to flooring manufacturer's printed instructions.

**3.3 RESILIENT SHEET FLOORING APPLICATION**

- .1 Install resilient sheet flooring in accordance with manufacturer's written instructions.
- .2 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturers instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.
- .3 Run sheets in direction of traffic. Double cut sheet joints and continuously seal according to manufacturer's printed instructions. Remove adhesive seepage of seams or surface while adhesive is still wet.
- .4 Heat weld seams in accordance with ASTM F1516 and manufacturer's printed instructions.
- .5 As installation progresses and after installation, roll flooring with minimum 45 kg roller to ensure full adhesion.
- .6 Cut flooring neatly around fixed objects.
- .7 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.
- .8 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

**3.4 RESILIENT BASE APPLICATION**

- .1 Resilient base: In accordance with Section 09 65 00. Coordinate with noted Section as required for installation of resilient base with resilient sheet flooring.



**3.5 CLEANING AND SEALING**

- .1 Forty-eight hours after installation, clean sheet flooring surfaces with a mild soap solution approved by finish manufacturer. Rinse clean and allow to dry.

**3.6 PROTECTION OF FINISHED WORK**

- .1 Protect floors and bases from time of final set of adhesive until accepted by Consultant.
- .2 Prohibit traffic on floor for 48 hours after installation.
- .3 Cover cleaned surfaces with fibre reinforced, clean, non-staining clean, kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for athletic flooring work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM F1861, Standard Specification for Resilient Wall Base.
- .2 CPSC FF 1-70, Flammability of finished textile floor covering material.

1.3 **SUBMITTALS**

- .1 Shop drawings: Submit shop drawings indicating seam layout and welding procedures in accordance with Section 01 30 00.
- .2 Closeout submittals: Submit maintenance and cleaning data for incorporating into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.4 **SITE CONDITIONS**

- .1 Maintain air temperature and structural base temperature at flooring installation area above 20°C for 48 hr before, during and 48 hr after installation.
- .2 Store materials for two (2) days prior to installation in area of Work to achieve temperature stability.
- .3 Do not lay flooring in conditions of high humidity or where exposed to cold drafts. In hot weather, protect from direct sunlight.
- .4 Do not install floor system until concrete has been cured 60 days.

1.5 **MAINTENANCE**

- .1 Submit extra five (5) % or to nearest full roll of each colour, pattern and type of flooring material required for maintenance use. Identify each roll. Store where directed. Submit maintenance material in one piece and of same production run as installed materials.

2 Products

2.1 **MATERIALS**

- .1 All materials under work of this Section, including but not limited to, coatings and adhesives are to have low VOC content limits.

- .2 Rubber athletic flooring: 610 mm x 610 mm x 25 mm thick rubber floor tile, high-density wear layer with shock absorption. 'Everlast UltraTile' as manufactured by Ecore Athletic or approved equivalent. Colour: Refer to Colour and Material Schedule.
- .3 Adhesive: Polyurethane or epoxy adhesive as recommended by flooring manufacturer.
- .4 Wall base: 100 mm high, three (3) mm thick, conforming to ASTM 1861, Type TV, Group 1; 'Duracove Rubber Wall Base' by Johnsonite or approved equivalent.
- .5 Sub-floor filler and leveller: White premix latex requiring water only to produce cementitious paste as recommended by flooring manufacturer
- .6 Reducing edge strips, thresholds: Nitrile rubber plasticized vinyl, 80-95 Shore A Durometer, adhesive as recommended by manufacturer.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 SUBFLOOR TREATMENT

- .1 Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- .2 Trowel and float sub-floor filler to leave smooth, flat hard surface. Prohibit traffic until filler is cured and dry.
- .3 Clean and remove all deleterious materials from surfaces to receive this work in accordance with the adhesive manufacturer's recommendations.
- .4 Prime concrete to flooring manufacturer's printed instructions.

#### 3.3 FLOORING APPLICATION

- .1 Apply adhesive uniformly using recommended trowel in accordance with flooring manufacturers instructions. Do not spread more adhesive that can be covered by flooring before initial set takes place.
- .2 Unroll flooring into freshly applied adhesive ensuring that all seams are in contact without compression.
- .3 Cut flooring neatly around fixed objects.
- .4 Terminate flooring at centreline of door in openings where adjacent floor finish or colour is dissimilar.

- .5 Roll flooring in both directions when complete.
- .6 Install reducing edge strips at unprotected or exposed edges where flooring terminates or where there are two finishes of different thicknesses.

### 3.4 **BASE APPLICATION**

- .1 Lay out base to keep number of joints at minimum.
- .2 Prior to installing base, fill cracks and irregularities with a filler recommended by base manufacturer.
- .3 Set base in adhesive using a three (3) kg hand roller, against wall and floor surfaces.
- .4 Install straight and level to variation of 1:1000.
- .5 Scribe and fit to door frames and other obstructions.
- .6 Cope internal corners.

### 3.5 **CLEANING**

- .1 Clean up all unused materials and debris and remove from the premises. Dispose of empty containers in accordance with federal and local statutes.
- .2 72 hours after installation, clean rubber mat by vacuuming then damp mopping. Rinse clean and let dry.

### 3.6 **PROTECTION OF FINISHED WORK.**

- .1 Protect floors from time of final set of adhesive until accepted by Consultant.
- .2 Prohibit traffic on floor for 72 hours after installation.
- .3 Cover cleaned surfaces with fibre reinforced, clean, non-staining clean, kraft paper. Secure in position with gummed tape to prevent drifting. Remove covering when directed by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for concrete floor sealer work in accordance with the Contract Drawings.

1.2 **SUBMITTALS**

- .1 Product data: Submit manufacturer's Product data in accordance with Section 01 30 00 indicating:
  - .1 Two copies of manufacturer's Product data on characteristics, performance criteria, and limitations.
  - .2 Preparation, installation requirements and techniques, Product storage, and handling criteria.
- .2 Samples: Submit samples in accordance with Section 01 30 00 indicating coating and final concrete finish.
- .3 Reports: Submit manufacturer's acceptance of substrate prior to installation in writing. Submit verification of moisture content of floor prior to installation.
- .4 Close-out submittals: Submit maintenance data for incorporation into Operations and Maintenance manuals in accordance with Section 01 78 00.

1.3 **QUALITY ASSURANCE**

- .1 Perform work of this Section by a company that has a minimum of five (5) years proven experience in installations of a similar size and nature and that is approved by manufacturer. Submit to Consultant, applicator's current certificate of approval by the material manufacturer as proof of compliance.
- .2 Mock-up:
  - .1 Construct one two (2) m<sup>2</sup> mock-up of floor sealer in location acceptable to Consultant.
  - .2 Arrange for Consultant's review and acceptance, allow 48 hours after acceptance before proceeding with Work.
  - .3 Mock-up may remain as part of Work if accepted by Consultant. If sealer application is unacceptable to Consultant, rework sealer in accordance with manufacturer's recommendations to provide a sealed concrete surface acceptable to Consultant.
  - .4 Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the work of this Section.
- .3 Pre-installation meetings: Arrange with manufacturer's representative and Consultant to inspect substrates, and to review mock-up and installation procedures 48 hours in advance of installation.

**1.4 SITE CONDITIONS**

- .1 Do not install the work of this Section outside of environmental ranges as recommended by the manufacturer without Product manufacturer's written acceptance and as follows:
  - .1 Relative Humidity: In accordance with manufacturers' requirements.
  - .2 When no dust is being raised.
  - .3 In well-ventilated and broom clean areas.
- .2 Install temporary protection and facilities to maintain the Product manufacturer's, and the above specification, environmental requirements for 24 hours before, during, and 24 h after installation.
- .3 Post do not enter and appropriate warning signs at conspicuous locations.

**1.5 DELIVERY, STORAGE, AND HANDLING**

- .1 Store materials at site in an area specifically set aside for purpose that is locked, ventilated, and maintained at a minimum temperature of 16°C.
- .2 Ensure that health and fire regulations are complied with in storage area, and during handling and application.

**2 Products**

**2.1 MATERIALS**

- .1 All materials under work of this Section, including but not limited to, sealers and coatings are to have low VOC content limits.
- 2. Each material used in the application of each flooring system shall be as recommended or manufactured by the supplier of the flooring system.
- .3 Concrete floor sealer: Alkali-silicate, water-soluble, inorganic concrete hardener and dustproofer; 'MasterKure HD 200WB' by Master Builders Solutions or 'Sikafloor 3S' by Sika Canada Inc. or approved equivalent.

**3 Execution**

**3.1 EXAMINATION**

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- .2 Verify that concrete floor has cured 28 days minimum and that substrate is acceptable to sealer manufacturer.

- .3 Test surfaces for moisture content to ensure that they are suitable for application.

### 3.2 **PREPARATION**

- .1 Prepare substrate in accordance with manufacturer's written instructions. Diamond grind and vacuum substrate free of debris and dust.
- .2 Protect adjacent surfaces from damage resulting from work of this Section. Mask and/or cover adjacent surfaces, fixtures, and equipment as necessary.
- .3 Clean surfaces to be sealed as recommended by sealer manufacturer.

### 3.3 **APPLICATION**

- .1 Apply concrete floor sealer in accordance with manufacturer's written instructions. Sealer manufacturer shall supervise application.
- .2 Spray apply concrete sealer to entire surface and keep from drying for 30 minutes as recommended by manufacturer.
- .3 Sprinkle surface with water as sealer begins to penetrate (after 30 minutes).
- .4 Flush surface with water and drying begins to remove excess material. Allow to harden for 24 hours.
- .5 Lightly buff floor with a commercial floor buffer and non-aggressive pad to bring up required sheen.

### 3.4 **CLEANING**

- .1 Remove promptly as work progresses spilled or spattered materials from surfaces of work performed under other Sections. Clean floors on completion of work. Do not mar surfaces while removing.

### 3.5 **PROTECTION**

- .1 Erect barriers to prevent the entry and presence of personnel not performing work of this Section during application of floor sealer, and for 48 hours following completion of application.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for painting work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 Master Painters Institute (MPI), Painting Specification Manual.
- .2 SSPC Steel Structures Painting Council, Standards.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Submit listing of manufacturer's Product types, Product codes, and Product names, number of coats, and dry film thicknesses, corresponding to each Painting Schedule code; submit listing minimum of eight (8) weeks before materials are required.
- .2 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00.
    - .1 Three 300 x 150 mm draw downs of each colour minimum four (4) weeks before paints are required.
    - .2 Identify each sample with Contract number and title, colour reference, sheen, date, and name of applicator.
- .3 Certificates:
  - .1 Submit certification from paint manufacturer, on company letterhead, indicating each product proposed for use is Manufacturer's premium grade, first line Product.
  - .2 Submit certified documentation to confirm each airless spray painter has minimum of 5 years experience on applications of similar complexity and scope.
  - .3 Submit certified documentation to confirm each worker has Provincial Tradesman Qualification certificate of proficiency.
- .4 Reports:
  - .1 Submit written field inspection and test report results after each inspection.
  - .2 Submit Field Quality Control test result reports for alkali content, substrate moisture, and dry film thickness.
  - .3 Submit electronic moisture meter manufacturer's specifications including tolerances. Submit record of latest meter calibration to meet manufacturer's recommendations.



#### 1.4 **QUALITY ASSURANCE**

- .1 Finishing work: Perform work to MPI requirements for premium grade.
- .2 Supervision: Have work supervised by a full-time qualified foreperson who has ten (10) years minimum experience on Contracts of similar complexity and scope.
- .3 Mock-up:
  - .1 Construct three (3) m<sup>2</sup> mock-ups of different Paint Schedule code systems, selected by Consultant, in locations acceptable to Consultant to demonstrate installation workmanship, colour, and hiding power of Products.
  - .2 Obtain Consultant's acceptance in writing before proceeding with the work of this Section.
  - .3 Mock-ups may remain as part of the Work if acceptable to Consultant and will serve as a standard for similar code systems.
  - .4 Repaint over mock-ups which do not form part of the Work.

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

- .1 Install correct, safe temporary storage for paint, thinner, solvents, and other volatile, corrosive, hazardous, and explosive materials in accordance with requirements of authorities having jurisdiction.
- .2 Post hazard warning signage in areas of storage and mixing. Install and maintain sufficient CO<sub>2</sub> fire extinguishers of minimum nine (9) kg capacity, accessible in each storage mixing and storage areas.
- .3 Maintain storage enclosures at minimum 10°C ambient temperature and to manufacturer's instructions.

#### 1.6 **SITE CONDITIONS**

- .1 Apply coatings under the following conditions:
  - .1 Exterior coatings (except Latex): 5° C minimum.
  - .2 Exterior latex coatings: 10°C minimum.
  - .3 24 hours minimum after rain, frost, condensation, or dew.
  - .4 When no condensation is possible (unless specifically formulated against condensation).
  - .5 Interior coatings: 7°C minimum.
  - .6 Relative humidity: 85% maximum.
  - .7 Not in direct exposure to sun light.
- .2 Maintain temperature conditions indicated above for 24 hours before, during and 24 hours after painting.
- .3 Install clean plywood sheets to protect floors and walls in storage and mixing areas, from paint drips, spatters, and spills.

- .4 Apply sufficient masking, clean drop cloths, and protective coverings for full protection of work not being painted including, but not limited to, the following:
  - .1 Light fixtures, fire and smoke detectors.
  - .2 Data cabling and data infrastructure.
  - .3 Sprinkler heads.
  - .4 Prepainted diffusers and registers.
  - .5 Prepainted equipment.
  - .6 Fire rating labels and equipment specification plates.
  - .7 Finished surfaces.

## 1.7 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

- 1. Provide paint products meeting MPI "Green Performance Standard GPS-1-12.

## 1.8 MAINTENANCE

- 1. Deliver to Owner's place of storage on completion of work, sealed containers of each finish painting material applied, and in each colour. Label each container as for original, including mixing formula. Provide the following:
  - .1 One (1) L of extra materials when less than 50 L are used for Project;
  - .2 3.78 L of extra stock when 50 to 200 L are used;
  - .3 7.57 L of extra stock when over 200 L are used.

## 2 Products

### 2.1 MATERIALS

- .1 Paint:
  - .1 All materials under work of this Section, including but not limited to, primers, stains, and paints are to have low VOC content limits.
  - .2 Products in accordance with the MPI Painting Specification Manual, Exterior and Interior Systems;
    - .1 For each MPI paint code, manufacture's premium grade, first line Products is to be use.
    - .2 Uniform dispersion of pigment in a homogeneous mixture.
    - .3 Ready-mixed and tinted whenever possible.
  - .3 Products within each MPI paint system code: From single manufacturer.
  - .4 Acceptable manufacturers:
    - .1 AkzoNobel.
    - .2 Benjamin Moore.
    - .3 PPG Industries Inc.
    - .4 Sherwin Williams.
    - .5 Or approved equivalent.

### 2.2 COLOUR SCHEDULE

- .1 Refer to Colour and Material Schedule for selected colour references.
- .2 Conform to gloss reflectance definitions listed in MPI Specification Manual.

## 2.3 PAINTING AND FINISHING SCHEDULE

- .1 Refer to Table 1, MPI Painting and Finishing Schedule coded systems, comply with MPI Painting Specification Manual.

Table 1: Painting and Finishing Schedule					
<b>EXTERIOR SUBSTRATES</b>	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System Code	Sheen	Topcoat
Galvanized steel	HM doors & frames, handrails	EXT 5.3	EXT 5.3L		Pigmented polyurethane
Galvanized steel (structural steel)	Structural steel components with galvanized finish	EXT 5.3	EXT 5.3L		Pigmented polyurethane
<b>INTERIOR SUBSTRATES</b>	Typical substrates (Including but not limited to)	MPI Manual Ref.	MPI Finish System		Topcoat
Concrete walls and ceilings		INT 3.1	INT 3.1A		Latex
Concrete floors		INT 3.2	INT 3.2C		Epoxy
Concrete block masonry		INT 4.2	INT 4.2A		Latex
Metal Fabrications (Factory primed)	Steel stairs, ladders	INT 5.1	INT 5.1R		High performance latex
Galvanized metal	HM doors & door frames, handrails	INT 5.3	INT 5.3B	Semi-Gloss	WB light industrial coating
Wood Millwork	Benches	INT 6.4	INT 6.4C	Satin	Semi-transparent stain
Wood paneling & casework	Millwork, partitions	INT 6.4	INT 6.4E	Satin	Poly-urethane

Table 1: Painting and Finishing Schedule					
Gypsum board	Drywall, walls, ceilings	INT 9.2	INT 9.2A	Eggshell	Latex
Gypsum board	Wet areas	INT 9.2	INT 9.2F	Semi-Gloss	Epoxy-modified latex
Gypsum Board	Ceilings	INT 9.2	INT 9.2A	Flat	Latex

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

#### 3.2 PREPARATION

- .1 General:
  - .1 Clean substrate surfaces free from, dust, grease, soiling, or extraneous matter, which are detrimental to finish.
  - .2 Patch, repair, and smoothen minor substrate defects and deficiencies e.g. machine, tool and sand paper marks, shallow gouges, marks, and nibs.
  - .3 Clean, sweep, and vacuum floors and surfaces to be painted, debris and dust-free prior to painting.
  - .4 Refer to MPI Painting Specification Manual for surface preparation requirements of substrates not listed here.
- .2 Where finish hardware has been installed remove, store, re-install finish hardware, to accommodate painting. Do not clean hardware with solvent that will remove permanent lacquer finishes.
- .3 Alkali Content tests and neutralization:
  - .1 Test for ph level using litmus paper on dampened substrate.
  - .2 Neutralize surfaces over 8.5 ph with 4% solution of Zinc Sulphate for solvent based systems and tetrapotassium pyrophosphate for latex based systems, to below 8.0 ph, and allow to dry.
  - .3 Brush-off any residual Zinc Sulphate crystals.
  - .4 Coordinate paint system primer / sealer to be alkali-resistant.

- .4 Substrate moisture tests:
  - .1 Test for moisture content over entire surface to be painted, minimum one test/two (2) m<sup>2</sup> in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.
  - .2 If any test registers above 10% allow entire substrate surfaces, within the plane, to dry further before paint system application. Install temporary drying fans if necessary.
  - .3 Re-test employing same criteria.
- .5 Mildew removal: Scrub with solution of trisodium phosphate and sodium hypochlorite (Javex) bleach, rinse with water, and allow to dry completely.
- .6 Cementitious and masonry (Concrete, block, brick, stucco, cement rendering):
  - .1 Allow 28 days cure before painting.
  - .2 Coordinate repair of protrusion-chipping and grinding, and honeycomb filling with responsible trades.
  - .3 Remove dirt, loose mortar, scale, powder, efflorescence, and other foreign matter.
  - .4 Remove form oil and grease with trisodium phosphate, rinse, and allow to dry thoroughly.
  - .5 Remove rust stains with solution of sodium metasilicate after thorough wetting; allow to dry thoroughly.
- .7 Concrete floors (new):
  - .1 Allow 28 days cure before painting.
  - .2 Remove contamination, acid etch, rinse with water, and allow to dry completely. Test and adjust for neutral ph.
- .8 Galvanized steel sheet:
  - .1 Z275 (Satin & Spangled Sheet): SSPC SP7 brush blast.
  - .2 ZF075 (Wiped Coat): Remove contamination, wash with Xylene solvent.
  - .3 Touch-up damaged galvanized areas with organic zinc rich primer.
- .9 Galvanized iron and steel: Prepare galvanized and ungalvanized metal surfaces as follows:
  - .1 Unpassivated, unweathered and weathered: Remove contamination, wash with Xylene or Toluol solvent, allow to dry thoroughly. Make paint system primer/sealer an etching type primer.
  - .2 Manufacturer pre-treated (including passivated): SSPC SP7.
  - .3 Touch-up damaged galvanized areas with organic zinc rich primer.
- .10 Structural steel and miscellaneous metal fabrications:
  - .1 Coordinate the following with the responsible trades:
    - .1 Rust, mars, mill scale, and weld-burn touch-ups.
    - .2 Oil, grease, weld flux and other residue removal.
  - .2 Prime paint items, not otherwise indicated to be primed as part of another Section.
  - .3 Touch-up damaged galvanized areas with organic zinc rich primer.

- .11 Wood and Millwork:
  - .1 Wood surfaces to be clean and dry with a moisture content of less than 15%.
  - .2 Remove foreign matter prior to prime coat; spot coat knots, pitch streaks and sappy sections with sealer.
  - .3 Fill nail holes and fine cracks after primer has dried.
  - .4 Backprime interior and exterior woodwork.
- .12 Factory primed surfaces:
  - .1 Touch up damaged areas.
  - .2 Clean as required for top coat.
- .13 Gypsum board:
  - .1 Apply primer/sealer paint to reveal defects and deficiencies and to equalize absorption areas.
  - .2 Coordinate repairs and touch-ups with the responsible trade.
  - .3 Re-prime repairs.
- .14 Coordinate with other trades to prevent:
  - .1 Damage, and inadvertent activation of fire and smoke detectors.
  - .2 Odour and dust distribution by permanent HVAC systems including fouling of ducts and filters.
- .15 Field-mix Products in accordance with manufacturer's written instructions.

### 3.3 **APPLICATION**

- .1 Apply painting systems in accordance with the MPI Painting Specification Manual. Apply each Product to manufacturer's recommended dry film thickness.
- .2 Painting systems listed are required minima, apply additional coats if necessary to obtain substrate hiding acceptable to the Consultant.
- .3 Tint intermediate coats lighter than final top coats for identification of each succeeding coat and to facilitate inspections. Include only manufacturer's recommended reducing and tinting accessories. Do not add adulterants.
- .4 Primer to be specialized primer coating system as required by manufacturer for selected colour. Standard primer being tinted shall be tinted to a maximum of 1.5% by volume.
- .5 Sand lightly between coats to achieve a tooth or anchor for subsequent coats.
- .6 Apply paint uniformly in thickness, colour, texture, and gloss, as determined by the Consultant under adequate illumination and viewed at a distance of 1500 mm. Apply finishes free of defects in materials and application which, in the opinion of the Consultant, affect appearance and performance. Defects include, but are not limited to:
  - .1 Improper cleaning and preparation of surfaces.
  - .2 Entrapped dust, dirt, rust.
  - .3 Alligatoring, blisters, peeling.
  - .4 Scratches, blemishes.
  - .5 Uneven coverage, misses, drips, runs, and poor cutting in.

- .7 Do not apply coatings on substrates which are not sufficiently dry. Unless indicated otherwise, allow each painting system coat to cure dry and hard before following coats are applied.
- .8 Repaint entire areas of damaged or incompletely covered surfaces, to the nearest inside or outside corner; patching will not be permitted.
- .9 Miscellaneous painting requirements:
  - .1 Paint projecting ledges, and tops, bottoms and sides of doors both above and below sight lines to match adjacent surfaces.
  - .2 Paint door frames, access doors and frames, door grilles, prime coated butts, and prime coated door closers to match surface in which they occur.
  - .3 Finish closets and alcoves as specified for adjoining rooms.
  - .4 Paint light coves white whether a light lense is installed or not, unless otherwise indicated.
  - .5 Paint interior columns to match walls of room.
  - .6 Allow for:
    - .1 2 wall colours per room, one ceiling colour per room.
    - .2 Different door colours in each functionally different area.
    - .3 Different colours on both sides of same door.
- .10 Mechanical, electrical and other painting coordination:
  - .1 Paint following items unless specified or indicated on drawings not to be painted.
  - .2 Paint mechanical services in accordance with Mechanical Identification Division 21, 22 and 23.
  - .3 Coordinate painting of pipes, ducts, and coverings with the work of Division 21, 22 and 23 to precede pipe colour banding, flow arrows, and other pipe identification labeling installation.
  - .4 Paint exposed conduit, pipes, hangers, ductwork, grilles, gratings, louvres, access panels, fire hose cabinets, registers, convactor and radiator covers, enclosures, and other mechanical and electrical equipment including services concealed inside cupboard and cabinet work; apply colour and sheen to match adjacent surfaces, except as noted otherwise.
  - .5 Paint portions of surfaces such as duct interiors, piping, ductwork, hangers, insulation, walls, and similar items, visible through grilles, louvres, convactor covers etc., matte black in colour.
  - .6 Remove the following to accommodate painting, carefully store, clean, then re-install on completion of each area and when dry:
    - .1 Switch and receptacle plates, fittings and fastenings, grilles, gratings, louvres, access panels, convactor covers, and enclosures .

### 3.4 FIELD QUALITY CONTROL

- .1 Dry film thickness tests:
  - .1 Test for film thickness over entire surface to be painted, minimum one test/2 m<sup>2</sup> in field areas and one test/600 mm along inside corners including at ceiling to wall juncture.
  - .2 If any test registers below specified thickness, re-apply paint to entire surface to nearest inside and outside corners.

- .3 If test registers more than 50% above specified thickness, consult with paint manufacturer, determine if problem exists, offer solutions to Consultant, and repair as directed.
- .4 Re-test employing same criteria after repair.

**3.5 CLEANING**

- .1 Remove spilled, splashed, and spattered paint promptly as work proceeds and on completion of work. Clean surfaces soiled by paint spillage and paint spatters. Repair or replace damaged work, as directed by Consultant.

**3.6 PROTECTION**

- .1 Post Wet Paint signs during drying and restrict or prevent traffic where necessary.
- .2 Post sign, after Consultant's inspection and acceptance of each room, reading:  
PAINTING COMPLETE - NO ADMITTANCE WITHOUT CONTRACTOR'S PERMISSION.

END OF SECTION



1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for signage Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 CSA-A23.1; Concrete Materials and Methods of Concrete Construction.
- .2 CAN/CSA-G40.20/G40.21; General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steels.
- .3 CAN/CSA-G164; Hot Dip Galvanizing of Irregular Shaped Articles.

1.3 **SUBMITTALS**

- .1 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Provide full scale sign layouts for all signs specified, for review by the Consultant. Layouts shall include correct symbols, lettering, lettering styles, and shall indicate colours.
    - .2 All signs shall be bilingual (English/French).

2 Products

2.1 **MATERIALS**

- .1 Sign Posts:
  - .1 One piece, cold-rolled channel sign posts, 64 mm wide x 32 mm deep, hot-dip galvanized steel, 4.2 mm base metal thickness, minimum 340 MPa yield, perforated for sign attachment, as manufactured by Armtec Limited, or an approved equivalent. Provide mounting hardware.
  - .2 Post Lengths: As per drawings.
- .2 Signs: 1.63 aluminum with MTO standard traffic colours and graphics.
- .3 Concrete:
  - .1 Proportion normal density concrete in accordance with CSA-A23.1, and as follows:
  - .2 Cement: Type 10 Portland Cement.
  - .3 Minimum compressive strength at 28 days: 25Mpa.
  - .4 Exposure Classification: C-2.
  - .5 Coarse Aggregate Size: 16mm, crushed (smooth aggregate not acceptable).
  - .6 Slump at time and point of discharge: 80mm ± 20mm.

3 Execution

3.1 **INSTALLATION**

- .1 Place concrete in post holes then embed posts into concrete to minimum 914 mm depth. Extend concrete 25 mm above ground level and slope to drain away from posts.
- .2 Brace posts in plumb position and true to alignment and elevation until concrete has set.
- .3 Bolt signs to top of posts with tamper-proof galvanized steel bolts and nuts.

3.2 **SCHEDULE**

- .1 Refer to Drawings for sign types and locations.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services for washroom accessories work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A167, Specification for Stainless Steel and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- .2 ASTM A312, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
- .3 ASTM A653/A653M, Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
- .4 ASTM F2285, Standard Consumer Safety Performance Specification for Diaper Changing Tables for Commercial Use.
- .5 CAN/CSA B651-M, Accessible Design for the Built Environment.

1.3 **SUBMITTALS**

- .1 Product data: Submit Product data to requirements of Section 01 30 00 indicating each washroom accessory describing size, finish, details of function, attachment methods, hardware and locks, description of rough-in frame, and building-in details of anchors for grab bars.
- .2 Closeout submittals:
  - .1 Submit for each Product operation and maintenance instructions for incorporating into the Operations and Maintenance Manuals in accordance with Section 01 78 00.
    - .1 Supply two (2) keys for each lockable washroom accessory to Consultant.
    - .2 Master key washroom accessories which are keyed..

1.4 **DELIVERY, STORAGE AND HANDLING**

- .1 Deliver materials in sealed cartons and containers with manufacturer's name and product description clearly marked.

1.5 **MAINTENANCE**

- 1. Maintenance Tools: Provide special tools necessary for accessing, assembly/disassembly or removal of toilet, bath and cleaning accessories in accordance with Section 01 78 00.

2 Products

2.1 **MATERIALS**

- .1 Stainless steel:
  - .1 Sheet metal: ASTM A167, Type 304.
  - .2 Tubing: ASTM A312, Type 304.
- .2 Sheet steel: ASTM A653M, Z275; Cold rolled, commercial quality, surface preparation and pretreatment as required for applied finish.
- .3 Fasteners, screws and bolts: ASTM A167, Type 304 stainless steel, tamper-proof.

2.2 **ACCESSORIES**

- .1 Refer to City of Barrie Procurement documents for the process for submitting alternates during tender.
- .2 The following Products are by Bobrick Washroom Equipment of Canada Ltd. except where noted. Quantity and location of accessories as shown on Contract Drawings. Equivalent Products from ASI/Watrous and Bradley are acceptable. Alternatives may be considered provided they are approved by Consultant prior to ordering of products.
- .3 All washroom accessories shall be mounted in strict conformance to meet all requirements of the Ontario Building Code 2012 and all amendments. Confirm mounting configurations and heights with Consultant prior to installing at all washroom accessories.
- .4 Toilet tissue dispenser: To be owner supplied and contractor installed.
- .5 Soap dispenser: To be owner supplied and contractor installed.
- .6 Paper towel dispenser and receptacle: To be owner supplied and contractor installed.
- .7 Soap dish:
  - .1 #B4380 by Bobrick Washroom Equipment of Canada; Recessed mounted 185 mm W x 125 mm H x 90 mm deep, drawn and beveled, one piece seamless with countersunk mounting holes.
  - .2 Finish: Type 304 stainless steel with matte polish.
- .8 Mirror: Six (6) mm thick, mirror quality tempered glass with type 304 stainless steel frame in satin finish. Corners to be heliarc welded, ground and polished smooth.
  - .1 Standard frame (M): #B-290 Series by Bobrick Washroom Equipment of Canada; or approved equivalent; 610 mm x 914 mm.

- .9 Grab Bars: 38 mm diameter, 1.2 mm thick, concealed mounting with snap flange, complete with escutcheons, type 304 stainless steel with a satin finish and peened grip in the following configurations:
  - .1 GB1: 762 mm long horizontal and vertical legged "L" shaped grab bar beside watercloset: Series 6806.99-L30x30 by Bobrick Washroom Equipment of Canada or approved equivalent.
  - .2 GB2: 610 mm long straight grab bar to be located behind watercloset table of : Series B-6806.99 by Bobrick Washroom Equipment of Canada or approved equivalent.
  - .3 GB3: 305 mm long straight grab bar for use at urinals: Series B-6806.99 by Bobrick Washroom Equipment of Canada or approved equivalent.
  - .4 GB4: 1000 mm long straight grab bar beside showerseat: Series B-6806.99 by Bobrick Washroom Equipment of Canada or approved equivalent.
- .10 Coat hook:
  - .1 Model 1150-SS by Frost Product Inc. or approved equivalent; collapsible single spring loaded coat hook, maximum weight capacity 11 kg.
  - .2 Finish: Type 304 stainless steel, #4 Finish.
- .11 Stainless steel shelf:
  - .1 #0692 Series by ASI Group Canada or approved equivalent; shelf fabricated from 1.2 mm thick stainless steel with 13 mm return edge and front edge hemmed for safety.
  - .2 Shelf complete with brackets fabricated from 1.2 mm thick stainless steel.
  - .3 Size: 100 mm wide x 450 mm length.
  - .4 Finish: Type 304 stainless steel, satin finish.
- .12 Folding Shower seat:
  - .1 #B-5191 by Bobrick Washroom Equipment of Canada or approved equivalent; surface wall mounted seat with eight (8) mm thick water-resistant, ivory coloured solid phenolic.
  - .2 Dimensions: 405 mm deep x 460 mm wide.
  - .3 Finish: Type 304 stainless steel frame.
- 13. Shower curtain rod:
  - .1 #B6047 by Bobrick Washroom Equipment of Canada; 32 mm diameter, 1.0 mm thick tube, complete with 81 mm diameter flanges, #B204-1 by Bobrick or #1200-SHU by ASI Group Canada stainless steel curtain hooks or approved equivalent. Length as indicated on drawings.
  - .2 Finish: Type 304 stainless steel satin finish.
- 14. Shower curtain:
  - .1 #B204-2 by Bobrick Washroom Equipment of Canada; 0.2 mm thick matte white vinyl, anti-bacterial treated, bottom and sides hemmed, complete with nickel plated brass grommets at 150 mm o.c.
  - .2 Size: 1065 mm wide x 1830 mm high.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.

3.2 **INSTALLATION**

- .1 Verify and coordinate templates, inserts, and rough-in frames and verify exact location of washroom accessories for installation.
- .2 Verify there is adequate supports and/or blocking in gypsum wall assemblies prior to installation of washroom accessories.
- .3 Provide fastening and mounting kits for washroom accessories.
- .4 Locate washroom accessories where indicated on Drawings and where directed by Consultant.
- .5 Install washroom accessory fixtures, accessories, and items in accordance with manufacturer's instructions and CAN/CSA B651-M. Provide exposed tamper-proof screws of stainless steel to match units.
- .6 Install washroom accessories plumb, level, and securely and rigidly anchored to substrate surfaces and framing. Adjust accessories for proper operation and verify mechanisms function smoothly.
- .7 Install grab bars to withstand minimum load of 1.3 kN applied vertically or horizontally. Provide necessary reinforcements as required.
- .8 Clean and polish exposed surfaces and fill accessories with necessary supplies prior to acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for lockers Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 CAN/CGSB-44.40, Steel Clothing Locker.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating type and class of lockers, elevations, sections, dimensions, gauges, tops, bases, hooks, shelves, trim, numbering, doors, handles, anchorage and hardware, and finishes.
  - .3 Samples: Submit following samples in accordance with Section 01 30 00. Two 50 mm x 50 mm samples of colour and finish on actual base metal.
  - .4 Closeout submittals: Submit maintenance and cleaning instruction for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

2 Products

2.1 **MANUFACTURED UNITS**

- .1 Lockers (Bunker Gear Locker Room): Custom sized as indicated on drawings, open style locker; Freestanding Racks and Wall Mounted Racks by Ready Rack Lockers or approved equivalent.
  - .1 Locker Construction:
    - .1 Frames: Tubular steel frames.
    - .2 Walls and backs: Large open steel mesh.
    - .3 Equipment: Manufacturer's standard hooks and shelves.
    - .4 Numbering: Each locker to have number plate with non-removable numerals, one number designation for each locker space.
    - .5 Finish: High performance baked on epoxy powder coating. Colours: Refer to Colour and Material Schedule.

3 Execution

3.1 **INSTALLATION**

- .1 Assemble and Install lockers in accordance with reviewed shop drawings and manufacturer's written instructions.
- .2 Securely fasten lockers to bases and grounds and nailing strips and to each other when in locker banks.
- .3 Install trim and closures where indicated and where obstructions occur.
- .4 Install locker numbers.
- .5 Upon completion, test doors and adjust for ease of operation.

3.2 **CLEANING**

- .1 Touch up scratches and abrasions to match original finish. Clean and polish lockers prior to final acceptance by Consultant.

END OF SECTION



1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for miscellaneous specialties Work as listed below in accordance with the Contract Documents:
  - .1 Janitor shelf.
  - .2 Corner guard.
  - .3 Tackboard.
  - .4 Whiteboard.

1.2 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data for each Product specified in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating elevations, sections, details, dimensions, materials, gauges, and finishes.
  - .3 Closeout submittals: Submit cleaning and maintenance instructions for miscellaneous specialties for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.3 **DELIVERY, STORAGE, AND HANDLING**

- .1 Package or crate, and brace products to prevent distortion in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings.

2 Products

2.1 **MANUFACTURED UNITS**

- .1 Refer to City of Barrie Procurement documents for the process for submitting alternates during tender.
- .2 The following Miscellaneous Specialties items is the minimum quality standard for the work of this Section. Alternatives may be considered provided they are approved by Consultant prior to ordering of products.
- .3 Janitor's shelf with mop and broom holders and hooks:
  - .1 #B-239 x 34 by Bobrick Washroom Equipment of Canada or approved equivalent.
  - .2 330 mm H by 205 mm deep. Shelf constructed of minimum 1.2 mm stainless steel, mop and broom holders to have spring loaded rubber cam to grip handles up to 30 mm in diameter, and stainless steel hooks positioned below shelf.

- .3 Finish: Type 304 stainless steel with satin finish.
  - .4 Stainless steel corner guard: 89 mm x 89 mm x 90°, stainless steel corner guard. Surface mounted 'CO-0' by C/S Group, or by McGill Architectural Products or approved equivalent. Finish: #4 Satin Finish
  - .5 Tackboard: "Tackboards" by ASI Visual Display Products or approved equivalent consisting of six (6) mm natural cork laminated under heat and pressure to six (6) mm hardboard, clear aluminum frame; wall mounted with concealed wall hanger.
  - .6 Whiteboard:
    - .1 Porcelain on steel laminated to eight (8) mm impregnated core with zinc coated backing sheet, with recessed tray and clear anodized aluminum perimeter trim with squared corners.
    - .2 Colour and finish: High gloss finish in white, 'Porcelain Surface' by ASI Visual Display Products or approved equivalent.
    - .3 Sizes and layout: As shown on Contract Drawings.
- 3 Execution
- 3.1 **EXAMINATION**
- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
- 3.2 **PREPARATION**
- .1 Verify substrate surfaces are solid, free from surface water, dust, oil, grease, projections and other foreign matter detrimental to performance.
  - .2 Items to be built-in: Provide information and templates required for installation of work of this Section, and assist or supervise, or both, the setting of anchorage devices, and construction of other work incorporated with products specified in this Section in order that they function as intended.
  - .3 Verify there is adequate supports and/or blocking in gypsum wall assemblies prior to installation of miscellaneous specialty items as required and janitors shelf.
- 3.3 **INSTALLATION**
- .1 Install miscellaneous specialties level and securely and rigidly anchored to substrate in accordance with authorities having jurisdiction, reviewed shop drawings, and manufacturer's written instructions.
  - .2 After installation, adjust miscellaneous specialties in accordance with manufacturer's written instructions.

3.4            **CLEANING**

- .1            Clean and polish exposed surfaces prior to acceptance by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for supplied and installed equipment work in accordance with the Contract Documents.

1.2 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations and warranties.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Samples:
  - .1 Submit following sample panels in accordance with Section 01 30 00.
    - .1 Colour and finish of each item.
- .3 Certificates: Submit manufacturer's certificates stating that products are in accordance with this specification.
- .4 Closeout submittals: Submit recommended maintenance instructions and listing of recommended maintenance Products for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00.

1.3 **QUALITY ASSURANCE**

- 1. Regulatory Requirements: All electrical equipment shall have attached labels attesting to CSA or Electrical Safety Authority approval, and shall have magnetic starters for motors, transformers, and overload protection.

1.4 **DELIVERY, STORAGE AND HANDLING**

- 1. Package or crate, and brace products to prevent damage or distortion of equipment in shipment and handling. Label packages and crates, and protect finish surfaces by sturdy wrappings or equivalent protection. Provide temporary skids under large or heavy units.
- 2. Do not deliver products to site until conditions are such that no damage will occur to them while in storage.
- 3. Store equipment at site in a manner to prevent damage to equipment.
- 4. Uncrate equipment only before installation.

1.5      **SCHEDULING**

1.      Provide equipment or its parts ready for installation in accordance with construction schedule. Verify required delivery date sufficiently before delivery to ensure that construction is not delayed.

2          Products

2.1      **EQUIPMENT**

1.      Provide equipment indicated in the cutsheets appended to this Section. If the base bid products are not available, provide products identified as alternatives in appended cutsheets.
2.      Provide reinforcing and anchorage for built-in products.
3.      Insulate between dissimilar metals, and metal and masonry, to prevent electrolysis.
4.      Equipment shall include all electrical components required by jurisdictional authorities, and to protect the equipment from damage during operation.
5.      Equipment shall include all components, connections, devices and controls required to make it fully and safely operable.

2.2      **FABRICATION**

1.      Fit joints and junctions between components tightly, in true planes, and to prevent entry of water to collect in component voids. Cap open ends of sections exposed to view.
2.      Fabricate work with materials and component sizes, metal gauges, reinforcing anchors, and fastenings of adequate strength to ensure that it will remain free of warping, buckling, opening of joints and seams, and distortion within limits of intended and specified use. Conceal and weld connections wherever possible.
3.      Cleanly and smoothly finish exposed edges of materials including holes and cutouts.
4.      Provide reinforcing and attached anchorage for built-in products.
5.      Provide holes and connections for work installed under other Sections.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of work of this Section means acceptance of existing conditions.
2. Before installation commences, ensure that mounting devices, members and surfaces are satisfactory for fitting, and adequate for securing of work.
3. Take site measurements of construction to which work of this Section must conform, and through which access must be made, before work is delivered to site, to ensure that adaptation is not required which would result in construction delay.

3.2 **INSTALLATION**

1. Obtain from manufacturer or supplier, anchorage information, roughing-in dimensions, templates and service requirements for installation of work of this Section. Also obtain assistance from manufacturer or supplier, for the setting of anchorage devices, and construction of other work incorporated with equipment specified in this Section in order that they function as intended.
2. Install work to meet manufacturer's recommended specifications, true, tightly fitted, and level or flush to adjacent surfaces, as suitable for installation.
3. Work shall include rough hardware, fastenings and other items necessary for secure installation.
4. Use only fastenings suitable for materials. Do not use through fastening at floors or walls.
5. Install work straight, plumb, level, and secured to prevent distortion or displacement, or both. Shim as necessary with concealed shims. Where required, use grout on which iron oxide deposits will not form.
6. Secure fixed equipment to building structure or construction as required to maintain it permanently in place, and so that it functions properly with no damaging vibration to the building or itself.
7. Install equipment with connections provided as required for plumbing and electrical services.
8. Provision of mechanical services and connection of equipment to mechanical work is specified in Division 22.
9. Provision of electrical service and connections of equipment to the services is specified in Division 26.

**3.3 REPAIR**

1. Refinish damaged or defective work so that no variation in surface appearance is discernible. Refinish work at site only if approved by Architect.

**3.4 ADJUSTING**

1. Verify under work of this Section that installed products function properly, and adjust them accordingly to ensure satisfactory operation.
2. Lubricate equipment as specified by equipment manufacturer.

**3.5 CLEANING**

1. Clean and polish all surfaces that are exposed to view from any location on completion of installation.
2. Remove packaging materials and debris from installation from the site.

**3.6 DEMONSTRATION**

1. After start-up, adjusting and cleaning, demonstrate operation of equipment to Owner and Architect, prior to Substantial Performance of the Work. Demonstrations shall be made:
  - .1 When the Work is certified complete by the Architect.
  - .2 When the Work is turned over to the Owner.
2. Knowledgeable representatives of the manufacturers and installers of the equipment being demonstrated shall be present at time of demonstrations.

**3.7 SCHEDULE OF EQUIPMENT**

1. As indicated below for Selected Contractor Purchase/Contractor Install Selected Equipment:
  - .1 Doors.
  - .2 Additional items to be selected by Consultant.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for manually operated window coverings Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 AAMA 611, Voluntary Standards for Anodized Architectural Aluminum.
- .2 ANSI, H35.1M, Alloy and Temper Designation Systems for Aluminum (Metric).

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, limitations, and finishes.
    - .2 Product transportation, storage, handling and installation requirements.
  - .2 Shop drawings:
    - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
      - .1 Elevations, sections and details of opening size, clearances, handling of operating components, anchorage, dimensions, gauges, materials, and finishes.
- .3 Samples: Submit following samples in accordance with Section 01 30 00. Two 300 x 300 mm samples of fabric type.
- .4 Closeout submittals:
  - .1 Submit following for each Product for incorporation into Operations and Maintenance Manuals in accordance with Section 01 78 00:
    - .1 Functional description detailing operation and control of components.
    - .2 Performance criteria and maintenance data.
    - .3 Operating instructions and precautions.
    - .4 Safety precautions.

2 Products

2.1 **ACCEPTABLE PRODUCTS AND MANUFACTURERS**

- .1 Manual Roller Shade: Factory assembled, manual chain operated, roller type fabric shades with "snap-in" mounting, end brackets, shade tube, aluminum fascia, hembar and fabric as indicated on drawings and as specified herein. 'Teleshade' by Solarfective or by Sun Glow, Sun Project or Urban Edge Shading or approved equivalent.



## 2.2 **BLACKOUT FABRIC**

- .1 Yarn: Vinyl coated polyester, four (4) ply ( one (1) ply woven fibreglass, three (3) ply PVC film)  
Weight (g/sq.m) 12 (oz./sq.yd.)  
Tougue tear (lbs) Warp - 12  
Fill - eight (8)  
Breaking Strength - Warp 240  
- Fill 179  
Tear Strength - Warp 1,360  
- Fill 720  
Tensile Strength - Warp 246  
- Fill 207  
Flame Test - NFPA 701 small scale
- .2 Fabric colour: Selected by Consultant from full colour range of any of the specified manufacturers. Shade fabric on any one floor shall be from the same dye lot.

## 2.3 **FABRICATION**

- .1 Extruded Aluminum Shade Tube: 1.52 mm thick, 38 mm diameter with three internal, continuous fins 4.82 mm high for strength and drive capabilities when attached to the nylon sprocket. The fins shall be spaced 120 degrees apart.
- .2 Fascia: 1.7 mm thick, extruded aluminum cover, complete with three continuous screw flutes which accept end brackets to form unitized unit (totally assembled). To cover front of shade and return at underside to conceal roller and hardware, notched for chain clearance.
- .3 Drive Assemblies:
  - .1 Factory set, spring clutch type drive assembly to suit size and travel of fabric shades, complete with built-in shock absorber system to prevent chain breakage under normal conditions, and balancing spring or lift assist mechanism.
  - .2 Capable of being field adjusted from exterior of shade without having to disassemble shades.
- .4 Exterior Hembar: Extruded aluminum in clear anodized finish with plastic end finials.
- .5 Drive Chain:
  - .1 No. 10 "bright" finished series 300 stainless steel bead type chain forming continuous loops and capable of withstanding 400 N pull test.
  - .2 Provide drive chains with upper and lower stops to prevent overwinding or underwinding.
- .6 Dynamic Hembar: At sill locations, in lieu of bottom channel, provide aluminum Dynamic Hembar with same finish as side channels. Upon contact with sill, it shall provide a light seal even if the sill is slightly out of level.

- .7 End Bracket: Two piece moulded ABS construction with a nylon drive sprocket. Incorporate snap-in clip on each end bracket to engage snap-in mounting hardware. Bracket colour shall coordinate with the fascia colour.
- .8 Colour: Exposed surfaces (excluding fabric) shall be colour selected by Consultant, and not necessarily from manufacturer's full colour range. Metal components shall be pretreated and finished with an acceptable baked enamel finish.
- .9 Fasteners: Non-corrosive metal screws for attachment to windows or curtain wall framing, concealed in completed installation.
- .10 Mounting System: Snap-in brackets which allow the shade to be removed without disassembling the shade unit.
- .11 Shade and mounting system to be designed to allow air between shade and glass.
- .12 Fabric shall hang flat, without buckling or distortion. Trimmed edges shall hang straight without curling or raveling.
- .13 Unguided vertical shades shall not drift sideways more than three (3) mm in total run.
- .14 Provide stops at highest and lowest shade positions to prevent over winding and unrolling.
- .15 Design and fabricate shades so that there is a maximum 12 mm gap both sides of fabric.
- .16 Blackout side and bottom channels: Extruded aluminum channels 38 mm x 28 mm to reduce light infiltration around sides of shade. Channels shall include 11 mm 'Fuzz' on both sides to further minimize infiltration.
- .17 Shades shall be Fully Factory Assembled Units of unitized construction consisting of end brackets, shade tube, extruded aluminum fascia, Hembar and specified fabric.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

#### 3.2 INSTALLATION

- .1 Install shade in accordance with accepted shop drawings and manufacturer's written instructions.
- .2 Install shades in locations shown using specified fasteners, plumb, true, square, straight, and level in proper planes, complete with all fascias/soffits, trims and accessories.

### 3.3 **ADJUSTMENT AND CLEANING**

- .1 The shade cloth fabric shall hang flat, without buckling or distortion. The edge, when trimmed, shall hang straight without ravelling. An unguided roller shade cloth shall roll true and straight, without shifting sideways more than three (3) mm in either direction due to warp distortion, or weave design.
- .2 Adjust, correct and lubricate fabric shade as required, to provide smooth and efficient operation without binding.
- .3 Clean shade surfaces and remove all finger marks and smudges from fascia, soffits, and trim surfaces. Remove all protective films.
- .4 Leave fabric shade in raised position and in first-class condition upon completion of the Work of this Section.

END OF SECTION

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## **1 General**

### **1.1 GENERAL REQUIREMENTS**

- .1 Read and conform to:
  - .1 The General Conditions of the Contract and the Supplementary Conditions,
  - .2 Division 1 requirements and documents referred to therein.
- .2 Section 21 01 01 applies to and governs the work of all Sections of the Mechanical Division.
- .3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
- .4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
- .5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

### **1.2 DEFINITIONS**

- .1 The following are definitions of words found in this specification and on associated drawings under this Division:
  - .1 "Concealed" - locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
  - .2 "Exposed" - mechanical work normally visible to building occupants.
  - .3 "Furnish" - (and its derivatives) has the same meaning as the term "Supply".
  - .4 "Install" - (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
  - .5 "Provide" - (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
  - .6 "Supply" - (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
  - .7 "Wet" - locations exposed to moisture, requiring special materials and arrangement.

### **1.3 WORK INCLUDED**

- .1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
- .2 Cutting and patching of new or existing work
- .3 Excavating and backfilling
- .4 Identification of equipment, piping, ductwork, and valves and controllers
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches.
- .6 Motors required for equipment supplied under this Division.
- .7 Variable frequency drives for motors and equipment supplied under this Division.
- .8 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.
- .9 Disconnect switches for exhaust fans located on the roof complete with;
  - .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,

- .2 EEMAC 3 enclosure if exposed to weather
- .10 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
- .11 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
- .12 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

#### **1.4 RELATED WORK**

- .1 Power wiring, conduit and connections for motors under this Division will be by Electrical Division.
- .2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Electrical Division. Wiring and connections from VFD to motors under this Division will be by Electrical Division.
- .3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
- .4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

#### **1.5 SUBMITTALS**

- .1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.
- .2 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
  - .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
  - .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
  - .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
  - .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:  
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
- .3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Mechanical Division. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.

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- .4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.
  - .5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:
    - .1 description of the system (description and type),
    - .2 description of the tests conducted and results observed, including re-testing, where necessary,
    - .3 description of any corrective measures undertaken,
    - .4 description of materials used (pipe and fittings),
    - .5 list of witnesses for each test conducted,
    - .6 date system left ready for service,
    - .7 signature of installing Contractor.
  - .6 Directories & Schematics
    - .1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.
    - .2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
    - .3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.
  - .7 Maintenance Data and Operating Instructions
    - .1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
    - .2 Ensure the binder spines have typewritten lettering as follows:

**OPERATION & MAINTENANCE MANUAL**  
for  
[Insert name of project]  
[Insert date of submission]  
[Insert Division Title]
    - .3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
    - .4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
    - .5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
    - .6 Ensure operating instructions include the following:
      - .1 General description of each mechanical system.
      - .2 Step by step procedure to follow in putting each piece of equipment into service.
      - .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
      - .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
      - .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
    - .7 Ensure maintenance instructions include the following:
      - .1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.
      - .2 Summary list of each item of mechanical equipment requiring lubrication,

- .3 indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
- .4 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
- .5 Balancing and testing reports.
- .5 Copy of valve directory.
- .8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.
- .9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.
- .10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

## 1.6 QUALITY ASSURANCE

- .1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
- .2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
  - .1 AABC Associated Air Balance Council
  - .2 AMCA Air Moving and Conditioning Association
  - .3 ANSI American National Standards Institute
  - .4 ASA American Standards Association
  - .5 ASHRAE American Society of Heating, Refrigerating, and Air Conditioning Engineers
  - .6 ASME American Society of Mechanical Engineers
  - .7 ASSE American Society of Sanitary Engineers
  - .8 ASPE American Society of Plumbing Engineers
  - .9 ASTM American Society of Testing and Materials
  - .10 AWWA American Water Works Association
  - .11 CAN2 National Standard of Canada (Published by CGSB)
  - .12 CAN3 National Standard of Canada (Published by CSA)
  - .13 CGSB Canadian General Standards Board
  - .14 CSA Canadian Standards Association
  - .15 EEMAC Electrical & Electronic Manufacturer's Association of Canada
  - .16 NBC National Building Code of Canada
  - .17 NEBB National Environmental Balancing Bureau
  - .18 NFPA National Fire Protection Association
  - .19 NEMA National Electrical Manufacturers Association
  - .20 OBC Ontario Building Code
  - .21 OFC Ontario Fire Code
  - .22 OFM Ontario Fire Marshall
  - .23 SMACNA Sheet Metal & Air Conditioning Contractors National Association
  - .24 TIAC Thermal Insulation Association of Canada
  - .25 ULC Underwriter's Laboratories of Canada Ltd
  - .26 UL Underwriter's Laboratories (including cUL)
- .3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
- .4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
- .5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
- .6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.

- .7 All refrigeration work shall be executed only by mechanics with valid ODP cards.

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

- .1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
- .2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

## **1.8 JOB CONDITIONS**

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

## **1.9 INTERRUPTIONS**

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

## **1.10 WARRANTY**

- .1 Refer to Division 1 and to Section 21 01 01 General Requirements.
- .2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
- .3 Make submissions necessary to register product warranties to the benefit of the Owner.
- .4 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

## **1.11 EXTRAS AND CREDITS**

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
  - .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
  - .2 Labour hours and unit costs.
  - .3 Total materials and labour costs.
  - .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

## **2 Products**

### **2.1 MATERIALS AND EQUIPMENT**



- .1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.
- .2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.
- .3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.
- .4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

## **2.2 MOTOR STARTERS & CONTROLS**

- .1 Mechanical Division shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Mechanical Division equipment. Starters and controls shall be Canadian General Electric or Alternate noted. All starters, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one manufacturer except as specifically approved otherwise for integral pre-wired assemblies.
- .2 Starter and control units shall be equipped with necessary number of auxiliary contacts and relays to provide control sequences described in Mechanical Equipment Starter Schedule on Drawings. Auxiliary contacts shall be interchangeable normally open or normally closed, by conversion in field without additional parts exterior to starter.
- .3 Manual starters may only be provided for single phase equipment operated by control device such as thermostat or limit control when such control device is rated for full electrical load of equipment.
- .4 Manual starters provided for single phase equipment actuated by electric timer or shall have H.O.A. feature. "Hand" position shall permit shunting of time switch. Where such units also have protective device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" positions and shall not be shunted.
- .5 Manual starters may only be provided for three phase equipment which is not actuated by pilot control device (pressure switch, float switch, safety limit devices, remote manual control device) unless otherwise noted in Starter Schedule.
- .6 Magnetic starters for manually operated equipment shall have "On/Off" selector switch or "Start-Stop" pushbutton in cover as scheduled.
- .7 Magnetic starters which are started automatically by electric time switch shall include "Hand-Off-Automatic" (H.O.A.) selector switch. "Hand" position shall permit shunting of time switch or E.M.S. Where such units also have protective pilot device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" position and shall not be shunted.
- .8 Magnetic starters which are started automatically by remote pilot device (or interlocked units) such as level controller, pressure switch, thermostat or flow switch shall include "Hand-off-Auto" (H.O.A.) selector switch, and, where scheduled, a "Test" pushbutton. "Hand" position shall permit shunting of remote pilot device and thereby permit operation of starter but only while depressing "Test" button.
- .9 Equip starter apparatus for prime plumbing, heating, air conditioning and ventilating equipment so that these units will automatically restart on resumption of power after power outage. Starters for these units shall have "On/Off" selector switch in cover if not fitted with H.O.A. selector feature or manual starter or otherwise noted.
- .10 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.
- .11 Manual motor starter shall be toggle operated with following general construction features:
  - Quick-Make, Quick-Break mechanism with double-break contacts.
  - Overload protection heaters, one per phase and speed.
  - Enclosure to suit application.
  - Pilot light, neon lamp.
  - Cover engraved with "On-Trip-Off".
- .12 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:

- Quick-Make, Quick-Break mechanism with double-break contacts.
  - Fuse holders to accept specified fuses, one per phase.
  - Adjustable overload relays, one per phase.
  - CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
  - "Reset" button.
  - Pilot Lights of transformer type incandescent with amber safety lens cap.
  - Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.
  - Scheduled cover mounted control devices with standard duty double break contact blocks.
  - Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).
- .13 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT time delay HRC1-J fuses or approved equal, rated for load, and with enclosed continuous current rating of at least 125% of connected full load.
- .14 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.
- .15 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.
- .16 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.
- .17 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices. Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated. Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:
- Proposed equipment nameplate data
  - Actual full load amperes of motor
  - Speed of motor
  - Temperature Class in degrees Celsius rise and insulation class.
  - Circuit breaker or fuse type and proposed rating
  - Type of motor, duty and service factor.
- .20 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.
- .21 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted, or other approved equal) to provide specified operation.
- .22 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J, or approved equal, current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.
- .23 Acceptable Alternate Manufacturers
1. Furnas Electric
  2. Westinghouse
  3. Allen Bradley
  4. Square 'D'
  5. Cutler Hammer
  6. Klockner-Moeller.
  7. Commander
  8. Telemecanique
  9. Or approved equivalents

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### **2.3 EQUIVALENTS AND ALTERNATIVES**

- .1 Refer to the General Conditions and the Supplementary Conditions of the Contract.

### **2.4 SUBSTITUTIONS DURING PROGRESS OF WORK**

- .1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.
- .2 Apply, in writing, to Consultant for substitution of any products, indicating the following:
  - .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
  - .2 Reason for substitution.
  - .3 Any revisions to the contract price made necessary by substitution.
  - .4 Any revisions to the contract time made necessary by substitution.
  - .5 Any revisions to layout, arrangement or services made necessary by substitution.
- .3 No substitutions will be permitted without written authorization from the Consultant.

### **2.5 CONSULTANT'S REVIEW**

- .1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor.

## **3 Execution**

### **3.1 INSTALLATION REQUIREMENTS**

- .1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
- .2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
- .3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
- .4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
- .5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.
- .8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
- .9 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.
- .10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

### **3.2 CONTRACT DRAWINGS**

- .1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
- .2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.

- .3 Make changes where required to accommodate structural conditions, (beams, columns, etc.). Obtain Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
- .5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.
- .6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.
- .7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

### **3.3 CONSTRUCTION DRAWINGS**

- .1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
- .2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
- .3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
- .4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.
- .5 Submit construction drawings prior to commencement of work.

### **3.4 RECORD DRAWINGS**

- .1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
- .2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
- .3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.
- .4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
- .5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
- .6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

### **3.5 USE OF EQUIPMENT**

- .1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.
- .2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the edges are sealed so that the filters are not bypassed. Change the filters frequently, to the

satisfaction of the Consultant, until the building is turned over the Owner.

### **3.6 SPECIAL TOOLS AND SPARE PARTS**

- .1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.
- .2 On completion of the project furnish spare parts to the Owner as follows:
  - .1 One set of mechanical seals for each pump.
  - .2 One casing joint gasket for each pump.
  - .3 One head gasket for each heat exchanger.
  - .4 One glass for each gauge glass installed.
  - .5 One set of v-belts for each piece of machinery.
  - .6 One set of new filters for each filter bank installed.
- .3 Identify spare parts containers as to contents and replacement parts number.
- .4 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

### **3.7 TRAINING**

- .1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange training for each system separately.
- .2 Provide training for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
- .3 Ensure each training period includes, but is not limited to the following;
  - .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
  - .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
  - .3 demonstration of the proper operating procedures for each item of equipment,
  - .4 explanation of the purpose and function of all safety devices provided,
  - .5 demonstration of all measures required for safe and proper access for operation and maintenance.
- .4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.
- .5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

### **3.8 START UP AND COMMISSIONING**

- .1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
- .2 The Startup and Commissioning Team shall be comprised of;
  - .1 The individual, company or agency undertaking the work of each Section,
  - .2 Representatives of the Contractor and his sub-contractors as required,
  - .3 Representatives of equipment manufacturers,
  - .4 Representatives of the Consultants,
  - .5 Representatives of the Owner.
- .4 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the startup and commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.
- .5 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.
- .6 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.
- .7 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;

- 
- .1 name and logo of Facility,
  - .2 name of the project,
  - .3 the Owner's project number,
  - .4 identification of the system commissioned,
  - .5 the date that the system was commissioned.
- .8 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 22 01 01.

**1.2 SECTION INCLUDES**

- .1 Pipe, pipe fittings, valves, and connections for piping systems.
  - .1 Storm Sewer.
  - .2 Sanitary Sewer
  - .3 Sanitary Vent
  - .4 Domestic (Potable) Water.
- .2 Disinfection of potable water distribution system.
- .3 Testing and reporting results.

**1.3 REFERENCES**

- .1 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .2 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .3 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
- .4 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.
- .5 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
- .6 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems.
- .7 ASTM A74 - Cast Iron Soil Pipe and Fittings.
- .8 ASTM B32 - Solder Metal.
- .9 ASTM B42 - Seamless Copper Pipe, Standard Sizes.
- .10 ASTM B68 - Seamless Copper Tube, Bright Annealed.
- .11 ASTM B75 - Seamless Copper Tube.
- .12 ASTM B88 - Seamless Copper Water Tube.
- .13 ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
- .14 ASTM B302 - Threadless Copper Pipe, Standard Sizes.
- .15 ASTM B306 - Copper Drainage Tube (DWV).

**1.4 SUBMITTALS FOR REVIEW**

- .1 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

**1.5 SUBMITTALS AT PROJECT CLOSEOUT**

- .1 Project Record Documents: Record actual locations of valves.

**1.6 QUALITY ASSURANCE**

- .1 Perform Work to Province of Ontario standards. Maintain one copy on site.
- .2 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

**1.7 REGULATORY REQUIREMENTS**

- .1 Perform Work to Province of Ontario plumbing code.
- .2 Conform to applicable code for installation of backflow prevention devices.
- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.



## **1.8 DELIVERY, STORAGE, AND PROTECTION**

- .1 Accept valves on site in shipping containers with labelling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

## **1.9 ENVIRONMENTAL REQUIREMENTS**

- .1 Do not install underground piping when bedding is wet or frozen.

## **1.10 EXTRA MATERIALS**

- .1 Provide two repacking kits for each size valve.

## **2 Products**

### **2.1 SANITARY SEWER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING**

- .1 Cast Iron Pipe: ASTM A74 extra heavy weight.
  - .1 Fittings: Cast iron.
  - .2 Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- .2 Cast Iron Pipe: CISPI 301, hubless.
  - .1 Fittings: Cast iron.
  - .2 Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.
- .3 Copper Tube: ASTM B306, DWV.
  - .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper.
  - .2 Joints: ASTM B32, solder, Grade 50B.
- .4 ABS Pipe: ASTM D2751 or ASTM F628.
  - .1 Fittings: ABS.
  - .2 Joints: ASTM D2235, solvent weld.
- .5 ABS Pipe: ASTM D2661 or ASTM D2751.
  - .1 Fittings: ABS.
  - .2 Joints: ASTM D2235, solvent weld.
- .6 PVC Pipe: ASTM D2665 or ASTM D3034.
  - .1 Fittings: PVC.
  - .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- .7 PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679.
  - .1 Fittings: PVC.
  - .2 Joints: ASTM F477, elastomeric gaskets.

### **2.2 SANITARY SEWER PIPING, ABOVE GRADE**

- .1 Cast Iron Pipe: ASTM A74, service weight.
  - .1 Fittings: Cast iron.
  - .2 Joints: ASTM C564, neoprene gasket system
- .2 Cast Iron Pipe: CISPI 301, hubless, service weight.
  - .1 Fittings: Cast iron.
  - .2 Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- .3 Copper Tube: ASTM B306, DWV.
  - .1 Fittings: ASME B16.23, cast bronze, or ASME B16.29, wrought copper, or ASME B16.32, sovent.
  - .2 Joints: ASTM B32, solder, Grade 50B.

### **2.3 WATER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING**

- .1 Copper Tubing: ASTM B42, hard drawn.
  - .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
  - .2 Joints: AWS A5.8, BCuP silver braze.
- .2 Copper Tubing: ASTM B42, annealed.



- .1 Fittings: ASME B16.26, cast bronze.
- .2 Joints: Flared.
- .3 Ductile Iron Pipe: AWWA C151.
  - .1 Fittings: Ductile iron, standard thickness.
  - .2 Lining: cement
  - .3 Joints: AWWA C111, rubber gasket with 3/4" (19 mm) diameter rods.

#### **2.4 WATER PIPING, ABOVE GRADE**

- .1 Copper Tubing: ASTM B88M, Type L, hard drawn.
  - .1 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  - .2 Joints: ASTM B32, solder, Grade 95TA.
- .2 Copper Tubing: ASTM B88M, Type L, hard drawn.
  - .1 Fittings: Cast iron, coated.
  - .2 Joints: Grooved mechanical couplings.

#### **2.5 STORM WATER PIPING, BURIED WITHIN 1500 mm (5 FEET) OF BUILDING**

- .1 Cast Iron Pipe: ASTM A74 extra heavy weight.
  - .1 Fittings: Cast iron.
  - .2 Joints: ASTM C564, neoprene gasket system or lead and oakum.
- .2 Cast Iron Pipe: CISPI 301, hubless, service weight.
  - .1 Fittings: Cast iron.
  - .2 Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.
- .3 ABS Pipe: ASTM D2680 or ASTM D2751.
  - .1 Fittings: ABS.
  - .2 Joints: ASTM D2235, solvent weld, maximum VOC content of 325 g/L.
- .4 PVC Pipe: ASTM D2665 or ASTM D3034.
  - .1 Fittings: PVC.
  - .2 Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- .5 PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679.
  - .1 Fittings: PVC.
  - .2 Joints: ASTM F477, elastomeric gaskets.

#### **2.6 STORM WATER PIPING, ABOVE GRADE**

- .1 Cast Iron Pipe: ASTM A74 extra heavy weight.
  - .1 Fittings: Cast iron.
  - .2 Joints: ASTM C564, neoprene gasket system or lead and oakum.
- .2 Cast Iron Pipe: CISPI 301, hubless, service weight.
  - .1 Fittings: Cast iron.
  - .2 Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

#### **2.7 FLANGES, UNIONS, AND COUPLINGS**

- .1 Pipe Size 3-1/4" (80 mm) and Under:
  - .1 Ferrous pipe: Class 150 malleable iron threaded unions.
  - .2 Copper tube and pipe: Class 150 bronze unions with soldered joints.
- .2 Pipe Size Over 1" (25 mm):
  - .1 Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
  - .2 Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- .3 Grooved and Shouldered Pipe End Couplings:
  - .1 Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
  - .2 Sealing gasket: "C" shape composition sealing gasket.
- .4 Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water

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impervious isolation barrier.

## **2.8 PIPE HANGERS AND SUPPORTS**

- .1 Plumbing Piping - Drain, Waste, and Vent:
  - .1 Conform to ASME B31.9.
  - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
  - .3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
  - .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .5 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
  - .6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
  - .7 Vertical Support: Steel riser clamp.
  - .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .2 Plumbing Piping - Water:
  - .1 Conform to ASME B31.9.
  - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (15 to 40 mm): Malleable iron, adjustable swivel, split ring.
  - .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
  - .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
  - .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
  - .6 Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
  - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
  - .8 Wall Support for Pipe Sizes to 3-1/4" (80 mm): Cast iron hook.
  - .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
  - .10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
  - .11 Vertical Support: Steel riser clamp.
  - .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
  - .14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
  - .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## **2.9 VALVES - GENERAL**

- .1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .2 Provide valves of the same manufacturer where possible.
- .3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .4 Valid CRN (Canadian Registration Number) issued by Province of Ontario required for each valve.
- .5 Materials:
  - .1 Bronze: ASTM B62 or B61 as applicable
  - .2 Brass: ASTM B283 C3770
  - .3 Cast Iron: ASTM A126 Class B
- .6 End Connections:
  - .1 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
  - .2 Face-to-face dimensions: ANSI B16.10
- .7 Design and Testing:
  - .1 Bronze Gate & Check valves: MSS-SP-80

- 
- |    |                         |            |
|----|-------------------------|------------|
| .2 | Ball Valves:            | MSS-SP-110 |
| .3 | Cast Iron Gate Valves:  | MSS-SP-70  |
| .4 | Cast Iron Globe Valves: | MSS-SP-85  |
| .5 | Cast Iron Check:        | MSS-SP-71  |
| .6 | Butterfly Valves:       | MSS-SP-67  |
- .8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products listed on spread sheet attached.

## 2.10 ISOLATION VALVES

- .1 Up To and Including 2" (50mm) - Ball type
- |    |   |
|----|---|
| .1 | Manufacturer: Kitz #69AMLL or approved equal.   |
| .2 | Construction: MSS SP-110, Class 150, 600 psi (4140 kPa) CWP, forged brass, two piece body, stainless steel ball and stem, full port, virgin PTFE seats and stem packing, blow-out proof stem, lever handle with balancing stops, stem extensions for insulated piping, solder ends. |
- .2 2-1/2" (65 mm) and Larger - Butterfly type:
- |    |   |
|----|---|
| .1 | Manufacturer: Kitz 6122EL or approved equal.  |
| .2 | Construction: MSS-SP-67, MSS-SP-25 and API-609; lug type having bi-directional "Dead End Service" pressure rating of 1380 kPa (200 psi) with the downstream flange removed; stainless steel stem with top and bottom bushings of dissimilar materials and with positive stem retention mechanism, aluminum bronze disc and molded or bonded style EPDM seat; suitable for both chilled water and hot water operation; supplied with 10 position locking lever handle 2" extended neck to allow for insulation. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 8-Ft (2400 mm) above floor. |

## 2.11 THROTTLING VALVES

- .1 Up To and Including 2" (50 mm) - Globe type:
- |    |   |
|----|---|
| .1 | Manufacturer: Kitz 10 or approved equal.  |
| .2 | Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, rising stem, union bonnet, inside screw, PTFE disk, solder ends. |
- .2 2-1/2" (65 mm) and Larger - Globe type:
- |    |  |
|----|--|
| .1 | Manufacturer: Kitz 76 (Globe) or approved equal. |
| .2 | Construction: Cast iron body globe               |
- .3 2-1/2" (65 mm) and Larger - Butterfly type
- |    |   |
|----|---|
| .1 | Manufacturer: Kitz 6122EL or approved equal.  |
| .2 | Construction: MSS-SP-67, MSS-SP-25 and API-609; lug type having bi-directional "Dead End Service" pressure rating of 1380 kPa (200 psi) with the downstream flange removed; stainless steel stem with top and bottom bushings of dissimilar materials and with positive stem retention mechanism, aluminum bronze disc and molded or bonded style EPDM seat; suitable for both chilled water and hot water operation; supplied with 10 position locking lever handle 2" extended neck to allow for insulation. Provide gear operators for valves 150 mm and larger, and chain-wheel operators for valves mounted over 8-Ft (2400 mm) above floor. |

## 2.12 CHECK VALVES

- .1 Up To and Including 3" (75 mm):
- |    |   |
|----|---|
| .1 | Manufacturers: Kitz 23 or approved equal.   |
| .2 | Construction: MSS SP-80, 860 kPa (125psig) 200 WOG, bronze body to ASTM B62, bronze trim, solder ends |
- .2 4" (100mm) and Larger:
- |    |   |
|----|---|
| .1 | Manufacturers: Kitz 78 or approved equal.   |
| .2 | Construction: MSS SP-71, 1380 kPa Class 125 / 200 WOG, Cast iron body to ASTM A126 Class B, Bronze trim, Bolted Bonnet, flanged ends. |

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## **2.13 DRAIN VALVES**

- .1 Up to 150 psig - Ball type:
  - .1 Manufacturers: Kitz 68C or approved equal.
  - .2 Construction: 150 psig (1034 kPa), 600 WOG, brass body to ASTM C37700, two piece body, full port, PTFE seats and stem packing or double "O" ring, blow-out proof stem, Chrome Plated ball, lever handle with cap and chain, (3/4") 20 mm hose connection.

## **2.14 WATER PRESSURE REDUCING VALVES**

- .1 Up to 2" (50 mm):
  - .1 Manufacturers:
    - .1 Armstrong Model GD 24.
    - .2 Watts Model Series 223.
    - .3 Or approved equal.
  - .2 MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded ends.
- .2 Over 2" (50 mm):
  - .1 Manufacturers:
    - .1 Armstrong Model GD 200.200H.
    - .2 Watts Model Series N223.
    - .3 Or approved equal.
  - .2 MSS SP-85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

## **2.15 RELIEF VALVES**

- .1 Pressure Relief:
  - .1 Manufacturers:
    - .1 Watts Model Series 40.
    - .2 Or approved equal.
  - .2 AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.

## **2.16 STRAINERS**

- .1 Up to 125 psig:
  - .1 Size 2" (50 mm) and Under:
    - .1 Manufacturers: Mueller Steam 351M or approved equal.
    - .2 Construction : 860 kPa (125 psig) 200 WOG Rating, Bronze body, Screwed Cap, Y Pattern, 304 stainless steel screen with 20 Mesh perforation, Threaded Ends.
  - .2 Size 2-1/2" (65 mm) and larger:
    - .1 Manufacturers: Mueller Steam 758 or approved equal.
    - .2 Construction : 860 kPa (125 psig)/ 200 WOG Rating, Cast Iron body, Bolted Cover, Y Pattern, 304 stainless steel screen with 1/16 & 1/8 perforation, Threaded Ends.
- .2 Up to 250 psig:
  - .1 Size 2" (50 mm) and Under:
    - .1 Manufacturers: Mueller Steam 11M or approved equal.
    - .2 Construction : Class 250, 400 psig WOG, cast iron body, Y-pattern, screwed cap and ends, A167 304 stainless steel screen with 1/32" perforations.
  - .2 Size 2-1/2" (65 mm) and larger:
    - .1 Manufacturers: Mueller Steam 758 or approved equal.
    - .2 Construction : 300 psig non-shock WOG, cast iron, Y-pattern, bolted cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends.

## **2.17 DISINFECTION CHEMICALS**

- .1 Chemicals: AWWA B300, Hypochlorite,.

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### **3 Execution**

#### **3.1 EXAMINATION**

- .1 Verify that excavations are to required grade, dry, and not over-excavated.

#### **3.2 PREPARATION**

- .1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- .2 Remove scale and dirt, on inside and outside, before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.

#### **3.3 INSTALLATION**

- .1 Install to manufacturer's instructions.
- .2 Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- .3 Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- .4 Install piping to maintain headroom, conserve space, and not interfere with use of space.
- .5 Group piping whenever practical at common elevations.
- .6 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .7 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- .8 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with general trades.
- .9 Establish elevations of buried piping outside the building to ensure not less than 4' (1.2 m) of cover.
- .10 Install vent piping penetrating roofed areas to maintain integrity of roof assembly; refer to Division 07.
- .11 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (maximum VOC content of 80 g/L) to welding.
- .12 Provide support for utility meters to requirements of utility companies.
- .13 Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting where required. Coordinate with general trades.
- .14 Excavate and backfill as required for work of this Section.
- .15 Install bell and spigot pipe with bell end upstream.
- .16 Install valves with stems upright or horizontal, not inverted.
- .17 Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- .18 Sleeve pipes passing through partitions, walls and floors.
- .19 Inserts:
  - .1 Provide inserts for placement in concrete formwork.
  - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
  - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- .20 Pipe Hangers and Supports:
  - .1 Install to OBC (Plumbing Code)
  - .2 Support horizontal piping as scheduled.
  - .3 Install hangers to provide minimum 1/2" (15 mm) space between finished covering and adjacent work.
  - .4 Place hangers within 12" (300 mm) of each horizontal elbow.
  - .5 Use hangers with 1-1/2" (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  - .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze

- hangers.
- .8 Provide copper plated hangers and supports for copper piping.
- .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- .10 Provide hangers adjacent to motor driven equipment with vibration isolation.
- .11 Support cast iron drainage piping at every joint.

### **3.4 APPLICATION**

- .1 Use grooved mechanical couplings and fasteners only in accessible locations.
- .2 Install unions downstream of valves and at equipment or apparatus connections.
- .3 Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- .4 Install gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .5 Install globe valves for throttling, bypass, or manual flow control services.
- .6 Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- .7 Provide spring loaded check valves on discharge of water pumps.
- .8 Provide plug valves in natural gas systems for shut-off service.
- .9 Provide flow controls in water recirculating systems where indicated.

### **3.5 ERECTION TOLERANCES**

- .1 Establish invert elevations, slopes for drainage to 2 percent minimum. Maintain gradients.
- .2 Slope water piping minimum 0.25 percent and arrange to drain at low points.

### **3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM**

- .1 Disinfect all new and altered water distribution piping.
- .1 Verify that piping system is complete and has been flushed, cleaned, inspected, and pressure tested.
- .2 Isolate existing piping to full extent possible. Ensure that all fixtures, exiting and new that are served from piping being disinfected, are taken out of service and signs are placed at each fixture prohibiting use during the disinfection period.
- .2 Schedule and perform disinfecting activities with start-up, testing, adjusting, balancing, and demonstration procedures. Coordinate with related systems.
- .3 Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- .4 Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- .5 Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- .6 Maintain disinfectant in system for 24 hours.
- .7 If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- .8 Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- .9 Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze to AWWA C651.

### **3.7 SERVICE CONNECTIONS**

- .1 Provide new sanitary sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- .2 Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves pressure reducing valve.
- .3 Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 1.75 kPa. Provide regulators on each line serving gravity type appliances, sized to equipment.

### **3.8 SCHEDULES**

- .1 Pipe Hanger Schedule:
  - .1 Metal Piping:
    - .1 Pipe size: 1/2" to 1-1/4" (15 to 32 mm):

- .1 Maximum hanger spacing: 6.5' (2 m).
- .2 Hanger rod diameter: 3/8" (9 mm).
- .2 Pipe size: 1-1/2" to 2" (40 to 50 mm):
  - .1 Maximum hanger spacing: 10' (3 m).
  - .2 Hanger rod diameter: 3/8" (9 mm).
- .3 Pipe size: 2-1/2" to 3" (65 to 75 mm):
  - .1 Maximum hanger spacing: 10' (3 m).
  - .2 Hanger rod diameter: 1/2" (13 mm).
- .4 Pipe size: 4" to 6" (100 to 150 mm):
  - .1 Maximum hanger spacing: 10' (3 m).
  - .2 Hanger rod diameter: 1/2" (15 mm).
- .5 Pipe size: 8" to 12" (200 to 300 mm):
  - .1 Maximum hanger spacing: 14' (4.25 m).
  - .2 Hanger rod diameter: 3/4" (22 mm).
- .6 Pipe size: 14" (350 mm) and Over:
  - .1 Maximum hanger spacing: 20' (6 m).
  - .2 Hanger rod diameter: 1" (25 mm).

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 22 01 01.

**1.2 SECTION INCLUDES**

- .1 Roof and floor drains.
- .2 Cleanouts.
- .3 Hose bibs.
- .4 Hydrants.
- .5 Backflow preventers.
- .6 Water hammer arrestors.
- .7 Oil Interceptor.
- .8 Trap Seal Primers.

**1.3 REFERENCES**

- .1 ASME A112.21.1 - Floor Drains.
- .2 ASME A112.21.2 - Roof Drains.
- .3 ASME A112.26.1 - Water Hammer Arrestors.
- .4 ASSE 1011 - Hose Connection Vacuum Breakers.
- .5 ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- .6 ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
- .7 AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.
- .8 PDI WH-201 - Water Hammer Arrestors.

**1.4 SUBMITTALS FOR REVIEW**

- .1 Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- .2 Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.

**1.5 SUBMITTALS FOR INFORMATION**

- .1 Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

**1.6 SUBMITTALS AT PROJECT CLOSEOUT**

- .1 Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors
- .2 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

**1.7 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

**1.8 DELIVERY, STORAGE, AND PROTECTION**

- .1 Accept specialties on site in original factory packaging. Inspect for damage.

**2 Products**

**2.1 GENERAL**



## **2.2 ROOF DRAINS**

### **.1 Built - Up Roofs**

- .1 Manufacturer: Watts Drainage Model RD100-BED-W-1 or approved equal.
- .2 Assembly: ANSI A112.21.2.
- .3 Body: Lacquered cast iron with sump.
- .4 Strainer: Removable polyethylene dome with vandal proof screws.
- .5 Accessories: Coordinate with roofing type, refer to Division 7:
  - .1 Membrane flange and membrane clamp with integral gravel stop.
  - .2 Adjustable under deck clamp.
  - .3 Roof sump receiver.
  - .4 Adjustable extension sleeve for roof insulation

### **.2 Landscaped Roofs**

- .1 Manufacturer: Watts Drainage Model RD200-GSS-BED or approved equal.
- .2 Assembly: ANSI A112.21.2.
- .3 Body: Lacquered cast iron with sump.
- .4 Strainer: Removable polyethylene dome with vandal proof screws.
- .5 Accessories: Coordinate with roofing type, refer to Division 7.
  - .1 Membrane flange and membrane clamp with integral gravel stop.
  - .2 Adjustable under deck clamp.
  - .3 Roof sump receiver.
  - .4 Adjustable extension sleeve for roof insulation.
  - .5 Perforated stainless steel ballast guard extension.

## **2.3 FLOOR DRAINS**

### **.1 Floor Drain (FD):**

- .1 Watts Drainage model FD-100-C-5 or approved equal.
- .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable round nickel-bronze strainer with removable perforated sediment bucket.

### **.2 Floor Drain (FFD):**

- .1 Watts Drainage Model FD-100-C-EG or approved equal.
- .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer with polished bronze elongated funnel.

### **.3 Floor Drain (HD):**

- .1 Watts Drainage Model FD-100-C-AS-7-8 or approved equal.
- .2 ANSI A112.21.1; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, adjustable nickel-bronze angle strainer, trap primer tapping, and backwater valve.

### **.4 Linear Drain:**

- .1 Zurn Model ZS880 or approved equal.
- .2 Fabricated Stainless Steel Type 304 linear shower drain.
- .3 Complete with vertically adjustable anchoring support legs, anti-ponding V-shaped channel with 2" (51mm) No-Hub center outlet, adjustable secured leveling frame with built-in tile edge, integral membrane flange for glue on waterproofing membrane, and secured light duty, slotted heel-proof grate.

## **2.4 TRAP SEAL PRIMERS**

### **1. Individual Traps:**

- 1. Watts Drainage model MS-810 or approved equal.
- 2. Automatic cast brass body, renewable disc and seat rings, vacuum breaker and removable cover.

### **2. Groups of Traps:**

- 1. PPP Inc. Oregon #1, or approved equal, complete with supply tube and/or distribution units. up to 8 drains.

## **2.5 CLEANOUTS**

- .1 Exterior Surfaced Areas:
  - .1 Watts Drainage model CO-200-RFC or approved equal.
  - .2 Round cast nickel bronze access frame and non-skid cover.
- .2 Exterior Unsurfaced areas:
  - .1 Watts Drainage model CO-300-MF or approved equal.
  - .2 Extra Heavy Duty type with epoxy coated cast iron body with two fixed anchor flanges and round heavy duty ductile iron gasketed cover.
- .3 Interior Finished Floor Areas:
  - .1 Watts Drainage model CO-200-R, CO-200-U or approved equal.
  - .2 Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.
- .4 Interior Finished Wall Areas:
  - .1 Watts Drainage model WUCO or approved equal.
  - .2 Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.
- .5 Interior Unfinished Accessible Areas: Caulked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.
- .6 Line Cleanouts: lacquered cast iron Malcom type with cleanout ferrule, 1/2" (13mm) thick epoxy coated gasketed cover.
- .7 Caulking for cleanouts: VOC content not to exceed 250g/L.

## **2.6 HYDRANTS**

- .1 Exterior Wall Hydrant, (H-1):
  - .1 Watts Drainage model HY-725 or approved equal.
  - .2 ANSI/ASSE 1019; non-freeze, self-draining type with polished nickel bronze box and cover for recessed mounting, all bronze head, seat casting and internal working parts, 3/4" (20 mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.
- .2 Interior Wall Hydrant, (H-2):
  - .1 Watts Drainage model HY-330 or approved equal.
  - .2 ANSI/ASSE 1019; self-draining type with polished nickel bronze box and cover for recessed mounting, all bronze head, seat casting and internal working parts, 3/4" (20 mm) hose thread spout, key operated, integral vacuum breaker, galvanized wall casing and hydrant key.

## **2.7 BACKFLOW PREVENTERS**

- .1 Reduced Pressure Backflow Preventers:
  - .1 Manufacturers:
    - .1 Watts Model 909.
    - .2 ITT lawler Model RZ.
    - .3 Baukman Model BF-299.
    - .4 Febco Model 825Y
    - .5 Or approved equivalent
    - .6 Substitutions: Refer to Section 01 62 00.
  - .2 ANSI/ASSE 1013; bronze body with bronze internal parts and stainless steel springs; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve that opens under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two gate valves, strainer, and four test cocks.

## **2.8 WATER HAMMER ARRESTORS**

- .1 Watts Drainage Series 05 or approved equal.
- .2 ANSI A112.26.1; copper construction, piston type sized to PDI WH-201, precharged suitable for

operation in temperature range 99°F to 300°F (-73°C to 149°C) and maximum 150 psi (1000 kPa) working pressure.

## **2.9 OIL INTERCEPTOR**

- .1 Watts Drainage OI-535-X or approved equal.
- .2 Oil interceptor with extra heavy duty cover and extension as required.
- .3 Steel fabricated with epoxy coating inside and outside.
- .4 Unit shall include sediment bucket, code approved deep seal trap, cover securing bolts, adjustable automatic draw-off assembly, double vent connections, removable stainless steel calibrated orifice plate, and epoxy coated, non-skid removable cover.
- .5 Supplied with secondary storage tank.

## **2.10 IN-LINE WATER FILTER**

- .1 Single housing water treatment system with a drop-in 10" (250 mm) cartridge, reduce sediment down to 0.5 micron and to reduce chlorine, taste & odor at a flow rate of 1.5 gpm for 15,000 gallons, scale inhibiting technology, protection against the precipitation and accumulation of scale and provides a protective barrier to help guard against corrosion, high capacity activated carbon filtration, stainless steel mounting bracket and full-flow inlet shut-off valve, built-in pressure gauge, 1/2" (15 mm) inlet and outlet connection. OptiPure FXI-11 or approved equal.

## **2.11 CATCH BASIN**

- .1 24" x 24" x 36" deep catch basin with standard H20 rated welded steel bar grate finished with black retardant paint. Catch basin shall be complete with 8" deep removable trash basket with perforated bottom, 4" OD pipe x 2" long connection for outlet piping, trench inlet saddle and welded in steel bottom.
- .2 Acceptable manufacturers:
  1. Northstar Industries
  2. Watts
  3. J.R.Smith
  4. Or approved equal.

## **2.12 SLOTTED GRATING (FOR TRENCH DRAIN)**

- .1 Type of grating: Slotted
- .2 Material: Ductile Iron
- .3 Loading class: E 600
- .4 Width: to suit the formed trench
- .5 Length: to suit the formed trench as shown on the architectural drawings.
- .6 Acceptable manufacturers:
  1. Northstar Industries (Model MEADRAIN Top 2000)
  2. Watts
  3. J.R.Smith
  4. ACO
  5. Or approved equal

## **3 Execution**

### **3.1 GENERAL**

- .1 Install all products in accordance with the plumbing code and with manufacturer's instructions.

### **3.2 CLEANOUTS**

- .1 Cleanouts shall be the same size as the pipe up to 4" (100mm) and not less than 4" (100mm) for larger pipes.
- .2 Provide cleanouts at the end of mains and branches, at changes in direction, in long straight runs and at the base of all soil stacks and rainwater leaders and where required by code.
- .3 Extend cleanouts to finished floor or wall surface.
- .4 Encase exterior cleanouts in concrete flush with grade.
- .5 Install floor cleanouts at elevation to accommodate finished floor.
- .6 Cleanouts in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
- .7 Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.
- .8 Ensure clearance at cleanout for rodding of drainage system.

### **3.3 FLOOR DRAINS**

- .1 Provide floor drains where indicated on architectural and plumbing floor plans.
- .2 Inspect locations where floor drains are shown to determine that floor is sloped appropriately. Report concerns to Consultant prior to installation of drains.
- .3 Coordinate installation with general trades.
- .4 Trap and vent all floor drains in accordance with Plumbing Code.
- .5 Provide trap seal priming for each floor drain trap.
- .6 Floor drains in floors with surface membranes shall be installed with a membrane clamp and anchoring flange.
- .7 Floor drains, traps and drain pipes installed in slabs on grade shall be embedded in concrete and made water-tight to prevent water seepage.

### **3.4 ROOF DRAINS**

- .1 Locate roof drains where indicated on roofing plans.
- .2 Inspect locations where roof drains are shown to determine that roof is sloped appropriately. Report concerns to Consultant prior to installation of drains.
- .3 Coordinate installation with roofing trade.

### **3.5 WALL HYDRANTS**

- .1 Locate wall hydrants where indicated.
- .2 Coordinate installation with general trades.

### **3.6 WATER HAMMER ARRESTORS**

- .1 Install water hammer arrestors complete with an accessible isolation valve on hot and cold water supply piping to;
  - .1 plumbing fixtures and fixture groups,
  - .2 Owner's equipment and appliances with flush valves, solenoid valves or other quick closing valves,
  - .3 Downstream of each backflow preventer,
  - .4 Wherever necessary to prevent water hammer.

### **3.7 TRAP SEAL PRIMERS**

- .1 Traps may be primed from the flush tube of a flush valve or from the waste of a drinking fountain.
- .2 No more than three (3) traps may be primed from one flush valve or one drinking fountain.
- .2 Condensate drains from cooling units may not be used to prime traps.
- .3 Trap seal primers shall be provided where flush valves and/or drinking fountains are not available.
- .4 Group trap primers shall be provided where specifically shown and where agreed with the Consultant.

### **3.8 INTERCEPTORS**

- .1 Install interceptors so as to be accessible for cleaning and all other maintenance and repair which may be required.

- .2 Make all piping connections. Vent in accordance with Plumbing Code.
- .3 Fill with appropriate media as required and turn over spare media to Owner.

### **3.9 BACKFLOW PREVENTION**

- .1 Backflow prevention includes backflow preventers, anti-siphon devices and vacuum breakers.
- .2 Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur;
  - .1 on boiler feed water lines,
  - .2 housekeeping faucets,
  - .3 fire sprinkler systems,
  - .4 premise isolation,
  - .5 irrigation systems,
  - .6 flush valves,
  - .7 interior and exterior wall hydrants (hose bibs).
  - .8 Where require by codes, regulations and/or standards.
- .3 Pipe relief or drain from backflow prevention device to nearest drain.
- .4 Install a strainer upstream of each backflow preventer.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 22 01 01.

**1.2 SECTION INCLUDES**

- .1 Water closets, seats, tanks, flush valves, supplies, carriers
- .2 Urinals, tanks, flush valves
- .4 Lavatories, faucets, spouts, waste, carriers
- .5 Stainless steel sinks, faucets, spouts,
- .6 Service sinks, traps, faucets, spouts, accessories
- .7 Eye and Face wash, valves, fittings, accessories, signs

**1.3 REFERENCES**

- .1 ANSI Z124.1 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Bathtub Units.
- .2 ANSI Z124.2 - Gel-Coated Glass-Fibre Reinforced Polyester Resin Shower Receptor and Shower Stall Units.
- .3 ANSI Z358.1 - Emergency Eye Wash and Shower Equipment.
- .4 ARI 1010 - Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- .5 ASME A112.6.1 - (Floor Affixed) Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- .6 ASME A112.18.1 - Plumbing Fixture Fittings.
- .7 ASME A112.19.1 - Enamelled Cast Iron Plumbing Fixtures.
- .8 ASME A112.19.2 - Vitreous China Plumbing Fixtures.
- .9 ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- .10 ASME A112.19.4 - Porcelain Enamelled Formed Steel Plumbing Fixtures.
- .11 ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.

**1.4 SUBMITTALS FOR REVIEW**

- .1 Product Data:
  - .1 Provide catalogue illustrations of fixtures,
  - .2 sizes,
  - .3 rough-in dimensions,
  - .4 service sizes (capacities)
  - .5 trim,
  - .6 finishes.

**1.5 SUBMITTALS FOR INFORMATION**

- .1 Manufacturer's Instructions: Indicate installation methods and procedures.

**1.6 SUBMITTALS AT PROJECT CLOSEOUT**

- .1 Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- .2 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

**1.7 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum five years documented experience.
- .2 Installer Qualifications: trades licence with minimum five years documented experience.

**1.8 DELIVERY, STORAGE, AND PROTECTION**

- .1 Transport, handle, store, and protect products.
- .2 Accept fixtures on site in factory packaging. Inspect for damage.

- .3 Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

## 2 Products

### 2.1 MANUFACTURERS

1. All plumbing fixtures, fixture trim and accessories shall be products of one manufacturer to the extent that this is possible.
2. Vitreous China fixtures:
  - .1 Manufacturer: American Standard.
  - .2 Other acceptable manufacturers offering equivalent products.
    - .1 Crane
    - .2 Kohler
    - .3 Toto
    - .4 Eljer
    - .5 Or approved equal
3. Stainless Steel fixtures:
  - .1 Manufacturer: Acorn.
  - .2 Other acceptable manufacturers offering equivalent products.
    - .1 Bradley
    - .2 Willoughby
    - .3 Or approved equal
4. Seats
  - .1 Manufacturer: Centoco
  - .2 Other acceptable manufacturers offering equivalent products.
    - .1 Benecke
    - .2 Olsonite
    - .3 Kohler
    - .4 Bemis
    - .5 Or approved equal
5. Mechanical Flush Valves
  - .1 Manufacturer: Sloan "Regal"
  - .2 Other acceptable manufacturers offering equivalent products:
    - .1 Zurn
    - .2 Cambridge Brass
    - .3 Powers
    - .4 Or approved equal
6. Diverter Valves
  - .1 Manufacturer: Powers
  - .2 Other acceptable manufacturers offering equivalent products.
    - .1 Kohler
    - .2 Sloan
    - .3 Or approved equal.
7. Carriers
  - .1 Manufacturer: Watts Ancon
  - .2 Other acceptable manufacturers offering equivalent products.
    - .1 Zurn
    - .2 J. R. Smith
    - .3 MIFAB
    - .4 Or approved equal.

### 2.2 WATER CLOSET WALL MOUNTED - FLUSHOMETER – EXPOSED – MANUAL (W-2) (BF)

1. **American Standard Afwal Flowise Elongated Flushometer Toilet #3351.101**, or approved equal, white vitreous china with EverClean antimicrobial surface which inhibits the growth of stain and odor causing bacteria mold and mildew, wall mounted, siphon jet flush action, operates in the range of 4.2L to 6.0L per flush, condensate channel, 54mm (2-1/8") fully glazed internal trapway, wall outlet, bolt caps, 38mm (1-1/2") dia. Top

Spud.

2. **American Standard #5901.100 heavy duty** open front, less cover.
3. **Sloan Regal #111-XL-CP**, exposed manual Flushometer for Top Spud toilet, chrome plated, 6L (1.6 US Gal) factory set flow, quiet action diaphragm type, non-hold open feature, A. D. A oscillating handle, back-check angle stop (screwdriver operated), flush tube for 292mm (11-1/2") rough-in, vacuum breaker or approved equal.
4. **Water closet carrier** with epoxy coated cast iron fitting and foot supports, no hub waste and vent connections, adjustable for standard and wheel chair heights, rated for 500lb static load.

### **2.3 WATER CLOSET WALL MOUNTED- FLUSHOMETER – EXPOSED – MANUAL (W-1)**

1. **American Standard Afwal Flowise Elongated Flushometer Toilet #3351.511**, white vitreous china with EverClean antimicrobial surface which inhibits the growth of stain and odor causing bacteria mold and mildew, wall mounted, siphon jet flush action, operates in the range of 4.2L to 6.0L per flush, condensate channel, 54mm (2-1/8") fully glazed internal trapway, wall outlet, bolt caps, 38mm (1-1/2") dia. Top Spud, or approved equal.
2. **American Standard #5901.100 heavy duty** open front, less cover
3. **Sloan Regal #111-XL-CP**, exposed manual Flushometer for Top Spud toilet, chrome plated, 6L (1.6 US Gal) factory set flow, quiet action diaphragm type, non-hold open feature, A. D. A oscillating handle, back-check angle stop (screwdriver operated), flush tube for 292mm (11-1/2") rough-in, vacuum breaker, or approved equal.
4. **Water closet carrier** with epoxy coated cast iron fitting and foot supports, no hub waste and vent connections, adjustable for standard and wheel chair heights, rated for 500lb static load.

### **2.4 WALL HUNG LAVATORY – TWO HANDLE FAUCET (L-2) (BF)**

1. **American Standard Murro with Everclean #0954.004EC/0059.020EC Basin**, 540mm x 520mm x 165mm (21-1/4" x 20-1/2" x 6-1/2") high, vitreous china, for carrier with concealed arms, rear overflow, recessed self-draining faucet ledge, **semi-pedestal P-trap cover**, or approved equal.
2. **Chicago Faucets #802-VCP-317VP-XK-E2805 Two handle faucet**, 4" (102mm) centerset, solid brass body construction, ceramic 1/4 turn cartridge, with Vandal Resistant 1.9LPM (0.5 GPM), aerator outlet, metal red and blue index buttons 102mm (4") long wrist blade handle with vandal resistant screw, or approved equal.
3. **McGuire #155AC open grid drain**, chrome plated cast brass one piece top, 1.5mm (1/16") tubular 32mm (1-1/4") tailpiece, or approved equal.
4. **McGuire #H170BVRB Faucet Supplies**, chrome finish polished brass, 13mm (1/2") I. D. Inlet x 127mm (5") horizontal extension tubes, combination V. P. Loose key handle, escutcheon and stainless steel braided flexible riser, or approved equal.
5. **McGuire #8872C P-Trap**, heavy cast brass adjustable body, with slip nut, 32mm (1-1/4") size, shallow wall flange and seamless tubular wall bend, or approved equal.
6. **Watts #TCA-411, Carrier**, mounted on concrete floor, with epoxy coated cast iron concealed arms with sliding adjustable arm brackets, heavy gauge steel uprights with integral welded feet. Minimum space required: for one unit: 102mm (4") for two to six units in a row: 152mm (6") finished metal stud wall to back of pipe space, or approved equal.

### **2.5 COUNTER MOUNTED LAVATORY- TWO HANDLE FAUCET (L1)**

1. **American Standard Aqualyn #0476.028 Basin**, 518mm x 441mm x (20-3/8" x 17-3/8" x 7") high, oval, vitreous china, self-rimming - drop-in, front overflow, faucet ledge, tapered edges, or approved equal.
2. **Chicago Faucets #802-VCP-369VP-XK-E2805 Two handle faucet**, 4" (102mm) centerset, solid brass body construction, ceramic 1/4 turn cartridge, with Vandal Resistant 1.9LPM (0.5 GPM), aerator outlet, metal red and blue index buttons 60mm (2-3/8") long lever handle with vandal resistant screw, or approved equal.
3. **McGuire #155AC open grid drain**, chrome plated cast brass one piece top, 1.5mm (1/16") tubular 32mm (1-1/4") tailpiece, or approved equal.
4. **McGuire #H170BV Faucet Supplies**, chrome finish polished brass, 13mm (1/2") I. D. Inlet x 127mm (5") horizontal extension tubes, combination V. P. Loose key handle, escutcheon and flexible copper riser or approved equal.
5. **McGuire #8872C P-Trap**, heavy cast brass adjustable body, with slip nut, 32mm (1-1/4") size, shallow wall flange and seamless tubular wall bend or approved equal.



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**2.6 BUILT ON SITE SHOWER- SHOWER VALVE AND HEAD (SH1)**

1. **Chicago Faucets #1902-CP Shower Valve**, solid brass body construction, pressure balancing, washerless ceramic drip-free disc valve cartridge, metal wall escutcheon, 4.7LPM maximum flow rate '620A' ball joint showerhead with arm and flange, or approved equal.
2. **Watts #FD-100-A, Floor Drain**, 2" (51mm) outlet, epoxy coated cast iron, anchor flange, adjustable round nickel bronze strainer, reversible clamping collar with primary & secondary weepholes, or approved equal.
3. **Provide P-Trap**, same material as the connecting pipe drain.

**2.7 BARRIER FREE SHOWER (SH2) - VALVE AND HANDSHOWER**

1. **Chicago Faucets #SH-PB1-00-000/151-WB-WS**, pressure balancing, washerless ceramic drip-free disc valve cartridge, metal wall escutcheon. **Comply with local codes for Shower Control location and Trim Kit requirements.**
2. **Chicago Faucets #151-VB-WS Commercial hand shower slide bar, 24" (610 mm)**, 4.7 LPM maximum flow rate, spray head, 60" (1524 mm) flexible metal hose, wall supply elbow with flange, in-line vacuum breaker.
3. **Watts #FD-100-C-A Floor Drain**, epoxy coated cast iron, anchor flange, 5" (127 mm) adjustable round nickel bronze strainer, reversible clamping collar with primary & secondary weepholes.
4. **Provide P-Trap**, same material as the connecting pipe drain.

**2.8 TWO COMPARTMENT STAINLESS STEEL SINK (S1) (KITCHEN)**

1. **Franke Commercial #LBD6408-1/3 Double bowl countertop mount sink**, 3 hole, 8" (203mm) center, 521mm (20-1/2") x 794mm (31-1/4") x 203mm (8") deep, spillway, counter mounted, backledge, type 302, 20 gauge (0.9mm) stainless steel, satin finish rim and bowl, mounting kit, fully undercoated to reduce condensation and resonance, factory applied rim seal, 3-1/2" (89mm) crumb cup waste assembly with 1-1/2" (38 mm) tailpiece, or approved equal.
2. **Chicago Faucets #1100-L8-E35VP-XK Two handle faucet**, 8" (203mm) centerset, solid brass body construction, ceramic 1/4 turn cartridge, 203mm (8") swing cast brass spout. With Vandal Resistant 5.7LPM (1.5 GPM), aerator outlet, metal red and blue index buttons 51mm (2") long canopy lever handle with vandal resistant screw. **Supply Provide Faucet Supplies**, chrome finish all metal constructions, escutcheons and flexible metal risers, or approved equal.
3. **Provide P-Trap**, adjustable all metal construction, 38mm (1-1/2") size, and escutcheon.

**2.9 SINGLE BOWL KITCHEN SINK (S2)**

1. **Franke Commercial # LBS6808-1/3 Single bowl – countertop mounted sink – 18-10 type 302 20 GA Stainless steel – backledge –satin finish rim and bowls- mounting kit provided – fully undercoated to reduce condensation and resonance – factory applied rim seal – 3 1/2" crumb cup waste assembly with 1 1/2" tailpiece. Nominal Dimensions 20 1/2" x 20" x 8" deep, or approved equal.**
2. **Chicago Faucet #1100-ABCP-GN2FC-1000VP-XK two handle manual faucet**, 8" cnterset, lead free chrome plated solid brass body, ceramic 1/4 turn cartridges, 5 3/8" rigid/swing gooseneck spout, 1.6GPM max. flow pressure compensating laminar outlet, plain spout end. Metal red and blue index buttons 2" long canopy lever handles with vandal resistant screw, or approved equal.
3. **Provide Faucet Supplies**, chrome plated all metal construction, light duty residential angle stops, escutcheons and metal flexible risers.
4. **Provide P-Trap**, adjustable all metal construction, 1 1/2" size, with cleanout and escutcheon.

**2.10 SERVICE SINK (MS1)**

1. **Stern Williams #SB-900 square service / Mop sink**, 610mm (24") x 610mm (24") x 305mm (12") deep, floor mounted, terrazzo composed of pearl gray marble chips and Portland cement ground smooth, sealed to resist stain, one piece stainless steel cast integral on all sides, without tiling flange, cast brass drain with stainless steel strainer, 3"(75mm) outlet, or approved equal.
2. **Chicago Faucets #305VB-XK-369VP wall mounted Two handle manual faucet**, 8" (203mm) centerset, solid brass exposed body construction, ceramic 1/4 turn cartridge, unrestricted hose end outlet, with

body-mounted vacuum breaker, metal red and blue index buttons 60mm (2-3/8") long lever handle with vandal resistant screw, or approved equal.

3. **Stern Williams T-35 Hose and Wall Hook** hose 36" (914mm) long with 3/4" (19mm) chrome coupling, stainless steel wall bracket. **Stern Williams T-40 Mop Hanger** stainless steel #4 finish, 24" (610mm) long with 3 rubber spring loaded clips. **Stern Williams BP-224 Back Splash Panel** 20 gauge type 304 stainless steel. **Stern Williams TC-3 Gasket** 3" (76mm) for XHCl, plastic and steel pipe. All can be approved equal.
4. **Provide P-Trap**, same material as the connecting pipe drain.

#### **2.11 SERVICE SINK (MS2)**

1. **Sink will be provided by others.**
2. **Chicago Faucets #305VB-XK-369VP wall mounted Two handle manual faucet**, 8" (203mm) centerset, solid brass exposed body construction, ceramic 1/4 turn cartridge, unrestricted hose end outlet, with body-mounted vacuum breaker, metal red and blue index buttons 60mm (2-3/8") long lever handle with vandal resistant screw, or approved equal.
3. **Stern Williams T-35 Hose and Wall Hook** hose 36" (914mm) long with 3/4" (19mm) chrome coupling, stainless steel wall bracket. **Stern Williams T-40 Mop Hanger** stainless steel #4 finish, 24" (610mm) long with 3 rubber spring loaded clips. **Stern Williams BP-224 Back**. All can be approved equal. **Splash Panel** 20 gauge type 304 stainless steel. **Stern Williams TC-3 Gasket** 3" (76mm) for XHCl, plastic and steel pipe, or approved equal.
4. **Provide P-Trap**, same material as the connecting pipe drain.

#### **2.12 EMERGENCY EYE WASH WALL HUNG (EW1)**

1. **Haws 7360B-7460B-'AXION MSR™' Emergency Eye/Face Wash**, wall hung, stainless steel receptor, 'Saniguard' anti-microbial protection, antimicrobially treated Axiom MSR eye/face wash single 14 LPM (3.7 GPM) laminar inverted flow design head, volume regulator, 297 micron (50 mesh) in-line filter, in-line S.S. strainer, S.S. push handle brass ball valve with S.S. trim, all factory assembled, wall hanger and emergency sign, or approved equal.

2. **McGuire #8872C 'p' Trap**, C.P., polished, cast brass adjustable body, 1-1/4" (32mm) with cleanout plug, seamless brass wall bend and escutcheon. All exposed piping to be chrome plated. If piping length to unit is more than 50'-0" (19.7 m), provide 3/4" (19mm) CW supply, 1/2" (12.7mm) connection. 1/2" (13mm) connection and escutcheon. Eye / face wash requires min. 11.3 LPM (3.0 GPM) flow for 15 minutes. ANSI STANDARD: Outlet heads mounted between 33" (838mm) and 45" (1143mm) above floor, 6" (153mm) from wall or nearest obstruction. Provide adequate support in wall for eye wash mounting. Or approved equal.

#### **2.13 EMERGENCY EYE WASH TEMPERED WATER MIXER STATION**

1. **Haws #9201EW Emergency Supply Fixture For Eyewash/ Facewash**, thermostatic mixing valve, all brass and stainless steel design, with liquid-filled thermal motor, inlet check valves, safety shut-off should cold water supply fail, hot water failure will allow cold water flow through both the fixed and variable by-pass, outlet temperature gauge, 1/2" (12mm) NPT inlets and outlets. Tempered water factory set at 85 deg. F (29 deg.C). Or approved equal.

### **3 Execution**

#### **3.1 EXAMINATION AND PREPARATION**

- .1 Section 22 01 01: Verification of existing conditions before starting work.
- .2 Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- .3 Verify that electric power is available and of the correct characteristics.

#### **3.2 PREPARATION**

- .1 Rough-in fixture piping connections to minimum sizes indicated in fixture rough-in schedule for particular fixtures.

#### **3.3 INSTALLATION**

- .1 Install each fixture with trap, easily removable for servicing and cleaning.

- 
- .2 Provide chrome plated rigid supplies to fixtures with screwdriver stops, reducers, and escutcheons.
  - .3 Install components level and plumb.
  - .4 Install and secure floor mounted fixtures in place with bolts.
  - .4 Install and secure wall hung fixtures in place with wall carriers and bolts.
  - .5 Seal fixtures to wall and floor surfaces with sealant having VOC content not exceeding 250 g/L, colour to match fixture.
  - .6 Solidly attach water closets to floor with lag screws.

**3.4 ADJUSTING**

- .1 Section 01 78 10 - Execution Requirements: Adjusting installed work.
- .2 Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

**3.5 CLEANING**

- .1 Section 01 78 10 - Execution Requirements: Cleaning installed work.
- .2 Clean plumbing fixtures and equipment.

**3.6 PROTECTION OF FINISHED WORK**

- .1 Section 01 78 10 - Execution Requirements: Protecting installed work.
- .2 Do not permit use of fixtures.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 22 01 01.

**1.2 SECTION INCLUDES**

- .1 Anti-Scale System
- .2 Domestic Water Heater
- .3 Domestic Hot Water Re-Circulation Pump.

**1.3 RELATED SECTIONS**

- .1 Section 01 33 00 - Administrative Requirements.
- .2 Section 01 61 00 - Common Product Requirements.
- .3 Section 01 78 10 - Execution Requirements.
- .4 Section 23 05 48 - Vibration Isolation.
- .5 Section 26 05 80 - Equipment Wiring: Electrical characteristics and wiring connections.

**1.4 REFERENCES**

- .1 ASHRAE 90A - Energy Conservation in New Building Design.
- .2 ASME Section 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.

**1.5 SUBMITTALS FOR REVIEW**

- .1 Section 01 33 00: Procedures for submittals.
- .2 Product Data:
  - .1 Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
  - .2 Indicate pump type, capacity, power requirements.
  - .3 Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
  - .4 Provide electrical characteristics and connection requirements.
- .3 Shop Drawings:
  - .1 Indicate heat exchanger dimensions, size of tappings, and performance data.

**1.6 SUBMITTALS AT PROJECT CLOSEOUT**

- .1 Section 01 78 10: Procedures for submittals.
- .2 Project Record Documents: Record actual locations of components.
- .3 Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- .4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

**1.7 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Provide pumps with manufacturer's name, model number, and rating/capacity identified.
- .3 Ensure products and installation of specified products are to recommendations and requirements of the following organizations:
  - .1 National Sanitation Foundation (NSF).
  - .2 American Society of Mechanical Engineers (ASME).
  - .3 National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
  - .4 National Electrical Manufacturers' Association (NEMA).
  - .5 Underwriters Laboratories (UL).

- .6 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

## **1.8 REGULATORY REQUIREMENTS**

- .1 Conform to ASME Section 8D for manufacture of pressure vessels for heat exchangers.
- .3 Conform to ASME Section 8D for tanks.
- .4 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

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

- .1 Section 01 61 00: Transport, handle, store, and protect products.
- .2 Provide temporary inlet and outlet caps. Maintain caps in place until installation.

## **1.10 WARRANTY**

- .1 Section 01 78 10.
- .2 Provide five year manufacturer warranty for domestic water heaters packaged water heating systems in-line circulator.

## **1.11 EXTRA MATERIALS**

- .1 Section 01 78 10.
- .2 Provide two of pump seals.

## **2 Products**

### **2.1 DOMESTIC WATER HEATERS**

- .1 Manufacturer: Bradford White – Model No. E-32-120R-3. Or approved equal.
- .2 The tank shall be lined with Vitroglas vitreous enamel with anti-microbial technology.
- .3 The tank shall consist of 3 screw type elements with a combined maximum input of 18kW.
- .4 The tank shall have one anode rod.
- .5 The heater shall be insulated with not less than 2”(51mm) of non-CFC foam.
- .6 The water heater shall be equipped with an ASME rated T & P relief valve.
- .7 The water heater shall be certified at 300psi test pressure and 150psi working pressure.
- .2 Other acceptable manufacturers offering equivalent products.
  - .1 A.O.Smith
  - .2 Rheem
  - .3 GE
  - .4 Or approved equal.

### **2.4 ANTI-SCALE SYSTEM**

- .1 Manufacturer: Watts Model OF1665-75 (75 GPM) or approved equal.
- .2 Equivalent products by other manufacturers.

### **2.5 DHW RECIRCULATION PUMP P-2**

- .1 Manufacturer: Astro Model 20BU 4 USGPM @3FT HEAD, 1/25 HP 115 V – 1 PHASE or approved equal.

## **3 Execution**

### **3.1 INSTALLATION**

- .1 Install water heaters to manufacturer's instructions and to local code requirements.
- .2 Coordinate with plumbing piping and electrical services to install a complete system.
- .3 Domestic Hot Water Storage Tanks:
  - .1 Provide steel pipe support, independent of building structural framing members.

- .2 Clean and flush prior to delivery to site. Seal until pipe connections are made.
- .4 Anti-Scale System:
  - .1 Install Anti-Scale System as per manufacturers installation instructions.
- .5 DHW Re-Circulation Pump: P-2
  - .1 Install re-circulation pump as per manufacturers installation instructions.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Read and conform to:
  - .1 The General Conditions and the Supplementary Conditions of the Contract,
  - .2 Division 1 requirements and documents referred to therein.
- .2 Section 23 01 01 applies to and governs the work of all Sections of Mechanical Division.
- .3 The technical Sections of this Division are generally divided into units of work for the purpose of ready reference. The division of the work among subcontractors is not the Consultant's responsibility and the Consultant assumes no responsibility to act as an arbiter and/or to establish subcontract limits between any Sections of the work..
- .4 The specifications are integral with the drawings which accompany them. Neither is to be used alone. Any item or subject omitted from one but implied in the other is fully and properly required.
- .5 Wherever differences occur in the tender documents, the most onerous condition governs. Base the bid on the most costly arrangement.

**1.2 DEFINITIONS**

- .1 The following are definitions of words found in this specification and on associated drawings under this Division:
  - .1 "Concealed" - locations hidden from normal sight in furred spaces, shafts, ceiling spaces, walls, and partitions.
  - .2 "Exposed" - mechanical work normally visible to building occupants.
  - .3 "Furnish" - (and its derivatives) has the same meaning as the term "Supply".
  - .4 "Install" - (and its derivatives) - receive, store and handle at the site, mount and support and connect all required services. Includes adjustment and calibration, testing, commissioning, inspection by authorities having jurisdiction and documentation.
  - .5 "Provide" - (and its derivatives) - supply, install in place, connect the associated required services ready for operation, adjust and calibrate, test, commission, warrant, and document. Includes inspection by authorities having jurisdiction.
  - .6 "Supply" - (and its derivatives) purchase and deliver to the site for installation. Includes submittals, manufacturer's field inspection and warranty.
  - .7 "Wet" - locations exposed to moisture, requiring special materials and arrangement.

**1.3 WORK INCLUDED**

- .1 Products and methods mentioned or shown in the Contract Documents complete with incidentals necessary for a complete operating installation. Provide all tools, equipment and services required to do the work.
- .2 Cutting and patching of new or existing work
- .3 Excavating and backfilling
- .4 Identification of equipment, piping, ductwork, and valves and controllers
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches.
- .6 Motors required for equipment supplied under this Division.
- .7 Variable frequency drives for motors and equipment supplied under this Division.
- .8 Internal wiring, relays, contactors, switches, transformers, motor starters, and all controls necessary for the intended operation, furnished with terminals and external controls suitable for connection to power source at a single easily accessed location for equipment items that are supplied with motors and/or electrical or electronic components under this Division.
- .9 Disconnect switches for exhaust fans located on the roof complete with;
  - .1 EEMAC 1 enclosure if housed within a weatherproof cabinet,

- .2 EEMAC 3 enclosure if exposed to weather
- .10 Take such measures and include in Bid Price for the proper protection of the existing building and its finishes at all times during alterations and construction of the new addition. Coordinate this protective work with all trades.
- .11 Refer to Mechanical/Electrical Equipment Schedule for extent of wiring and electrical characteristics.
- .12 Verify the correct operation of each equipment item provided and/or altered and each system in total and obtain the Owner's approval prior to starting and/or returning to operation.

#### **1.4 RELATED WORK**

- .1 Power wiring, conduit and connections for motors under this Division will be by Division 26.
- .2 Power wiring, conduit and connections to variable frequency drives for motors under this Division will be by Division 26. Wiring and connections from VFD to motors under this Division will be by Division 26.
- .3 Flashings for mechanical equipment and services located on or passing through roofs will be provided under Division 7. Supply counter flashings, and integral flashing collars on equipment and piping under this Division.
- .4 Painting of exposed piping and ductwork other than for identification will be supplied under Division 9.
- .5 Concrete equipment bases, housekeeping pads, sump pits and trenches will be provided under Division 3.

#### **1.5 SUBMITTALS**

- .1 Approval Drawings: Prepare and submit drawings necessary for approval to any authority having jurisdiction, and obtain two (2) copies of approved drawings for retention by Consultant prior to commencement of work under this Division.
- .2 Shop Drawings: Prepare and submit two (2) copies of shop drawings of major equipment items (including those items specifically indicated under Part 1: General of each Section), to the Consultant for review. The Consultant will return one copy, marked with comments and his review stamp as he deems appropriate. Prepare the necessary number of copies of the returned set and distribute to the Owner, the Prime Consultant, the General Contractor, the site, and to subcontractors and suppliers.
  - .1 Clearly indicate manufacturer's and supplier's names, catalogue model numbers, details of construction, accurate dimensions, capacities and performance. Prior to submission check and certify as correct, shop drawings and data sheets. Do not order equipment until a copy of the shop drawings, reviewed by Consultant, has been returned to Contractor.
  - .2 Clearly indicate the weight, location, method of support and anchor point forces and locations for each piece of equipment on shop drawings.
  - .3 The Consultant will not review shop drawings that fail to bear the Contractor's stamp of approval or certification.
  - .4 Read the following in conjunction with the wording on the shop drawing review stamp applied to each and every drawing submitted:  
"This review by the Consultant is for the sole purpose of ascertaining conformance with general design concept. This review shall not mean that the Consultant approves the detail design inherent in the shop drawings, responsibility for which shall remain with the Contractor submitting same, and such review shall not relieve the Contractor of his responsibility for errors or omissions in the shop drawings or of his responsibility for meeting all requirements of the Contract Documents. The Contractor is responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for coordination of the work of all sub trades."
- .3 Sleeving Drawings: Prepare and submit 4 copies of sleeving drawings to clearly and accurately indicate the exact location, elevation and size of any and all formed holes, recesses and sleeving required in the work of Mechanical Division. Obtain Consultant's approval in writing prior to sleeving, forming or cutting any such opening. Provide a copy of approved sleeving drawings to the reinforcement detailer well in advance of planned pours.



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- .4 Composite Wiring Diagrams: Prepare and submit three (3) copies of complete composite wiring diagrams of each specific mechanical system. Indicate all electrical equipment and wiring, both internal and external, for review and coordination of trades.
  - .5 Contractor's Material and Test Certificates: Prepare and submit certificates for each system installed. Where certificates are prescribed by regulations, codes or standards ensure they conform to the requirements of those documents (eg. NFPA-standards). Include a copy of each certificate in the Operation and Maintenance manual. Certificates shall include the following:
    - .1 description of the system (description and type),
    - .2 description of the tests conducted and results observed, including re-testing, where necessary,
    - .3 description of any corrective measures undertaken,
    - .4 description of materials used (pipe and fittings),
    - .5 list of witnesses for each test conducted,
    - .6 date system left ready for service,
    - .7 signature of installing Contractor.
  - .6 Directories & Schematics
    - .1 Submit five (5) copies of a neat typewritten directory indicating the valve number, related service, and location of each valve under this Division.
    - .2 Submit five (5) copies of system control schematics for each mechanical system indicating relative locations of equipment and control devices.
    - .3 Enclose one (1) copy of each directory/schematic under glass in a neat polished 18" x24" (460 mm x 610 mm) metal frame, complete with mounting clips.
  - .7 Maintenance Data and Operating Instructions
    - .1 Submit three (3) copies of Operation and Maintenance Manual individually bound in hard backed three-ring binders.
    - .2 Ensure the binder spines have typewritten lettering as follows:

**OPERATION & MAINTENANCE MANUAL**  
for  
[Insert name of project]  
[Insert date of submission]  
[Insert Division Title]
    - .3 Provide a list of names, addresses and telephone numbers of equipment suppliers, installing contractors, general contractors, architect and Consultant. Include special telephone numbers for service departments on normal and emergency call basis.
    - .4 Provide descriptive literature (shop drawings) of each manufactured item. Include a bill of material with purchase order numbers and vendor's identification of equipment orders for each item.
    - .5 Include copies of start-up reports and checklists and all certificates issued with respect to this contract.
    - .6 Ensure operating instructions include the following:
      - .1 General description of each mechanical system.
      - .2 Step by step procedure to follow in putting each piece of equipment into service.
      - .3 Schematic control diagrams for each separate mechanical system, control thermometers, freezestats, firestats, pressure gauges, automatic valves, and refrigeration accessories. Mark correct operating settings for each control device on these diagrams.
      - .4 Diagram of the electrical control system indicating the wiring of all related electrical components such as PE and EP switches, firestats, freezestats, fuses, interlocks, electrical switches and relays.
      - .5 Drawings of each control panel including temperature control and electrical panels, completely identifying all components on the panels and their function.
    - .7 Ensure maintenance instructions include the following:
      - .1 Manufacturer's maintenance instructions for each item of mechanical equipment installed under this Division. Instructions shall include installation instructions, parts numbers and lists, name of supplier and maintenance and lubrication instructions.

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.2 Summary list of each item of mechanical equipment requiring lubrication,

- indicating the name of the equipment item, location of all points of lubrication, type of lubricant recommended, and frequency of lubrication.
- .3 Equipment directory indicating name, model, serial number and nameplate data of each item of equipment supplied, and system with which it is associated.
- .4 Balancing and testing reports.
- .5 Copy of valve directory.
- .8 As-Built Records: Prepare and submit complete as-built records prior to Substantial Performance of the Contract. Refer to paragraph 3.2.5 and to Division 1 for requirements.
- .9 Requests for Shut-Down: Obtain permission for systems shut-down and/or service interruption from the Owner prior to disruption of any system or service in use by the Owner. Employ the Owner's standard form of request where available. Refer to Division 1 for additional requirements.
- .10 Requests for Start-up: Obtain permission from the Owner to start-up or to return to service any item of equipment, system or service installed new or previously shut-down. Refer to Division 1 for additional requirements.

## 1.6 QUALITY ASSURANCE

- .1 Conform to minimum requirements or better of provincial and local codes, where existing, and to requirements of local inspection authorities for execution of work under this Division.
- .2 Ensure materials supplied under this Division conform to minimum requirements and recommendations or better of applicable standards of the following:
- |     |        |  |
|-----|--------|--|
| .1  | AABC   | Associated Air Balance Council   |
| .2  | AMCA   | Air Moving and Conditioning Association                                    |
| .3  | ANSI   | American National Standards Institute                                      |
| .4  | ASA    | American Standards Association   |
| .5  | ASHRAE | American Society of Heating, Refrigerating, and Air Conditioning Engineers |
| .6  | ASME   | American Society of Mechanical Engineers                                   |
| .7  | ASSE   | American Society of Sanitary Engineers                                     |
| .8  | ASPE   | American Society of Plumbing Engineers                                     |
| .9  | ASTM   | American Society of Testing and Materials                                  |
| .10 | AWWA   | American Water Works Association   |
| .11 | CAN2   | National Standard of Canada (Published by CGSB)                            |
| .12 | CAN3   | National Standard of Canada (Published by CSA)                             |
| .13 | CGSB   | Canadian General Standards Board   |
| .14 | CSA    | Canadian Standards Association   |
| .15 | EEMAC  | Electrical & Electronic Manufacturer's Association of Canada               |
| .16 | NBC    | National Building Code of Canada   |
| .17 | NEBB   | National Environmental Balancing Bureau                                    |
| .18 | NFPA   | National Fire Protection Association                                       |
| .19 | NEMA   | National Electrical Manufacturers Association                              |
| .20 | OBC    | Ontario Building Code  |
| .21 | OFC    | Ontario Fire Code  |
| .22 | OFM    | Ontario Fire Marshall  |
| .23 | SMACNA | Sheet Metal & Air Conditioning Contractors National Association            |
| .24 | TIAC   | Thermal Insulation Association of Canada                                   |
| .25 | ULC    | Underwriter's Laboratories of Canada Ltd                                   |
| .26 | UL     | Underwriter's Laboratories (including cUL)                                 |
- .3 Use latest editions and amendments in effect on date of Bid call subject to requirements of OBC.
- .4 Arrange and pay for permits and inspections by authorities having jurisdiction, required in the undertaking of this Division. Make modifications required by authorities.
- .5 All tradesmen employed on the project shall hold valid trade certificates/licenses and shall make a copy available for review by the Consultant and/or Owner when requested.
- .6 All welding and brazing shall be executed by certified welders in accordance with registered procedures.

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- .7 All refrigeration work shall be executed only by mechanics with valid ODP cards.

**1.7 PRODUCT DELIVERY, HANDLING AND STORAGE**

- .1 Immediately after letting of contract, review material and equipment requirements for this work, determine supply and delivery dates for all items, and notify Consultant of any potential delays in completion of this project in order that remedial action may be taken.
- .2 Store neatly out of the way and protected from damage and theft, materials and equipment supplied under this Division that are received at the site by this Division.

**1.8 JOB CONDITIONS**

- .1 Visit site and examine existing conditions which may affect work of this Division.
- .2 Examine all Contract Documents to ensure that work of this Division may be satisfactorily completed.
- .3 Notify Consultant upon discovery of conditions which adversely affect work of this Division. No allowance will be made after letting of contract for any expenses incurred through failure to do so.
- .4 Submission of a bid confirms that the Contract Documents and site conditions are accepted without qualifications, unless exceptions are specifically noted in the Bid.

**1.9 INTERRUPTIONS**

- .1 Arrange execution of work to maintain present building operations, and to minimize the effect of work under this Division on existing operations.
- .2 Prior to interrupting any existing service notify the Owner and Consultant, in writing, at least 7 days in advance, and obtain written authorization. Do not interrupt any existing service without Consultant's specific authorization. Refer to Division 1 for requirements.
- .3 Arrange time and duration of interruption through the Owner's Physical Plant Department. Include in Bid Price for all overtime or premium time hours necessary to minimize duration of service interruption.
- .4 Test and verify the proper operation of existing equipment and systems that are shut down due to work of this project, prior to returning to service.
- .5 Assume responsibility for consequential costs on failure to obtain permission to shut-down and/or start-up any item of equipment, system or service.

**1.10 WARRANTY**

- .1 Refer to Division 1 and to Section 23 01 01 General Requirements.
- .2 Arrange with each manufacturer/supplier to extend warranties as necessary to coincide with warranty period or those periods specified.
- .3 Make submissions necessary to register product warranties to the benefit of the Owner.
- .4 Submit to Consultant, prior to Substantial Performance of the Contract, manufacturer's written warranties covering periods longer than one year or offering greater benefits than required in specifications and in the Owner's name.

**1.11 EXTRAS AND CREDITS**

- .1 Accompany all price submissions requested by Consultant for extra work, or work to be deleted, with a complete cost breakdown as follows:
- .1 Materials, quantities and unit costs including any applicable contractors trade discount clearly identified.
- .2 Labour hours and unit costs.
- .3 Total materials and labour costs.
- .4 Overhead and profit mark-ups in accordance with the General Conditions of the Contract.

**2 Products**

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## **2.1 MATERIALS AND EQUIPMENT**

- .1 Ensure materials and equipment provided under this Division are new and free from defects and bear labels of approval as required by codes referred to in this Division and/or by inspection authorities.
- .2 Ensure apparatus and equipment provided under this Division bears manufacturer's nameplate indicating name of manufacturer, model number or type, size, capacity, CRN, and other pertinent information. Ensure nameplates are easily read and clearly visible, with openings provided where equipment is insulated.
- .3 Ensure manufacturers and suppliers of equipment or materials under this Division determine if their products are composed of any hazardous materials. If they are, the products are suitably labeled and supplied with Material Safety Data sheets. Obtain the Owner's approval in writing to bring hazardous materials onto the site prior to doing so.
- .4 When utilizing any products that are hazardous, keep Material Safety Data sheets on file at the job site and present them to anyone requesting this information. When transferring hazardous materials from original container into other containers, provide Workplace Labels on such containers.

## **2.2 MOTOR STARTERS & CONTROLS**

- .1 Mechanical Division shall provide all motor starters and associated controls required and as scheduled on drawings and noted for Mechanical Division equipment. Starters and controls shall be Canadian General Electric or Alternate noted. All starters, contactors, thermal overloads, etc. must be EEMAC rated. All starters shall be of one manufacturer except as specifically approved otherwise for integral pre-wired assemblies.
- .2 Starter and control units shall be equipped with necessary number of auxiliary contacts and relays to provide control sequences described in Mechanical Equipment Starter Schedule on Drawings. Auxiliary contacts shall be interchangeable normally open or normally closed, by conversion in field without additional parts exterior to starter.
- .3 Manual starters may only be provided for single phase equipment operated by control device such as thermostat or limit control when such control device is rated for full electrical load of equipment.
- .4 Manual starters provided for single phase equipment actuated by electric timer or shall have H.O.A. feature. "Hand" position shall permit shunting of time switch. Where such units also have protective device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" positions and shall not be shunted.
- .5 Manual starters may only be provided for three phase equipment which is not actuated by pilot control device (pressure switch, float switch, safety limit devices, remote manual control device) unless otherwise noted in Starter Schedule.
- .6 Magnetic starters for manually operated equipment shall have "On/Off" selector switch or "Start-Stop" pushbutton in cover as scheduled.
- .7 Magnetic starters which are started automatically by electric time switch shall include "Hand-Off-Automatic" (H.O.A.) selector switch. "Hand" position shall permit shunting of time switch or E.M.S. Where such units also have protective pilot device (e.g. firestat) such device shall be wired into both "Hand" and "Auto" position and shall not be shunted.
- .8 Magnetic starters which are started automatically by remote pilot device (or interlocked units) such as level controller, pressure switch, thermostat or flow switch shall include "Hand-off-Auto" (H.O.A.) selector switch, and, where scheduled, a "Test" pushbutton. "Hand" position shall permit shunting of remote pilot device and thereby permit operation of starter but only while depressing "Test" button.
- .9 Equip starter apparatus for prime plumbing, heating, air conditioning and ventilating equipment so that these units will automatically restart on resumption of power after power outage. Starters for these units shall have "On/Off" selector switch in cover if not fitted with H.O.A. selector feature or manual starter or otherwise noted.
- .10 Safety control device such as flow switches, pressure switches, high and low limited ("Fire" and "Freeze") shall not be shunted by "Hand" position of switch.
- .11 Manual motor starter shall be toggle operated with following general construction features:
  - Quick-Make, Quick-Break mechanism with double-break contacts.
  - Overload protection heaters, one per phase and speed.

- 
- Enclosure to suit application.
  - Pilot light, neon lamp.
  - Cover engraved with "On-Trip-Off".
- .12 Magnetic motor starters shall comprise electrically-operated motor starters combined with disconnect switch with following general construction features:
- Quick-Make, Quick-Break mechanism with double-break contacts.
  - Fuse holders to accept specified fuses, one per phase.
  - Adjustable overload relays, one per phase.
  - CEMA listed enclosure to suit application. Disconnect with mechanical cover interlocks, line side barriers and switch operated electrical interlocks to disconnect external control voltage unless starter includes suitable approved enclosed contacts and connections.
  - "Reset" button.
  - Pilot Lights of transformer type incandescent with amber safety lens cap.
  - Control transformer with 120 volt fused secondary and sized to suit current rating of associated control devices.
  - Scheduled cover mounted control devices with standard duty double break contact blocks.
  - Minimum of two auxiliary contacts (unused "Seal-in" contact may be included).
- .13 Contactors for non-motor applications shall be built similar to combination magnetic starters, except less overload relays, and with Gould Shawmut AJT or approved equivalent time delay HRC1-J fuses, rated for load, and with enclosed continuous current rating of at least 125% of connected full load.
- .14 "Double Voltage Relays" shall be CGE Model CR120 LXMC with general purpose enclosure, number of contacts required and "Mylar" shroud of enclosure of contacts, or approved equivalent.
- .15 Pilot devices such as "Start-Stop" pushbuttons, "Hand-Off-Auto" selector switches and indicating lights shall be of heavy-duty construction. Indicating lamps shall be transformer type incandescent with amber safety lens caps.
- .16 Each control unit shall be provided with engraved nameplates for designation of device controlled and duty. See Subsection "Equipment Markers & Nameplates" for details.
- .17 Control wiring shall be 120 volt A.C. maximum. Provide control circuit transformers where these are not included in motor starters. Secondaries of control transformers shall be fused with one side grounded and controls, safety devices and interlocks shall be connected in ungrounded conductor, excepting only integral starter overload devices.
- .18 Single phase motors interlocked to start or operate with other equipment shall be provided with magnetic starters or suitable relays with necessary auxiliary contacts and double voltage relays or be otherwise electrically separated.
- .19 Overload relay heaters for starters shall be selected and field adjusted to trip at maximum value of 115% of actual nameplate full load amperes. Selection of heater elements shall be based on starter manufacturer's recommendations. Obtain data from Mechanical Division. Submit Motor Starter Schedule which shall list following for each motor:
- Proposed equipment nameplate data
  - Actual full load amperes of motor
  - Speed of motor
  - Temperature Class in degrees Celsius rise and insulation class.
  - Circuit breaker or fuse type and proposed rating
  - Type of motor, duty and service factor.
- .20 Overload relay heaters shall trip in 20 seconds or less from cold or motor-locked rotar condition.
- .21 Where equipment is noted to be electrically interlocked, provide necessary interlocks, double voltage relays (Mylar shroud accepted) to provide specified operation.
- .22 Provide all fuses required to protect equipment. Fuses shall be proper size blade type time delay HRC1-J current limiting. Supply three spare fuses of each size and type and obtain duplicate receipt for same. Fuse clips shall reject standard NEC fuses. Fuses shall be rated in accordance with manufacturer's published data. Fuses to be of one manufacturer throughout.
- .23 Acceptable Alternate Manufacturers

1. Furnas Electric
2. Westinghouse
3. Allen Bradley
4. Square 'D'
5. Cutler Hammer
6. Klockner-Moeller.
7. Commander
8. Telemecanique
9. Or approved equivalent

## **2.3 EQUIVALENTS AND ALTERNATIVES**

- .1 Refer to the procurement documents.

## **2.4 SUBSTITUTIONS DURING PROGRESS OF WORK**

- .1 If during the progress of work, specified products are not obtainable, equivalent or similar products by other manufacturers may be permitted by Consultant.
- .2 Apply, in writing, to consultant for substitution of any products, indicating the following:
  - .1 Manufacturer's name, model number, details of construction, accurate dimensions, capacities and performance of proposed products.
  - .2 Reason for substitution.
  - .3 Any revisions to the contract price made necessary by substitution.
  - .4 Any revisions to the contract time made necessary by substitution.
  - .5 Any revisions to layout, arrangement or services made necessary by substitution.
- .3 No substitutions will be permitted without written authorization from the Consultant.

## **2.5 CONSULTANT'S REVIEW**

- .1 The consultants will review and evaluate unsolicited alternatives and substitutions proposed by the Contractor. Such review and evaluation work will be undertaken by the Consultant on an additional fee basis. The Contractor shall reimburse the Owner for all costs associated with such reviews and evaluations.
- .2 The Contractor shall also reimburse the Owner for any and all costs incurred in updating Contract. Documents to reflect such changes.

## **3 Execution**

### **3.1 RELATIONSHIP WITH OTHER TRADES**

### **3.2 INSTALLATION REQUIREMENTS**

- .1 The Consultant's drawings and instructions govern the location of all items. Prepare fully coordinated installation drawings prior to installation.
- .2 Install equipment neatly to the satisfaction of the Consultant. Unless noted otherwise install products and services to follow building planes. Ensure installation permits free use of space and maximum headroom.
- .3 Confirm the exact location of outlets, fixtures and connections. Confirm location of outlets for equipment supplied under other Divisions.
- .4 Install equipment and apparatus to allow free access for maintenance, adjustment and eventual replacement.
- .5 Install metering and/or sensing devices to provide proper and reliable sampling of quantities being measured. Install instruments to permit easy observation.
- .6 Provide suitable shielding and physical protection for devices.
- .7 Install products and services in accordance with the manufacturer's requirements and/or recommendations.

- .8 Provide bases, supports, hangers and fasteners. Secure products and services so as not to impose undue stresses on the structure and systems.
- .9 Do not use powder activated tools except as permitted by the Prime Consultant and the Owner's workplace health and safety policies.
- .10 Ensure that the load onto structures does not exceed the maximum loading per square metre indicated on the structural drawings or as directed by the Consultant.

### **3.3 CONTRACT DRAWINGS**

- .1 The drawings of this Division are performance drawings and indicate general arrangement of the work. They are diagrammatic except where specific details are given.
- .2 Obtain accurate dimensions from the architectural and structural drawings, or by measurement. Location and elevation of services are approximate. Verify them before construction is undertaken.
- .3 Make changes where required to accommodate structural conditions, (beams, columns, etc.).
- .4 Obtain Consultant's approval before proceeding.
- .4 Adjust the location of materials and/or equipment as directed without adjustment to contract price, provided that the changes are requested before installation and do not affect material quantity. Note that outlets and/or equipment may be relocated up to 10 feet (3 m) in any direction without a change to the contract price.
- .5 Note that the layout and orientation of the ceiling outlets on the architectural reflected ceiling drawings may differ from that shown on the mechanical drawings. Make the installation in accordance with the latest architectural ceiling drawings. Provide the equipment as specified and/or shown on the documents of this Division.
- .6 The drawings of this Division are intended for tender pricing. The quantities and quality to be included in the bid price shall be based on the layout and specifications as shown on the mechanical documents. If there is a difference in quantity between the architectural and drawings of this Division, base the contract price on the greater quantity.
- .7 Prepare installation (construction) drawing to reflect the latest architectural ceiling layout.

### **3.4 CONSTRUCTION DRAWINGS**

- .1 Prepare fully dimensioned drawings showing devices, fixtures, equipment, outlets, sleeves and openings through structure. Indicate locations and weights on load points.
- .2 Prepare fully dimensioned construction drawings of products and services suitably interfaced with work of the sub-trades, in mechanical rooms, service and ceiling spaces, and other critical locations. Coordinate the work with other divisions. Base drawings on reviewed shop drawings and latest architectural drawings. Indicate details pertaining to the following: access, clearances, cleanouts, sleeves, electrical connections, drain locations and elevation of pipes, ducts, conduits.
- .3 Prepare drawings of pits, curbs, sills, equipment bases, anchors, inertia slabs, etc.
- .4 Submit construction drawings to other Divisions. Provide one (1) transparency and four (4) print copies of construction drawings to the Consultant for record purposes.
- .5 Submit construction drawings prior to commencement of work.

### **3.5 RECORD DRAWINGS**

- .1 Maintain project "as-built" record drawings. Obtain white prints from the Consultant for this purpose and pay printing costs. Identify each set as "Project Record Copy".
- .2 Record deviations from contract documents caused by site conditions or by changes ordered by the Consultant. Record deviations in red ink clearly and accurately, using industry standard drafting procedures consistent with quality and standards of Consultants documents.
- .3 Record deviations as work progresses throughout the execution of this contract. Maintain record drawings on site in clean, dry, legible condition, making them available for periodic review by the Consultant.



- .4 Record location of concealed services, particularly underground services. Before commencing any backfilling, obtain accurate measurements and information concerning correct location and depth of services.
- .5 Transfer records from the "Project Record Copy" to a DVD in Autocad format matching the Consultant's documents. Arrange computer file in layers to exactly match the layering system of the Consultant.
- .6 Submit the "Project Record Copy" on one or more DVD with white prints of each drawing to the Consultant at the time of Substantial Performance.

### **3.6 USE OF EQUIPMENT**

- .1 For the duration of this contract, do not use any piece of equipment provided under this contract for the purposes of heating, ventilation or air conditioning without the specific authorization of the Owner and Consultant. Ensure the building is "broom clean" and painting is finished before asking permission for testing to commence.
- .2 Where specific written authorization is given for the use of equipment while work is still in progress, seal off ductwork, grilles, diffusers, and registers or other openings to the air distribution systems or air handling equipment that is not in use. Provide filters over openings in ductwork, over grilles, diffusers and registers and in or at any air handling equipment that is in use. Ensure that the

edges are sealed so that the filters are not bypassed. Change the filters frequently, to the satisfaction of the Consultant, until the building is turned over the Owner.

### **3.7 SPECIAL TOOLS AND SPARE PARTS**

- .1 Within 30 days of award of contract, prepare a complete itemized list of special tools and spare parts and submit to Consultant for review. List will be used as a checklist and should include provision for sign off by the Owner on receipt.
- .2 On completion of the project furnish spare parts to the Owner as follows:
  - .1 One set of mechanical seals for each pump.
  - .2 One casing joint gasket for each pump.
  - .3 One head gasket for each heat exchanger.
  - .4 One glass for each gauge glass installed.
  - .5 One set of v-belts for each piece of machinery.
  - .6 One set of new filters for each filter bank installed.
- .3 Identify spare parts containers as to contents and replacement parts number.
- .4 Provide one set of special tools required to service equipment as recommended by manufacturers.
- .5 Furnish one grease gun and adaptors to suit different types of grease and fittings.

### **3.8 TRAINING**

- .1 Instruct and familiarize Owner's operating personnel with the various mechanical systems. Arrange training for each system separately.
- .2 Provide training for each system on two separate occasions, coordinated with the Owner's staff operating schedule, in order that interested personnel may arrange to attend.
- .3 Ensure each training period includes, but is not limited to the following;
  - .1 a classroom seminar with operating manuals, product and system drawings and such other audio/visual aids as may be appropriate,
  - .2 instruction during the classroom seminar by the manufacturer's representative regarding the proper operating and maintenance procedures for each item of equipment,
  - .3 demonstration of the proper operating procedures for each item of equipment,
  - .4 explanation of the purpose and function of all safety devices provided,
  - .5 demonstration of all measures required for safe and proper access for operation and maintenance.
- .4 Provide a period of follow-up instruction (on two occasions) approximately one month after completing Owner's instruction to clarify and reinforce earlier instructions.

- .5 Submit a letter from the Owner's management staff indicating the instruction has been given satisfactorily to the Consultant prior to substantial completion of the project.

### **3.9 START UP AND COMMISSIONING**

- .1 The Contractor shall start-up and completely commission all equipment and systems installed and/or modified under this contract. Commissioning work shall be completed to the satisfaction of the Consultant prior to acceptance of the Work or any part thereof.
- .2 The Startup and Commissioning Team shall be comprised of;
  - .1 The individual, company or agency undertaking the work of each Section,
  - .2 Representatives of the Contractor and his sub-contractors as required,
  - .3 Representatives of equipment manufacturers,
  - .4 Representatives of the Consultants,
  - .5 Representatives of the Owner.
- .4 The Contractor and his sub-contractors shall each assign an individual representing each of the relevant trades to the startup and commissioning team and shall ensure that representatives of the equipment manufacturers are present during the relevant commissioning tasks.
- .5 The Contractor shall provide all necessary labour, materials, equipment, testing apparatus and incidentals necessary to completely start-up, verify, test and commission each system provided as part of the Work.
- .6 Each Section shall prepare Check Sheets in accordance with the standards listed above and shall issue them to the commissioning team for use during the commissioning process.
- .7 Three (3) copies of commissioning manuals shall be provided, bound in hard cover D-ring binders with transparent cover on front and spine personalized to indicate;
  - .1 name and logo of Facility,
  - .2 name of the project,
  - .3 the Owner's project number,
  - .4 identification of the system commissioned,
  - .5 the date that the system was commissioned.
- .8 Commissioning manuals shall include machine printable index dividers to organize each manual by system and by commissioning stage.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

**1.2 SECTION INCLUDES**

- .1 Pipe and equipment hangers and supports.
- .2 Equipment bases and supports.
- .3 Sleeves and seals.
- .4 Flashing and sealing equipment and pipe stacks.

**1.3 REFERENCES**

- .1 ASME B31.1 - Power Piping.
- .2 ASME B31.2 - Fuel Gas Piping.
- .3 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- .4 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .5 MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- .6 MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- .7 MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- .8 NFPA 13 - Installation of Sprinkler Systems.
- .9 NFPA 14 - Installation of Standpipe, Private Hydrants, and Hose Systems.
- .10 UL 203 - Pipe Hanger Equipment for Fire protection Service.

**1.4 SUBMITTALS**

- .1 Section 23 01 01: Procedures for submittals.
- .2 Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- .3 Product Data: Provide manufacturers catalogue data including load capacity.
- .4 Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- .5 Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

**1.5 REGULATORY REQUIREMENTS**

- .1 Conform to CSA B-51 for support of piping.

**2 Products**

**2.1 PIPE HANGERS AND SUPPORTS**

- .1 Manufacturers:
  - .1 Anvil
  - .2 Myat
  - .3 Hunt
  - .4 Or approved equal.
- .2 Plumbing Piping:
  - .1 Conform to CSA B-51 and ASME B31.1
  - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
  - .3 Hangers for Cold Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
  - .4 Hangers for Hot Pipe Sizes 2" to 4" (50 to 100 mm): Carbon steel, adjustable, clevis.
  - .5 Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
  - .6 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .7 Multiple or Trapeze Hangers for Hot Pipe Sizes 6" (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

- .8 Wall Support for Pipe Sizes to 3" (76 mm): Cast iron hook.
- .9 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
- .10 Wall Support for Hot Pipe Sizes 6" (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
- .11 Vertical Support: Steel riser clamp.
- .12 Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .13 Floor Support for Hot Pipe Sizes to 4" (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
- .14 Floor Support for Hot Pipe Sizes 6" (150 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
- .15 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- .3 Refrigerant Piping:
  - .1 Conform to ASME B31.5.
  - .2 Hangers for Pipe Sizes 1/2" to 1-1/2" (13 to 38 mm): Carbon steel, adjustable swivel, split ring.
  - .3 Hangers for Pipe Sizes 2" (50 mm) and Over: Carbon steel, adjustable, clevis.
  - .4 Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - .5 Wall Support for Pipe Sizes to 3" (75 mm): Cast iron hook.
  - .6 Wall Support for Pipe Sizes 4" (100 mm) and Over: Welded steel bracket and wrought steel clamp.
  - .7 Vertical Support: Steel riser clamp.
  - .8 Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - .9 Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

## **2.2 ACCESSORIES**

- .1 Hanger Rods: galvanized, carbon steel continuous threaded.
- .2 Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## **2.3 EQUIPMENT ROOF CURBS**

- .1 Fabrication: Welded 0.05" (1.2 mm) galvanized steel shell and base, mitred 3" (75 mm) cant, variable step to match roof insulation, factory installed wood nailer.

## **2.4 ROOFTOP PIPE/DUCT SUPPORTS**

- .1 Acceptable manufacturers;
  - .1 Portable Pipe Hangers, Inc.
  - .2 Unistrut.
  - .3 Or approved equal.
- .2 Pre-engineered pipe/duct support system including;
  - 1. Bases: weather resistant and UV radiation resistant with seismic attachments
  - 2. Framing: 1-5/8" (41.3mm) strut or 1-7/8" (47.6mm) strut, fabricated of steel to ASTM A570, Grade 33., roll formed of 12-gauge (2.7mm thick) steel into 3-sided or tubular shape.
  - 3. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69, fabricated of carbon steel. Single roller supports for piping subject to expansion and contraction.
  - 4. Finishes:
    - .1 Plastics as moulded with UV radiation protection.
    - .2 Metal surfaces hot dip galvanized free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets and other surface blemishes. Galvanizing shall conform to ASTM A123 for tubing and to ASTM A153 for hardware and accessories.
  - .5 Shop Drawings: Manufacturer to provide detailed shop drawings to indicate layout and supporting capacities of system components with installation and assembly instructions for

each application. Shop drawings shall bear the signature and seal of a professional engineer licenced in Ontario.

### **3 Execution**

#### **3.1 INSTALLATION**

- .1 Install to manufacturer's instructions and best trade practices.

#### **3.2 INSERTS**

- .1 Provide inserts for placement in concrete formwork.
- .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
- .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

#### **3.3 PIPE HANGERS AND SUPPORTS**

- .1 Support horizontal piping in accordance to code requirements. Where there are no code requirements support as scheduled below.
- .2 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
- .3 Place hangers within 12" (300 mm) of each horizontal elbow.
- .4 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment.
- .5 Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
- .6 Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
- .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- .8 Support riser piping independently of connected horizontal piping.
- .9 Provide copper plated hangers and supports for copper piping.
- .10 Design hangers for pipe movement without disengagement of supported pipe.
- .11 Prime coat exposed steel hangers and supports. Refer to Section 09 91 10. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

#### **3.4 EQUIPMENT BASES AND SUPPORTS**

- .1 Provide housekeeping pads of concrete, minimum 4" (100 mm) thick and extending 6" (150 mm) beyond supported equipment. **Refer to Section 03 30 00.**
- .2 Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- .3 Construct supports of steel members. Steel pipe and fittings. Brace and fasten with flanges bolted to structure.
- .4 Provide rigid anchors for pipes after vibration isolation components are installed.

#### **3.5 ROOFTOP PIPE/DUCT SUPPORT**

- .1 Coordinate installation of supports and bases with roofing work. Ensure that roofing surfaces are smooth and flat and are ready to receive work.
- .2 Use care in installation of support systems not to damage roofing, flashing, equipment or related materials.
- .3 Install and secure support systems in strict accordance with manufacturer's written instruction.
- .4 Consult manufacturers of roofing system to determine if walk pads are required. Provide and fully adhere walk pads to roof system where required.
- .5 Bases and support framing shall be located as indicated on shop drawings provided by support system manufacturer and as specified herein. The support of all piping shall be complete and adequate, whether or not all required devices are shown.
- .6 The use of wood or wire for supporting piping will not be permitted.

- .7 Deflection of pipes shall not exceed 1/240th of the span.
- .8 Accurately locate and align bases. Where applicable, replace gravel around bases. Set framing posts into bases and assemble framing structure as indicated.
- .9 Use galvanized fasteners for galvanized framing, and use stainless steel fasteners for stainless steel framing.

### 3.6 FLASHING

- .1 Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- .2 Flash vent and soil pipes projecting 3" (75 mm) minimum above finished roof surface with lead worked 1" (25 mm) minimum into hub, 8" (200 mm) minimum clear on sides with 24" x 24" (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counterflash, and seal.
- .3 Flash floor drains in floors with topping over finished areas with lead, 10" (250 mm) clear on sides with minimum 36" x 36" (910 x 910 mm) sheet size. Fasten flashing to drain clamp device.
- .4 Seal roof, floor, shower and mop sink drains watertight to adjacent materials.
- .5 Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed to manufacturer's instructions for sound control.
- .6 Provide curbs for mechanical roof installations 14" (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- .7 Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

### 3.7 SLEEVES

- .1 Set sleeves in position in formwork. Provide reinforcing around sleeves.
- .2 Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- .3 Extend sleeves through floors 1" (25 mm) above finished floor level. Caulk sleeves.
- .4 Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing insulation and caulk. air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- .5 Install chrome plated steel escutcheons at finished surfaces.

### 3.8 SCHEDULES

- .1 Imperial Measure (IP)

Pipe Size(in)	Rod Diameter (in)	Support Spacing (Ft)	
		Steel Pipe	Copper Tube
1/2	3/8	7	6
3/4	3/8	7	6
1	3/8	7	6
1-1/4	3/8	7	6
1-1/2	3/8	9	8
2	3/8	10	9
2-1/2	3/8	12	10
3	3/8	12	10
4	5/8	14	12
6	7/8	17	
8	7/8	19	
10	7/8	21	
12	7/8	23	
14	1	25	
16	1	27	
18	1	28	

.2      Metric Measure (SI)

Pipe Size(mm)	Rod Diameter (mm)	Support Spacing (m)	
		Pipe	Steel Copper Tube
13	10	2.1	1.8
20	10	2.1	1.8
25	10	2.1	1.8
32	10	2.1	1.8
38	10	2.7	2.4
50	10	3	2.7
65	10	3.6	3
75	10	3.6	3
100	16	4.2	3.6
150	22	17	
200	22	5.7	
250	22	6.4	
300	22	7	

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

**1.2 SECTION INCLUDES**

- .1 Vibration control of piping, ductwork and equipment.  
.2 Inertia bases.

**1.3 REFERENCES**

- .1 Ontario Building Code.  
.2 SMACNA "HVAC Duct Construction Standards"

**1.4 PERFORMANCE REQUIREMENTS**

- .1 Provide vibration isolation on motor driven equipment over 0.35 kW, plus connected piping and ductwork.  
.2 Provide minimum static deflection of isolators for equipment as indicated.  
.1 Upper Floors, Normal  
.1 Under 400 rpm: 1-1/2" (40 mm)  
.2 400 - 600 rpm: 3-1/2" (90 mm)  
.3 600 - 800 rpm: 2" (50 mm)  
.4 800 - 900 rpm: 1" (25 mm)  
.5 1100 - 1500 rpm: 1/2" (12 mm)  
.6 Over 1500 rpm: 1/4" (5 mm)  
.3 Use concrete inertia bases for fans having static pressure in excess of 3.4 IN. WG (0.85 kPa) or motors in excess of 40 HP (30 kW), and on base mounted pumps over 10 HP (7.5 kW).  
.4 Provide seismic restraints in accordance with Ontario Building Code requirements for Post Disaster Buildings. Seismic restraints shall be designed, installed and reviewed under the direct supervision of a professional engineer licensed in the Province of Ontario.

**1.5 SUBMITTALS**

- .1 Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each.  
.2 Product Data: Provide schedule of vibration isolator type with location and load on each.  
.3 Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.  
.4 Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

**1.6 PROJECT RECORD DOCUMENTS**

- .1 Record actual locations of hangers including attachment points.

**1.7 Copy of REFERENCES**

- .1 AGA Z21.22 - Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems.  
.2 ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.  
.3 ASME B16.3 - Malleable Iron Threaded Fittings.  
.4 ASME B16.4 - Grey Iron Threaded Fittings.  
.5 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.  
.6 ASME B16.22-2001 (R2005) - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.  
.7 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings - DWV.  
.8 ASME B16.26 - Copper Alloy Bronze Fittings for Flared Copper Tubes.  
.9 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.  
.10 ASME B16.32 - Cast Copper Alloy Solder Joint Fittings for Solvent Drainage Systems.  
.11 ASME B31.1 - Power Piping.



- .12 ASME B31.2 - Fuel Gas Piping.
- .13 ASME B31.9 - Building Services Piping.
- .14 ASTM A47/A47M - Ferritic Malleable Iron Castings.
- .15 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .16 ASTM A74 - Cast Iron Soil Pipe and Fittings.

## **1.8 SUBMITTALS FOR REVIEW**

- .1 Section 01 33 00: Submission procedures.
- .2 Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.

## **1.9 QUALITY ASSURANCE**

- .1 Products of This Section: Manufactured to ISO 9000 certification requirements.
- .2 Perform Work to Province of Ontario, standards. Maintain one copy on site.
- .3 Valves: Manufacturer's name and pressure rating marked on valve body.
- .4 Welding Materials and Procedures: Conform to ASME SEC IX and applicable provincial labour regulations.
- .5 Welder's Certification: To ASME SEC IX.
- .6 Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

## **1.10 REGULATORY REQUIREMENTS**

- .1 Perform Work to applicable Province of Ontario plumbing code.
- .2 Conform to applicable code for installation of backflow prevention devices.
- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

## **2 Products**

### **2.1 MANUFACTURERS**

- .1 Manufacturer shall be a member of VISCMA.
- .2 Coordinate selection of Manufacturer with Section 15191.
- .3 Acceptable manufacturers;
  - .1 Vibron/Kinetics.
  - .2 VAW Systems.
  - .3 Korfund
  - .4 Masdom
  - .5 Or approved equal.

### **2.2 INERTIA BASES**

- .1 Structural Bases:
  - .1 Design: Sufficiently rigid to prevent misalignment or undue stress on machine, and to transmit design loads to isolators and snubbers.
  - .2 Construction: Welded structural steel with gusseted brackets, supporting equipment and motor with motor slide rails.
- .2 Concrete Inertia Bases:
  - .1 Mass: Minimum of 1.5 times weight of isolated equipment.
  - .2 Construction: Structured steel channel perimeter frame, with gusseted brackets and anchor bolts, adequately reinforced, concrete filled.
  - .3 Connecting Point: Reinforced to connect isolators and snubbers to base.
  - .4 Concrete: Reinforced 20 mPa concrete.

## 2.3 VIBRATION ISOLATORS

- .1 Open Spring Isolators:
  - .1 Spring Isolators:
    - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
    - .2 Code: Colour code springs for load carrying capacity.
  - .2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - .3 Spring Mounts: Provide with levelling devices, minimum 1/4" (6 mm) thick neoprene sound pads, and zinc chromate plated hardware.
  - .4 Sound Pads: Size for minimum deflection of 0.05" (1.2 mm); meet requirements for neoprene pad isolators.
- .2 Restrained Spring Isolators:
  - .1 Spring Isolators:
    - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
    - .2 Code: Colour code springs for load carrying capacity.
  - .2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - .3 Spring Mounts: Provide with levelling devices, minimum 1/4" (6 mm) thick neoprene sound pads, and zinc chromate plated hardware.
  - .4 Sound Pads: Size for minimum deflection of 0.05" (1.2 mm); meet requirements for neoprene pad isolators.
  - .5 Restraint: Provide heavy mounting frame and limit stops.
- .3 Closed Spring Isolators:
  - .1 Spring Isolators:
    - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
    - .2 Code: Colour code springs for load carrying capacity.
  - .2 Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
  - .3 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - .4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 1/4" (7 mm) clearance.
- .4 Restrained Closed Spring Isolators:
  - .1 Spring Isolators:
    - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
    - .2 Code: Colour code springs for load carrying capacity.
  - .2 Type : Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
  - .3 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - .4 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 1/4" (7 mm) clearance and limit stops.
- .5 Spring Hanger:
  - .1 Spring Isolators:
    - .1 For Exterior and Humid Areas: Provide hot dipped galvanized housings and neoprene coated springs.
    - .2 Code: Colour code springs for load carrying capacity.
  - .2 Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - .3 Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
  - .4 Misalignment: Capable of 20 degree hanger rod misalignment.

- .6 Neoprene Pad Isolators:
  - .1 Rubber or neoprene waffle pads.
    - .1 30 durometer.
    - .2 Minimum 1/2" (13 mm) thick.
    - .3 Maximum loading 275 kPa.
    - .4 Height of ribs: maximum 0.7 times width.
  - .2 Configuration: Single layer.
- .7 Rubber Mount or Hanger: Moulded rubber designed for 1/2" (13 mm) deflection with threaded insert.
- .8 Glass Fibre Pads: Neoprene jacketed pre-compressed moulded glass fibre.
- .9 Seismic Snubbers:
  - .1 Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
  - .2 Neoprene Elements: Replaceable, minimum of 3/4" (18 mm) thick.
  - .3 Capacity: 4 times load assigned to mount groupings at 3/8" (10 mm) deflection.
  - .4 Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

### **3 Execution**

#### **3.1 INSTALLATION**

- .1 Install to manufacturer's instructions.
- .2 Install isolation for motor driven equipment.
- .3 Bases:
  - .1 Set steel bases for 1" (25 mm) clearance between housekeeping pad and base.
  - .2 Set concrete inertia bases for 2" (50 mm) clearance between housekeeping pad and base.
  - .3 Adjust equipment level.
- .4 Install spring hangers without binding.
- .5 On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- .6 Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- .7 Provide pairs of horizontal limit springs on fans with more than 1.5 kPa static pressure, and on hanger supported, horizontally mounted axial fans.
- .8 Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.06" (1.5 mm) maximum clearance. Provide other snubbers with clearance between 1/8" and 1/4" (4 mm and 7 mm).
- .9 Support piping connections to isolated equipment resiliently as follows:
  - .1 Up to 4" (100 mm) Diameter: First three points of support.
  - .2 5" to 8" (125 to 200 mm) Diameter: First four points of support.
  - .3 10" (250 mm) Diameter and Over: First six points of support.
  - .4 Select three hangers closest to vibration source for minimum 1" (25 mm) static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1" (25 mm) static deflection or 1/2 static deflection of isolated equipment.
- .10 Connect wiring to isolated equipment with flexible hanging loop.

#### **3.2 MANUFACTURER'S FIELD SERVICES**

- .1 Inspect isolated equipment after installation and submit report. Include static deflections.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

**1.2 SECTION INCLUDES**

- .1 The mechanical contractor will be responsible for the work of Testing, Adjusting and Balancing of HVAC systems as follows;
- .1 Testing, adjustment, and balancing of air systems.
  - .2 Testing, adjustment, and balancing of plumbing systems.
  - .3 Measurement of final operating condition of HVAC systems.
- .2 This Section shall verify correct operation of;
- .1 piping systems,
  - .2 air systems,
  - .3 equipment

**1.3 REFERENCES**

- .1 Ontario Building Code.
- .2 Ontario Fire Code.
- .3 AABC - National Standards for Total System Balance.
- .4 ACG - AABC Commissioning Guideline.
- .5 ADC - Test Code for Grilles, Registers, and Diffusers.
- .6 ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- .7 ASHRAE Guideline 0 The Commissioning Process,
- .8 ASHRAE Guideline 1 The HVAC Commissioning Process,
- .9 ASHRAE Guideline 1.1 HVAC&R Technical Requirements for the Commissioning Process,
- .10 ASTM E779 Determining Air Leakage Rate by Fan Pressurization.
- .11 NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- .12 SMACNA - HVAC Systems Testing, Adjusting, and Balancing.
- .13 SMACNA HVAC Systems Commissioning Manual,

**1.4 SUBMITTALS**

- .1 Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- .2 Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- .3 Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
- .4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Consultant and for inclusion in operating and maintenance manuals.
- .5 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side.
- .6 Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
- .7 Test Reports: Indicate data on AABC National Standards for Total System Balance forms. Submit data in S.I. Metric units.
- .8 All reports shall be prepared in electronic (computer) format using MS Word software and all tabulations shall be prepared in electronic (computer) format using MS Excel spreadsheet software. Submittals shall include three (3) copies each of hard copy printout and two (2) copies with text in ".pdf" and tabulations in ".xls" or ".xlsx" formats on CD, DVD, or USB flash drive.

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**1.5 PROJECT RECORD DOCUMENTS**

- .1 Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- .2 Record actual locations of flow measuring stations.

**1.6 QUALITY ASSURANCE**

- .1 Perform total system balance to AABC National Standards for Field Measurement and Instrumentation, Total System Balance.
- .2 Maintain one copy of each document on site.

**1.7 INDEPENDENT AGENCY**

- .1 All work of Mechanical Testing, Adjusting and Balancing shall be undertaken by a single agency, employed under Mechanical Division.
- .2 The work of the agency consists of the furnishing of all labour, materials, equipment and accessories necessary in the testing, verification and documentation of the operational performance of all equipment and systems installed under the Sections of Mechanical Division.

**1.8 QUALIFICATIONS**

- .1 Agency: Company specializing in the testing, adjusting, and balancing of systems under this Section with minimum five years documented experience certified by AABC or prequalified as listed below.
- .2 Work shall be performed under the supervision of an AABC certified Test and Balance Engineer, an NEBB Certified Testing, Adjusting and Balancing Supervisor or a registered Professional Engineer experienced in the performance of this work and licensed at the place where the Project is located.
- .3 Prequalified agencies include;
  - .1 National Air Balancing
  - .2 Clark Balancing Ltd.
  - .3 Dynamic Flow Balancing
  - .4 Or approved equal.

**1.9 PRE-BALANCING CONFERENCE**

- .1 Convene one week prior to commencing work of this Section.

**1.10 SEQUENCING**

- .1 Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

**1.11 SCHEDULING**

- .1 Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

**1.12 CO-OPERATION**

- .1 Co-operate with installing Contractor(s) in advising them of specific scheduling requirements for systems verification.
- .2 Provide advice to installing Contractors regarding the location and installation of devices required to permit system balancing and measurements, prior to start of the installation work.
- .3 Coordinate verification of smoke control and automatic sprinkler systems with verification of fire alarm system under Division 26.

**2 Products**

**2.1 REFERENCE STANDARDS**

- .1 All equipment required for the verification of equipment and systems shall be furnished by the agency employed to conduct the Mechanical Systems Verification.
- .2 Testing and measuring equipment used in the verification of the mechanical systems shall be calibrated to give true readings within the accuracy specifications of the equipment used. A certificate of calibration from an independent testing laboratory may be required by the Consultant if there is any reason to suspect that the equipment used is giving erroneous readings. In such an event the verification agency shall reconduct its verifications.
- .3 All equipment used by the agency in its verification of mechanical systems remains the property/responsibility of the agency and is not included in the supply to the project.

### **3 Execution**

#### **3.1 EXAMINATION**

- .1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  - .1 Systems are started and operating in a safe and normal condition.
  - .2 Temperature control systems are installed complete and operable.
  - .3 Proper thermal overload protection is in place for electrical equipment.
  - .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - .5 Duct systems are clean of debris.
  - .6 Fans are rotating correctly.
  - .7 Fire and volume dampers are in place and open.
  - .8 Air coil fins are cleaned and combed.
  - .9 Access doors are closed and duct end caps are in place.
  - .10 Air outlets are installed and connected.
  - .11 Duct system leakage is minimized.
- .2 Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- .3 Beginning of work represents acceptance of existing conditions in the areas served.

#### **3.2 PREPARATION**

- .1 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Consultant to facilitate spot checks during testing.
- .2 Provide additional balancing devices as required.

#### **3.3 INSTALLATION TOLERANCES**

- .1 Roof Top Unit: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 5 percent of design for return and exhaust systems.
- .2 Air Outlets and Inlets: Adjust total to within plus 5 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 5 percent of design.

#### **3.4 ADJUSTING**

- .1 Ensure recorded data represents actual measured or observed conditions.
- .2 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- .3 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- .4 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- .5 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as

- selected and witnessed by the Owner.
- .6 Check and adjust systems approximately six months after final acceptance and submit report.

### 3.5 AIR SYSTEM PROCEDURE

- .1 Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
  - .2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
  - .3 Measure air quantities at air inlets and outlets.
  - .4 Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
  - .5 Use branch volume control dampers and splitters to regulate air quantities. Devices at air outlets may be used only to the extent that adjustments do not create objectionable air motion or sound levels.
  - .6 Vary total system air quantities by adjustment of fan speeds. Adjust airflow to design quantity.
- Provide drive changes as required.
- .7 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
  - .8 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan.
  - .9 Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
  - .10 Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
  - .11 Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
  - .12 Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 in.wg. (12.5 Pa) positive static pressure near the building entries.
  - .13 For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

### 3.6 WATER SYSTEM PROCEDURE

- .1 Adjust water systems to provide required or design quantities.
- .2 Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- .3 Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- .4 Effect system balance with automatic control valves fully open to heat transfer elements.
- .5 Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- .6 Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

### 3.7 VERIFICATION CHECKLIST

- .1 Prepare a series of checklists to record the verification of each item of equipment and each system. Submit a draft of each checklist to the Consultant and the Owner for review and approval. Discuss comments offered the Consultant and Owner and include improvements as directed.
- .2 Checklists shall include the following as a minimum;
  - .1 date(s) of observations and/or tests,
  - .2 a record of the nameplate data for each equipment item and each associated motor,
  - .3 a list of observations appropriate to the equipment item or system with space adjacent to



- .4 indicate whether the item was satisfactory or unsatisfactory,  
appropriate space for recording comments and/or instructions given during observations.

### 3.8 EQUIPMENT VERIFICATION

- .1 Test the operation of all equipment installed under Division 15 according to instructions in appropriate articles of this Division. Advise installing contractor of any required adjustments or replacements to ensure that equipment is operating as intended. Retest equipment after adjustment or replacement.
- .2 Ensure that the Contractor has given proper advance notification to all persons required to be present as tests are conducted. Refer to 15100.
- .3 Instrumentation: verify installation of air filter gauges, pitot traverse stations, and flow-measuring devices ensuring that:
  - .1 Location of points for readings is appropriate to measure what it is intended to measure;
  - .2 The scale range is appropriate to place the normal reading near mid-range of the scale;
  - .3 Proper positioning of instrumentation to allow reading from a convenient location, and for easy access.
- .4 Filters Inspection: visually inspect each filter installation. Verify adjustment of latching devices, installation of end spacers in filter boxes, and proper latching and sealing of access doors. Verify the installation of new (clean) filter media after Contractor's start-up procedures.
- .5 Pre-start-up Inspection:
  - .1 Verify proper equipment mounting and setting.
  - .2 Verify that control, interlock, and power wiring are complete.
  - .3 Verify proper alignment of motors and drives.
  - .4 Verify proper piping connections and accessories.
  - .5 Verify that lubrication is complete.
- .6 First Run Observation:
  - .1 Verify direction of rotation.
  - .2 Verify setting of safety controls.
  - .3 Monitor heat build-up in bearings.
  - .4 Check motor loads against nameplate ratings.
- .7 Equipment Checkout:
  - .1 Verify the proper overload heater sizes.
  - .2 Verify function of safety and operating controls.
  - .3 Verify proper operation of equipment.
  - .4 Report on inspection, observation, and checkout procedures.
- .8 Motor Rotation: visually inspect and verify the direction of motor rotation. It is possible for motor rotation to have been checked by the electrician when power connections were made on temporary electric power, then when final connections were made to the permanent transformer bank, crossed phasing may reverse the rotation of all three-phase motors on the system.
- .9 Overload Heaters: verify supply voltage to each equipment. If the applied voltage is different from the motor nameplate, determine whether the applied voltage is within the range allowed under the motor guarantee. If not, take the necessary action to have the Contractor change the motor or the applied voltage. When the voltage is off the nameplate value, but within the allowable range, compute the equivalent amperage at nameplate voltage and compare to the overload heater amperage rating range. Then, consider whether the ambient temperature of the starter is above, below, or the same as the ambient temperature are not the same. Advise the Contractor to use overload heaters of higher range for "hot area" starters or ones of lower range for "cold area" starters to compensate the heater trip point for heat gains or losses with the environment.
- .10 Alignment of Drives: verify the alignment of drives, belt and direct coupled, and the adjustment of belt tension.
- .11 Control Diagrams and Sequences: provide for coordination with work under the automatic control systems to have the control diagrams and sequences of operation corrected to "as installed", reflecting changes brought about in response to contract modifications and to the more pragmatic changes in



- diagrams and sequences to make the installed system control the building systems as intended by the designer.
- .12 Safety and Operating Control Setpoints: systematically verify the safety and operating controls of equipment, including an operational check of associated control sequences.
  - .13 Fin Straightening: inspect finned surface heat transfer coils for damages fins and advise Contractor of repairs required.
  - .14 Verify that manufacturer's start-up procedures have been performed and that equipment is installed in accordance with the manufacturers written installation recommendations.
  - .16 Where work is noted to be done in stages a complete air balance and verification report will be required at the end of each stage.

### 3.9 AIR SYSTEM VERIFICATION

- .1 Review drawings, specifications and installed work to ensure that systems may be properly balanced in accordance with drawings. Advise installing Contractor of any additional requirements for effective balancing.
- .2 In air handling systems which include supply fans with variable speed drives, airflows shall be verified to design with all filters clean and with all filters loaded to filter manufacturer's recommended final (change-out) resistance. Motor and drive capacity to accommodate full range of filter loadings shall be verified.
- .3 In air handling systems which include supply fans without variable speed drives, air filters shall be verified to design airflows with air filters loaded so that the air pressure drop through each filter is equal to the average of the manufacturers listed initial resistance and recommended final (change- out) resistance.
- .4 Test and record blower rpm for each fan and air handling unit.
- .5 Test and record motor full load amperes.
- .6 Make Pitot tube traverse of main supply and obtain operating air quantities at fans.
- .7 Test and record system static pressures, suction and discharge.
- .8 Test and record system operating recirculated air quantities.
- .9 Test and record system operating outside air quantities.
- .10 Test and record entering drybulb air temperatures (heating and cooling coils).
- .11 Test and record entering wet bulb air temperatures (heating and cooling coils).
- .12 Test and record leaving dry bulb air temperatures (heating and cooling coils).
- .13 Test and record leaving wet bulb air temperatures (cooling coils only).
- .14 Measure airflow in all main and zone branch supply and return air ducts.
- .15 Test and record airflow at each diffuser, grille, and register.
- .16 Witness and verify results of duct leakage tests conducted under section 15810.
- .17 Tabulate and certify test results on suitable forms and submit Consultant for approval and record. Identify each diffuser, grille, and register as to location and area. Identify and list size, type, and manufacturer of diffusers, grilles, registers, and all testing equipment. Use manufacturer's rating on all equipment to make required calculations.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

**1.2 SECTION INCLUDES**

- .1 Duct work insulation.
- .2 Insulation jackets.

**1.3 REFERENCES**

- .1 Section 23 01 01: Requirements for references and standards.
- .2 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
- .3 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.
- .4 ASTM C553 - Standard Specification for Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.
- .5 ASTM C612 - Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
- .6 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.
- .7 ASTM C1071 - Fibrous Glass Duct Lining Insulation(Thermal Sound Absorbing Material).
- .8 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- .9 ASTM E96 - Water Vapour Transmission of Materials.
- .10 ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- .11 ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- .12 NAIMA National Insulation Standards.
- .13 NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- .14 SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .15 UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.
- .16 CGSB-Canadian General Standards Board.
- .17 CAN/CGSB-51.9 Mineral Fiber Thermal Insulation for Piping and Round Ducting.
- .18 CAN/CGSB-51.10 Mineral Fiber Board Thermal Insulation
- .19 CAN/CGSB-51.11 Mineral Fiber Thermal Insulation Blanket..

**1.4 SUBMITTALS FOR REVIEW**

- .1 Section 23 01 01: Procedures for submittals.
- .2 Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

**1.5 SUBMITTALS FOR INFORMATION**

- .1 Section 23 01 01: Procedures for submittals.
- .2 Manufacturer's Instructions: Indicate installation procedures which ensure acceptable workmanship and installation standards will be achieved.

**1.6 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Applicator Qualifications: Company specializing in performing the work of this section with minimum 6 years documented experience.

## **1.7 REGULATORY REQUIREMENTS**

- .1 Materials: Flame spread/smoke developed rating of 25/50 to the requirements of the Ontario Building Code.

## **1.8 DELIVERY, STORAGE, AND PROTECTION**

- .1 Section 23 01 01: Transport, handle, store, and protect products.
- .2 Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- .3 Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

## **1.9 ENVIRONMENTAL REQUIREMENTS**

- .1 Section 23 01 01: Environmental conditions affecting products on site.
- .2 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- .3 Maintain temperature during and after installation for minimum period of 24 hours.

## **2 Products**

### **2.1 GLASS FIBRE, FLEXIBLE**

- .1 Manufacturer: Owens Corning Fiberglas
- .2 Other acceptable manufacturers offering equivalent products:
  - .1 Manson
  - .2 Knauf Fiber Glass
  - .3 Schuller
  - .4 Or approved equal.
- 3 Insulation: ASTM C553; flexible, noncombustible blanket.
  - .1 'ksi' value : ASTM C518,0.045 at 75.2 °F (24 °C).
  - .2 Maximum service temperature: 250 °F (121 °C).
  - .3 Maximum moisture absorption: 0.20 percent by volume.
- .4 Vapour Barrier Jacket:
  - .1 Kraft paper with glass fibre yarn and bonded to aluminized film.
  - .2 Moisture vapour transmission: ASTM E96; 0.02 perm.
  - .3 Secure with pressure sensitive tape.
- .5 Vapour Barrier Tape:
  - .1 Kraft paper reinforced with glass fibre yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- .6 Outdoor Vapour Barrier Mastic:
  - .1 Vinyl emulsion type acrylic or mastic, compatible with insulation, black colour.
- .7 Tie Wire: Annealed steel, 1/16" (1.5 mm).

### **2.2 GLASS FIBRE, RIGID**

- .1 Manufacturer: Owens Corning Fiberglas Model Vapour-Seal.
- .2 Other acceptable manufacturers offering equivalent products:
  - .1 Manson
  - .2 Knauf Fiber Glass
  - .3 Schuller
  - .4 Or approved equal.
- .3 Insulation: ASTM C612; rigid, noncombustible blanket.
  - .1 'ksi' value : ASTM C518,0.036 at 75.2 °F (24 °C).
  - .2 Maximum service temperature: 250 °F (121 °C).
  - .3 Maximum moisture absorption: 0.20 percent by volume.

- .4 Density: 48 kg/cu m.
- .4 Vapour Barrier Jacket:
  - .1 Kraft paper with glass fibre yarn and bonded to aluminized film.
  - .2 Moisture vapour transmission: ASTM E96; 0.04 perm.
  - .3 Secure with pressure sensitive tape.

## 2.3 JACKETS

- .1 Canv as Jacket: UL listed.
  - .1 Fabric: ASTM C921, 220 g/sq m, plain weave cotton treated with dilute fire retardant lagging adhesive.
  - .2 Lagging Adhesive: Compatible with insulation.
- .2 Mineral Fibre (Outdoor) Jacket: Asphalt impregnated and coated sheet, 2.45 kg/sq m.
- .3 PVC Jacket (Indoor):
  - .1 Jacket: ASTM C921, One piece sheet material.
    - .1 Minimum Service Temperature: -31 °F (-35 °C).
    - .2 Maximum Service Temperature: 150 °F (66 °C).
    - .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.
    - .4 Maximum Flame Spread: ASTM E84; 25 or less.
    - .5 Maximum Smoke Developed: ASTM E84; 50 or less.
    - .6 Thickness: 20 mil (0.4 mm) minimum.
  - .2 Colour: standard off-white **OR coloured to suit duct identification**
  - .3 Covering Adhesive Mastic
    - .1 Compatible with insulation, maximum VOC content of 50 g/L.
  - .4 Manufacturer;
    - .1 Ceel-Co 300 series
    - .2 Speedline *Smoke Safe*
    - .3 Or approved equal.
- .4 Aluminum Jacket: ASTM B209M.
  - .1 Thickness: 0.40 mm sheet.
  - .2 Finish: Smooth.
  - .3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
  - .4 Fittings: 0.4 mm thick die shaped fitting covers with factory attached protective liner.
  - .5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.015" (0.38 mm) thick aluminum.

## 2.4 ACCESSORIES

- .1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.
- .2 Vapor retarder lap adhesive shall be water based, fire retardant
- .3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
- .4 Tie wire shall be of 1/16" (1.5 mm) Ø stainless steel.
- .5 Fasteners shall be of 1/8" (4 mm) Ø pins, with 35 mm square clips. Clip length to suit insulation thickness.
- .6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
- .7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

### 3 Execution

#### 3.1 EXAMINATION

- .1 Verify that ductwork has been tested before applying insulation materials.
- .2 Verify that surfaces are clean, foreign material removed, and dry.

#### 3.2 INSTALLATION

- .1 Install duct insulations to TIAC National Installation Standards.
- .2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer' written instructions and as specified.
- .3 Insulated ductwork conveying air below ambient temperature:
  - .1 Provide insulation with vapour barrier jackets.
  - .2 Finish with tape and vapour barrier jacket.
  - .3 Continue insulation through walls, sleeves, hangers, and other duct penetrations.
  - .4 Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- .4 Insulated ductwork conveying air above ambient temperature:
  - .1 Provide with or without standard vapour barrier jacket.
  - .2 Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- .5 Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces below 3 metres above finished floor: Finish with canvas jacket sized for finish painting.
- .6 Exterior Applications: Provide insulation with vapour barrier jacket. Cover with outdoor jacket finished as specified.
- .7 External Duct Insulation Application:
  - .1 Secure insulation with vapour barrier with wires and seal jacket joints with vapour barrier adhesive or tape to match jacket.
  - .2 Secure insulation without vapour barrier with staples, tape, or wires.
  - .3 Install without sag on underside of duct work. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct work off trapeze hangers and insert spacers.
  - .4 Seal vapour barrier penetrations by mechanical fasteners with vapour barrier adhesive.
  - .5 Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- .8 Duct and Plenum Liner Application:
  - .1 Adhere insulation with adhesive for 90 percent coverage.
  - .2 Secure insulation with mechanical liner fasteners. Refer to SMACNA Standards for spacing.
  - .3 Seal and smooth joints. Seal and coat transverse joints.
  - .4 Seal liner surface penetrations with adhesive.
  - .5 Duct dimensions indicated are net inside dimensions required for air flow. Increase duct.

#### 3.3 DUCT INSULATION

- .1 Insulate new or altered ductwork and re-insulate existing ductwork where insulation has been removed or damaged as follows:

<u>Service</u>	<u>Type</u>	<u>Thickness</u>
Air supply rectangular	rigid	1" (25 mm)
Air supply round	flexible	1" (25 mm)
size to allow for insulation thickness		

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Exhaust 6' (2m) from outside) rectangular	rigid	3"	(75 mm)
Exhaust 6' (2m) from outside) round	flexible	3"	(75 mm)
Fresh air intake rectangular	rigid	3"	(75 mm)
Exhaust air plenums	rigid	3"	(75 mm)
Ductwork outdoors	rigid	3"	(75 mm)
Rectangular air supply runouts to terminal units <10' (3m) in length	rigid	1"	(25 mm)
Round air supply runouts to terminal units <10' (3m) in length	flexible	1"	(25 mm)
Duct mounted cooling coils	rigid	1 ½"	(40 mm)

- .2 Inline duct silencers shall be insulated in the same manner as ductwork.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

**1.2 SECTION INCLUDES**

- .1 Piping insulation.  
.2 Jackets and accessories.

**1.3 REFERENCES**

- .1 ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.  
.2 ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.  
.3 ASTM C195 - Mineral Fibre Thermal Insulating Cement.  
.4 ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.  
.5 ASTM C449/C449M - Mineral Fibre Hydraulic-setting Thermal Insulating and Finishing Cement.  
.6 ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Metre Apparatus.  
.7 ASTM C533 - Calcium Silicate Block and Pipe Thermal Insulation.  
.8 ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.  
.9 ASTM C547 - Mineral Fibre Pipe Insulation.  
.10 ASTM C552 - Cellular Glass Thermal Insulation.  
.11 ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.  
.12 ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).  
.13 ASTM C591 - Unfaced Preformed Cellular Polyisocyanurate Thermal Insulation.  
.14 ASTM C610 - Moulded Expanded Perlite Block and Pipe Thermal Insulation.  
.15 ASTM C921 - Properties of Jacketing Materials for Thermal Insulation.

**1.4 SUBMITTALS**

- .1 Product Data: Provide product description, list of materials and thickness for each service, and locations.  
.2 Manufacturer's Installation Instructions: Indicate procedures which ensure acceptable workmanship and installation standards will be achieved.

**1.5 QUALITY ASSURANCE**

- .1 Materials: Flame spread/smoke developed rating of 25/50 or less to ULC S102 and ASTM E84.

**1.6 QUALIFICATIONS**

- .1 Applicator: Company specializing in performing the work of this section with minimum three years experience.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- .1 Transport, handle, store, and protect products.  
.2 Deliver materials to site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.  
.3 Store insulation in original wrapping and protect from weather and construction traffic.  
.4 Protect insulation against dirt, water, chemical, and mechanical damage.

**1.8 ENVIRONMENTAL REQUIREMENTS**

- .1 Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

- .2 Maintain temperature during and after installation for minimum period of 24 hours.

## **2 Products**

### **2.1 GLASS FIBRE**

- .1 Manufacturers:
  - .1 Manufacturer: Owens Corning Fiberglas
- .2 Other acceptable manufacturers offering equivalent products:
  - .1 Manson
  - .2 Knauf Fiber Glass
  - .3 Schuller
  - .4 Or approved equal.
- .2 Insulation: ASTM C547; rigid moulded, noncombustible.
  - .1 'ksi' value : ASTM C335, 0.035 at 75°F (24°C).
  - .2 Minimum Service Temperature: -20°F (-28.9°C).
  - .3 Maximum Service Temperature: 302°F (150°C).
  - .4 Maximum Moisture Absorption: 0.2 percent by volume.
- .3 Vapour Barrier Jacket
  - .1 ASTM C921, White kraft paper reinforced with glass fibre yarn and bonded to aluminized film.
  - .2 Moisture Vapour Transmission: ASTM E96; 0.02 perm.
  - .3 Secure with self sealing longitudinal laps and butt strips.
  - .4 Secure with outward clinch expanding staples and vapour barrier mastic.
- .4 Tie Wire: 1.3 mm stainless steel with twisted ends on maximum 12" (300 mm) centres.
- .5 Vapour Barrier Lap Adhesive
  - .1 Compatible with insulation.
- .6 Insulating Cement/Mastic
  - .1 ASTM C195; hydraulic setting on mineral wool, VOC content not to exceed 80 g/L.
- .7 Fibrous Glass Fabric
  - .1 Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
  - .3 Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
- .8 Indoor Vapour Barrier Finish
  - .1 Vinyl emulsion type acrylic, compatible with insulation, white colour, VOC content not to exceed 250 g/L.
- .9 Outdoor Vapour Barrier Mastic
  - .1 Vinyl emulsion type acrylic, compatible with insulation, white colour.
- .10 Insulating Cement
  - .1 ASTM C449, VOC content not to exceed 80 g/L.

### **2.2 PHENOLIC INSULATION**

- .1 Manufacturers:
  - .1 Manufacturer: Resolco International bv "Insul-Phen"
  - .2 Or approved equal.
- .2 Insulation: ASTM C-1126 Phenolic Foam Thermal Insulation, CFC and HCFC free, rigid moulded, noncombustible insulation fabricated in required shapes by Resolco International approved fabricators to ASTM C-450 and C-585.
  - .1 Density: 2.5-lb/ft<sup>3</sup> (40-kg/m<sup>3</sup>)
  - .2 Temperature range: -290°F to +250°F (-129°C to +107°C)
  - .3 Closed cell content: 92%
  - .4 Compressive strength: 29 psi (2 bar)
  - .5 Thermal conductivity: 0.13 BTU-in/hr-ft<sup>2</sup>-°F (18.72 W-mm/m<sup>2</sup>-°C)
  - .6 Fire resistance rating: 25/50 to ASTM E84 on plain and faced product up to 3" (75mm) Thick
- .3 Joint Sealer:
  - .1 vapour barrier type, moisture and water resistant, 97% solids by weight, non-hardening, flexible in temperature range from -5°F to +200°F (-20.5°C to +93.3°C), Daxcel 161D,



- Fosters 30-45, Childers CP-76.
- .4 Vapour Barrier Mastic / Reinforcing:
- .1 Vimasco Vapor-Block, Fosters 30-80, #749 or Childers' Chil-Perm #SP-35, or approved equal with the following minimum requirements:
- .1 Wet Fammability: No flash to boiling
- .2 Water Vapor Permeance: Maximum 0.08 US perms
- .3 Average Non Volatile: 58% by volume
- .4 Service Temperature Range: -20°F to +190°F (29°C to 88°C)
- .5 Application: Two Coats
- .2 The membrane for reinforcement of vapor retardant mastic shall be 6 X 6 or 10 X 10 glass fiber reinforcing mesh, Chil Glas #5 made by Chilers or PC-79 Fabric, 5 X 6 mesh, by Pittsburgh Corning, or approved equal.
- .5 Vapour Barrier (Indoor Service)
- .1 Vapor barrier for indoor service shall be ASJ All Service Jacket as manufactured by Compac Corp or Lamtec Corp or approved equivalent as per the Resolco UL E84 test reports, 0.009 mm thick aluminum foil laminated to 30lb. Kraft paper by flame retardant adhesive (VOC content not to exceed 650 g/L for clear or 350 g/L for pigmented). The complete laminated product shall be reinforced with tri directional fiberglass yarn with yarn spacing of 5 per inch.
- .2 Venture 1555U factory applied zero perm jacket system shall be used in areas of high humidity or where there is a risk of mould/mildew growth.
- .3 In areas of heavy mechanical abuse or high pressure wash down areas use product for Outdoor Service.
- .6 Vapour Barrier (Outdoor Service)
- .1 The vapor barrier used to seal any plain pipe insulation for outdoor service prior to application of cladding shall be Polyguard Insulrap 30 rubberized bitumen adhesive laminated to a 4 mil polyethylene film. Total thickness shall be 30 mils (0.76mm), permeance; 0.015 max, or approved equal.
- .2 Polyguard 650 LT Liquid Adhesive or approved equivalent is required at application temperatures (10°C) or with dusty insulation surfaces. As an alternative to the use of Liquid Adhesive, a light pass may be made with a heat gun over the face of the adhesive mass, just prior to application.
- .3 Peel & Seal, self-stick, aluminum embossed finish; by Polyguard Products or approved equivalent considered as an alternative, outdoors. It eliminates the need for metal cladding, it is recommended for installation above +60°F (+16°C) and in no case, below +40°F (4°C).
- .4 All outdoor jacket systems shall be banded using 1/2" (12 mm) aluminum banding with wing seals at 12" (300 mm) centers.
- .7 Fabrication Adhesive
- .1 Fabriaction adhesive for Insul-Phen shall be H.B. Fuller's SC-1454, a contact adhesive or H.B. Fuller's HL-2278, hot melt adhesive, or approved equal.
- .8 Pipe and Hanger Supports
- .1 Pipe suport load bearing insulation shall be fabricated by a Resolco approved fabricator or approved equivalent from Resolco CFC & HCFC free heavy density Insul-Phen in 3.75lb/ft<sup>3</sup> density in accordance with the table in attachment 1. The upper 1870° section of the support can be fabricated from standard 2.5lb./ft<sup>3</sup> density Insul-Phen and 2.5lb./ft<sup>3</sup> can be used at the support point up to a certain pipe diameters (contact your local Resolco fabricator or technical rep or approved equivalent) with a 12" (300 mm) long saddle.
- .2 The pipe support insulation shall be supported by a saddle. Stainless steel saddles shall be used where edible food or open product is exposed. For all other applications it is acceptable to use painted, galvanied or carbon steel.
- .9 PVC Cladding (Indoor Use only)
- .1 The jacketing to provide protection to insluation and vapor barrier shall be 0.030" (0.8 mm) thick Ceel-Co 300 Series UVR PVC Jacketing or Proto LoSmoke 25/50 UVR PVC or approved equivalent. Jacketing shall be tough all purpose, UV resistant capable of enduring frequent washing with hot water or other cleaning agents. All joints of PVC jacket shall be solvent welded with Ceeltite or Proto PVC Adhesive or approved equivalent. As an alternative a high density (3.75lb) phenolic along with 0.020 PVC jacket can be used.

- .2 Ceel-Co 300 Series or Proto LoSmoke UVR PVC Jacket .040" (1 mm) or approved equivalent, or a double wrap of .030" (0.8 mm) thick shall be used where protection from mechanical abuse or high pressure washing is required.
- .3 A stainless steel diamond-mesh expanded metal lath cage shall be installed with spacers a minimum of 1" (25 mm) away from and over top of the pipe and insulation sealed with PVC Jacket in areas where it is possible for knives, etc. to damage jacket system.
- .4 In food preparation/hygenic areas cladding must withstand scalding water washdowns; wherever a higher temperature material is required: Proto EXOD (R) or approved equivalent, a CPVC material, light grey and is rated to +225°F (107°C). EXOD (R) shall be ordered "cut and precurled" for pipe insulation jacket.
- .10 Aluminum Cladding (Outdoor Use only)
  - .1 The metal cladding weather barrier to provide protection from weather, mechanical wear or other damage shall be aluminum alloys 3003, 1100 or 3105 meeting ASTM B209 with H-14 temper, 0.016" (0.4 mm) thick with Polysurlyn moisture barrier on the back side. Themetal jacketing shall be RPR Incul-mate, Childers Products or approved equal.
  - .2 .016 inch thick aluminum is acceptable for all piping except where excessive abuse is anticipated; use .024" (6 mm) thick. .024" (6 mm) thick shall be used on all equipment as minimum, however .032" (8 mm) thick is preferred.
  - .3 The metal cladding where frequent washing is antcipated, shall be smooth for all piping and horizontal equipment and 1-1/4" (30 mm) corrugated for all vertical equipment above 30" (762 mm) insulation OD. Stucco embossed finish may be used for other areas.
  - .4 Where foot traffic is likey and increased strength of jacket is necessary use rolls of pipe jacketing; Childers Corrolon or RPR Rib-Cor or approved equivalent, 3/16" (0.2 mm) corrugated in the circumferential direction
- .11 Fastening Accessories
  - .1 Tape for fastening plain pipe covering insulation shall be 3/4" (20 mm) Fiberglass reinforced strapping tape made by National Tape Co. or apporved equal.
  - .2 Stainless steel type T304/T316 or .020 aluminum strapping for fastening aluminum jacketing outdoors and outer layer of vessel and/or large diameter (above 16 inches O.D.) pipe insulation shall be 1/2" x .020" (15 mm x .5 mm) thick with stainless steel or aluminum wing seals made by RPR Products, Childers Products or approved equal. RPR no. 7 or breather spring 4 inches long made from stainless steel type T305 shall be used for securing large diameter vessels metal jacketing.
  - .3 Polypropylene 1/2" (15 mm) wide, 1/2" (15 mm) thick banding and clips, Q-Band/Q-Clip made by Band-It Inc. or approved equivalent shall be used for securing PVC jaceting indoors. The banding shall not be used in food processing areas where bacterial growth is anticipated. Banding may be used for temporary securement until PVC joint adhesive cures. The PVC Jacketing must be complete sealed at all joints to prevent entry of water or moisture. In non food processing areas PVC jacketing should be glued using manufacturers adhesive(VOC content not to exceed 510g/L).
- .12 Inspection Plugs
  - .1 NDT Inspection plugs made from EPDM and aluminum metal cap as manufactured by Parker Special Products or approved equivalent shall be installed on pipe and equipment requiring frequent inspections. Use 1-1/2" (40 mm) NDT plug for pipe and equipment insulation jacket OD of less than 9" (225 mm). Use 2-1/2" (65 mm) and 3" (75 mm) NDT plug for pipe and equipment between 9" (225 mm) and 24" (600 mm) insulation jacket OD. Use 5" (125 mm) NDT plug for pipe and equipment insulation jacket OD above 24" (600 mm).
- .13 Expansion/Contraction Joints
  - .1 Expansion/contraction joint material shall be 1lb/ft<sup>3</sup> density fiberglass blanket.

## 2.3 JACKETS

- .1 PVC Plastic
  - .1 Jacket: ASTM C921, One piece moulded type fitting covers and sheet material.
    - .1 Minimum Service Temperature: -31°F (-35°C).
    - .2 Maximum Service Temperature: 151°F (66°C).
    - .3 Moisture Vapour Transmission: ASTM E96; 0.03 perm inches.

- .4 Maximum Flame Spread: ASTM E84; 25 or less.
- .5 Maximum Smoke Developed: ASTM E84; 50 or less.
- .6 Thickness: 20 mil (0.4 mm) minimum.
- .2 Colour: standard off-white **OR** coloured to suit pipe identification.
- .3 Covering Adhesive Mastic
  - .1 Compatible with insulation, maximum VOC content of 50 g/L.
- .4 Manufacturer;
  - .1 Ceel-Co 300 series
  - .2 Speedline *Smoke Safe*
  - .3 Or approved equal.
- .2 Aluminum Jacket: ASTM B209.
  - .1 Thickness: 0.02" (0.40 mm) sheet.
  - .2 Finish: Smooth.
  - .3 Joining: Longitudinal slip joints and 2" (50 mm) laps.
  - .4 Fittings: 0.02" (0.40 mm) thick die shaped fitting covers with factory attached protective liner.
  - .5 Metal Jacket Bands: 3/8" (10 mm) wide; 0.01" (0.38 mm) thick aluminum.

## 2.4 REMOVABLE / REUSABLE INSULATION COVERS

- .1 Material: Teflon coated, woven fibreglass fabric
- .2 Weight: 16.5 oz/sq.yd. ( $\pm 10\%$ )
- .3 Thickness: 0.015" ( $\pm 10\%$ )
- .4 Colour: Gray
- .5 Tensile Strength: 400 x 330 lb. (W x F)
- .6 Tarp Tear strength: 60 x 40 lb. (W x F)
- .7 Mullen Burst Pressure: 650 psi
- .8 Insulation thickness: Match connecting piping
- .9 Temperature Range: -67°F to 500°F
- .10 Lacing Hooks: Stainless Steel
- .11 Tie Wire: 16-ga stainless steel

## 2.5 ACCESSORIES

- .1 Adhesives and finishes shall be as recommended by the insulation manufacturer and shall comply with Section 15100.2.2. Accessories such as adhesives, mastics and cements shall have the same properties as listed above and shall not detract from any of the system ratings specified.
- .2 Vapor retarder lap adhesive shall be water based, fire retardant
- .3 Tapes shall be of cloth reinforced aluminum, soft adhesive with minimum 2" (50 mm) width.
- .4 Tie wire shall be of 1/16" (1.5 mm)  $\varnothing$  stainless steel.
- .5 Fasteners shall be of 1/8" (4 mm)  $\varnothing$  pins, with 35 mm square clips. Clip length to suit insulation thickness.
- .6 Bands shall be 1/2" (12 mm) wide 1/4" (6mm) thick galvanized steel.
- .7 Facing shall be of 1" (25 mm) galvanized steel hexagonal wire mesh attached on both faces of insulation.

## 2.6 CELLULAR GLASS

- .1 Manufacturer: Pittsburgh Corning FOAMGLAS or approved equal.
- .2 Insulation: ASTM C552 "Standard Specification for Cellular Glass Thermal Insulation",
  - .1 'k' Value: 0.039 at 24 degrees C.
  - .2 Maximum Service Temperature: 482 degrees C.
  - .3 Maximum Water Vapour Transmission: 0.1 perm.
  - .4 Maximum Moisture Absorption: ASTM C240, 0.2% by volume.
  - .5 Density: 128 kg/cu m.
- .3 FOAMGLAS® or approved equivalent pipe insulation shall be fabricated according to the requirements of ASTM C1639 "Standard Specification for Fabrication of Cellular Glass Pipe and Tubing Insulation".

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### **3 Execution**

#### **3.1 EXAMINATION**

- .1 Verify that piping has been tested before applying insulation materials.
- .2 Verify that surfaces are clean, foreign material removed, and dry.

#### **3.2 INSTALLATION**

- .1 Install piping insulations to TIAC National Installation Standards.
- .2 Apply insulation materials, accessories, jackets and finishes in accordance with manufacturer's written instructions and as specified.
- .3 On exposed piping, locate insulation and cover seams in least visible locations.
- .4 Insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
  - .1 Provide vapour barrier jackets, factory applied or field applied.
  - .2 Insulate fittings, joints, and valves with moulded insulation of like material and thickness as adjacent pipe.
  - .3 Finish with glass cloth and vapour barrier adhesive.
  - .4 PVC fitting covers may be used.
  - .5 Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
  - .6 Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- .5 For insulated pipes conveying fluids above ambient temperature:
  - .1 Provide standard jackets, with or without vapour barrier, factory applied or field applied.
  - .2 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
  - .3 Finish with glass cloth and adhesive.
  - .4 PVC fitting covers may be used.
  - .5 For hot piping conveying fluids 140°F (60°C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
  - .6 For hot piping conveying fluids over 140°F (60°C), insulate flanges and unions at equipment.
- .6 Inserts and Shields:
  - .1 Application: Piping 1-1/2" (40 mm) diameter or larger.
  - .2 Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  - .3 Insert Location: Between support shield and piping and under the finish jacket.
  - .4 Insert Configuration: Minimum 6" (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  - .5 Insert Material: hydrous calcium silicate insulation.
- .7 Finish insulation at supports, protrusions, and interruptions.
- .8 Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapour barrier cement.
- .9 Provide integral vapour barrier jacket on insulation on pipe and fittings for exterior applications.
- .10 Provide PVC jacket and fitting covers for pipe in mechanical equipment rooms and where exposed in finished spaces.
- .12 Provide aluminum jacket and fitting covers with seams located on bottom side of horizontal piping for exterior applications, in boiler rooms and where subject to temperatures > 200°F (93°C).
- .11 For buried piping, provide factory fabricated assembly with inner all-purpose service jacket with self sealing lap, and asphalt impregnated open mesh glass fabric, with one mil (0.025 mm) thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- .12 For heat traced piping, insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

#### **3.3 TOLERANCE**

- .1 Substituted insulation materials: Thermal resistance within 10 percent at normal conditions, as materials indicated.

### 3.4 PIPE INSULATION

- .1 Insulate new or altered piping with rigid pipe insulation and re-insulate existing piping where insulation has been removed or damaged as follows:

Service	Operating Temperature Range °F (°C)	Pipe Diameter in. (mm)	Insulation Thickness in. (mm)
Cold water (outside building)	0 to 850 (-18 to 454)	All sizes	2 (50)
Condensate (cold)	0 to 850 (-18 to 454)	All sizes	1/2 (13)
Domestic cold water	0 to 850 (-18 to 454)	All sizes	1 (25)
Domestic hot water & hot water recirculation	105 (41) and higher	2 (50) and smaller 2-1/2 (65) and larger	1 (25) 1-1/2 (40)
Sanitary drainage	40 to 55 (4 to 13)	All sizes	1 (25)
Storm drainage	40 to 55 (4 to 13)	All sizes	1 (25)
Hydronic heating (hot water gn glycol/water)	105 to 140 (41 to 60) 105 to 140 (41 to 60) 141 to 200 (61 to 93)	4 (100) and smaller 5 (125) and larger All sizes	1 (25) 1-1/2 (40) 1-1/2 (40)

Note: Phenolic insulation may be used in place of rigid fibreglass pipe insulation, thickness to provide equivalent thermal resistance.

- .2 Insulate with flexible insulation as follows:
- | Service                                | Thickness  |
|--|------------|
| Horizontal storm and sanitary drainage | 1" (25 mm) |
- .3 Insulate valves, flanges and pipe connections with removable / reusable insulation covers.
- .4 Wrap butt joints with a 4" (100 mm) strip of fire resistant vapour barrier jacket cemented with lagging adhesive.
- .5 Where the pipe hanger is around the insulation, provide an insulation protection shield within the pipe saddle. Coordinate with installation of hangers.
- .6 Insulate all fittings, flanges and valves on pipes to provide equivalent insulation to that on adjoining pipe.
- .7 Continue insulation through sleeves including specified finish.
- .8 Cut back covering on strainers and finish off to expose removable head insulation.
- .9 Cover expansion joints first with 24 gauge (0.7 mm) galvanized metal sleeve and then insulate to provide equivalent thickness to that on adjoining pipe.
- .10 Protect insulation with protection saddles where insulated pipe is supported by rollers.
- .11 Insulate pipe hangers supporting new piping carrying water at 70°F (21°C) or less to prevent condensation. Extend insulating material along hanger rod to height 4 times thickness of insulation. Seal insulation with vapourproof sealant.
- .12 Extend pipe insulation and covering through walls, floors, ceilings, and concrete beams, unless indicated otherwise on drawings. protect exposed insulation extending through floors with 4" (100 mm) wide strip of 18 gauge (1.3 mm) galvanized iron.
- .13 Pack annular space between pipe sleeves and piping or pipe covering with glass fibre insulation or rockwool insulation. In fire rated assemblies use Dow Silicon RTV or other ULC listed materials. Seal exposed insulation with mastic.
- .14 Recover exposed surfaces of insulated piping installed in exposed areas, mechanical rooms, and equipment rooms with PVC jacketing and PVC fitting covers installed in accordance with manufacturers

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instructions.

- .15 Insulate and cover exposed surfaces of waste connections, traps, hot and cold supply risers and valves at each lavatory and sink designated for "handicapped" or "barrier free" use with: PVC insulated fitting covers specifically designed for this application. Vinyl material is not to exceed flame spread rating of 150, and if intended to be used in high buildings, its smoke developed classification does not exceed 300. Zeston or other equivalent material. or foamed plastic type insulation finished with two coats of Armstrong Armflex or other equivalent material.
- .16 Provide aluminum metal cladding over the insulation on the following services;
  - .1 All exposed piping located outdoors.
- .17 Insulate sprinkler and standpipe main from take-off from domestic water to a point approximately 6 feet (1800 mm) after electrically supervised valve.
- .18 Oversize insulation of Domestic hot water piping complete with heating cable for pipe sizes 1-1/4" (35 mm) dia. and smaller by 1/4" (6 mm) in inside diameter to allow for installation over heating cable.

### **3.5 REFRIGERATION PIPE INSULATION**

- .1 Insulate all refrigerant suction and hot gas piping and fittings with flexible foamed plastic pipe insulation. Insulation shall fit pipe. Thickness shall be as follows: 1/2" (13 mm) thick for pipe 1" (25 mm) O.D. and smaller; 3/4" (20 mm) thick for pipe 1-1/8" (28 mm) to 2" (50 mm) O.D.; 1" (25 mm) thick for pipes 2-1/8" (54 mm) O.D. and larger.
- .2 Slip insulation on to tubing before tubing sections and fittings are assembled. Keep slitting of insulation to a very minimum. Seal all joints in the insulation with Armaflex 520 BLV or approved equivalent. Insulate flexible pipe connectors.
- .3 On insulation exposed outside the building, place "slit" joint seams on bottom of pipe and provide two coats of grey Armaflex or approved equivalent finish. Extend insulation through pipe support clamps. Provide a 6" (150 mm) long, 20 gauge (1.1 mm) galvanized steel sleeve around pipe insulation at each support.

**End of Section**

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**Part 1: GENERAL**

**1.1 SCOPE / SUMMARY**

- 1.1.1 Provide all metering equipment required to measure and trend utility consumption by end use.

**1.2 RELATED SECTIONS**

- 1.2.1 01 91 00 Commissioning  
1.2.2 22 09 00 Instrumentation and Control for Plumbing  
1.2.3 23 09 13.01 Meter Installation/Startup Verification Form  
1.2.4 26 09 13 – Electrical Power Monitoring

**2 Design Requirements / Products**

**2.1 END USES TO BE MONITORED**

- 2.1.1 Provide meters for each separate end use, including but not limited to:

- 2.1.1.1 Facility incoming water
- 2.1.1.2 Facility incoming electricity
- 2.1.1.3 Space heating and cooling
- 2.1.1.4 Domestic water heating
- 2.1.1.5 Humidifiers
- 2.1.1.6 Solar power generation

**2.2 METERING EQUIPMENT**

**2.2.1 Meters**

- 2.2.1.1 Provide meters complete with bypass piping arrangement or other means to remove or isolate for service without interruption to utility flow.
- 2.2.1.2 Materials shall be compatible with the systems in which they are installed at all potential operating temperatures and pressures.
- 2.2.1.3 Meters shall provide a pulse output scaled to an appropriate volume.
- 2.2.1.4 Meters requiring power shall be hard-wired to an emergency power circuit. Battery powered units are not acceptable.
- 2.2.1.5 Provide meters with readout of totalized volume.
- 2.2.1.6 Accuracy +/- 1.5% in expected operating range.

**2.2.2 Data logging Equipment**

- 2.2.2.1 Internet Protocol (IP) based data logger complete with:
  - 2.2.2.1.1 Built-in web server.
  - 2.2.2.1.2 Capable of operating with a dedicated IP address (to be provided by the City).
  - 2.2.2.1.3 Communications Protocols:
    - 2.2.2.1.3.1 HTTP/Post capable of pushing data to 3<sup>rd</sup> party applications/databases.
    - 2.2.2.1.3.2 Modbus TCP



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- 2.2.2.1.4 Built-in real-time and historic graphics accessible with any HTML 5 internet browser (computer, tablet, phone) on the City's network. Data to be displayed in local time, adjusted for daylight savings time.
  - 2.2.2.1.5 Real-time clock with battery backup and email alert for battery end of life.
  - 2.2.2.1.6 Time-Stamp:
    - 2.2.2.1.6.1 Represent date and time
    - 2.2.2.1.6.2 In UTC time or offset from a specified UTC time
    - 2.2.2.1.6.3 Resolution: Minimum 1 second
  - 2.2.2.1.7 Ability to export all stored trend data to comma separated value (.csv) or Microsoft Excel format for importing into spreadsheets. Time-stamps to be exported as a single field with a numeric (non-text) value in local time.
  - 2.2.2.1.8 Published application programming interface (API) allowing data to be retrieved from the pulse counter via non-proprietary means, such as JavaScript Object Notation (JSON).
  - 2.2.2.1.9 Provide minimum 2 spare inputs for future additional meters. Location of spare inputs to be determined by the City.
  - 2.2.2.1.10 Minimum two universal inputs for addition of 0-10V and 0-20mA/4-20mA sensors.
  - 2.2.2.1.11 Built-in trending and data storage:
    - 2.2.2.1.11.1 3 years of consumption data (m<sup>3</sup>) at 5 minute intervals for each input with time-stamp.
    - 2.2.2.1.11.2 Stored in non-volatile memory.
  - 2.2.2.1.12 Battery/power backup (for pulse counting):
    - 2.2.2.1.12.1 Lasting a minimum of 72 hours.
    - 2.2.2.1.12.2 Rechargeable.
    - 2.2.2.1.12.3 Email alert for battery end of life.
  - 2.2.2.1.13 No special software required to set up data logger or access data.
  - 2.2.2.1.14 Security:
    - 2.2.2.1.14.1 Unrestricted access to data and graphics over the City's network.
    - 2.2.2.1.14.2 Password protection for access to setup, changing settings/parameters and deleting data.
  - 2.2.2.1.15 Ability to measure, store and trend the following data complete with timestamp:
    - 2.2.2.1.15.1 Totalized consumption
  - 2.2.2.2 Acceptable product: z3 Controls Inc. NetMeter OMNI or as approved.
  - 2.2.3 Data Cabling
    - 2.2.3.1 Cat 5e or Cat 6 Unshielded Twisted Pair (UTP)
    - 2.2.3.2 Colour: Green

### 3 Execution



### 3.1 INSTALLATION REQUIREMENTS

- 3.1.1 Optimize plumbing distribution to allow reduction in number of meters by grouping similar/like end use loads.
- 3.1.2 Install data logger in a painted, hinged NEMA 1 (or better) enclosure complete with power supply. Label front of enclosure with data logger name, IP address, meter name(s) and load(s) measured.
- 3.1.3 Provide optical isolation/safety devices as required by the local utility or other authorities having jurisdiction.
- 3.1.4 All communication and signal cables to be continuous. No splicing is allowed.
- 3.1.5 Affix asset ID tag (to be provided by the City) to data logging unit prior to installation.
  
- 3.1.6 Data logger and network configuration to be done in consultation with the City's Property Services Branch.
- 3.1.7 Connect data logging equipment to the City's IT network.
- 3.1.8 Commission data logger:
  - 3.1.8.1 Ensure latest available firmware version is installed in data logger.
  - 3.1.8.2 Obtain Network information from the City project manager and program into data logger, including IP address, subnet mask, default gateway, primary and secondary DNS addresses.
  - 3.1.8.3 Set data logger clock to current local time.
  - 3.1.8.4 Set up email alerts as specified and/or requested by the City's project manager.
  - 3.1.8.5 Set up trend logging as specified and/or requested by the City's project manager. At minimum, set up trend logging per 2.2.2.1.10 and 2.2.2.1.14 above.
  - 3.1.8.6 Set default homepage to display real-time demand graphs and consumption statistics.
  - 3.1.8.7 Confirm data logger readings correspond to physical meter reading.
  - 3.1.8.8 Calibrate any analog sensors connected to the data logger.
  - 3.1.8.9 Verify data logger information is viewable through a web browser on a device on the City's network.
  - 3.1.8.10 Complete and submit Meter Installation/Startup Verification Form (23 09 13.01).
  - 3.1.8.11 Provide training on data logger software use to City staff including Facilities Operations and Maintenance and Corporate Energy Services.
  - 3.1.8.12 Provide meter manufacturer's calibration certificate(s), installation, operations and maintenance manuals (for meter(s) and data logger) and recommended meter recalibration interval(s).

#### **BTU Meter:-**

- 1. Meters to be supplied and installed by mechanical contractor.**
- 2. Meters to be complete with BACnet communication, meter must be BACnet listed.**
- 3. System 10 – BTU Meter by Onicon or approved equivalent is acceptable.**
- 4. Manufacturer's technician to be on site for the start-up, to be included with meter supply.**

#### **Water Meter or Sub Meter:-**

- 1. Meter to be supplied and installed by the mechanical contractor.**
- 2. Meter must have Dual pulse contacts (1 for utility and 1 for BAS) or separate meter for BAS with pulse contacts.)**

**End of Section**

## **1 General**

### **1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

### **1.2 SECTION INCLUDES**

- .1 Pipe and pipe fittings for:
  - .1 Heating water piping system.
  - .2 Equipment drains and overflows.
- .2 Valves:
  - .1 Gate valves.
  - .2 Globe or angle valves.
  - .3 Ball valves.
  - .4 Check valves.
  - .5 Circuit balancing valves
  - .6 Drain valves.

### **1.3 REFERENCES**

- .1 ASME -Welding and Brazing Qualifications.
- .2 ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- .3 ASME B16.5 Pipe Pumps & Fittings.
- .4 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .5 ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- .6 ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
- .7 ASME B31.1 - Code for Power Piping.
- .8 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .9 A183 Carbon Steel Track Bolts and Nuts.
- .10 ASTM A234/A234M - Piping Fittings of Wrought-Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .11 ASTM B32 - Solder Metal.
- .12 ASTM B88 - Seamless Copper Water Tube.
- .13 ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- .14 ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- .15 ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
- .16 ASTM D2310 - Machine-Made Fibreglass' (Glass Fibre-Reinforced Thermosetting Resin) Pipe.
- .17 ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- .18 ASTM D2467 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- .19 ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping.
- .20 ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- .21 ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- .22 ASTM D2855 - Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
- .23 ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
- .24 ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- .25 ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- .26 ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
- .27 ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.

### **1.4 SUBMITTALS**

- .1 Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- .2 Welders Certificate: Include welders certification of compliance with ASME SEC 9.
- .3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining

procedures.

## **1.5 PROJECT RECORD DOCUMENTS**

- .1 Record actual locations of valves.

## **1.6 OPERATION AND MAINTENANCE DATA**

- .1 Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

## **1.7 QUALIFICATIONS**

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- .2 Installer: Company specializing in performing the work of this section with minimum 3 years documented experience.
- .3 Welders: Certify to ASME SEC 9.

## **1.8 REGULATORY REQUIREMENTS**

- .1 Conform to ASME B31.9 code for installation of piping system.
- .2 Welding Materials and Procedures: Conform to ASME SEC 9 and applicable provincial labour regulations.
- .3 Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

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

- .1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

## **1.10 ENVIRONMENTAL REQUIREMENTS**

- .1 Do not install underground piping when bedding is wet or frozen.

## **1.11 EXTRA MATERIALS**

- .1 Provide two repacking kits for each size and valve type.

# **2 Products**

## **2.1 VALVES - GENERAL**

- .1 Conform to requirements of ANSI, ASTM, ASME, and applicable MSS standards.
- .2 Provide valves of the same manufacturer where possible.
- .3 Manufacturer's name and pressure rating clearly marked on body to MSS-SP-25.
- .4 Valid CRN (Canadian Registration Number) required for each valve.
- .5 Materials:
  - .1 Bronze: ASTM B62 or B61 as applicable
  - .2 Brass: ASTM B283 C3770
  - .3 Cast Iron: ASTM A126 Class B
- .6 End Connections:
  - .1 Threaded ends: ANSI B1.20.1
  - .3 Flanged ends: ANSI B16.1 (Class 125), ANSI B16.5
  - .4 Face-to-face dimensions: ANSI B16.10
- .7 Design and Testing:
  - .1 Bronze Gate & Check valves: MSS-SP-80

- |    |                         |            |
|----|-------------------------|------------|
| .2 | Ball Valves:            | MSS-SP-110 |
| .3 | Cast Iron Gate Valves:  | MSS-SP-70  |
| .4 | Cast Iron Globe Valves: | MSS-SP-85  |
| .5 | Cast Iron Check:        | MSS-SP-71  |
| .6 | Butterfly Valves:       | MSS-SP-67  |
- .8 First named product as indicated in paragraphs below; other acceptable manufacturers, subject to equivalent products include:
- |    |                    |
|----|--------------------|
| .1 | Kitz.              |
| .2 | Crane, Jenkins     |
| .3 | Conbraco.          |
| .4 | Nibco              |
| .5 | Or approved equal. |

## 2.2 HYDRONIC SYSTEMS TO 150 PSIG, ABOVE GROUND

- |     |                               |   |
|-----|-------------------------------|---|
| .1  | Nominal Operating Pressure    | 125 psig  |
| .2  | Design Pressure               | 150 psig  |
| .3  | Test Pressure                 | 225 psig  |
| .4  | Design Temperature            | 350°F   |
| .5  | Corrosion Allowance           | 0.0625 in.  |
| .6  | Steel Pipe                    | ASTM A53 Gr. B or ASTM A106 Gr. B, schedule 40, black steel, seamless                                 |
| .7  | Joints, 2" and smaller        | screwed   |
| .8  | Screwed Fittings              | 150 Lb. malleable iron  |
| .9  | Unions                        | Cl.150, ASTM A-47 malleable iron, ASTM A-153 galvanized, ANSI B2.1 threads.                           |
| .10 | Joints, 2-1/2" and larger     | welded, with flanges at connections to equipment  |
| .11 | Butt weld fittings            | ASTM A234 Gr. WFB   |
| .12 | Flanges                       | ASTM A105, Class 150, raised face, weld neck or slip on   |
| .13 | Bolts                         | ASTM A307 C.S. bolts, sq. head; ASTM A563 nuts, hex head  |
| .14 | Gaskets                       | 1/16" (1.6 mm) thick preformed non-asbestos graphite fibre.   |
| .15 | Copper Tubing, 2" and Smaller | ASTM B88, Type L, hard drawn.   |
| .16 | Joints:                       | Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 220°C to 280°C. |
| .17 | Fittings:                     | ASME B16.18, cast brass, or ASME B16.22, solder wrought copper  |

.18	Dielectric Unions	Union with galvanized or plated steel threaded end, copper
.19	Valves, 2" and smaller Gate Valves (Isolating) Globe Valves (Throttling) Check Valves (Backflow) Ball Valves (Drain)	ASTM A105 300 psig non-shock WOG, ASTM B62 bronze body, solid wedge disc, rising stem, bronze trim, threaded ends, Kitz #25 or approved equivalent. 300 psig non-shock WOG, ASTM B62 bronze body, composition (Teflon) disc, rising stem, bronze trim, threaded ends, Kitz #09 or approved equivalent. 300 psig non-shock WOG, ASTM B62 bronze body, Y-pattern horizontal, swing type disc, threaded ends, Kitz #29 or approved equivalent 600 psig non-shock WOG, forged brass, 2-piece, chrome ball and stem, full port, blow-out proof PTFE seats & stem, lever handle, threaded ends, Kitz #68AC or approved equivalent.
.20	Valves, 2-1/2" and larger Gate Valves (Isolating) Globe Valves (Throttling) Check (Backflow)	ASTM A216 WCB 200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, solid wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #72 or approved equivalent. 200 psig non-shock WOG, ASTM A126 Class B cast iron body, bolted bonnet, bronze mounted, bevelled wedge disc, OS&Y, non-asbestos packing, flanged ends, Kitz #76 or approved equivalent. 200 psig non-shock WOG, ASTM 126 Class B cast iron body, bolted cover, bronze mounted, swing type disc, flanged ends, Kitz #78 or approved equivalent.
.21	Provide stem extensions for insulated piping.	
.22	Provide gear operator and chain on valves installed above 10-ft AFF.	
.23	Strainers, 2" and smaller Class 250, 400 psig WOG, cast iron body, Y-pattern, screwed cap and ends, A167 304 stainless steel screen with 1/32" perforations. Mueller Steam 11M or approved equivalent.	
.24	Strainers, 2-1/2" and larger Class 250 psig non-shock WOG, cast iron, Y-pattern, bolted flange cover, blow-out plug, A167 304 stainless steel screen with 1/32" perforations, flanged ends, Mueller Steam 752 or approved equivalent.	

## 2.5 EQUIPMENT DRAINS AND OVERFLOWS

- .1 Copper Tubing: ASTM B88, Type M and DWV, hard drawn.
  - .1 Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  - .2 Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 4428°F to 536°F (220°C to 280°C).

## 2.6 CIRCUIT BALANCING VALVES

1. Circuit Balancing Valves; 2" (50 mm) and smaller
  - .1 Screwed connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy. Each valve shall be such that when installed in any direction, it will not affect flow measurement.
  - .2 Valves shall provide the following functions:
    - .1 Precise flow measurement.
    - .2 Precision flow balancing.
    - .3 Positive shut off with no drip seat and teflon disc.
    - .4 Drain connection with protective cap.
  - .3 Valves shall have four 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
  - .4 Valves shall be shipped in a 4.5 R factor polyurethane container that shall be used as insulation after valve in installed.
  - .5 Provide valves suitable for maximum working pressure of 250 psi (1720 kPa) and

- maximum operating temperature of 250°F (121°C).
- .6 Acceptable Products: S.A. Armstrong CRV I indicated or Tour & Anderson STA-D or Newman Hattersley or approved equivalent.
- 2. Circuit Balancing Valves 2 1/2" (65 mm) and larger
  - .1 Flanged, line size connection, globe style design, nonferrous, pressure die-cast, nonporous Ametal Copper Alloy.
  - .2 Valves, shall provide the following functions:
    - .1 Precise flow measurement.
    - .2 Precision flow balancing.
    - .3 Positive shut off with no drip seat and teflon disc.
  - .3 Valves shall have twelve 360° adjustment turns of handwheel for maximum vernier-type setting with "Hidden Memory" feature to program the valve with precision tamper-proof balancing setting.
  - .4 Valves shall be suitable for maximum working pressure of 250 psi (1720 kPa) and maximum operating temperature of 250°F (120°C).
  - .5 Acceptable Products: S.A. Armstrong CBV II indicated or Tour & Anderson STA-F or Newman Hattersley or approved equivalent.

### **3 Execution**

#### **3.1 PREPARATION**

- .1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- .2 Remove scale and dirt on inside and outside before assembly.
- .3 Prepare piping connections to equipment with flanges or unions.
- .4 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- .5 After completion, fill, clean, and treat systems. Refer to Section 15515.

#### **3.2 APPLICATIONS**

- .1 Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- .2 Where permitted, install grooved mechanical couplings and fasteners in accessible locations.
- .3 Install unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- .4 Provide non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- .5 Provide pipe hangers and supports to CSA B51 unless indicated otherwise.
- .6 Use gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- .7 Use globe valves for throttling, bypass, manual flow control services, for balancing & in bypass around control valves.
- .8 Use spring loaded check valves on discharge of condenser water pumps.
- .9 Use wafer check valves where required to suit space and or weight limitations
- .10 Use 3/4 inch (20 mm) gate or ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.
- .11 Use lug end butterfly valves to isolate equipment..
- .12 Butterfly valves may be used isolation and throttling duty for large pipe sizes 2-1/2" (65 mm) and above.
- .13 Gasket material shall be Grade 'E' EPDM compound conforming of ASTM D2-2000 and suitable for an operating temperature range of -34°C to 110°C.
- .14 Small runouts, size 3/4" (20 mm) and less for extension of domestic make-up piping may be constructed using hand drawn copper tube type 'K' or 'L' and comply to ASTM B88.

#### **3.3 INSTALLATION**

- .1 Install to manufacturer's instructions.

- .2 Install heating water, glycol, chilled water, condenser water piping to CSA B51.
- .3 Route piping in orderly manner, parallel to building structure, and maintain gradient.
- .4 Install piping to conserve building space, and not interfere with use of space.
- .5 Group piping whenever practical at common elevations.
- .6 Sleeve pipe passing through partitions, walls and floors.
- .7 Slope piping and arrange to drain at low points.
- .8 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .9 Inserts:
  - .1 Provide inserts for placement in concrete formwork.
  - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4" (100 mm).
  - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- .10 Pipe Hangers and Supports:
  - .1 Install to CSA B51.
  - .2 Support horizontal piping as scheduled.
  - .3 Install hangers to provide minimum 1/2" (13 mm) space between finished covering and adjacent work.
  - .4 Place hangers within 12" (300 mm) of each horizontal elbow.
  - .5 Use hangers with 1-1/2" (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - .6 Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  - .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - .8 Provide copper plated hangers and supports for copper piping.
  - .9 Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- .11 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- .12 Provide access where valves and fittings are not exposed.
- .13 Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- .14 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer (VOC content not to exceed 250 g/L) to welds.
- .15 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting.
- .16 Install valves with stems upright or horizontal, not inverted.
- .17 Air vents shall be selected to suit the system operating pressures and shall be automatic and complete with isolating valves.
- .18 All strainers 1-1/2" & larger shall be fitted with chain valves.
- .19 Unless specified otherwise, drain piping shall be sloped down in the direction of flow not less than 1" in 40 feet.
- .20 Eccentric reducers shall be provided to keep the bottom of sloped piping aligned in order to minimize risk of water hammer and to facilitate drainage.
- .21 Valves shall be installed with stems upright or angled 45 deg. above horizontal unless instructed otherwise.
- .22 Pipe all discharge from temp. & safety relief valves to a point of safe discharge directly into a floor drain, hub drain or safe outdoor location.

### **3.4 EQUIPMENT CONNECTIONS**

- .1 Install unions or flanges at connections to all equipment and specialty components.
- .2 Arrange piping connections to allow ease of access and removal of equipment.
- .3 Align and independently support piping adjacent to equipment connections in order to prevent piping



- 
- stresses from being transferred to equipment.
  - .4 Piping reducers shall be used where equipment connections differ from pipe sizes indicated. The use of bushings will not be permitted.
  - .5 Install removable sections of pipe 12" (300 mm) spool pieces on the suction side of pumps and where needed for ease of maintenance.

### **3.5 VALVES, COCKS AND FAUCETS**

- .1 Use valves of line size unless noted otherwise.
- .2 Provide isolating valves in each branch from the main line and where indicated.
- .3 Provide isolating valves at all equipment connections.
- .4 Provide globe valves or ball valves complete with memory stop at the discharge of each pump and where valves are used for regulating or throttling purposes.
- .5 Provide 1/2" (13 mm) brass hose bibbs at all low points of each system, where the system cannot be drained through the main floor or return piping.
- .6 Where new valves are installed to replace existing valves and it is impractical to shut-down and drain the entire system, valves shall be replaced using pipe freezing techniques.

### **3.6 HYDRONIC SPECIALTIES**

- .1 Air Vents
  - .1 Provide 1" (25 mm) diameter air vent chamber at each riser feeding terminal units. Install chambers as high as possible within unit, and provide manual air vent connected to air chamber by flexible tubing.
  - .2 Provide a float type automatic air vent at any high points of hot water supply and return piping not vented through a convector etc. and at high point of piping for each hot water coil. The discharge of air vent shall terminate over a floor drain in mechanical rooms or over a sink in service rooms. A shut-off valve shall be provided on each automatic air vent and an access door and frame shall be provided for air vents located above ceilings.
- .2 Automatic Feed Valves: provide automatic feed valve on the cold water make-up line to each new hot water heating system.
- .3 Air Cushion Tanks
  - .1 Provide air cushion tanks of size noted where indicated.
  - .2 Provide housekeeping pad for floor mounting of tank.
  - .3 Terminate drainout line at nearest funnel floor drain, or service sink.
  - .4 Adjust charge to system static pressure at point of connection plus 5 psi (35 kPa).
- .4 Air Eliminators: provide an air eliminator at each new air cushion (expansion) tank.
- .5 Circuit Balancing Valve (CBV): provide a CBV in each branch serving a heating and/or cooling terminal unit and where indicated on drawings. Installation shall be in accordance with manufacturer's installation instructions. Ensure that manufacturer's recommended clearances are maintained to minimize turbulence and to promote accuracy.
- .6 Supply and install threaded couplings or half coupling for flow switches that are supplied under Section 15900.
- .7 Install flow switches as supplied under Section 15900.

### **3.7 TESTING AND INSPECTION**

- .1 Test liquid heat transfer piping hydrostatically at not less than 150% of operating pressure or not less than 125 psi (860 kPa) whichever is the greater. Test period shall be not less than six (6) hours duration during which time each joint shall be inspected, given a sharp tap with a hammer and checked for leaks.
- .2 Arrange and pay for inspection by authorities having jurisdiction.

### **3.8 ADJUSTING AND BALANCING**

- .1 Instruments used for this work shall be accurately calibrated and maintained in good working order, and shall include:
  - .1 one set of pressure gauges and fittings.
  - .2 dry bulb thermometer.
  - .3 wet bulb thermometer.
  - .4 thermocouple unit and thermocouple.
  - .5 set of balancing cock adjustment wrenches.
  - .6 portable field flow meter.



- 
- .2 Prepare the liquid heat transfer systems as follows:
    - .1 Install any additional devices required for effective balancing as advised by the Systems Verification Agency.
    - .2 Open all valves, and return line balancing cocks.
    - .3 Remove and clean all strainers.
    - .4 Check pump rotation.
    - .5 Check expansion tanks to make sure they are not air bound and that the system is full of water.
    - .6 Check all air vents at high points of water systems to make sure they are installed properly and are operating freely. Make certain all air is removed from circulating system.
    - .7 Set all temperature controls so that all coils are calling for full cooling. This should close all automatic bypass valves at coil and chillers. To balance hot water coils, set systems to call for full heating.
    - .8 Check operation of automatic bypass valve.
    - .9 Check and set operating temperature of heat exchangers to design requirements.
  - .3 Balance the liquid heat transfer systems as follows:
    - .1 Complete air balance must have been accomplished before water balance is begun.
    - .2 Set chilled water, hot water and glycol pumps to proper gpm delivery.
    - .3 Adjust flow of hot water through heat exchangers.
    - .4 Check leaving water temperatures and return water temperatures, and pressure drop through heat exchangers. Reset to correct design temperatures.
    - .5 Check water temperature at inlet side of cooling and heating coils. Note rise or drop of temperatures from source.
    - .6 Balance each chilled water and hot water coil.
    - .7 Upon completion of flow readings and coil adjustments, mark all settings and record all data.
    - .8 After making adjustments to coils, recheck settings at pumps, and heat exchangers. Readjust if required.
    - .9 Install pressure gauges on each coil, then read pressure drop through coil at set flow rate on call for full cooling and full heating. Set pressure drop across bypass valve to match coil full flow Pressure drop.
    - .10 Check and record the following items at each cooling and heating element:
      - .1 Inlet water and air temperature.
      - .2 Leaving water and air temperature.
      - .3 Pressure drop of each coil.
      - .4 Pump operating suction and discharge pressures and final t.d.h.
      - .5 Pressure drop across bypass valve.
      - .6 All mechanical specifications of pumps.
      - .7 Rated and actual running amperage of pump motor.
  - .4 After completion of adjusting and balancing and submittal of records notify the Systems Verification Agency and the Consultant and assist in verifications. If systems fail verification, readjust and balance systems to the satisfaction of the Consultant.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 15010.

**1.2 SECTION INCLUDES**

- .1 Vertical in-line pumps.
- .2 In-line Circulator pumps.

**1.3 REFERENCES**

- .1 UL 778 - Motor-Operated Water Pumps.

**1.4 PERFORMANCE REQUIREMENTS**

- .1 Ensure pumps operate at specified system fluid temperatures without vapour binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

**1.5 SUBMITTALS**

- .1 Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- .2 Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.

**1.6 OPERATION AND MAINTENANCE DATA**

- .1 Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

**1.7 QUALIFICATIONS**

- .1 Manufacturer: Company specializing in manufacture, assembly, and field performance of pumps with minimum three years experience.

**1.8 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

**1.9 EXTRA MATERIALS**

- .1 Provide one set of mechanical seals for each pumps.
- .2 Provide 2 sets of cartridges for each side-stream filter.

**2 Products**

Refer to the mechanical drawings for the Pump Schedule.

**2.1 MANUFACTURERS**

- .1 Tacho Pumps is the Basis of Design.
- .2 Other acceptable manufacturers offering equivalent products.
  - .1 Bell & Gossett
  - .2 Grundfos
  - .3 Or approved equal.

## **2.2 IN-LINE CIRCULATORS: CP-2A, CP-2B, CP-3**

- .1 Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125psi (860 kPa) maximum working pressure.
- .2 Casing: Stainless steel, with flanged pump connections.
- .3 Impeller: One piece non-ferrous impeller.
- .4 Bearings: Rugged bronze sleeve bearings.
- .5 Shaft: Stainless steel with bronze sleeve, integral thrust collar.
- .6 Seal: Carbon rotating against a stationary ceramic seat, 225°F (107°C) maximum continuous operating temperature.
- .7 Drive: Close-coupled.
- .8 Motor type: Resilient mounted, permanent split capacitor with built-in overload protector.
- .9 Performance: as scheduled
- .10 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

## **2.3 IN-LINE CIRCULATORS: CP-4**

- .1 Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125psi (860 kPa) maximum working pressure.
- .2 Casing: Stainless steel, with flanged pump connections.
- .3 Impeller: 30% glass filled Noryl.
- .4 Bearings: Permanently lubricated ball bearings.
- .5 Shaft: Stainless steel with bronze sleeve, integral thrust collar.
- .6 Seal: Carbon rotating against a stationary ceramic seat, 225°F (107°C) maximum continuous operating temperature.
- .7 Drive: Close-coupled.
- .8 Motor housing: Aluminum.
- .9 Motor type: Open drip proof, permanent split capacitor, thermally protected.
- .10 Performance: as scheduled
- .11 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

## **2.4 VERTICAL IN-LINE PUMPS: P-1, P-2**

- .1 Type: Vertical, close coupled, for in-line mounting, for 175 psi (1200 kPa) maximum operating pressure.
- .2 Casing: Cathaphoresis coated ductile iron, flanged suction and discharge.
- .3 Impeller: PPS.
- .4 Shaft: Stainless steel with sealed ball bearing.
- .5 Seal: Carbon-SiCarbide-EPT.
- .6 Performance: as scheduled
- .7 Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to code.

## **2.5 SIDE-STREAM FILTRATION SYSTEM**

- .1 System: Flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valve.
- .3 Performance: Design flow 1.0 GPM (0.25 L/sec) with maximum pressure drop of 3 psi (20.7 kPa).
- .4 Hot Water and Glycol Filter Housing: Glass reinforced nylon plastic suitable for 221°F (105°C) and 200 psi (1380 kPa) operating conditions.
- .5 Cartridges: 0.001" (0.03 mm) for start-up and 0.002 (0.005 mm) for system operation.

## **3 Execution**

### **3.1 PREPARATION**

- .1 Verify that electric power is available and of the correct characteristics.

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### **3.2      INSTALLATION**

- .1      Install to manufacturer's instructions.
- .2      Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- .3      Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4" (102 mm) and over.
- .4      Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- .5      Provide air cock and drain connection on horizontal pump casings.
- .6      Provide drains for bases and seals, piped to and discharging into floor drains.
- .7      Check, align, and certify alignment of base mounted pumps prior to start-up.
- .8      Lubricate pumps before start-up.
- .9      Provide side-stream filtration system for heating water systems. Install across pump with flow from pump discharge to pump suction from pump tapplings.

**End of Section**

## **1 General**

### **1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

### **1.2 REFERENCES**

- .1 ASHRAE HANDBOOK, HVAC SYSTEMS & EQUIPMENT, Duct Construction Recommendations
- .2 Sheet Metal And Air Conditioning Contractors' National Association (SMACNA)
  - .1 HVAC Duct Construction Standards - Metal and Flexible
  - .2 HVAC Duct Systems Design
  - .3 Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems
  - .4 Accepted Industry Practice for Industrial Duct Design
  - .5 HVAC Systems - Testing, Adjusting and Balancing
  - .6 Round Industrial Duct Construction Standards
  - .7 Rectangular Industrial Duct Construction Standards
  - .8 HVAC Air Duct Leakage Test Manual.
  - .9 Guide for Steel Stack Construction
- .3 National Fire Protection Association (NFPA)
  - .1 80 Standard for Fire Doors and Windows
  - .2 90A Standard for Installation of AC and Ventilation Systems
  - .3 90B Standard for Installation of Warm Air Heating and AC Systems
  - .4 96 Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations.
  - .5 255 Building Materials, Test of Burning Characteristics (same as ASTM E84)

### **1.3 PERFORMANCE REQUIREMENTS**

- .1 No variation of duct configuration or sizes permitted except by written permission.
- .2 Size round ducts installed in place of rectangular ducts to ASHRAE table of equivalent rectangular and round ducts.
- .3 Sizes indicated on drawings are clear inside dimensions and do not include for duct linings.

### **1.4 SUBMITTALS**

- .1 Division 1: Procedures for submittals.
- .2 Product Data: Provide data for duct materials.
- .3 Shop Drawings:
  - 1. Plenums and plenum related items showing physical dimensions, joints, sealants, door construction and hardware.
  - 2. Factory fabricated ducts, fittings and joining systems.
  - 3. Firewall duct penetrations; fire and smoke dampers; louvers and access doors.
  - 4. Duct fitting particulars such as gauges, sizes, welds, reinforcements and configuration for 4" wg. (1000 kPa) pressure class and higher systems.
- .4 Submit changes or alterations in ductwork layout, with supporting calculations showing that the modified design will not increase total pressure, before work commences. Submittals for proposed changes shall be stamped for acceptance prior to commencement of work.
- .5 Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.
- .6 Material Safety Data Sheets (MSDS) for sealants, adhesives and coatings.

### **1.5 PROJECT RECORD DOCUMENTS**

- .1 Division 1: Submittals for project closeout.
- .2 Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

## 1.6 QUALITY ASSURANCE

- .1 Perform Work to SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- .2 Perform Duct Leakage Testing to SMACNA "HVAC Air Duct Leakage Testing Manual"
- .3 Maintain one copy of document on site.
- .4 Asbestos Free: Insulating and sealing materials must be certified to be free of asbestos.
- .5 Brazing: Certify brazing procedures, brazers, and operators in accordance with AWS B2.2 Brazing Procedures and Performance Qualifications
- .6 Welding: Certify welding procedures, welding equipment and welders in accordance with AWS D9.1 Sheet Metal Welding Code.

## 1.7 REGULATORY REQUIREMENTS

- .1 Ontario Building Code (OBC)
- .2 Ontario Fire Code (OFC)
- .3 Construct ductwork to NFPA 90A standards.

## 1.8 ENVIRONMENTAL REQUIREMENTS

- .1 Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- .2 Maintain temperatures during and after installation of duct sealants.

## 2 Products

### 2.1 MATERIALS

- .1 Table of Materials

APPLICATIONS	MATERIALS
Rigid HVACducts, casings and fittings	ASTM A653 galvanized steel sheet, lock form quality, G90 zinc coating (0.90 oz/ft2) to ASTM A90. Sheets free of pits, blisters, slivers, and ungalvanized spots.
Rigid HVACducts, casings and fittings installed underground (below slabs on grade). Rigid HVACducts, casings and fittings installed in swimming pools (natatorium).	PVCcoated, galvanized steel sheets, lock form quality to ASTM A653, G90 zinc coating (0.90 oz/ft2 both sides) and factory applied 4-mil PVC coating. Ductwork shall be UL-181, Class 1 listed.

- .2 Hanger Rod: continuously threaded, ASTM A36 galvanized steel.
- .3 Sealant: Non-hardening, water resistant, fire resistive, low VOC (VOC content not to exceed 250 g/L), compatible with mating materials; liquid used alone or with tape, or heavy mastic.
- .4 Supports: Angle iron, channels, rods and related supporting materials shall be galvanized or red oxide coated.
- .5 Fasteners: Use galvanized rivets, screws and bolts throughout, except on stainless steel ductwork, use SS fasteners.
- .6 Reinforcements: Provide galvanized steel or stainless steel reinforcement shapes and plates to match ductwork.
- .7 Tie Rods: Use galvanized steel, 1/4 inch minimum diameter fasteners for ductwork 36 inch or less in length; use 3/8 inch minimum diameter for lengths longer than 36 in.

### 2.2 DUCT CONSTRUCTION

- .1 Duct Construction Schedule \_

Duct Application	Duct Pressure	Pressure Class (in.wg.)	Seal Class	Leakage Class
Rectangular HVAC Supply from terminal unit to air outlet	Positive	2	A	6
Round HVAC Supply from terminal unit to air outlet	Positive	2	A	3
Rectangular HVAC Single zone supply from AC Unit to air outlet	Positive	2	A	6
Round HVAC Single zone supply from AC Unit to air outlet	Positive	2	A	3
Rectangular HVAC Return from air outlet to AHU	Negative	2	A	6
Rectangular HVAC Return from air outlet to AHU	Negative	2	A	3
Rectangular Sanitary exhaust ductwork	Negative	2	A	6
Round Sanitary exhaust ductwork	Negative	2	A	3
Rectangular General HVAC exhaust ductwork	Negative	2	A	6
Round General HVAC exhaust ductwork	Negative	2	A	3

## 2.3 DUCT SEALING

### .1 Duct Sealing Requirements

SEAL CLASS	SEALING REQUIREMENTS
<b>A</b>	All tranverse joints, longitudinal seams and duct wall penetrations
<b>B</b>	All tranverse joints and longitudinal seams a
<b>C</b>	All tranverse joints

## 2.4 DUCT LEAKAGE

### .1 Leakage Class is defined as

$$C_L = F / (P)^{0.65}$$

where:  $C_L$  = Leakage Class

F = Leakage Factor (cfm/100-ft<sup>2</sup> of duct surface) P = Static pressure in the duct (in.wg.)

### .2 Table

LEAKAGE FACTOR (F) CFM / 100-SQ.FT. of DUCT SURFACE					
LEAK CLASS	PRESSURE CLASS (in.wg.) (+ve or -ve)				
Q	1	2	4	6	10
48	48	75	118	154	214
24	24	38	59	77	107
12	12	19	30	38	54
6	6	9	15	19	27
3	3	5	7	10	13
0	0	0	0	0	0

## 2.5 DUCTWORK FABRICATION

- .1 All Ductwork shall be constructed to withstand 1-1/2 times fan pressure at shut-off and 2" (500 Pa) minimum.
- .2 Fabricate and support to SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated in accordance with recommendations of ASHRAE and SMACNA.
- .3 Joints and reinforcements:
  1. to SMACNA and ASHRAE
  2. may be made with the Ductmate System or Nexus System. System components shall be made of standard catalogue manufacture as supplied by Ductmate Industries, Inc. or Nexus Inc. or approved equivalent.
- .4 Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centreline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fibre insulation.
- .5 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- .6 Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints: minimum 100 mm cemented slip joint, brazed or electric welded. Prime coat welded joints.
- .7 Provide standard 45-degree lateral wye takeoffs. Alternative 90-degree conical tee connections may be used only where specifically indicated.

## 2.6 ROUND SPIRAL LOCK SEAM DUCTWORK

- .1 Sprial ducts and elbows shall not be used for watertight exhaust systems.
- .2 Ducts and fittings shall be manufactured from minimum G90 galvanized steel meeting ASTM A527/A527M-85.
- .3 Ductwork shall be "Uni-Seal" single wall, round spiral lock-seam type duct in wall thicknesses listed below.
- .4 Fittings shall be "Uni-Form" single wall, round fittings suitable for use with "Uni-Seal" ductwork in wall thicknesses as follows:
 

Diameter In.(mm)	Duct Metal Thickness		Fitting Metal Thickness	
	In. (GA)	(mm)	In. (GA)	(mm)
3 (75) to 14 (356)	0.022 (26 ga.)	(0.56)	0.028 (24 ga.)	(0.70)
15 (380) to 26 (660)	0.028 (24 ga.)	(0.71)	0.034 (22 ga.)	(0.86)
27 (686) to 36 (914)	0.034 (22 ga.)	(0.86)	0.040 (20 ga.)	(1.0)
37 (939) to 50 (1270)	0.040 (20 ga.)	(1.0)	0.052 (18 ga.)	(1.32)
52 (1321) to 60 (1524)	0.052 (18 ga.)	(1.32)	0.064 (16 ga.)	(1.62)
- .5 Acceptable Manufacturer: "Uni-Seal" spiral lock-seam duct and "Uni-Form" fittings as manufactured by United Sheet Metal or approved equivalent.

## 2.7 FLEXIBLE DUCTWORK

- .1 Flexible ducts shall be factory fabricated to CAN/ULC S110, factory fabricated assembly with a laminated inner liner of aluminum foil, fiberglass and polyester, a galvanized steel helix coil formed to the inner liner, a fiberglass insulation blanket, and a polyethylene outer jacket. Flexible duct shall have a flame resistant rating of 25 or less and a smoke developed rating of 50 or less.

Pressure Rating                      Low & Medium                      High Pressure



Max. positive pressure	6"wg (3 kPa)	12"wg (6 kPa)
Max. negative pressure	4"wg (2 kPa)	5"wg (2.5 kPa)
Maximum velocity	4000 fpm (20m/s)	5500 fpm (28m/s)
Permeance	0.1 perm	0.1 perm
Operating temperature	-20 to 250 deg. F	-20 to 250 deg. F
Max. thermal conductance	0.23 BTU/Hr-F°	0.23 BTU/Hr-F°
Listed & Labelled	Class 0 /Class 1	Class 0 /Class 1
Flexmaster Type	5	3

- .3 Lab Exhaust Systems: Ductwork to be a factory fabricated assembly of neoprene-coated polyester with galvanized steel helix reinforcement. Flexible duct shall be rated for a minimum of 6.0" w.g. positive pressure, 4.0" w.g. negative pressure, 5500 FPM velocity, -65 to 250 degrees F. Flexible duct shall have a flame resistant rating of 25 or less and a smoke developed rating of 50 or less. Uni-flex Model U-LOK 200.
- .4 Accessories: conical spin-in collars with butterfly volume dampers for connections to ductwork, round rigid galvanized steel fittings fabricated to SMACNA Standards and ASHRAE recommendations, bridge and gear clamps.
- .5 Acceptable Manufacturers:
  - .1 Flexmaster
  - .2 Or approved equivalent.
- 26 (650) to 32 (800)                      20                      0.040      (1.006)
- .4 Acceptable Manufacturers:
  - .1 Uni-Coat as manufactured by United Sheet Metal.
  - .2 Or approved equal.

## 2.8 DESIGN REQUIREMENTS

### Ductwork System:

- .1 Primary supply air ductwork (between discharge side of fan and terminal boxes) shall be medium pressure class as a minimum.
- .2 Secondary supply air ductwork (eg downstream of terminal boxes) shall be low pressure class as a minimum.
- .3 Use round or oval ducts instead of rectangular ducts to reduce leakage and drum effect from vibration.
- .4 Ductwork shall be as direct as possible to minimize the number of elbows, abrupt contractions and expansions and transitions.
- .5 Long radius elbows and 45 degree lateral take-offs should be used wherever possible.
- .6 Provide sufficient straight duct run before diffusers to minimize turbulence induced noise.
- .7 Flexible ductwork may be used but shall be limited to connections between duct branches and diffusers or terminal units and shall be limited to 6' long. Flexible ductwork shall be installed fully extended with bend radius greater than the duct diameter to avoid kinking.
- .8 Ductwork outside the building should be avoided to minimize heat gain to or heat loss from the ductwork.
- .9 Duct-mounted access doors shall be provided in ductwork wherever there are manual dampers, fire dampers, turning vanes, coils to allow inspection.
- .10 All exhaust ductwork within the building shall be under negative pressure.
- .2 Ductwork Protection and Cleaning:
  - .1 During manufacture and storage, cap off ends of ducts until ready for installation.
  - .2 During installation cap off ends of unfinished ducts while plastering, drywall and other operations are in progress.

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- .3 Cover open ends or registers of exhaust/return ducts with 1" thick filter media secured with tape. Filter media to remain until all dust producing operations are completed.
  - .4 If after inspection by the Project Architect and/or the City Project Manager the ductwork systems is deemed to be unacceptable, the Contractor shall prior to operation or test and balance, clean systems and equipment including but not limited to ductwork (supply/return/exhaust), air handling equipment, plenums, terminal units, fans, dampers, grilles/registers/diffusers with high power vacuum machines. Cleaning shall be performed in accordance with National Duct Cleaners Association (NADCA) standards, and by agent specializing in this field of work, and a member in good standing with NADCA. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Submit report, verified by TAB Agent, identifying the extent of duct system cleaning and certifying that NADCA standards have been met.
  - .5 Provide adequate access into ductwork for cleaning purposes.
- .3 Ductwork Sealing and Leak Testing:
- .1 Ductwork seams and joints shall be sealed for a Seal Class B including all traverse joints, longitudinal seams, and connections. Connections include spin-ins, taps, branch connections, access doors, and connections to equipment.
  - .2 Ductwork shall be leak tested at the rated pressure in accordance with SMACNA HVAC Duct Leakage Test Manual. A leak test report shall be provided to the City.
  - .3 Duct sealing and leak testing shall be conducted before ductwork is insulated or concealed by drywall or T bar ceiling to allow for re-sealing or repairing duct sections.
  - .4 The leakage shall not exceed the allowable cfm/100ft<sup>2</sup> of duct area for the seal and leakage class apportioned to each section tested.
  - .5 **Ductwork leak testing shall be witnessed by the Commissioning Authority or a Municipality of Barrie representative.**
- .4 Duct Insulation:
- .1 All supply air ductwork shall be insulated.
  - .2 All return air ductwork located above the ceiling and below the building roof shall be insulated.
  - .3 All outdoor supply or return ductwork shall be insulated.
  - .4 Insulate the first 3m of all exhaust ductwork from an exterior wall.
  - .5 All exhaust or relief air ductwork between motor operated dampers and building exterior penetration point shall be insulated.
- .5 Air Plenums:
- .1 Return air plenums that are formed by exterior walls, and roof slabs shall be sealed air-tight to prevent untreated outdoor air from being drawn into the return air stream.
- .6 Air Terminal Units:
- .1 Damper controls to be accessible from outside the unit. Damper position to be visible from outside the unit.
  - .2 Re-heat coils shall have access for cleaning.

### **3 Execution**

#### **3.1 INSTALLATION**

- .1 Install and seal ducts to SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- .2 Install ductwork parallel to building lines.
- .3 Support all ductwork from structural members. Where structural bearings do not exist, suspend strapping or hangers from steel channels or angles. Provide supplementary structural members. Do not suspend from metal deck.
- .4 Do not break continuity of insulation vapour barrier by hangers or rods.
- .5 Hangers shall be steel angles with supporting rods, locking nuts and washers to following table;  
*[Except for Fire Rated Ventilation Ductwork or Fire Rated Kitchen Exhaust Grease Duct which shall comply with ULC Listing and manufacturers instructions]*

Duct Sizes	Angle Size	Rod Size	Spacing
up to 30"	1" x 1" x 1/8"	1/4"	10 feet
31" to 42"	1-1/2"x1-1/2"x1/8"	1/4"	10 feet
43" to 60"	1-1/2"x1-1/2"x1/8"	3/8"	10 feet
61" to 84"	2" x 2" x 1/8"	3/8"	8 feet

Duct Sizes	Angle Size	Rod Size	Spacing
Up to 750 mm	25 x 25 x 3 mm	6 mm	3 metres
775 to 1050 mm	40 x 40 x 3 mm	6 mm	3 metres
1075 to 1500 mm	40 x 40 x 3 mm	10 mm	3 metres
1525 to 2100 mm	50 x 50 x 3 mm	10 mm	2.5 metres
- .6 Anchor all risers at bottom and support from building structure at each floor level.
- .7 Vertical ducts passing through floors shall be supported on angles secured to duct bearing on the floor.
- .8 Where ducts pass through walls, floors, openings required to have a fire resistance rating the opening in the construction around the duct shall be filled with an approved fire stop material as per NFPA 90A and fire damper shall also be installed with access doors as per the code.
- .9 Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- .10 Provide openings in duct work where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- .11 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .12 Use crimp joints with or without bead for joining round duct sizes 8" (200 mm) and smaller with crimp in direction of air flow.
- .13 Use double nuts and lock washers on threaded rod supports.
- .14 Connect terminal units to supply ducts directly or with 12" (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.
- .15 Connect diffusers or light troffer boots to low pressure ducts directly or with 60" (1.5 m) maximum length of flexible duct held in place with strap or clamp.
- .16 Connect flexible ducts to metal ducts with adhesive and metal or nylon straps.
- .17 Ground across flexible connector with No. 2/0 braided copper strap.
- .18 Set plenum doors 6" to 12" (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
- .19 During construction provide temporary closures of metal or taped polyethylene on open duct work to prevent construction dust from entering duct work system.
- .20 Install HTL ductwork between duct silencer and mechanical room wall.
- .21 Balancing dampers shall be installed on branches as per locations shown on the drawings and as per the requirements of NEBB and AABC listing/measuring standards.
- .22 Perform duct leakage testing for all ductwork installed under this contract.

### 3.10 FLEXIBLE DUCTWORK

- .1 Flexible ductwork may be installed for final connections to air outlets provided that not more than 5 ft. (1.5 mm) in length is used for each connection, and where specifically indicated on drawings.
- .2 All fittings used with flexible ductwork shall be rigid round duct.
- .3 Use pre-insulated flexible ductwork where application is to be insulated.

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**3.11 DUCT LEAKAGE TESTING**

- .1 Ductwork shall be leak tested in accordance with the SMACNA "HVAC Air Duct Leakage Test Manual". The maximum permitted duct leakage shall be determined by multiplying the leakage factor from paragraph 2.4 above by the surface area of the ductwork in the test zone.
- .2 Ductwork that exceeds the maximum permitted leakage shall be re-sealed and re-tested.
- .3 Duct leakage test shall be witnessed and certified by the Systems Verification Agency of section 15020.
- .4 Record and submit three (3) copies of test results to the Consultant for review prior to application of duct insulation or concealment of ductwork.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.

**1.2 SECTION INCLUDES**

- .1 Diffusers.
- .2 Registers/grilles.

**1.3 REFERENCES**

- .1 ADC 1062 - Air Distribution and Control Device Test Code.
- .2 AMCA 500 - Method of Testing Louvres for Ratings.
- .3 AMCA 5000 - Method of Testing Dampers for Ratings.
- .4 ARI 650 - Air Outlets and Inlets.
- .5 ASHRAE 70 - Method of Testing for Rating the Performance of Outlets and Inlets.
- .6 SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- .7 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

**1.4 SUBMITTALS**

- .1 Section 23 01 01: Procedures for submittals.
- .2 Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- .3 Samples: Submit two of each required air outlet and inlet type.

**1.5 PROJECT RECORD DOCUMENTS**

- .1 Section 23 01 01: Submittals for project closeout.
- .2 Record actual locations of air outlets and inlets.

**1.6 QUALITY ASSURANCE**

- .1 Test and rate air outlet and inlet performance to ADC Equipment Test Code 1062 and ASHRAE 70.
- .2 Test and rate louvre performance to AMCA 500.

**1.7 QUALIFICATIONS**

- .1 Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

**2 Products**

REFER TO DIFFUSERS & GRILLES SCHEDULE ON DRAWINGS

**2.1 MANUFACTURERS**

- .1 E. H. Price model indicated or equivalent products by;
  - .1 Titus
  - .2 Kreuger
  - .3 Metalaire
  - .4 Nailor
  - .5 Or approved equal.

**2.2 SQUARE CONE DIFFUSERS, FIXED PATTERN**

- .1 Manufacturer's Reference: E. H. Price Model SCD or approved equivalent.
- .2 Type: Square, fixed pattern, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.
- .3 Frame: Inverted T-bar type. In plaster ceilings, provide plaster frame and ceiling frame.
- .4 Fabrication: Steel with baked enamel off-white finish.
- .5 Accessories: Radial opposed blade damper and multi-louvred equalizing grid with damper adjustable from diffuser face.

### **2.3 CEILING GRID CORE EXHAUST AND RETURN GRILLES**

- .1 Manufacturer's reference: E. H. Price 80D or approved equivalent.
- .2 Type: Fixed grilles of 1/2" z 1/2" x 1/2" (13 x 13 x 13 mm) louvres.
- .3 Frame: 1-1/4" (32 mm) margin with concealed mounting. Channel lay-in frame for suspended grid ceilings.
- .4 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from Face.

## **3 Execution**

### **3.1 INSTALLATION**

- .1 Install in accordance with manufacturer's instructions.
- .2 Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- .3 Install diffusers and grilles and connect to ductwork with air tight connections.
- .4 Provide balancing dampers in duct take-off to diffusers, grilles and registers, whether or not dampers are included as part of the diffuser, grille or register assembly.
- .5 Paint visible ductwork behind air outlets and inlets matte black.
- .6 Install filters in diffusers, grilles and registers after final cleaning of rooms and ductwork has been completed and accepted and when environmental conditions are suitable. Ensure that air tight seal is achieved.
- .7 Provide balancing dampers in duct take-off to diffusers, return grilles etc whether or not dampers are shown on the drawings. Contractor is fully responsible to provide dampers required for proper balancing of the system.

**End of Section**

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## **1 General**

### **1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 23 01 01.
- .2 Supply and install Thermo2000 electric boiler Model BTH Ultra 17 or of approved equivalent electric boiler shown on the drawings.
- .3 Each boiler shall be factory assembled and tested. Each boiler shall be shipped self-contained and ready for operation except for connection at the installation site of heating piping and electrical power and remote control wiring. Each boiler shall include all accessories and construction features as described here in.
- .4 The boiler shall be UL certified and shall comply with Canadian Electrical Codes.
- .5 The boiler shall include an ASME IV pressure vessel.

## **2 Product**

### **2.1 RATINGS**

1. The boiler shall be a Thermo2000 Model BTH Ultra 17 or approved equal, rated 17kW, designed and fabricated for a balanced 3-phase, 3 wire, delta load at 208V/3Ph/60Hz. The boilers shall be designed for 11.65 gpm with a discharge temperature of **110 °F** with entering water at **100 °F**.

### **2.2 PRESSURE VESSEL**

1. The pressure vessel and all trim shall be as set forth in the ASME Code including ASME "HV" stamped safety relief valve sized as required. The vessel shall be provided with a 30psi safety valve and drain nozzle as required.
2. The pressure vessel shall be housed in a 16 gauge steel enclosure allowing 4" of insulation space around the vessel and filled with 4" of fiberglass insulation.
3. The electrical panel and the vessel shall be mounted on a common structural steel base.

### **2.3 INTERNAL POWER DISTRIBUTION**

1. The power distribution shall be through cable connection to mechanical lugs. Power shall be fed through current limiting fuses to magnetic contactors and then to the heating element circuits. Contactors shall be 3-pole magnetic contactors tested by UL for 500,000 cycles at full load.

### **2.4 HEATING ELEMENTS**

1. Elements shall be individually mounted in steel flanges. Element sheath material shall be incoloy and element watt density shall be 75WSI.

### **2.5 CONTROLS**

1. Control voltage shall be provided by an integral control circuit transformer, fused on both legs of the primary, with a control circuit fuse on the ungrounded leg of the secondary.
2. The controls shall include an ON/OFF switch, temperature controller, solid state step control with 4 steps, indicator lights and manual limiting switches for each stage of heating, a low water cut-off with test/reset buttons, and one auto reset and one manual reset high limit temperature switch.

### **2.6 DELIVERY, STORAGE, AND PROTECTION**

1. **Section 23 01 01:** Transport, handle, store, and protect products.
2. Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

### **2.7 WARRANTY**

1. **Section 23 01 01:** Submittals for project closeout.
2. Provide a ten year pro-rated warranty for the boiler pressure vessel and heating elements.

### **3 Execution**

#### **3.1 INSTALLATION**

1. Boiler shall be installed in accordance with manufacturers' instructions, Canadian Electrical Code and requirements of any local authority having jurisdiction.
2. Provide start-up, testing, balancing and commissioning. Submit commissioning report to the engineer for review. Re-test, adjust and balance if required as per Engineer's review comments.

**End of Section**



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## **1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 21 01 01.

### **1.2 SECTION INCLUDES**

- .1 Air-to-Air Heat Recovery Equipment, ERV-1.
- .2 Controls.

### **1.3 REFERENCES**

- .1 Air-to-Air Energy Recovery Ventilation Equipment Certification Program, ARI Standard 1060 - 2000.
- .2 cUL 1812.
- .3 AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.
- .4 ASHRAE/IESNA 90.1 - Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

### **1.4 SUBMITTALS FOR REVIEW**

- .1 Section 21 01 01, para 1.5 Submittals.
- .2 Submittals shall include the following: performance and capacity details of the unit at specified indoor and outdoor conditions, wiring diagrams, and warranty information.

### **1.5 SUBMITTALS FOR INFORMATION**

- .1 Submit manufacturer's installation instructions. Indicate assembly, support details, connection requirements, and include start-up instructions.

### **1.6 SUBMITTALS FOR CLOSEOUT**

- .1 Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with startup requirements shall be provided.
- .2 Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.
- .3 Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

### **1.7 QUALITY ASSURANCE**

- .1 Unit shall be manufactured at an ISO 9001 certified facility. Unit shall be listed by Underwriters Laboratories (UL 1812) and UL listed for Canada (cUL 1812). Unit shall be ARI certified in accordance with the ARI Air-to Air Energy Recovery Ventilation Equipment Certification Program. Unit shall bear the AMCA certified ratings seal for air performance.
- .2 Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

### **1.8 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

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

- .1 Section 21 01 01: Transport, handle, store, and protect products.
- .2 Protect finished cabinet from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

## **2 PRODUCTS**

### **2.1 CONSTRUCTION**

- .1 Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, energy wheel, motorized intake damper, motorized exhaust damper, electric preheater, filter assembly for intake and exhaust air, supply air blower assembly, exhaust air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

### **2.2 CABINET**

- .1 Materials: Formed single wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
- .2 Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish.
- .3 Internal assemblies: 18 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
- .4 Access doors shall be hinged.
- .5 Shall have factory-installed duct flanges on all duct openings.
- .6 Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
- .7 Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
  - i. Thickness: 1 inch (25 mm)
  - ii. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
  - iii. Location and application: Full coverage of entire cabinet exterior to include walls, roof and floor of unit. Insulation shall be of semi-rigid type and installed between inner and outer shells of all cabinet exterior components.
- .8 Energy wheel: Energy wheel shall be of total enthalpy, rotary air-to-air type and shall be an element of a removable energy wheel cassette. The cassette shall consist of a galvanized steel framework (designed to produce laminar air flow through the wheel), an energy wheel as specified and a motor and drive assembly. The cassette shall incorporate a pre-tensioned urethane drive belt with a five year warranty. The wheel media shall be a polymer film matrix in a stainless steel framework and be comprised of individual segments that are removable for servicing. Non-segmented energy wheels are not acceptable. Silica gel desiccant shall be permanently bonded to the polymer film and shall be designed and constructed to permit cleaning and servicing. The energy wheel is to have a five year warranty. Performance criteria are to be as specified in AHRI Standard 1060, complying with the Combined Efficiency data in the submittal.
- .9 Supply Air and Exhaust Air blower assemblies: Blower assemblies consist of an electric motor and a belt driven blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on 1.125 inch thick neoprene vibration isolators.
- .10 Control panel / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.

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.11 Frost control: preheater.

- .12 Electric preheater shall be provided for frost control of the energy wheel. Preheater assembly shall include a thermostat and pressure sensor on the wheel assembly to initiate frost control sequence. Preheater shall comply with UL 1995 and be constructed on a galvanized steel frame.
- .13 Motorized dampers for Exhaust Air and Intake Air, shall be of low leakage type and shall be factory installed.

## **2.4. BLOWER**

- .1 Blower section construction, Supply Air and Exhaust Air: Direct drive motor and blower.
- .2 Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- .3 Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
- .4 Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
- .5 Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

## **2.5. MOTORS**

- .1 General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley.
- .2 Fan motors shall be 60 cycle, 1 phase 208 volts.

## **2.6. FILTERS**

- .1 Unit shall have permanent metal filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the intake air stream and MERV 8 filters in the exhaust air stream.

## **2.7 ACCESSORIES**

- .1 ERV shall be supplied furnished with the following accessories: Pre-heat frost control 2 stage, motorized dampers for exhaust air and intake air, painted finish in standard grey, intake/exhaust hoods with mesh bird screen, hinged access doors with quarter turn handles, purge section, GFI convenience outlet, wheel rotation sensor, DP sensor on both supply and exhaust filters, 24 volt control panel supplied loose for install and wiring by contractor, CO<sub>2</sub> sensor factory fitted in the return air intake.

## **2.8 ACCEPTABLE MANUFACTURERS / MODELS**

- .1 Greenheck
- .2 Loren Cook
- .3 Oxygen8
- .4 Tempeff
- .5 Or approved equal

# **3 EXECUTION**

## **3.1 DELIVERY, STORAGE AND HANDLING**

- .1 Units shall be stored and handled according to the manufacturer's recommendations. Units shall be kept clean and isolated from dust and debris

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- .2 Contractor shall inspect all equipment upon delivery and notify shipping company and manufacturer immediately of any damage.

### **3.2 INSTALLATION**

- .1 Install ERV suspended from the underside of the roof structure in the mechanical room as shown in the drawings. Provide supports as recommended by the equipment manufacturer.
- .2 Provide all necessary control wiring as recommended by the manufacturer.
- .3 Provide flexible duct connections between the rigid ductwork and the ERV.
- .4 Engage a factory authorized service representative to perform startup service.
- .5 Provide start-up, testing, adjusting, balancing, and commissioning of the ERV. Submit commissioning reports to the Engineer for review. Adjust, re-test, if required as per the Engineer's comments.

**End of Section**

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## **1 GENERAL**

### **1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 21 01 01.

### **1.2 SECTION INCLUDES**

- .1 Variable Refrigerant Flow HVAC System.
- .2 Controls.

### **1.3 REFERENCES**

- .1 ANSI/AHRI Standard 1230-2010 – Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment.
- .2 CSA B52 Mechanical Refrigeration Code.
- .3 ANSI/UL Standard 1995.
- .4 ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- .5 ASHRAE/IESNA 90.1 - Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- .6 ASHRAE Standard 15, Safety Standard for Mechanical Refrigeration.

### **1.4 SUBMITTALS FOR REVIEW**

- .1 Section 21 01 01, para 1.5 Submittals.
- .2 Submittals shall include the following: performance and capacity details of all units at specified indoor and outdoor conditions, piping schematics outputted from manufacturer specific software including pipe sizes and estimated piping lengths, refrigerant charge per system including CSA B-52 analysis, wiring diagrams, and 10 year parts only warranty information.
- .3 Submittal shall include a copy of the installing contractor's certification of VRF manufacturer approved training.

### **1.5 SUBMITTALS FOR INFORMATION**

- .1 Submit manufacturer's installation instructions. Indicate assembly, support details, connection requirements, and include start-up instructions.

### **1.6 SUBMITTALS FOR CLOSEOUT**

- .1 Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with startup requirements shall be provided.
- .2 Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.
- .3 Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

### **1.7 QUALITY ASSURANCE**

- .1 Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- .2 Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- .3 Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

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## **1.8 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

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

- .1 Section 23 01 01: Transport, handle, store, and protect products.
- .2 Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

## **2 PRODUCTS**

### **2.1 GENERAL**

- .1 This section includes the design, performance, refrigerant details, controls and installation requirements for Variable Refrigerant Flow HVAC System.
- .2 All units shall be listed and rated by ANSI/AHRI Standard 1230-2010 and meet all minimum IEER performance requirements as scheduled.
- .3 The units shall be ANSI/UL STD 1995 listed and listed by Electrical Testing Labs (ETL) and bear the cETL label.
- .4 All wiring shall be in accordance with the National Electric Code (NEC) / Canadian Electrical Code.
- .5 The system shall be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
- .6 The system and the design shall be in compliance with CSA B52 Mechanical Refrigerant Code.
- .7 Basis of design: Daikin multi-split VRV System, distributed by DXS Ontario.
- .8 Acceptable Manufacturers: Daikin, Mitsubishi, Carrier, Trane or approved equal.
- .9 Alternate manufacturers shall send approval requests to consultant 14 days prior to bid day, and include all information relevant to the alternate VRF system, including but not limited to: unit selections, refrigerant piping layout, refrigerant charge with ASHRAE 15 analysis, branch selector box layout and locations, heating and cooling capacities at design temperatures and including capacity losses from piping lengths, defrost cycles, and combination ratios, dimensional and weight differences, and any other aspect of the system that differs from the system specified.

### **2.2 SYSTEM DESCRIPTION**

- .1 VRF system shall automatically vary the target evaporating and condensing temperatures based on building load and weather conditions to increase part load efficiency (Variable Refrigerant Temperature). The condensing unit shall also feature customizable operating modes which allows for the manual setting of target evaporating and condensing temperatures.
- .2 System shall permit simultaneous heating and cooling of each indoor unit. Multiple indoor units connected to a single branch selector port shall operate in the same mode (heating or cooling). Refer to the controls section of this specification for central controller and/or mode switchover sequence that are required.

### **2.3 START-UP AND WARRANTY**

- .1 Installing contractor must be certified by VRF manufacturer. The bidders shall be required to submit training certification proof with bid documents and submittal documents.
- .2 The manufacturer shall provide a factory trained service technician to start-up each unit. Manufacturer shall provide instruction to the owners' personnel on proper unit operation and maintenance.

- .3 The warranty period on all parts and compressors shall commence on the date of initial start-up and shall continue for a period of Ten (10) years not to exceed one hundred and twenty six (126) months from date of shipment.
- .4 All manufacturer warranty shall be for parts only. All diagnosis and labour warranty shall be carried out by the installing contractor.

## **2.4 REFRIGERANT PIPING**

- .1 Refer and comply to the refrigerant piping specifications, including the special considerations for VRF refrigerant piping section.
- .2 Standard T style joints are not acceptable for the variable refrigerant volume system. Manufacturer specific Y joints shall be supplied by the VRF manufacturer.

## **2.5 FAN COILS**

- .1 Fan coils shall monitor and maintain the unit superheat (cooling mode) or subcooling (heating mode) using a computerized PID control. Internal unit components shall be factory wired and piped, and complete with electronic proportional expansion valve, flare connections, condensate drain pan, self-diagnostics, and auto-restart function.
- .2 The indoor fan coil unit shall be a built-in ceiling concealed fan coil unit with variable speed direct drive DC type fan and auto CFM adjustment at commissioning. Casing shall be constructed of galvanized steel. Configuration shall be horizontal discharge air with horizontal return air, with a maximum height of 9-5/8" and be designed to fit in tight ceiling plenums.
- .3 The indoor unit's sound pressure shall range from 28 dB(A) to 36 dB(A) at low speed measured 5 feet below the ducted unit.
- .4 The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump shall provide up to 25" of lift from the center of the drain outlet and have a built-in safety shutoff and alarm.
- .5 The fan shall have a variable speed direct drive DC motor with statically and dynamically balanced impeller with 3 user-selectable fan speeds. The automatic fan speed mode shall allow the fan to vary between 5 speeds based on space load. The unit shall have logic for automatically adjusting external static pressure settings of the fan motor (selectable during commissioning).
- .6 The unit shall ship from the factory in a rear return configuration and shall be field convertible to a bottom return configuration.
- .7 Provide field installed MERV8 filters and filter kits with 2" filter depths.

## **2.6 CONDENSING UNITS**

- .1 The condensing unit shall be factory assembled in North America and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of inverter scroll compressors, motors, fans, heat exchanger, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, liquid receiver and suction accumulator.
- .2 The system will automatically restart operation after a power failure and will not cause any settings to be lost.
- .3 The unit shall incorporate an auto-charging feature to ensure proper refrigerant charge.
- .4 The following safety devices shall be included on the condensing unit: high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter, and anti-recycling timers.



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- .5 The inverter scroll compressors shall be high efficiency reluctance DC (digitally commutating), hermetically sealed, variable speed type. Temperatures and pressures shall be read every 20 seconds and calculated. With each reading, the compressor capacity (INV frequency) shall be controlled to eliminate deviation from target value.
  - .6 Neodymium magnets shall be adopted in the rotor construction to yield a higher torque and efficiency in the compressor instead of the normal ferrite magnet type. Upon complete stop of the compressor, the neodymium magnets will position the rotor into the optimum position for a low torque start.
  - .7 The compressors' motors shall have a cooling system using discharge gas, to avoid sudden changes in temperature resulting in significant stresses on winding and bearings.
  - .8 Inverter board shall be refrigerant-cooled to prevent inefficient and unstable operation that can result from air-cooled inverter boards due to varying ambient conditions.
  - .9 The compressor shall be internally isolated to avoid the transmission of vibration.
  - .10 The variable speed inverter compressors shall also use Flash Vapor injection technology with back pressure control for reduced leakage and additional balancing weights on main shaft for increased compressor lifetime.
  - .11 The fan motor shall have inherent protection and permanently lubricated bearings. The motor shall be provided with a fan guard to prevent contact with moving parts. The condensing unit shall consist of one or more propeller type, direct-drive 600 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
  - .12 The condensing unit shall have configurable settings for intermittent fan operation to help minimize snow accumulation on fan blades when the system is off.
  - .13 Night setback control for low noise operation shall automatically limit the maximum speed of the fan motor.
  - .14 The heat exchanger on the condensing units shall be manufactured from Hi-X seamless copper tubes with N-shape internal grooves mechanically bonded on to aluminum fins to an e-Pass Design. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
  - .15 The fins are to be covered with an anti-corrosion hydrophilic blue coating as standard with a salt spray test rating of 1000hr (ASTM B117 & Blister Rating:10), Acetic acid salt spray test of 500hr (ASTM G85 & Blister Rating:10).
  - .16 The connection ratio of indoor units to condensing unit shall be permitted and optimized for operation up to 200% of nominal capacity.
  - .17 System refrigerant piping shall be capable of being sized to accommodate current and future indoor units without any changes to main piping riser. Any changes to piping shall be the responsibility of the installing contractor.
  - .18 Condensing units shall be specifically designed and built for cold climate applications, where the VRF system will be the primary or sole source of heating. Condensing units shall have heating capacity and efficiency data down to -13F.
  - .19 The outdoor coil shall have a three-circuit heat exchanger design. The lower part of the coil shall be a hot gas base pan circuit to prevent ice buildup in the drain pan, allowing installation without additional drain pan heaters. Manufacturers without hot gas base pan circuits shall provide a drain pan heater accessory, installed and wired by contractor.
  - .20 The outdoor unit shall be capable of heating operation down to -13°F ambient temperature. Tested factory data on heating capacity and efficiency shall be available.
  - .21 The outdoor unit shall be capable of cooling operation down to +23°F without any additional low ambient controls.



- .22 The outdoor coil shall have a three-circuit heat exchanger design. The lower part of the coil shall be used for inverter cooling, enhancing defrost during heating operation.

## **2.7 BRANCH SELECTOR BOX**

- .1 Selector box cabinets shall have a galvanized steel plate casing and shall house multiple electronic expansion valves and a sub-cooling loop. The unit shall contain sound absorption thermal insulating material made of flame and heat resistant foamed polyethylene.
- .2 Branch selector box shall not require drain pan and drain connections. Manufacturers with branch selector boxes requiring secondary drain pans and drain connections shall coordinate with the installing contractor at no extra cost to the owner.
- .3 Manufacturers with branch selector box sizes, arrangements, or locations that differ from what is specified shall make the necessary arrangements to ensure their alternative branch selector boxes both fit in the space and that ASHRAE 15 compliance is still met.
- .4 Manufacturers shall provide sound data for branch selector box. If sound data is unavailable or exceeds 40 dB(A), or if branch boxes make use of solenoid valves instead of electronic expansion valves, necessary precautions shall be taken. Precautions shall include the supply and install of sound blankets, or the relocation of branch boxes away from the occupied spaces, or extra insulation to the ceilings and walls around the branch selector boxes, all at no extra cost to the owner.

## **2.8 LOCAL CONTROLS**

- .1 Fan coil units shall be supplied with individual zone controllers.
- .2 Zone controllers shall be hard wired by installing contractor.
- .3 Controllers shall be able to function as follows:
- i. The controller shall have single and dual setpoints for occupied periods, and independent setback setpoints for unoccupied periods.
  - ii. The controller shall have the ability to digitally prohibit individual buttons and functions, including custom mode selection.
  - iii. The controller shall have a self diagnosis function that constantly monitors the system for malfunctions.
  - iv. The controller shall be equipped with a thermostat sensor.
  - v. Controller shall have built-in 7 day, weekday plus Saturday Sunday (5+1+1), weekday plus weekend (5+2) and everyday (1) scheduler.

## **2.9 CENTRAL CONTROLS**

- .1 Provide an advanced multi-zone controller for installation in a common area as shown on the plans. The controller shall have a 10" LCD touch screen display with the following screen views and functionalities:
- i. Central control of set points, schedules, fan speeds, heat/cool mode, and of setback (override) temperature settings during unoccupied periods.
  - ii. Adjustable temperature limits to restrict local wall mounted thermostat setpoint ranges.
  - iii. Visible and audible alarm indication of any system malfunctions with error code.
  - iv. Tiered hierarchy allowing for control of fan coil units independently or as a group.
  - v. Remotely disable individual functions of the wall mounted zone controllers.
  - vi. Web enabled for remote access from PC, tablet or portable device and automatic alert and error emails.

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- .2 The following two automatic changeover methods shall be available. One shall be selected upon commissioning.
- i. Averaging Method – the central controller shall sum up the difference between room temperatures and set points for all indoor units in the system. Once this delta reaches the primary changeover deadband of  $\pm 2^{\circ}\text{F}$  (adjustable), the central controller shall change over the system automatically.
  - ii. Voting Method – The central controller shall evaluate the difference between individual room temperatures and set points, and only include a fan coil in the algorithm if the difference has passed the primary dead band for more than the guard timer, or past the secondary dead band. Heating priority option shall be available.
- .3 For both automatic changeover options, a weight (0-3) can be added to each indoor unit. The automatic changeover algorithm shall use this weighting to prioritize changeover for the more heavily weighted fan coils.
- .4 Upon any changeover, a guard timer shall prevent another changeover for a period of 15, 30, or 60 (default) minutes.
- .5 The guard timer shall be ignored by a change of setpoint manually from either the central controller or the remote controller, by schedule, or if the secondary deadband is reached with either of the automatic changeover algorithms. The secondary changeover deadband shall be the sum of the primary changeover deadband (adjustable)  $\pm 1^{\circ}\text{F}$  (adjustable)
- .6 The central controller shall have the capability for site floor plans to be uploaded as a background to create a graphics interface. Background shall be project specific floor plans rendered in “2D” or “3D”.
- .7 Floor plan layout shall be displayed both on the local central controller, as well as accessible from the web.
- .8 Floor plan will include capability to control indoor unit, and auxiliary inputs / outputs, such as designated lighting control, as follows:
1. Up to 4 status points to be assigned to the control point icon (room name, room temperature, set point, and mode).
  2. Status and control points to display on corresponding location of zone served on floor plan.
  3. Digital input and output icons shall display On/Off status.
  4. Analog input icons shall display analog value.
  5. Up to 60 floor layout sections shall be possible.
- .9 The iTM BACnet Server Gateway Option shall be capable of making the iTouch Manager, or approved equal, work as a BACnet gateway using the BACnet/IP protocol. The iTM BACnet Server Gateway Option shall be capable of exposing indoor unit management points as BACnet objects to the BMS.
- .10 The iTM BACnet Server Gateway Option shall allow the following functions:
- i. Support Change of Value (COV) notifications.
  - ii. Provide unique virtual BACnet device identification number (ID) for every indoor unit group address.
  - iii. The iTM BACnet Server Gateway Option shall be capable of being configured as a foreign device. It shall be capable of communicating across BACnet Broadcast Management Devices (BBMD) in different subnet networks.
- .11 In addition to the standard BACnet VRF points, the Building Management System shall monitor and/or control the following BACnet objects for indoor units:

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- i. Occupancy Mode : Unoccupied, Occupied, Standby
  - ii. Cooling and heating setpoints during occupied and unoccupied modes.
- .12 The Building Management System may choose to monitor and control the following BACnet objects linked to iTM control logic:
- i. Enable/Disable iTM Schedule operation.
  - ii. Enable/Disable iTM Auto Changeover Operation.
  - iii. Set Timed Override Minutes - Monitor and configure timer extension for the indoor unit on iTM (30, 60, 90, 120, 150, 180 minutes)
  - iv. System forced off - Enable/Disable all emergency stop programs that are registered on the iTM.
- .13 The BMS shall have the ability to utilize scheduling functions on the iTouch Manager.
- .14 The BMS shall have the ability to utilize automatic changeover function on the iTouch Manager, removing the need to program automatic changeover sequences on the BMS.
- .15 VRF manufacturer shall commission the BACnet server. BMS contractor shall provide VRF manufacturer with static IP address and instance number for commissioning. IP connection shall be by BMS contractor.
- .16 All programming for monitoring and control of VRF system via the BACnet server shall be by BMS contractor, as per the Sequence of Operation.
- .17 The control voltage between the indoor and outdoor unit shall be 16VDC. The control wiring shall be communication type stranded non-shielded 18-2 AWG.
- .18 Control wiring shall be installed in a daisy chain configuration between all VRF components as per Manufacturer.

### **3 EXECUTION**

#### **3.1 DELIVERY, STORAGE AND HANDLING**

- .1 Units shall be stored and handled according to the manufacturer's recommendations. Units shall be kept clean and isolated from dust and debris.
- .2 Contractor shall inspect all equipment upon delivery and notify shipping company and manufacturer immediately of any damage.

#### **3.2 INSTALLATION**

- .1 Install condensing units on a flat surface level within 1/8 inch, and elevated a minimum of 18" from ground or roof surface. Provide intermediate supports as recommended by the equipment manufacturer.
- .2 Provide all necessary control wiring as recommended by the manufacturer.
- .3 High/low pressure gas line, liquid, and suction lines must be individually insulated between the outdoor and indoor units.
- .4 Contact the manufacturer or dealer prior to installation to review and confirm piping layout and lengths.
- .5 Use refrigeration best practice to allow pipes to expand and contract freely. Review manufacturer installation instructions to ensure expansion joints are properly designed.
- .6 Pressure test ALL systems to 550 PSI after system was vacuumed and held to below 500 microns for at least one hour. Review manufacturer installation instructions for proper pressure test procedures.
- .7 Provide start-up, testing, adjusting, balancing and commissioning of the VRF system. Commissioning Agent shall be present during the start-up and commissioning along with mechanical contractor, VRF contractor and BAS contractor. Submit commissioning reports to the Engineer for review. Make adjustments, re-test, if required as per the Engineer's comments.

**End of Section**

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**1 GENERAL**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 21 01 01.

**1.2 SECTION INCLUDES**

- .1 Air-to-Water Heat Pump.  
.2 Controls.

**1.3 REFERENCES**

- .1 Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapour Compression Cycle, AHRI Standard 550/590.  
.2 ANSI/ASHRAE Standard 15, Safety Standard for Mechanical Refrigeration.  
.3 CSA B52 Mechanical Refrigeration Code..  
.4 ASHRAE/IESNA 90.1 - Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

**1.4 SUBMITTALS FOR REVIEW**

- .1 Section 21 01 01, para 1.5 Submittals.  
.2 Submittals shall include the following: performance and capacity details of the unit at specified indoor and outdoor conditions, wiring diagrams, and warranty information.

**1.5 SUBMITTALS FOR INFORMATION**

- .1 Submit manufacturer's installation instructions. Indicate assembly, support details, connection requirements, and include start-up instructions.

**1.6 SUBMITTALS FOR CLOSEOUT**

- .1 Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation, and Maintenance manual with startup requirements shall be provided.
- .2 Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances and connection details. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.
- .3 Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

**1.7 QUALITY ASSURANCE**

- .1 Unit shall be manufactured at an ISO 9001 certified facility. Unit shall be listed by Underwriters Laboratories (UL 1812) and UL listed for Canada (cUL 1812). Unit shall be AHRI certified in accordance with the AHRI Standard 550/590.
- .2 Unit Energy Efficiency Ratio (EER) shall be equal to or greater that prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

**1.8 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

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

- .1 Section 21 01 01: Transport, handle, store, and protect products.
- .2 Protect finished cabinet from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

## **2 PRODUCTS**

### **2.1 GENERAL**

- .1 The unit shall meet the performance data as detailed in the schedule. Construction and ratings shall be in accordance with latest ARI Standard 590, ANSI/ASHRAE 15, CSA-B52 and ASME Code.

### **2.2 CABINET**

- .1 The unit shall be assembled on a rugged heavy gauge steel base not requiring field supplied structural steel support.
- .2 Exterior casing shall be cleaned and phosphatized, then coated with a polyester powder paint.
- .3 Unit shall have easily removable, separate access panels to the control centre and the compressor compartment.

### **2.3 EVAPORATOR**

- .1 Each evaporator / heat exchanger shall be a brazed plate-to-plate type heat exchanger with 316 stainless steel plates. Each heat exchanger shall have one independent refrigerant circuit on the refrigerant side, and one circuit on the water side.
- .2 The heat exchanger shall be protected with an electric resistance heater and insulated with a thick closed-cell polyurethane insulation, providing freeze protection down to -20°F (-29°C) ambient air temperature.
- .3 Evaporator shall be provided with an inlet strainer and flow switch.
- .4 Balancing valves must be field installed and provided by the installing contractor.

### **2.4 CONDENSER**

- .1 Condenser coils shall be constructed from seamless copper tubes mechanically expanded into aluminum fins and shall have integral subcooling circuits.
- .2 Condenser fans shall be axial type, aerodynamically designed for ultra-low noise level generation.

### **2.5 COMPRESSORS**

- .1 The compressors shall be positive-displacement direct drive with hermetically sealed casing.
- .2 Each compressor has a crankcase oil heater, and suction strainer.
- .3 Capacity Control: On-off compressor cycling.
- .4 Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug, and initial oil charge.
- .5 Vibration Isolation: Mount individual compressors on vibration isolators.
- .6 Compressors must be enclosed in acoustically insulated and waterproof compartments.

### **2.6 REFRIGERANT CIRCUIT**

- .1 Shall include a thermal-expansion valve, a discharge check valve, a mechanical dehydrator filter, a sight glass with moisture indicator, a liquid-line solenoid valve, an insulated suction line, and high and low pressure safeties. High pressure safeties shall require a manual reset.

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## **2.7 ELECTRICAL**

- .1 A centrally located weatherproof control panel shall contain the unit control system, control interlock terminals and field-power connection points. Hinged control panel access doors shall be tool-lockable. Barrier panels shall be provided to protect against accidental contact with line voltage when accessing the control system.
- .2 Power and starting components shall include: individual contactors and circuit breakers for fan motors, circuit breakers and factory mounted transformers for each control circuit, and unit power terminal blocks. Fan motors shall have inherent overload protection and compressor motors shall have three-phase motor overload protection.
- .3 The unit shall be supplied with factory installed non-fused disconnect.
- .4 Wiring shall be numbered and color-coded to match the wiring diagram.
- .5 Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.

## **2.8 CONTROL SYSTEM**

- .1 Unit shall be equipped with a standalone DDC microprocessor-based control system. The control logic shall be designed to maximize operating efficiency and equipment life with protections for operation under unusual conditions and to provide a history of operating conditions. The system shall intelligently stage the unit to sustain leaving water temperature precision and stability while minimizing compressor cycling.
- .2 The DDC controller shall support the following safety and operating controls: high pressure switches for each refrigerant circuit; loss of flow in the evaporator water circuit; condenser fan staging by head pressure; digital setting of low evaporator water temperature cutout, high pressure cutout, suction pressure cutout, and freeze protection cutout; compressor soft loading; demand limit control based on 4-20 mA DC signal input; automatic circuit lead/lag based on fewest operating hours (with manual override); hot water reset based on (an externally applied 4-20 mA signal).
- .3 The keypad/display shall provide access to all vital equipment data. Data shall include full description of current unit status, set point parameters, and alarms. Programmable security password protection shall be provided.
- .4 Control system shall: continuously perform self diagnostic checks; monitor all system temperatures, pressures and safeties; and shall automatically shut down a compressor, refrigerant circuit or entire unit should a fault occur. Diagnostic function shall provide operator with a pre-alarm status indication allowing time to take corrective action prior to a safety shutdown.
- .5 The DDC controller shall be equipped with a time clock to allow the user to program a daily / weekly schedule.
- .6 Controller shall provide output contact closure for control of heating water pump, CP-3.
- .7 The controller shall support an RS-485 network communications trunk.

## **2.9 START UP, SERVICE AND WARRANTY**

- .1 Manufacturer shall furnish a factory trained service technician to perform the unit startup. Manufacturer shall provide instruction of the owner's personnel on the operation and maintenance of the unit. The warranty period shall commence at the date of initial startup and shall continue for a period of one (1) year not to exceed eighteen (18) months from shipment. Manufacturer's warranty shall include all parts and labor to install parts.

## **2.10 ACCEPTABLE MANUFACTURERS / MODELS**

- .1 AERMEC, model ANK050H
- .2 Or approved equal.

# **3 EXECUTION**

## **3.1 INSTALLATION**

- .1 Install units on a flat surface level within 1/8 inch and of sufficient strength to support concentrated loading with isolation spring assemblies under the units.
- .2 Provide components furnished as per manufacturer's literature.
- .3 Provide all water piping so unit and water circuits are serviceable, without having to dismantle excessive lengths of pipe.
- .4 Provide valves in water piping upstream and downstream of the evaporator water connections for isolating the shells and to balance the system.
- .5 Provide certified wiring schematics to the electrical division for the Air-to-Water heat pump, associated equipment and controls.

**End of Section**

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**1 General**

**1.1 GENERAL REQUIREMENTS**

- .1 Comply with General Requirements of Section 21 01 01.

**1.2 SECTION INCLUDES**

- .1 Radiant Floor Heating System.
- .2 Cabinet unit heaters.

**1.3 SUBMITTALS FOR REVIEW**

- .1 Provide submittals and shop drawings in accordance with the General Requirements and as specified herein. Shop drawings shall indicate schematic layout of system, including equipment, critical dimensions and piping/slab penetration.
- .2 Submit manufacturer's technical installation instructions.
- .3 Submit independent certification results for the piping systems from a recognized testing laboratory.
- .4 Submit system design indicating pipe sizing, floor construction, floor covering, tubing layout and output capacity at pipe spacing and water temperatures selected. Design calculations to be performed on pipe manufacturer's software using ASHRAE heat loss data on the basis of continuous 24 h /day, 7 day per week heating cooling operation.
- .5 Submit catalog data on all equipment, fittings, fasteners and associated items necessary for the installation of the piping and manifolds.
- .6 Submit installer's certification and project installation resume of experience. System shall be installed by a contractor experienced in radiant floor heating system installation.

**1.4 SUBMITTALS FOR INFORMATION**

- .1 Section 21 01 01: Submittals for information.
- .2 Manufacturer's Instructions: Indicate installation instructions and recommendations.

**1.5 SUBMITTALS AT PROJECT CLOSEOUT**

- .1 Section 21 01 01: Submittals for project closeout.
- .2 Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- .3 Operation and Maintenance Data: Include manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- .4 Warranty: Submit manufacturer warranty and ensure forms have been completed in Owners name and registered with manufacturer.

**1.6 QUALITY ASSURANCE**

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

**1.7 REGULATORY REQUIREMENTS**

- .1 Products Requiring Electrical Connection: Listed and classified by CSA, ULC, cUL or Special Inspection as suitable for the purpose specified and indicated.

**1.8 WARRANTY**



- .1 The radiant floor heating pipe manufacturer shall warrant the cross-linked polyethylene piping and any "Everloc" fittings, to be free from defects in material and workmanship for a period of twenty-five (25) years. The design shall be approved either by submittal or stamped by a registered engineer as being complete and accurate.
- .2 All manifolds and controls shall be warranted for 18 months and/or two heating seasons.
- .3 Coordinate services of Klimatrol Environmental Systems Ltd to provide Letters of Inspection of installation and witnessing pressure test prior to the thermal mass emplacement. Klimatrol shall provide Owner Training on proper operation and maintenance of the system and provide owner with "As-built" shop drawings, manuals and certified Installation Warranty.

## **2 Products**

### **2.1 PIPING**

- .1 Material: All radiant floor heating piping shall be nominal high density cross-linked polyethylene as manufactured by REHAU (approved equivalent) using the peroxide method of cross-linking (PEXa) and with an approved cell classification in accordance with ASTM D 3350. Pipe shall conform with ASTM F 876 and CSA B137.5, and be certified by CSA.
- .2 Temperature and Pressure Ratings: Piping shall be rated for 100 PSIG gauge pressure at 180°F temperature (690 kPa @ 82°C) continuous, and 80 PSIG gauge pressure at 200°F temperature (550 kPa @ 93°C) continuous.
- .3 Oxygen Diffusion Barrier: Piping shall have a co-extruded oxygen diffusion barrier capable of limiting oxygen diffusion through the pipe to less than 0.10 mg/l/day at 104°F (40°C) water temperature, in accordance with DIN 4726.
- .4 Bend Radius: The minimum bend radius for cold bending of the pipe shall be not less than five (5) times the outside diameter. Bends with a radius less than this shall require the use of a bending template as supplied by the pipe manufacturer, and/or hot air.
- .5 Install Radiant heating cooling piping in pattern as shown on the drawings.

### **2.2 FITTINGS**

- .1 Fittings shall be manufactured of dezincification-resistant brass and shall be supplied by the piping manufacturer as a proven part of cataloged system. Manifold fittings shall be compression nut style with split compression ring.
- .2 Fittings shall be certified to ASTM F 877, F 2080 and CSA B 137.5 as part of the manufacturer's PEX piping system. Pipe couplings embedded within the thermal mass or behind drywall shall be EVERLOC® or approved equivalent cold-expansion compression-sleeve fittings.

### **2.3 MANIFOLDS**

- .1 Material: Distribution manifolds shall be manufactured of dezincified brass or stainless steel and be a proven cataloged part of the manufacturer's system.
- .2 Rehau Pro-Balancing Manifolds shall be equipped with visual circuit flow gauges, balancing valves and isolation valves for each circuit. Manifold isolation valves, air vent, and drain service ports shall be pre-assembled and mounted on metal brackets ready to install.
- .3 Each manifold shall be provided with automatic air vent.
- .4 Manifolds shall be incorporated into Pre-Build KLIMAPANEL or approved equivalent.

### **2.4 KLIMAPANEL and CONTROLS**

- .1 KLIMAPANEL or approved equivalent pre-built pump / mixing panel shall maintain space and floor temperature setpoints. The panels shall consist of 0-10Vdc mixing valve and slow opening 24V Zone control valves, space for BAS controller including temperature mixing and slab safety features.
- .2 Supply, Return and Floor Slab sensors shall be a 10 k  $\Omega$  NTC Type II thermistor (supplied by

Klimatrol.) BAS shall sense space temperature and floor slab temperature with target air temperature of (72F), floor slab not to exceed 91F (33C) at design heating output and (95F) maximum slab temperatures. Maximum supply water temperature limit of 140F and shall not be exceeded. System shall de-energize if maximum temp is exceeded by 2F or more for a period greater than 10 minutes. If no call for heat is received Manifold zone valves and circulators shall operate for a minimum of 10 minutes then shutdown. Radiant floor heating system shall be enabled on outdoor temperature below 68°F if registered for a period greater than one hour. Provide and install spare slab sensors.

- .3 KLIMAPANEL or approved equivalent BACnet Controller shall track the long-term “trailing average daily outdoor air (dry-bulb) temperature (OAT). Outdoor Air temperature readings are recorded hourly. Number of days determining the averaging time period is two days (adjustable). Slab target temperature is calculated daily from the linear function derived from the setpoints defined for peak heating and cooling conditions and the current “trailing average daily outdoor dry bulb temperature” (OAT adb). Default settings for each zone (adjustable through BAS).
- .4 Supply sensors shall be mounted on manifolds and KLIMAPANEL or approved equivalent controller shall prioritize modulating supply fluid temperature to maintain target supply temperature.
- .5 Space temperatures in individual zones shall be provided indirectly back to KLIMAPANEL or approved equivalent via BAS. BAS Shall provide space sensors.
- .6 Water cooled fractional horsepower 120V/1Ph, FLA: 3 Amp Pumps shall be silent and energy efficient as manufactured by Grundfos and sized specifically for area being heated.
- .7 KLIMAPANEL or approved equal Shall be c/w BACnet ready controls

## **2.5 ACCESSORIES FOR IN-FLOOR HYDRONIC RADIANT FLOOR HEATING**

- .1 Required installation accessories shall include: nylon cable binders or Railfix tube track, pipe conduit bend guides, protective sleeving, pressure test kit, pipe cutter, pipe uncoiler, Everloc tool kit and other installation tools and aids required for complete installed and approved system.

## **2.6 UNIT HEATERS**

- .1 Cabinets shall be constructed from heavy duty cold-rolled corrosion-resistant steel finished in grey baked enamel. Front panels shall have integral double-folded discharge frame for additional cabinet rigidity. Back panels shall have integral inlet collars for superior stiffness. Suspension tappings to be securely fastened to top panel.
- .2 Fans shall be designed and selected for high efficiency standards. Fans shall be statically and dynamically balanced for quiet, low vibration operation.
- .3 Coils shall be constructed from heavy wall 5/8” outside diameter copper tube with mechanically bonded aluminum fins. Coils to be tested at 350 psig.
- .4 Standard motors shall be 115/60/1, totally enclosed, with automatic thermal overload protection. Motors shall be resilient mounted onto fan guards for quiet, low-vibration operation.
- .5 Acceptable manufacturers: Sigma, Engineered Air, Modine or approved equal.

## **3 Execution**

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**3.1            INSTALLATION**

- .1 Concrete Slab on Grade: Subgrade should be compacted, flat and smooth to prevent damage to pipe or insulation. Approved vapor barrier material should be installed. Insulation shall be installed vertically along all exterior walls or footings to which the edge of the slab will meet against. Horizontal insulation shall be installed flat against the vapor barrier under which the slab will be poured. Reinforcing wire mesh or rebar, if required by structural design, must be flat and level, with all sharp ends pointing down. Finished grade of the thermal mass shall be minimum of 3/4" (19 mm) above the top of PEX heating pipes.
- .2 Install floor heating piping in a combination spiral / counter flow spiral design pattern as shown on the shop drawings.
- .3 All floor heating piping shall be fastened using nylon cable binders to a middle rebar mesh (provided by general contractor) maintaining a consistent level and minimum 50 mm pipe clearance from top or bottom of the concrete slab. Preferred level is just above midpoint of the concrete slab. Coordinate mesh elevation in slab for high level in radiant floors.
- .4 Pre-cast Concrete Subfloor: Subfloor must be clean and free from all construction debris and sharp edges. Replace any areas that appear weak. If called for by design, approved vapor barrier and insulation shall be installed vertically along all exterior walls slab edges as well as flat under where the slab will be poured. Finished grade of the thermal mass overpour must be a minimum of 3/4" (19 mm) above the top of PEX heating pipes.
- .5 Manifold Installation and Preparation of Wall Cavity: Review drawings and/or design to determine proper locations for manifolds. Mount the manifold cabinet minimum 4" (100mm) above finished surface. Manifold must be installed in an area that will allow easy access for supply/return piping as well as future access for maintenance.
- .6 Unit Heaters: Install to manufacturer's instructions. Maintain factory installed pipe caps until water connections are made. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage. Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated. Locate the units as shown on the drawings and ensure that mounting position allows for full access to the service panel.

**End of Section**

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**Part 1: GENERAL**

**1.1 CONDITIONS**

- .1 Read and conform to:
  - .1 The General Conditions of the Contract as amended,
  - .2 The General Requirements of Division 21 01 01,

**1.2 BUILDING MANAGEMENT SYSTEM SUBCONTRACTOR**

- .1 All work of this Section shall be coordinated and provided by a single BMS Subcontractor.
- .2 The work of this Section shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Mechanical Division Sections for details.
- .3 The work of this Section shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, warranties, services, and items which are required for the complete, fully functional and commissioned BMS, even if these are not specifically mentioned or fully described under this Section.
- .4 If the BMS subcontractor believes there are conflicts or missing information in the project documents, the subcontractor shall promptly request clarification and instruction from the design team.

**1.3 GENERAL DESCRIPTION**

- .1 This document outlines the minimum equipment and performance standards for a completely interoperable Building Automation System (BAS).
- .2 The work shall include design, supply, installation, and commissioning a complete microprocessor based automatic control system to achieve the performance specified in the following Sections.
- .3 The BAS shall be capable of total integration of facility infrastructure systems with user access to all system data, either locally over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet.
- .4 The entire BAS shall be peer-to-peer networked, stand-alone, distributed control in accordance with American National Standards Institute/American Society of Heating, Refrigerating and Air Conditioning Engineers (ANSI/ASHRAE) Standard 135-2004, BACnet – A Data Communication Protocol for Building Automation and Control Networks.
- .5 All labour, material, equipment and software not specifically referred to herein or on the plans, but is required to meet the functional intent, shall be provided without additional cost to the Owner.
- .6 Contractors shall be manufacturers or licensed factory representatives and installers of the manufacturers, specified for the local area in which the Site is located.
- .7 The BAS contractor shall provide the necessary engineering, installation, supervision, commissioning and programming for a complete and fully operational system. The contractor will provide as many trips to the job site for installation, supervision, and commissioning as are necessary to complete the project to the satisfaction of the consultant and/or project supervisor.
- .8 The controls contractor will specifically read all mechanical and electrical drawings, specifications, and addenda and determine the controls work provided by the mechanical contractor, his subcontractors, and the electrical contractor. The controls contractor is expected to have the expertise to coordinate the work of other contractors and to make a completely coordinated Building Automation Control System (BAS) for the mechanical systems.
- .9 The BAS shall be compatible with future control Products for 10 years or more.
- .10 Ensure compliance with all applicable codes and authorities having jurisdiction.
- .11 The system shall be installed by trade certified electricians regularly employed by the controls contractor. The system shall be tested and calibrated by factory certified technicians qualified for this type of work and in the regular employment of the BAS manufacturer or its exclusive factory authorized installing contracting field office representative. The installing office shall have a minimum of five years of installation experience with the manufacturer. Supervision, calibration and commissioning of the system shall be by the employees of the factory authorized BAS branch or representative.

## **2: ACCEPTABLE BMS SUBCONTRACTORS**

.1 The Building Automation System shall be one of the following:

- .1 Automated Logic
- .2 Delta Controls
- .3 Reliable Controls.
- .4 Or approved equal.

## **3: SCOPE**

This project scope shall include, but not be limited to, the following work:

- .1 Preparation of control shop drawings for review and approval. *See Submittals.*
- .2 Supply and install a network of Building Automation Control System (BAS) panels and field devices. *See Hardware, Software and Field Devices.*
- .3 Supply and install customized graphics software as specified. *See Software.*
- .4 Install, wire and label all BAS control system components. *See Installation.*
- .5 Calibrate and commission the installed control system. *See Commissioning.*
- .6 Provide maintenance manuals and as-built drawings. *See As-Built Documentation.*
- .7 Provide customized training for operations, maintenance and technical staff. *See Training*

## **4: DRAWINGS AND SUBMISSIONS**

Submit four (4) copies of following information to the consultant and/or the project manager for review and approval:

- 4.1 Control Schematics.
- 4.2 Detailed sequence of operation for each control schematic or controlled system.
- 4.3 System Architecture indicating the proposed interconnection and location of all BAS panels, network connections and key peripheral devices (workstations, modems, printers, repeaters, etc.)
- 4.4 BAS Points List indicating the panel ID, panel location, hardware address, point acronym, point description, field device type, point type (i.e, AO/DO/AI/DI), end device fail position, end device manufacture and model number, and wire tag ID). Terminal identification for all control wiring shall be shown on the shop drawings.
- 4.5 Wiring diagrams including complete power system, interlocks, control and data communications.
- 4.6 Hard copy graphical depiction of the application control programs.
- 4.7 Manufacturers' data / specification sheets for all material supplied.

## **5 Materials**

- 5.1 All points shall be available to BACnet.
- 5.2 Points shall be field reconfigurable. No set points shall be hard coded in the programs.
- 5.3 All controllers shall be loaded to a maximum of 80%. 20% of each of the inputs, outputs and variables shall remain unused to allow for future growth and expandability.
- 5.4 The system shall consist of all operator interfaces, microprocessor-based controllers, sensors, wells, automatic control valves, control dampers, transducers, and relays, automatic control valves, and damper actuators.

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- 5.5 All equipment, points, etc. shall have common labelling.
- 5.6 Software shall be completely programmable and capable of all control and mathematical functions.
- 5.7 All temperature units for BAS and controlled equipment shall be in °C (degrees celcius).
- 5.8 Operator Activity Tracking - An audit trail report to track system changes, accounting for operator initiated actions, changes made by a particular person or changes made to a specific piece of equipment designated time frame, shall be printable and archived for future use. The operator activity tracking shall be in a tamper-proof buffer file.
- 5.9 Operator workstation interface software shall optimize operator understanding through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:
- a. Real-time graphical viewing and control of environment
  - b. Scheduling and override of building operations
  - c. Collection and analysis of historical data and dynamic data (trend plot)
  - d. Definition and construction of dynamic color graphic displays
  - e. Editing, programming, storage and downloading of global controller databases
  - f. Alarm reporting, routing, messaging, and acknowledgment
- 5.10 Provide a graphical user interface, which shall minimize the use of the keyboard through the use of a mouse or a similar pointing device and a "point and click" approach to menu selection.
- 5.11 Battery backup: Automatic restart after power failure: Upon restoration of power after an outage, the BAS shall automatically, and without human intervention, update all monitored functions, resume operation based on current synchronized time and status and implement special start-up strategies as required.
- 5.12 Refresh rate – The maximum permissible refresh rate is ONE (1) second. The refresh rate is defined as the time it takes the controller central processing unit (CPU) to sample all inputs, calculate all variables, update all timers and proportional integral derivative (PID) controllers, check all schedules, update all trend logs and runtime logs, execute all programs and assign values to all outputs.
- 5.13 The building automation system shall have direct control of dampers, heating and cooling stages without the requirement of BACnet, Lonworks or any other type of communication interface. Factory installed interlocks, safeties and anti-cycle timers shall be provided as required.
- 5.14 Reports shall be generated on demand or via a pre-defined schedule and directed to video displays, printers or hard drive. As a minimum, the system shall allow the user to easily obtain the following types of reports:
- a. A general listing of all or selected points in the network
  - b. List of all points currently in alarm
  - c. List of all points currently in override status
  - d. List of all disabled points
  - e. List of all points currently locked out
  - f. List of user accounts and access levels
  - g. List all weekly schedules
  - h. List of limits and dead-bands
  - i. Excel reports
  - j. System diagnostic reports including a list of BAS panels on line and communicating, and the status of all BAS terminal unit device points
  - k. List of programs
- 5.15 Provide a means for the operator to view the communication status of all controllers connected to the system. The status should show whether the controller is communicating or not.

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- 5.16 Provide a means for the operator to reset the error count for all controllers to zero.
  - 5.17 Provide a means for the operator to display and change the system configuration. This shall include, but not be limited to, system time, day of the week, date of day light savings set forward/ set back, printer type and port addresses, modem port and speed, etc. Items shall be modified utilizing easy to understand terminology using simple mouse/cursor key movements.
  - 5.18 Provide a security system that prevents unauthorized use unless the operator is logged on. Access shall be limited to the operator's terminal functions unless the user is logged on.
  - 5.19 Where possible, utilize Optimized Start features on equipment to reduce hydro demand charges.
  - 5.20 During the initial design, the Owner shall supply the controls contractor a range of BACnet addresses the BAS will run on. The BAS network will run either BACnet over IP or BACnet over MSTP. All BAS points will be network visible so that other BACnet systems can auto discover them. Contractor shall consult with Project Manager at City of Barrie during the development of addresses.

## **6 Operator's Workstation**

- 6.1 Supply and install all operating software and dynamic system graphics on the Operator's Workstation. Workstation to be supplied by BAS contractor unless stated otherwise by The City Project Manager.
- 6.2 Supply licenses for all software required to monitor, configure system, edit graphics, trend storage, (data exchange including ODBC (if applicable)) without limitations to points.
- 6.3 Reliable Controls shall include licensing for the following: RC Studio, RC Webview, RC Archive.
- 6.4 Delta Controls shall include licensing for the following: ORCAweb-Large, Illustrator, ORCAweb, OWS, ODBC, DDE, Historian Large.
- 6.5 Automated Logic shall include licensing for the following: WEB CTRL, Advanced reports.
- 6.6 The operator workstation interface software shall be designed to operate on the Windows 7 Professional platform.

## **7 WAN Access**

- 7.1 Provide necessary interface and cabling to connect the BAS to the City WAN. Obtain the particular WAN system details from the Engineer or Project Supervisor.
- 7.2 The City shall supply the WAN IP address, Gateway and Subnet mask for the BBMD router in the network. The controls contractor will facilitate integration into the City's existing BAS BACNET network.
- 7.3 On the network a BACnet IP device that is capable of BBMD will route information from other sites and the operator work station. In addition there shall be a CAT5 wire that is run to the City's IT switch with a 4' pigtail and connector.

## **8 Trend Data**

- 8.1 Provide trend logs for every hardware input and output.
- 8.2 All trends should be accessible via the graphical interface.
- 8.3 Trends should contain all related variables of a control loop (i.e. setpoint, measured variable and control output) and have the ability to be plotted simultaneously on the same graph. Field Devices Individual trends should provide an appropriate "snapshot" of the variable. Trends should contain a minimum of 1 year worth of trend data.
- 8.4 Provide trending capabilities at 5 minute intervals that allow the user to easily monitor and preserve records of system activity over a one year period. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data may be stored on hard drive for future diagnostics and reporting. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
- 8.5 Trending shall be accessible from the graphics screens for each point. Each point shall have its associated trend capability accessible from the graphic via an icon located beside the point name on the graphic page.



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- 8.6 Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual point or predefined groups of at least six points. Provide sufficient capacity to allow for trending a minimum of 100 points at 2000 samples each. Reports should be easily transferable on-line to Microsoft Excel. The Contractor shall provide custom designed spreadsheet reports for use by the Owner to track energy usage and cost, equipment run-times, equipment efficiency, and/or building environmental conditions.
- 8.7 The operator shall be able to change trend log setup information. This includes information to be trend logged as well as the interval at which the information is to be logged. All points in the system may be logged. All operations shall be password protected. Setup and viewing may be accessed directly from any and all graphics where the point is displayed.
- 8.8 Trending shall include the ability to track energy management aspects including, but not limited to, the following:
- Daily use
  - Monthly use
  - Daily Hi and Low
  - Monthly Hi and Low
  - Demand Limiting and Load Shedding Program
  - Run time accumulation for any specified equipment
  - After hour use log
  - Instantaneous kW demand trending, minimum of 5 minute intervals
- 8.9 The primary input sensor for all control loops must connect to the same panel containing the control loop output.
- 8.10 Trend data storage must be in the same panel as the hardware or logical points being trended.

## **9 Alarms**

- 9.1 The BAS will be configured to provide for remote alarm capabilities.
- 9.2 Alarms shall be capable of being routed to The City's IT server so that they can be sent to Operator's email addresses.
- 9.3 The operator workstation shall provide audible, visual and printed means of alarm indication. The Alarm Dialog box shall always become the Top Dialog box regardless of the application(s) being run at the time (such as a word processor). A printout of all alarms shall be sent to the assigned terminal and port.
- 9.4 Provide a log of alarm messages. The alarm log shall be archived to the hard drive of the operator workstation. Each entry shall include a point descriptor and address, time and date of alarm occurrence, point value at the time of alarm, time and date of point return to normal condition and time and date of alarm acknowledge.
- 9.5 The Controls Contractor shall work with the City to determine the alarms unless specified otherwise.
- 9.6 Alarm messages shall be in plain English and shall be user definable on site or via remote communication.

## **10. Field Devices**

- 10.1 Automatic Control Valves
- Valves used for throttling applications shall have a linear percentage-to-flow characteristic.
  - Ball valves are the preferred valve type for zone and HVAC control valves. Globe and butterfly valves shall be used where required to provide the desired pressure drop and CV.
  - Automatic Control valves shall be manufactured by Belimo or approved equivalent.
- 10.2 Control Valve Actuators
- Size control valve actuators to provide a tight close off against system head pressures and pressure differentials.
  - Valve actuators shall accept a 0-10VDC control voltage for all proportional applications.
  - Floating point control of valves is not acceptable under any circumstances.
  - Heating valves shall spring-return fail open and cooling valves shall spring-return fail closed. Non-spring-return



control valves may be used for terminal reheat coils and large HVAC control valves requiring a higher close off pressure.

**10.3 Damper Actuators**

- a. Actuators shall be direct coupled for either modulating or two position control. Actuators shall be powered by
- b. an overload-proof synchronous motor. Provide 0-10 VDC control voltage for all proportional applications and either line or low voltage actuators for all two position applications.
- c. Damper actuators are to be manufactured by Belimo or approved equivalent.

**10.4 Automatic Control Dampers**

- a. All automatic control dampers not furnished with packaged equipment shall be supplied by the controls subcontractor and installed by the sheet metal subcontractor (except for VAV Boxes which shall be supplied by the Mechanical Contractor). All dampers in a mixing application shall be opposed blade. Parallel blade shall be permitted in other applications. Dampers shall be a tight closing, low leakage type with replaceable extruded vinyl seals on all outdoor and exhaust applications.

**10.5 Smart Room Sensors/Thermostats**

- a. Office: Temp Display, Set point Display, Set point Adjust, Schedule Override, High and Low Limit on set points.
- b. All areas except offices: Set point Adjust, Schedule Override, High and Low Limit on set points.
- c. Mount sensors at a height of 5'-6" unless otherwise indicated.
- d. Mount thermostats and space sensors as noted on the drawing. Do not mount on outside walls without permission of consultant.
- e. Smart sensors with temperature, humidity, CO2 and occupancy.

**10.6 Current Switches (Digital)**

- a. Provide BAS status for fan and pump motors using a mosfet type digital switch. Acceptable manufactures are ACI, Enercorp, Greystone, Veris and Elkor or approved equivalent.

**10.7 Pressure Transmitters**

- a. Technical Performance - Solid State design, operating on capacitance principle, with non-interactive fine resolution, zero and span adjustments. End-to-end accuracy +/- 2% of full scale pressure range, including temperature compensation. 4-20mA or 0-5 VDC output.
- b. Standard of Acceptance – ACI, Enercorp, Greystone, Modus or approved equivalent.

**10.8 Duct Temperature Sensor**

- a. Probe - Technical Performance – 10 k ohm thermistor sensor encapsulated in a 200mm long, 6mm OD copper or stainless steel probe. Operating range 0-60 degrees C. End-to-end accuracy +/- 0.3 degC. Assembly complete with wiring housing and mounting flange.
- b. Averaging - Technical Performance - 10 k ohm thermistor constructed of FT6 plenum rated cable or soft copper tubing, incorporating numerous temperature sensors encapsulated at equal distances along the length of the element. The assembly acts as a single sensor reporting the average temperature from all individual sensors. End-to-end accuracy +/- 0.3oC. Assembly complete with wiring housing and mounting flange. Mount in a zig-zag manner to provide continuous coverage of the entire duct cross-sectional area.

**10.9 Outdoor Air Temperature Sensor**

- a. Two outdoor air temperature sensors shall be installed and shall be programmed to check each other for accuracy. In the event of sensor failure the sensor deemed to be accurate shall be used to control the systems. The outdoor air sensors shall be located on a north wall if possible and a minimum of three (3) feet from any opening in the building envelope which could affect the sensor readings. The back face of the sensor enclosure shall be insulated to prevent temperature pick up from the building wall.
- b. Technical Performance, 10 k ohm thermistor -50°C to 50°C in a weatherproof enclosure mounted on north exposure.

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End accuracy of +/- 0.3 °C over the entire operating range.

10.10 Pipe Temperature Sensor

- a. Well - Technical Performance - 10k ohm thermistor sensor encapsulated in a 6mm OD, 50mm long probe, with screw fitting for insertion into a standard thermowell. Operating range -10 - +100 oC. End-to-end accuracy +/- 0.3 oC over the entire operating range. Complete with brass thermowell. Use heat transfer paste when mounting the sensor in thermowell. No surface mount strap on temperature sensors shall be used to monitor fluid temperature unless approved by the engineer.

10.11 CO<sub>2</sub> Detector

- a. Technical Performance – Infrared CO<sub>2</sub> monitor c/w 4-20mA or 0-5 VDC output, accuracy of +/- 40 ppm +3% reading.
- b. Standard of Acceptance – ACI-CO<sub>2</sub>-D or Telaire duct mount or approved equivalent.

**11 Security System Monitoring to BAS**

- 11.1 Provide digital input from security system.
- 11.2 When building security armed all outside lighting control shuts off 20 minutes after alarm system armed.
- 11.3 When building security armed all AHU's, Exhaust Fans and heating systems shall be changed to unoccupied mode immediately when armed regardless of scheduled times.
- 11.4 All critical alarms as determined by the City.

**12 Enclosure**

The BAS control and power supply cabinets shall conform with the following:

- 12.1 Panel enclosures shall be a locking type, metal cabinet, with common keying.
- 12.2 CSA certified 150359 and UL listed E109310.
- 12.3 16 or 14 gauge steel.
- 12.4 Slip hinges enabling door removal for easier access and mounting. Door shall be lockable.
- 12.5 1/4 turn keyed latch standardized to G549 keyset.
- 12.6 14 or 12 gauge galvanized steel panel on collar studs natural finish.
- 12.7 Grounding stud on inner cover surface.
- 12.8 Grounding hole on mounting panel with grounding screw.
- 12.9 ANSI/ASA61 grey polyester - epoxy textured powder coating inside out.
- 12.10 3" deep wire duct shall be installed to neatly conceal controller wiring.
- 12.11 Power supply cabinets shall be provided with a ESA Field Evaluation approval.
- 12.12 2-100VA 120/24 Transformers Class II UL5085-3.
- 12.13 Over Current Protection by Circuit Breaker.
- 12.14 Outlet Receptacle for Service Laptop Power.

**13 BAS Database Naming Conventions & Programs**

- 13.1 All BAS programs shall be created in each panel in logical order as determined by the equipment being controlled by each panel on the network.
- 13.2 All programs and program code is to follow proper coding practices including internal comments to describe the function of the statements and also ensure the source code is formatted in a consistent and logical manner. Programming coding should be kept as simple as possible.
- 13.3 System Schedules shall be submitted for approval and will include global and local scheduling.
- 13.4 The Outdoor Air Temperature Program shall be in its own program named OAT PG.

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- 13.5 Network Status Panel Naming Conventions should indicate the building, panel location and panel number. The building name can be abbreviated as necessary to fit in the space.
- 14 Graphic Display Screens**
- 14.1 All Graphic Display Screens shall have the following common elements and functions regardless of system manufacturer. Every site shall have a graphic display screen for Site Graphic, System Architecture, each Fan Coil Unit (VRF System), VRF Condenser unit, Air Source Heat Pump, In-Floor hydronic radiant heating system, boilers, heating pumps, emergency generator, lighting, exhaust fans, Energy Recovery Unit, domestic hot water heaters, and for each room controlled by the BAS system.
- 14.2 All operator accessible points shall be yellow text and all information points shall be blue.
- 14.3 Trending shall be accessible from the graphics screens for each point. Each point shall have its associated trend capability accessible from the graphic via an icon located beside the point name on the graphic page.
- 14.4 Appendix A at the end of this document shows examples of typical graphic screens. These are examples only. Graphics shall comply with the following specific screen content. Not all equipment and systems are listed below but the format will be the same for other equipment:
- 14.5 Graphic Screens General All Screens
- a. Navigation buttons to each major system in the building which indicate current screen display by a change in button colour
  - b. Background colour shall be black
  - c. Outdoor air temperature shall be displayed on every graphic screen
- 14.6 Site Graphic
- a. The City of Barrie Logo on the site or opening graphic screen
  - b. Artist concept or scanned in picture of the front of the building
  - c. Access links to all global schedules or specific screens affecting entire building operation
  - d. Access buttons links to Set Time, Holiday Schedule, Schedule, Alarms, Points on Manual
- 14.7 System Architecture
- a. Control panel layout and network architecture
  - b. Indicating BAS panels and panel type(model)
  - c. Panel locations room number text on screen
  - d. Systems controlled by each panel
  - e. Links to points list accessible from each panel
- 14.8 Architecture Panel Layout (Locations on Floor Plans)
- a. Locations of each panel on each floor plan level
  - b. Panel types indicated by different icon
  - c. Controls transformers locations
  - d. Main network wiring and sub-network wiring layout
- 14.9 Floor Plans graphics
- a. Room numbers accurate as per room signage
  - b. Mechanical rooms locations & signage tags
  - c. Space temperatures for every temperature on each floor in appropriate room
  - d. Space focus pick area for individual room control where applicable shall be yellow text
  - e. Air Handler symbols indicating areas of the floor plan serviced by each air handler by a corresponding colour
  - f. Status of Air Handler by colour change Red for off status, or text indication
  - g. Supply air temperature for each air handler

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14.10 VRF Fan Coil Unit (FCU) graphic

- a. Accurate representation of the FCU design
- b. All associated control points to be displayed
- c. All points to be monitored for automatic mode and shall be displayed when in Manual mode
- d. A calculated percentage of fresh air shall be indicated on the FCU graphic
- e. Operator offset adjustment of the supply air setpoint, adjustable directly from the graphic
- f. FCU physical location shall be indicated on the graphic
- g. Weekly occupied time of day schedule for the associated FCU shall be accessible directly from the graphic by selecting an icon
- h. Trend logs shall be accessible directly form the graphic by selecting an icon

14.11 Boiler graphic

- a. Boiler graphic piping layout shall be accurate as per piping layout
- b. All associated control points for the boiler system to be displayed
- c. Operator offset adjustment of the scheduled water setpoint, adjustable directly from the graphic
- d. Lead boiler and boiler stages shall be indicated
- e. Lead pump shall be indicated
- f. Boiler status shall be indicated graphically
- g. Pump status shall be indicated graphically
- h. Calculated scheduled water setpoints to be displayed
- i. Operator offset editable directly from the graphic screen
- j. Weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon
- k. Trend logs shall be accessible directly from the graphic by selecting an icon

14.12 Exhaust fans graphic

- a. Exhaust fans control shall be editable directly from the graphic
- b. Exhaust fan status shall be indicated in text and a change in the exhaust fan icon
- c. Exhaust fan physical location shall be indicated on the graphic
- d. Area of the building being exhausted shall be indicated on the graphic

14.13 Air Source Heat Pump graphic

- a. Accurate representation of the ASHP operating conditions
- b. All associated control points to be displayed
- c. Operator offset adjustment of the discharge water temperature setpoint, adjustable directly from the graphic
- d. ASHP physical location shall be indicated on the graphic
- e. ASHP status shall be indicated graphically
- f. Trend logs shall be accessible directly form the graphic by selecting an icon

14.14 In-Floor Hydronic Radiant Heating System graphic

- a. Accurate representation of the in-floor radiant heating system design
- b. All associated control points to be displayed
- c. Operator offset adjustment of the floor slab temperature setpoint, adjustable directly from the graphic
- d. In-floor radiant heating system physical location including that of the manifold cabinet shall be indicated on the graphic
- e. Status of pump, CP-4, and of the 3-way valve in the manifold cabinet shall be indicated graphically
- f. Trend logs shall be accessible directly form the graphic by selecting an icon

14.15 Heating pumps, P-1/P-2

- a. Accurate representation of the heating pumps operating conditions
- b. All associated control points to be displayed
- c. Operator control of the pumps, adjustable directly from the graphic
- d. Pumps physical location shall be indicated on the graphic
- e. Pumps status shall be indicated graphically
- f. Trend logs shall be accessible directly from the graphic by selecting an icon

14.16 Energy Recovery Ventilator graphic

- a. ERV graphic ducting layout shall be accurate as per ducting layout drawing
- b. All associated control points for the ERV to be displayed
- c. Operator control of the ERV status, adjustable directly from the graphic
- d. Outdoor air inlet and exhaust air outlet dampers statuses shall be indicated
- e. CO2 level shall be indicated
- f. Filter status shall be indicated graphically
- g. Supply and exhaust fan status shall be indicated graphically
- h. Supply air temperature, exhaust air temperature and outdoor air inlet temperature to be displayed
- i. Weekly time of day schedule for the building occupied schedule shall be accessible directly from the graphic by selecting an icon
- j. Trend logs shall be accessible directly from the graphic by selecting an icon

14.17 Domestic Hot Water Heater graphic

- a. DHW heater status shall be indicated graphically
- b. Supply water temperature shall be shown graphically
- c. DHW heater physical location shall be indicated on the graphic
- d. Status of the circulating pump, CP-1, shall be indicated graphically

**15 Installation**

- 15.1 All wiring line and low voltage shall be installed in EMT conduit unless specifically specified otherwise.
- 15.2 All wiring shall be in accordance with the Ontario Electrical Code and any applicable local codes. All BAS wiring shall be installed in conduit unless otherwise allowed by the Ontario Electrical Code or applicable local codes. Where BAS plenum-rated cable wiring is allowed, it shall be run parallel to, or at right angles to, the structure, properly supported and installed in a neat and workmanlike manner. BAS wiring that runs in exposed ceiling spaces (eg garages, mechanical rooms) shall be installed in conduit.
- 15.3 In accessible ceilings, wiring from BAS controllers to sensors and actuators, control system network and low voltage wiring only may be installed with yellow jacket LVT cable. Where the ceiling is used as a return air plenum install plenum rated yellow jacket cable instead of LVT.
- 15.4 BX or flex conduit may only be used for the final (approximately one meter) run to controls devices, where the controls equipment is mounted on vibrating machinery.
- 15.5 Install EMT and cable at right angles to building lines, securely fastened, and in accordance with the standards set out in Division 16.
- 15.6 No wire smaller than 18 gauge is to be used on the project except for: wiring between terminal computer devices, wire in standard communication cables, such as printers and short haul modems, wire used in communication networks, i.e. any cable transferring digital data, using twisted shielded pairs.
- 15.7 All field wiring including sensor wiring and wiring from panels to devices shall be continuous. The use of wire connectors, wire nuts or splicing is not allowed.

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- 15.8 Provide wells for all specified temperature sensors in hydronic piping system. Strap-on sensors may be only be used where a well installation is not possible. Obtain approval of Engineer for the use of strap-on sensors.
- 15.9 Power for control system shall not be obtained by tapping into miscellaneous circuits that could be inadvertently be switched off.
- 15.10 Mount transformers and other peripheral equipment in panels located in serviceable areas. Provide line side breakers/fuses for all transformers.
- 15.11 All 120 VAC power for any controls equipment shall be from dedicated circuits. Provide a breaker lock for each breaker used to supply the control system. Update the panel circuit directory.
- 15.12 The controller may be powered from the equipment that it is directly controlling (i.e. heat pump, roof-top unit) only if the controller controls no other equipment and the power supply to the controller remains energized independently of unit operation or status.
- 15.13 All BAS control wiring shall be yellow jacket for identification purpose.
- 15.14 The breaker or power isolation location shall be clearly marked on the inside door of each BAS panel enclosure.
- 15.15 Wiring in ceiling spaces to be installed clear of ceiling tiles and lights to allow access and removal of tiles and lights.
- 15.16 Contractor shall prepare a wiring mock-up of a typical system/device/main panel to demonstrate quality and workmanship for approval by the City. This approved mock-up quality shall be maintained throughout the entire installation. System requiring mock-up to be discussed with the City's Project Manager.
- 15.17 All wiring shall be routed orthogonally and drops shall have additional wiring coiled in ceilings to facilitate future sensor relocation.
- 15.18 Wiring in ceiling spaces to be secured/tied every 48" minimum.
- 15.19 Surge suppression shall comply, as a minimum, with the manufacturer's requirements.
- 15.20 All equipment including controllers shall be grounded.
- 15.21 All end-of-wire connectors shall be certified.
- 15.22 All components shall be labelled and detailed in manuals.
- 15.23 All wiring systems shall be colour coded to simplify maintenance.
- 15.24 All equipment shall be located for ease of service access.
- 15.25 Contractor shall maintain a list of deficiencies when close to completion, and shall update this list on a regular basis for review by the Owner's representative.
- 15.26 If the project is a retrofit of an existing system:
- Contractor shall remove all old redundant wiring following system verification
  - Re-use of existing wiring is not allowed. Run continuous new wiring
  - Re-use of components (eg enclosures, transformers) is not allowed unless approved by the City's Project Manager

## **16 Equipment Location**

- 16.1 All distributed equipment such as unit ventilators, fan coil units, etc. that utilize dedicated BAS controllers, shall have locally mounted controllers, in accessible locations within the building envelope. All locally mounted controllers shall be installed in enclosures suitable for that location. BAS controllers for mechanical equipment other than those listed above shall be mounted in mechanical rooms as noted below, unless specifically approved by the Engineer for this project.
- 16.2 All other BAS controllers, and interface devices that require regular inspection or that serve multiple HVAC systems shall be located in mechanical rooms, or in pre-approved storage rooms, or janitor closets.
- 16.3 No BAS panel shall be located inside the rooftop fan enclosure under any circumstances. All BAS panels shall be located within the building envelope, and shall be enclosed in a metal locking enclosure, as specified in 16.4.

- 16.4 All equipment located in mechanical rooms, storage rooms or janitor closets shall be installed in metal cabinets with hinged, lockable covers.
- 16.5 Transformers or power supplies shall not be located in ceiling spaces unless approved by the engineer for terminal control valves, actuators or zone controllers. When transformers are installed above ceilings, transformers shall be installed in metal enclosures, and the location shall be clearly labeled on the t-bar ceiling to indicate power transformer location.
- 16.6 A 120 VAC duplex receptacle for laptop power shall be provided if the cabinet is located further than 5' laterally from the nearest outlet.

## **17. Identification and Labelling Equipment**

- 17.1 All panels must have a lamacoid tag (min. 3"x1") affixed to the front face indicating panel designation and function (i.e. "BAS Panel 1" or "Relay Panel 3").
- 17.2 All field sensors or devices must have a lamacoid tag (min. 3"x1") attached with tie-wrap or adhesive indicating the point software name and hardware address (i.e. AHU1\_MAT, 2.IP4).
- 17.3 Room sensors and other sensors in finished areas will require a device tag.
- 17.4 All devices within a field enclosure will be identified via a label or tag.
- 17.5 All BAS panel power sources must be identified by an adhesive label indicating the source power panel designation and circuit number on the outside of the enclosure door (i.e. "120vac fed from LP-2A cct #1).
- 17.6 All field equipment panels fed from more than one power source must have a warning label on the front cover.
- 17.7 All wires will be identified with self-adhesive wire labels or clip-on plastic wire markers at both ends.
- 17.8 All rotating equipment controlled by the BAS will have a tag or label affixed indicating that the equipment may start without warning.
- 17.9 All BAS panels will have a points list sheet (within a plastic sleeve) attached to the inside door. The points list will identify the following for each point: Panel number, panel location, hardware address, software name, point description, field device type, point type (i.e. AI or DO), device fail position, device manufacturer and model number or reference and wire tag reference.
- 17.10 Where required, field panels will have wiring diagrams attached to the inside door.
- 17.11 Provide new equipment wiring diagrams (i.e. boilers, VRF system etc.) wherever the BAS interfaces to other equipment.

## **18 Commissioning**

- 18.1 Perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning.
- 18.2 Upon completion of the performance tests, repeat these tests, point-by-point in the presence of the Owner's representative, as required. Properly schedule these tests so that testing is completed by the time directed by the Owner's representative.
- 18.3 Confirm and demonstrate to the Engineer and the Owner's agent that all systems are programmed and operating correctly. When project is complete the contract shall allow sufficient programming time in order to customize the sequences to meet operational needs, fine tuning of the system and other duties as required. The City of Barrie will determine the schedule.
- 18.4 Submit a four (4) copies of the system commissioning report to the Engineer for review and approval.
- 18.5 Each analogue inputs (i.e. temperatures, pressure, etc.) shall be verified with an approved calibration device. All actual readings should be with the following verified calibration limits:

Temperature	-	+/- 0.5F
Humidity	-	+/- 5%
CO <sub>2</sub>	-	+/- 10%



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- 18.6 Each analogue output shall be verified by manually commanding the output channel from the operator workstation to two or more positions within the 0-100% range and verifying the actual position of the actuator or device. All devices shall operate over their entire 0-100% range from a minimum control range of 10-90%.
  - 18.7 Digital outputs shall be verified by witnessing the actual start/stop operation of the equipment under control.
  - 18.8 Digital inputs shall be verified by observing the status of the input point as the equipment is manually cycled on and off.
  - 18.9 Record all out-of-season or unverified points in the commissioning report as "uncommissioned".
  - 18.10 The BAS field panel power source shall be toggled on and off to ensure reboot functionality and power down memory retention of all parameters. During the power down test, all connected system components should go to their fail-safe state.
  - 18.11 All trends should be reviewed to ensure that setpoints are being maintained and excessive cycling of equipment is not occurring.
  - 18.12 Control loop tuning parameters can be verified by applying a change to the current setpoint and observing the resulting trend log. Setpoint should be reached in a "reasonable" period of time without excessive cycling or hunting of the controlled device.

## **19 Training**

- 19.1 Once 5 consecutive Days of alarm-free operation are complete and documented, operator training may begin.
- 19.2 Provide 1 day of instruction to the Owner's designated personnel on the operation of the BAS and describe its intended use with respect to the programmed functions. Operator orientation of the BAS shall include, but not be limited to, the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the system's operation.

## **20 Warranty**

- 20.1 Warranty all components supplied under this contract for a period of two years from substantial completion. Replace all controls equipment that fails during this period without cost to the owner.
- 20.2 All Controllers shall have a 5 year manufacturer's warranty.

## **21 As-Built Documentation**

- 21.1 Within two weeks following substantial completion of the project, update the original submittal documents to reflect the "As Built" conditions of the project and submit four copies as required by the consultant and/or the Project Manager.
- 21.2 Provide a separate laminated copy of the control drawings for mounting in the mechanical room or in the controls panels.
- 21.3 Provide final point lists, shop drawings and all installed equipment data and operations sheets.
- 21.4 Submit diskettes/CD's (including back-up diskettes/CD's) containing up to date copies of the programs in each controller. Provide original program disks and documentation proving registration for all software programs provided as a part of this contract including: the BAS operator interface software, and the BAS graphics (bitmap files). Provide one set of original disks for every computer supplied under this contract or that the software has been loaded onto.
- 21.5 Submit (4) printed copies of the final programs that include all point definitions, weekly and annual schedule setting, controller setpoints and tuning parameters, and documented programmed sequences of operation.

## **22 Control Points and Points List**

- 22.1 A typical points list for system control and monitoring is shown in Appendix B and shall be used as a guide for system design.
- 22.2 This points list is not intended to be complete. It is intended to be a typical list to capture all foreseeable equipment types. Project specific points list must be created on a project-by-project basis by the BAS contractor and shall be reviewed by the City.



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- 22.3 The City of Barrie staff shall be consulted to develop the sequence of operations. The City will provide the BACnet address range for each building.
  - 22.4 All control points shall have built in time delays to prevent short cycling.
  - 22.5 Point Naming conventions shall be submitted for review by The City Project team. Names may be changed to comply with the City's naming conventions.

**End of Section**

## **1 General**

### **1.1 GENERAL**

- .1 Read and conform to:
  - .1 The Contract CCDC 2-2020, Stipulated Price Contract as amended.
  - .2 Division 21 01 01 General Requirements.

### **1.2 SECTION INCLUDES**

- .1 Sequence of operation:
  - .1 VRF System.
  - .2 Energy Recovery Ventilator, ERV-1.
  - .3 Air-to-Water Heat Pump, AWHP-1.
  - .4 Electric Boiler, B-1.
  - .5 In-floor hydronic radiant heating system.
  - .6 Exhaust Fans EF-2 to EF-9.
  - .7 EF-1, Bunker Gear Room Exhaust Fan.
  - .8 Unit Heaters UH-1 to UH-7.
  - .9 Vehicle Tail Pipe Exhaust System for Apparatus Bay.
  - .10 Circulating Pump CP-1.
  - .11 Circulating Pump CP-2.
  - .12 Circulating Pump CP-3.
  - .13 Circulating Pumps P-1/P-2.
  - .14 Circulating Pump CP-4.
- .2 Points List

## **.1 VRF System**

### **.1 General**

- .1 The VRF system serves the space through Fan Coil Units that supply conditioned air. The fan coil units are piped to a branch selector box that is connected to the outdoor units through refrigerant pipes.
- .2 The outdoor condensing unit, CU-1 has variable speed compressor that can vary the capacity from 15% to 100%.
- .3 The fan coil units have variable speed direct drive DC motor that will allow fans to vary between 5 speeds based on space load.

### **.2 Modes of Operation**

- .1 The occupied and unoccupied modes of operation are determined by a time clock. The fan coil units are set to run continuously in the occupied mode. The schedule of space temperature set points shall include temperature set backs for the unoccupied modes.
- .2 Standby mode: In the occupied mode, if no occupancy is sensed by the occupancy sensor embedded in the wall thermostat for 15 minutes, the FCU shall be shut off and the space temperature set point shall be reset to that of the unoccupied mode. Upon sensing occupancy, the temperature setpoint shall be reset to that of occupied mode and the FCU shall be started.
- .3 In the unoccupied mode, the fan coil units will operate/run only when the space temperature drops below the set point in the heating mode. There is no cooling in the unoccupied mode and the fan coil units will be OFF.

### **.3 Start Up/Shutdown**

- .1 The VRF system will remain enabled by BAS all the time throughout the year.
- .2 The supply fan of each of the fan coil unit will be started per schedule by the respective wall mounted FCU controller.
- .3 The supply fan of each of the fan coil unit will be shut down at the beginning of unoccupied hours per schedule by the wall mounted controller.

### **.4 Occupied Mode**

- .1 The supply fan in each of the fan coil unit runs continuously supplying the required airflow to each of the spaces. Each fan coil unit, in the automatic fan speed mode, varies the fan speed to deliver the required airflow to maintain the space temperature at the set point. The unit adjusts the external static pressure settings of the fan automatically.
- .2 The Central controller of the VRF system shall set the heating and cooling mode based on one of the 2 automatic change over system available that is selected upon commissioning.
- .3 Each fan coil unit monitors and maintains the unit superheat (cooling mode) or sub-cooling (heating mode) using a computerized PID control.
- .4 In the heating mode, if the unit failed to maintain the space temperature as sensed by the wall mounted controller, the unit shall energize the duct mounted electric heater to maintain the space temperature at the set point.
- .5 BAS will enable electric duct heaters when the OAT drops below 0°C and disables the electric duct heaters when the OAT rises above 3°C.

### **.5 Unoccupied Mode**

- .1 The supply fan in each of the fan coil unit is off.
- .2 Each fan coil unit starts its supply fan when there is a heating load demand as sensed by the wall mounted controller. The supply fan stops when the space temperature reaches the set point. There is no cooling during the unoccupied mode.
- .3 In the heating mode, if the unit failed to maintain the space temperature at the set point as sensed by the wall mounted controller, the unit shall energize the duct mounted electric heater to provide the additional heating required.
- .4 BAS will enable electric duct heaters when the OAT drops below 0°C and disables the electric duct heaters when the OAT rises above 3°C.

### **.6 Critical Alarms**

- .1 Fan coil units are enabled and status is not received (2 minute delay).
- .2 Low temperature limit.
- .3 High supply air temperature shutdown.
- .4 High return air temperature shutdown.

### **.7 General Alarms**

- .1 The supply air temperature drops below 7 Deg C.
- .2 The supply air temperature rises above 43 Deg C.
- .3 The duct heater is ON.

## **.8 Maintenance Alarms**

- .1 Fan is commanded off and status is on (10-minute delay).

## **.9 Trends**

- .1 Supply air temperature and setpoint.
- .2 Outside air temperature.
- .3 Return air temperature.
- .4 Mixed air temperature.
- .5 Supply air static pressure and setpoint.
- .6 Fan status.

## **.2 Energy Recovery Ventilator, ERV-1**

### **.1 Modes of Operation**

- .1 The occupied and unoccupied modes of operation are determined by a time clock. ERV-1 runs continuously during occupied hours.
- .2 In the unoccupied mode, ERV-1 remains OFF.

### **.2 Start Up/Shutdown**

- .1 ERV-1 will be enabled by BAS as per the occupancy schedule. The motorised dampers at the outdoor air inlet and the exhaust air outlet are opened. The supply and exhaust fans are started.
- .2 The BAS disables the ERV-1 at the beginning of the unoccupied hours. The motorised dampers at the outdoor air inlet and the exhaust air outlet are closed.

### **.3 Occupied Mode**

- .1 The supply fan and the exhaust fan run at variable speed based on the input from the in-built CO2 sensor. The minimum speed of the supply and exhaust fans will correspond to 50% of the design airflow. BAS to signal the ERV to increase speed if any one of the room sensors detect CO2 levels above the set point. The unit controller modulates the energy recovery wheel speed for optimum energy recovery efficiency.
- .2 The electric pre-heater is energized by the unit controller for frost control. When the outdoor air temperature is below -15°C(5F) and the differential pressure across the energy wheel is above 1.5", the frost control is enabled by the unit control panel. Once the differential pressure falls below the set point or the outside air temperature rises above the set point, the ERV will resume normal operation.

### **.4 Unoccupied Mode**

- .1 ERV-1 remains OFF. The motorized dampers at the outdoor air intake and exhaust air outlet remain closed.

### **.5 Critical Alarms**

- .1 ERV is enabled and status is not received (2 minute delay).
- .2 Low temperature limit.

- .3 Dirty filter.
- .4 Motorised dampers status.

## **.6 General Alarms**

- .1 The supply air temperature drops below 5 Deg C (adjustable).
- .2 The supply air temperature rises above 43 Deg C(adjustable).

## **.7 Maintenance Alarms**

- .1 ERV-1 is disabled by the BAS but the status is ON (10 minute delay).

## **.8 Trends**

- .1 Supply air temperature.
- .2 Outside air temperature.
- .3 Exhaust air temperature.
- .4 CO<sub>2</sub> in rooms

## **.3 Air-to-Water Heat Pump, AWHP-1**

### **.1 Modes of Operation**

- .1 The Air-to-Water Heat Pump, AWHP-1, remains enabled during the entire heating season from September 1<sup>st</sup> (adjustable) to June 30<sup>th</sup> (adjustable).
- .2 During the summer months of July and August, AWHP-1 remains OFF.

### **.2 Start Up/Shutdown**

- .1 AWHP-1 will be enabled by BAS on September 1<sup>st</sup> (adjustable) and disabled on June 30<sup>th</sup> (adjustable). If the leaving water temperature as sensed by the temperature sensor in the mechanical room drops below 37.8°C(100°F), the condenser fans are started by the unit controller. After a time lag of 2 minutes (adjustable), compressors are started if the water flow through the heat exchanger is confirmed by the in-built flow switch. BAS shuts down the AWHP-1 during the emergency mode when the hydronic loop temperature is reset to 180°F.

### **.3 Enabled Mode**

- .1 In the enabled mode, the AWHP-1 runs its compressors to maintain the leaving water temperature as sensed by the temperature sensor mounted on the supply pipe in the mechanical room.
- .2 AWHP-1 modulates the speed of the compressors and the condenser fans to meet the heating load. Once the leaving water temperature rises above the set point (110°F / 43.3°C), the compressors are stopped and then after time lag of 2 minutes(adjustable), the condenser fans are stopped.
- .3 When the outside air temperature rises above 21°C(69.8°F) or drops below -6.7°C(20°F), BAS disables AWHP-1.

### **.4 Disabled Mode**

- .1 AWHP-1 remains OFF.

### **.5 Critical Alarms**

- .1 AWHP-1 is enabled and status is not received (2 minute delay).
- .2 Low temperature limit.

- 
- .3 Low leaving water temperature.

## **.6 General Alarms**

- .1 The leaving water temperature drops below 37.8 Deg C (adjustable).
- .2 The leaving water temperature rises above 43.3 Deg C(adjustable).

## **.7 Maintenance Alarms**

- .1 AWHP-1 is disabled by the BAS but the status is ON (10 minute delay).

## **.8 Trends**

- .5 Leaving water temperature.
- .6 Compressor run hours.
- .7 Condenser fan run hours.

## **.4 Electric Boilers, B-1 / B-2**

### **.1 Modes of Operation**

- .1 The Electric Boilers, B-1 & B-2, remain enabled during the entire heating season from September 1<sup>st</sup> to June 30<sup>th</sup>.
- .2 During the summer months of July and August, **B-1 & B-2** remains OFF.

### **.2 Start Up/Shutdown**

- .1 **B-1 & B-2** will be enabled by BAS on September 1<sup>st</sup> (adjustable) and disabled on June 30<sup>th</sup> (adjustable). Boiler is switched ON by its own controller once the water flow through the heat exchanger is confirmed by the flow switch. Boiler is switched OFF by the controller when the leaving water temperature rises above 110°F/43.3°C.

### **.3 Enabled Mode**

- .1 In the enabled mode, if the leaving water temperature as sensed by the temperature sensor in the mechanical room remains below 37.8°C(100°F) for more than 15 minutes(adjustable), the circulating pump CP-2A is started by the BAS, followed by the lead electric boiler (B-1) started by its own controller.
- .2 The lead boiler (B-1) switches OFF when the leaving water temperature as sensed by the temperature sensor on the supply pipe in the mechanical room equals (43.3°C)110°F.
- .3 If the heating water temperature remains below the set point for more than 15 minutes after the lead boiler is ON, the BAS switches ON the circulating pump(CP-2B) of the lag boiler(B-2). Once the water flow through the heat exchanger is confirmed as sensed by the in-built flow switch, the lag boiler (B-2) is switched ON by its own controller. The lag boiler (B-2) switches OFF when the leaving water temperature as sensed by the temperature sensor on the supply pipe in the mechanical room equals (43.3°C)110°F.
- .3 When the outside air temperature rises above 10°C(adjustable), BAS disables both the lead and lag electric boilers, B-1 & B-2.
- .4 The BAS alternates the lead and lag boiler every week.

### **.4 Emergency Mode**

- .1 In the emergency mode when the doors of the apparatus bay are opened, and the indoor air temperature of the apparatus bay drops and remains below 0°C for more than 5 minutes, the BAS raises

the heating water loop temperature set point to 82.2°C (180°F), starts pumps CP-2A and CP-2B. Boilers B-1 and B-2 are switched ON by the OEM controllers. BAS switches OFF the pump, CP-3, and the Air-to-Water Heat Pump, AWHP-1.

- .2 Boilers B-1 & B-2 run simultaneously to maintain the heating water loop at the set point. When the heating water loop temperature exceeds the set point by 0.5°C, the BAS switches OFF the pump (CP-2A) of the lead boiler (B-1) and the lead boiler (B-1) is switched OFF by its own controller. The BAS switches OFF the pump (CP-2B) of lag boiler (B-2) when the heating water temperature exceeds the set point by 1°C. The lag boiler (B-2) is switched OFF by its own controller when there is no water flow through the heat exchanger as sensed by the in-built flow switch.
- .3 When the doors of the apparatus bay are closed, and the air temperature inside the apparatus bay reaches the set point and the boilers are switched OFF, the BAS lowers the heating water loop temperature set point to 43.3°C (110°F) and switches ON the Air-to-Water Heat Pump, AWHP-1.

## **.5 Disabled Mode**

- .1 Boilers B-1 and B-2 remain OFF.

## **.6 Critical Alarms**

- .1 The lead boiler (B-1) is enabled and status is not received (2 minute delay).
- .2 Low temperature limit.
- .3 Low leaving water temperature.

## **.7 General Alarms**

- .1 The leaving water temperature remains below 37.8 Deg C (adjustable) for more than 30 minutes.
- .2 The leaving water temperature remains above 43.3 Deg C(adjustable) for more than 30 minutes.

## **.8 Maintenance Alarms**

- .1 The boilers are disabled by the BAS but the status is ON (10 minute delay).

## **.9 Trends**

- .1 Leaving water temperature.
- .2 Boiler run hours.
- .3 Return water temperature.

## **.5 IN-FLOOR HYDRONIC RADIANT HEATING SYSTEM**

### **.1 Modes of Operation**

- .1 The in-floor hydronic radiant heating system remains enabled during the entire heating season from September 1<sup>st</sup> to June 30<sup>th</sup>.
- .2 During the summer months of July and August, the system remains OFF.

### **.2 Start Up/Shutdown**

- .1 The circulating pump, CP-4, in the manifold cabinet will be enabled by BAS on September 1<sup>st</sup> (adjustable) and disabled on June 30<sup>th</sup> (adjustable). The circulating pump is switched ON/OFF by its own controller based on the temperature in the Apparatus Bay.

### **.3 Enabled Mode**

- .1 In the enabled mode, the circulating pump, CP-4, runs circulating heating water through the embedded pipes in the floor slab when there is a demand for heating. The three-way valve modulates to maintain the required supply loop temperature.
- .2 The circulating pump, CP-4, switches OFF when the space temperature as sensed by the thermostat in the Apparatus Bay equals the set point (adjustable). The three-way valve closes the port connected to the high temperature water.
- .3 When the outside air temperature rises above 21°C(adjustable), BAS disables the circulating pump, CP-4, and the three-way valve closes the port connected to the high temperature water.

#### **.4 Disabled Mode**

- .1 The circulating pump, CP-4, remains OFF and the three-way valve port connected to the high temperature water remains closed.

#### **.5 Critical Alarms**

- .1 The circulating pump, CP-4, is enabled and status is not received (2 minute delay).
- .2 High temperature limit.
- .3 Low leaving water temperature.

#### **.6 General Alarms**

- .1 The leaving water temperature remains below 37.8 Deg C (adjustable) for more than 30 minutes.
- .2 The leaving water temperature remains above 43.3 Deg C(adjustable) for more than 30 minutes.

#### **.7 Maintenance Alarms**

- .1 The circulating pump, CP-4, is disabled by the BAS but the status is ON (10 minute delay).

#### **.8 Trends**

- .1 Leaving water temperature.
- .2 Pump run hours.
- .3 Return water temperature.
- .4 Space temperature in the Apparatus Bay.

### **.6 EXHAUST FANS, EF-2 TO EF-9**

#### **.1 Modes of Operation**

- .1 The exhaust fans EF-2 to EF-9 are switched ON/OFF automatically by the occupancy sensor in the respective washroom.

#### **.7 EF-1, BUNKER GEAR ROOM EXHAUST FAN**

#### **.1 Modes of Operation**

- .1 The exhaust fan EF-1 is switched ON/OFF manually by the user through wall mounted H-O-A switch. In the auto mode, BAS shall command the fan ON/OFF.

#### **.8 EF-11, APPARATUS BAY VENTILATION AIR EXHAUST FAN**



**.1 Modes of Operation**

- .1 The exhaust fan EF-11 is switched ON/OFF by the CO/NOx sensor mounted in the Apparatus Bay based on the amount of CO/NOx present in the air.

**.2 Critical Alarms**

- .1 The CO/NOx level rises above the set point but the fan status is OFF.
- .2 The fan status is ON but the air intake motorised damper position is CLOSED.

**.3 General Alarms**

- .1 The CO/NOx level is below the set point but the fan status is ON.

**.4 Trends**

- .1 Fan run hours.
- .2 CO/NOx level.

**.9 EF-12, EF-13, EF-14 and EF-15**

**.1 Modes of Operation**

- .1 The exhaust fan is switched ON/OFF by BAS based on input from the wall mounted temperature sensor in the respective space when the space temperature exceeds 26.6°C (80°F)(adjustable) during the summer months of July and August.

**.2 Critical Alarms**

- .1 The space temperature level rises above the set point but the fan status is OFF.

**.3 General Alarms**

- .1 The space temperature level is below the set point but the fan status is ON.

**.4 Trends**

- .1 Fan run hours.
- .2 space temperature.

**.10 UNIT HEATERS UH-1 TO UH-7**

**.1 Modes of Operation**

- .1 Unit heaters UH-1 to UH-7 are enabled by BAS in the entire heating season from September 1<sup>st</sup> to June 30<sup>th</sup>. In the summer months of July and August, the unit heaters remain disabled by the BAS.

**.2 Start Up/Shutdown**

- .1 The unit heaters are switched ON/OFF by the BAS based on the input from the respective space temperature sensors in the spaces.

### **.3 Enabled Mode**

- .1 The unit heater fan runs delivering the airflow to the room. The two-way valve on the heating water supply pipe remains open. When the space temperature equals the set point (70°F/21°C), the BAS shuts off the fan and the two-way valve.
- .2 In the Apparatus Bay when the space temperature drops to 65°F/18°C, the BAS opens the two-way valve on the heating supply pipe and starts the unit heater fan (UH-1 to 4). When the space temperature equals the set point (72°F/22.2°C), the BAS shuts off the unit heaters and 2-way valves.
- .3 When the outside air temperature rises above 18°C, the unit heaters are disabled by the BAS.

### **.4 Disabled Mode**

- .1 The unit heaters remain OFF and the two-way valve on the heating supply pipe remains closed.

### **.5 Critical Alarms**

- .1 The unit heaters are enabled and status is not received (2 minute delay).
- .2 Unit heater is ON but the fan not running.
- .3 Unit heater fan is running but the two-way valve is closed.

### **.6 General Alarms**

- .1 The space temperature remains below set point for more than 30 minutes.

### **.7 Maintenance Alarms**

- .1 The unit heaters are disabled by the BAS but the status is ON (10 minute delay).

### **.8 Trends**

- .1 Leaving water temperature.
- .2 Fan run hours.
- .3 Space temperature.

## **.11 AIR FILTRATION SYSTEM FOR APPARATUS BAY**

### **.1 General**

- .1 The air filtration system comprises of an air circulating unit with a blower and multiple filters. The units are suspended from the under side of the roof structure.

### **.2 Modes of Operation**

- .1 The air filtration units remain enabled all the time by the BAS.

### **.3 Start Up/Shutdown**

- .1 The units are started by the control panel mounted on the wall by one of the following inputs:
  - a. Signal from the optical eye view sensors mounted on the opposite sides of the overhead doors in the Apparatus Bay.
  - b. Signal from the particulate sensor mounted on the wall near the control panel.
  - c. Signal from the CO/NOx sensor when the CO/NOx level exceeds the set point.
- .2 The units are switched off at the end of the cycle time by the control panel. Cycle time is set at a rotary selector provided in the control panel.

#### **.4 Enabled Mode**

- .1 When the overhead doors open, the flag fitted on the door breaks the light beam between the 2 eye sensors on the opposite walls. The sensors send the signals to the control panel that starts the filtration blower drawing air through the filters and discharging at the outlet.
- .2 When the overhead doors are closed and the trucks are turned ON, the units are started by the particulate sensor or the CO/NOx sensor.

#### **.5 Critical Alarms**

- .1 The status of the units is OFF(disabled).
- .2 The status of control panel is OFF.
- .3 Filter alarm from the units.

#### **.6 General Alarms**

- .1 The exhaust fan, EF-10, runs more than 3 minutes after the fire truck is out of range.

#### **.7 Trends**

- .1 Fan status.
- .2 Fan run hours.

#### **.12 CIRCULATING PUMP, CP-1**

##### **.1 Modes of Operation**

- .1 The circulating pump, CP-1, is enabled during the occupancy hours by the integral timer. CP-1 is disabled by the timer during unoccupied hours.

##### **.2 Start Up/Shutdown**

- .1 The circulating pump, CP-1, is switched ON/OFF by the integral thermostat based on the return hot water temperature.

##### **.3 Enabled Mode**

- .1 The circulating pump, CP-1, runs continuously circulating the domestic hot water until the return water temperature exceeds 105°F/40.6°C when it is stopped by the integral aquastat. When the water temperature drops below 85°F/29.4°C, the pump CP-1 is started by the aquastat.

##### **.4 Disabled Mode**

- .1 The circulating pump, CP-1, remains OFF.

##### **.5 Critical Alarms**

- .1 No critical alarm.

##### **.6 Trends**

- .1 Pump status.

#### **.13 CIRCULATING PUMPS, CP-2A and CP-2B**

**.1 Modes of Operation**

- .1 The circulating pumps, CP-2A and CP-2B, are enabled by the BAS for the entire heating season from September 1<sup>st</sup> to June 30<sup>th</sup>. The pumps are disabled by the BAS during the summer months of July and August.

**.2 Start Up/Shutdown**

- .1 The circulating pumps, CP-2A and CP-2B, are switched ON/OFF by the BAS as described in the sequence of operations for the boilers.

**.3 Enabled Mode**

- .1 The circulating pump, CP-2A, is switched ON by the BAS before starting the boiler B-1. The BAS switches OFF the pump, CP-2A, when the leaving water temperature as sensed by the temperature sensor on the supply pipe in the mechanical room equals (43.3°C)110°F.
- .2 The circulating pump, CP-2B, is switched ON by the BAS before starting the boiler B-2. The BAS switches OFF the pump, CP-2B, when the leaving water temperature as sensed by the temperature sensor on the supply pipe in the mechanical room equals (43.3°C)110°F.
- .3 When the outside air temperature rises above 10°C (adjustable), the BAS disables the circulating pumps, CP-2A and CP-2B.
- .4 Refer to sequence of operations of the boilers for emergency mode operation of the pumps.

**.4 Disabled Mode**

- .1 The circulating pumps, CP-2A and CP-2B, remain OFF.

**.5 Critical Alarms**

- .1 The circulating pumps are enabled and status is not received (2-minute delay).
- .2 The circulating pump is ON but there is no water flow.

**.6 Trends**

- .1 Pumps status.
- .2 Pumps run hours.

**.14 CIRCULATING PUMP, CP-3**

**.1 Modes of Operation**

- .1 The circulating pump, CP-3, is enabled by the BAS for the entire heating season from September 1<sup>st</sup> to June 30<sup>th</sup>. CP-3 is disabled by the BAS during the summer months of July and August.

**.2 Start Up/Shutdown**

- .1 The circulating pump, CP-3, is switched ON/OFF by the BAS based on the heating supply temperature as sensed by the temperature sensor on the heating supply pipe.

**.3 Enabled Mode**

- .1 The circulating pump, CP-3, is switched ON by the BAS when the heating supply temperature as sensed by the temperature sensor in the heating supply pipe drops below 37.8°C(100°F) (adjustable). The BAS switches OFF the pump, CP-3, after 5 minutes(adjustable) when the leaving water temperature as sensed by the temperature sensor on the supply pipe in the mechanical room rises above (43.3°C)110°F.
- .2 When the outside air temperature rises above 21 °C(adjustable), the BAS disables the circulating pump, CP-3.

**.4 Disabled Mode**

- .1 The circulating pump, CP-3, remains OFF.

**.5 Critical Alarms**

- .1 The circulating pump, CP-3, is enabled and status is not received (2-minute delay).
- .2 The circulating pump, CP-3, is ON but there is no water flow.

**.6 Trends**

- .1 Pump status.
- .2 Pump run hours.

**.15 CIRCULATING PUMPS, P-1/P-2**

**.1 Modes of Operation**

- .1 The circulating pumps, P-1/P-2, are enabled by the BAS for the entire heating season from September 1<sup>st</sup> to June 30<sup>th</sup>. P-1/P-2 are disabled by the BAS during the summer months of July and August.

**.2 Start Up/Shutdown**

- .1 The circulating pump, either P-1 or P-2, is run continuously during the heating season when the outside air temperature remains below 21°C. When the outside air temperature rises above 21 °C, the BAS shuts down the pump.

**.3 Enabled Mode**

- .1 The circulating pump, either P-1 or P-2, is switched ON by the BAS when the outside air temperature drops below 21°C(70°F). The speed of the pump is varied based on the differential pressure in the heating supply pipes.
- .2 If there is no heating demand from any of the zones for 5 minutes, the pump shall be stopped. Upon heating demand from any one of the zones as sensed by the temperature sensors in the room, BAS shall start the pump.
- .3 The BAS alternates the duty pump between P-1 and P-2 every Monday(adjustable).

**.4 Disabled Mode**

- .1 The circulating pumps, P-1 and P-2, remain OFF.

**.5 Critical Alarms**

- .1 The circulating pumps, P-1 and P-2, are enabled and status is not received (2-minute delay).
- .2 The circulating pumps, either P-1 or P-2, is ON but there is no water flow.

**.6 Trends**

- .1 Pump status.
- .2 Pump run hours.

**.16 CIRCULATING PUMP, CP-4**

**.1 Modes of Operation**

- .1 The circulating pump, CP-4, is enabled by the BAS for the entire heating season from September 1<sup>st</sup> to June 30<sup>th</sup>. CP-4 is disabled by the BAS during the summer months of July and August.

**.2 Start Up/Shutdown**

- .1 The circulating pump, CP-4, is switched ON/OFF by the pump controller mounted inside the manifold cabinet for in-floor hydronic radiant floor heating system.

**.3 Enabled Mode**

- .1 The circulating pump, CP-4, is switched ON by the pump controller in the manifold cabinet when the floor slab temperature as sensed by the temperature sensor embedded in the floor slab of the Apparatus Bay drops below 22.2°C(72°F) (adjustable). The pump is switched OFF when the temperature of the floor slab rises above 23.9°C(75°F).
- .2 When the outside air temperature rises above 21 °C(adjustable), the BAS disables the circulating pump, CP-4.

**.4 Disabled Mode**

- .1 The circulating pump, CP-4, remains OFF.

**.5 Critical Alarms**

- .1 The circulating pump, CP-4, is enabled and status is not received (2-minute delay).
- .2 The circulating pump, CP-4, is ON but there is no water flow.

**.6 Trends**

- .1 Pump status.
- .2 Pump run hours.

Points List

		Analog Points												Digital points						Misc.				Notes			
	Point name EQ Type	Input												Output			Input			Output			Alarm		Weekly Sch.	BACNET Object Exchan	Graphic
		Temperature	CO2/CO/NO2	Sub-metering	Diff. Press.	Pressure	Low Limit	Flow	Timer	Position	Speed	Humidity	Lux	Electric	Damper	H / C Valve	Status	Position	Switch	Start/Stop	On/Off						
OUTDOOR	OAT																					X				Sensor fail alarm	
Temperature		X																				X				2 Sensors with temp avg	
Photo Cell												X										X					
Humidity											X											X					
Building Pressure Sensor						X																X					
VRF SYSTEM																											
Outdoor Condensing Unit				X													X					X			X		
Fan Coil Units				X													X					X			X		
Electric duct heater				X													X			X		X			X		
Supply Air		X																				X					
Return Air		X									X											X					
Mixed Air		X											X									X					
Space Temp - Display/Adjust/Override		X																				X					
Freeze Stat						X																X					
Humidification																X			X			X					
Outdoor Air Flow Monitor	OAF						X															X					

	Point name EQ Type	Analog Points												Digital points					Misc.				Notes				
		Input												Output			Input		Output			Alarm		Weekly Sch.	BACNET Object Exchan	Graphic	
		Temperature	CO2/CO/NO2	Sub-metering	Diff. Press.	Pressure	Low Limit	Flow	Timer	Position	Speed	Humidity	Lux	Electric	Damper	H / C Valve	Status	Position	Switch	Start/Stop	On/Off						
HYDRONIC HEATING Systems																											
Boiler	B-1			X													X			X			X			X	
Boiler Circulator	CP-2																X			X	X		X			X	
Heating water Supply Temperature	HST	X																				X				X	
Heating water return temperature	HRT	X																				X					
Air-to-Water Heat Pump	AWHP-1			X													X			X		X			X		
Circulator Pump	CP-3																X			X	X		X			X	
Circulator Pump	CP-4																X			X		X			X		
Discharge water temp. from AWHP-1		X																				X			X		
Two-Way valve																	X			X		X			X		All heating valves will be fully modulating 0-10V
Space Temp - Display/Adjust/Override		X																				X					
Circulating pumps, P-1/P-2						X					X						X			X		X	X		X		
Heating water supply pressure						X																X			X		
Heating water return pressure						X																X			X		
ENERGY RECOVERY VENTILATOR - 1																											
Fans																	X			X		X			X		
Motorised Dampers																	X	X				X			X		
Filters																	X					X			X		
Supply air temperature		X																									
Return air temperature		X																									
Exhaust air temperature		X	X																								
Pre-heater amps													X														
EXHAUST FANS																											Washroom exhaust fans to be controlled by time of the day schedule.
Fan	EF1 to 9																X					X			X		
Fan	EF-10																X					X			X		
Fan	EF-11																X					X			X		
Motorised damper – Air Intake	EF-11																	X	X			X			X		
CO/NOx Level – Apparatus Bay	CO/NOx Sensor		X																			X			X		
Fan	EF-12 to 15																X					X			X		
Space temperature	Thermostat	X																									



	Point name EQ Type	Analog Points															Digital points						Misc.				Notes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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End of Section

**1 GENERAL****1.01 REFERENCES**

- .1 The General Conditions of the Contract, the Supplementary Conditions, and all Sections of Division 01 apply to and are a part of this Section of the Specification.

**1.02 APPLICATION**

- .1 This Section specifies requirements that are common to electrical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

**1.03 NOTE RE: BOLD LETTERING**

- .1 "**Bold**" type lettering is used throughout this Specification in an attempt to enhance the readability of the text. The use of "**bold**" lettering does not indicate a greater level of importance.

**1.04 SUBMITTALS**

- .1 As specified in this Section, submit the following to the Consultant:
  - .1 **project close-out documentation:** O & M Manuals, record as-built drawings, and all associated data.
  - .2 **progress payment breakdown:** a detailed breakdown of the electrical work cost
  - .3 **Extended Warranties:** copies of all extended warranties specified and shall be in the name of the Owner.
  - .4 **O & M Training Schedules & Manual:** a proposed schedule of demonstration and training dates and times, and a preliminary copy of the training manual developed for operational and maintenance training.

**1.05 DEFINITIONS**

- .1 The following are definitions of words found in electrical work Sections of the Specification and on associated drawings:
  - .1 "concealed" – means work hidden from normal sight in furred spaces, shafts, tunnels, ceiling spaces, walls and partitions
  - .2 "exposed" – means work normally visible, including work in electrical and equipment rooms and similar spaces
  - .3 "provide" (and tenses of provide) – means supply and install complete
  - .4 "install" (and tenses of install) – means install and connect complete
  - .5 "supply" – means supply only

- 6 "finished area" - means any area or part of an area which receives a finish such as paint, or is factory finished
- .7 "governing authority" and/or "regulatory authority" and/or "Municipal authority" – means all government departments, agencies, standards, rules and regulations that apply to and govern the electrical work and to which the work must adhere
- .8 "Consultant" – means the Architect or Consulting Engineer who has prepared the Contract Documents on behalf of the Owner
- .2 Wherever the words "indicated", "shown", "noted", "listed", or similar words or phrases are used in the specification they are understood, unless otherwise defined, to mean that the product referred to is "indicated", "shown", "listed", or "noted" on the drawings.
- .3 Wherever the words "approved", "satisfactory", "as directed", "submit", "permitted", "inspected" or similar words or phrases are used in the specification or on the drawings they are understood, unless otherwise defined, to mean that work or product referred to is "approved by", "inspected by", etc., the Consultant.
- .4 In the electrical specification, singular may be read as plural, and vice-versa.

#### **1.06 QUALITY ASSURANCE**

- .1 All electrical work is to be done by journeyman tradesmen who perform only the work that their certificates permit, or by apprentice tradesmen under direct on-site supervision of an experienced journeyman tradesman. The use of apprentice tradesmen is to be limited and the journeyman/apprentice ratio is subject to the Consultant's approval.
- .2 An experienced and qualified superintendent is to be on-site at all times when electrical work is being performed.

#### **1.07 CODES, REGULATIONS, AND STANDARDS**

- .1 All Codes, Regulations, and Standards referred to in this Section and in Sections to which this Section applies are the latest edition of the Codes, Regulations, and Standards in effect at the time of bidding on this Project.
- .2 All electrical items are to be certified and bear the stamp or seal of a recognized testing agency such as CSA, UL, ULC, ETL, etc., or bear a stamp to indicate special electrical utility approval.
- .3 Requirements of the Contract Documents are to take precedence when they are more stringent than codes, ordinances, standards, and statutes.

#### **1.08 IMPERIAL AND METRIC MEASUREMENTS**

- .1 Conform to requirements of CAN/CSA-Z234.1, Canadian Metric Practice Guide.
- .2 Both Metric and Imperial units of measurement are indicated in the electrical Specification. Metric measurements are "soft" and have been rounded off.

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**1.09 EXAMINATION OF SITE AND DOCUMENTS**

- .1 When estimating the cost of the work and prior to submitting a bid for the work carefully examine all of the bid documents and visit the site to determine and review all existing site conditions that will or may affect the work and include for all such conditions in the bid price.
- .2 Report to the Consultant, prior to bid submittal, any existing site condition that will or may affect performance of the work as per the drawings and specifications. Failure to do so will not be grounds for additional costs.

**1.10 DRAWINGS AND SPECIFICATION**

- .1 Read the electrical work drawings in conjunction with all other structural, architectural, sprinkler, mechanical, etc., drawings.
- .2 The electrical drawings are performance drawings, diagrammatic, and show approximate locations of equipment and connecting services. Any information regarding accurate measurement of the building are to be taken at the site. Do not scale the drawings, and do not use the drawings for prefabrication work.
- .3 The drawings are intended to convey the scope of work and do not show architectural and structural details. Provide, at your cost, all offsets, fittings, transformations, and similar products required as a result of obstructions and other architectural and structural details but not shown on the drawings.
- .4 The locations of equipment and materials shown may be altered, when reviewed by the Consultant, to meet requirements of the equipment and/or materials, other equipment or systems being installed, and of the building, all at your cost.
- .5 Sections of the electrical specification are not intended to delegate functions nor to delegate work and supply of materials to any specific trade, but rather to generally designate a basic unit of work, and the Sections are to be read as a whole.
- .6 The electrical specification does not generally indicate the specific number of items or extent of material required. The specification is intended to provide product data and installation requirements. It is necessary to refer to drawing schedules, layouts, schematic diagrams, riser diagrams, and details to determine correct quantities.
- .7 The electrical drawings and specification are intended to be cooperative. Perform all work that is shown, specified, or reasonably implied on the drawings but not mentioned in the specification, or vice-versa, as though fully covered by both.
- .8 When the scale and date of the drawings are the same, or when the discrepancy exists within the specification, the most costly arrangement will take precedence.
- .9 In the case of discrepancies or conflicts between the drawings and specification, the documents will govern in the following order:
  - .1 the specification
  - .2 drawings of larger scale

- .3 drawings of smaller scale
- .4 drawings of later date when the scale of the drawings is the same.
- .10 In the case of discrepancies between the drawings and specifications, the documents will govern in the order specified in the General Conditions, however, when the scale and date of the drawings are the same, or where the discrepancy exists within the specification, the costliest arrangement will take precedence.

#### **1.11 PLANNING AND LAYOUT OF THE WORK, AND ASSOCIATED DRAWINGS**

- .1 Properly plan, coordinate, and establish the locations and routing of services with all subcontractors affected prior to installation such that the services will clear each other as well as any obstructions, including structural components of the building. Unless otherwise specified, the order of right-of-way for services is to be as follows:
  - .1 piping requiring uniform pitch
  - .2 piping 100 mm (4") dia. and larger
  - .3 large ducts (main runs)
  - .4 electrical cable tray and bus duct
  - .5 conduit 100 mm (4") dia. and larger
  - .6 piping less than 100 mm (4") diameter
  - .7 smaller branch ductwork
  - .8 conduit less than 100 mm (4") diameter
- .2 Unless otherwise shown or specified, conceal all work in finished areas, and conceal work in partially finished or unfinished areas to the extent made possible by the area construction. Install conduit, raceway, and similar services as high as possible to conserve headroom and/or ceiling space. Notify the Consultant where headroom or ceiling space appears to be inadequate prior to installation of the work.
- .3 Revise or alter the arrangement of work that has been installed without proper coordination, study and review, even if it was completed in accordance with the Contract Documents, in order to conceal the work behind finishes, or to allow the installation of other work, at no additional cost. In addition, pay for the cost of alterations in other work required by the alterations to your work.
- .4 All junction boxes, equipment and similar products, particularly such products located above suspended ceilings must be located for easy access for servicing and/or removal. Products which do not meet this location requirement are to be relocated to an accessible location at no additional cost.

#### **1.12 COORDINATION OF THE WORK**

- .1 Review all the Contract Documents and coordinate the work with the work of all subcontractors. Coordination requirements are to include, but not be limited to, the following:

- .1 written notifications of all concrete work such as housekeeping pads, bases, etc., required for electrical work, and including required dimensions, operating weight of equipment, location, etc.
- .2 depth and routing of excavation required for electrical work, and requirements for bedding and backfill

### **1.13 GENERAL RE: INSTALLATION OF EQUIPMENT**

- .1 Unless otherwise specified all equipment is to be installed in accordance with the equipment manufacturer's recommendations and instructions, and requirements of governing Codes, Standards, and Regulations. Governing Codes, Standards, and Regulations take precedence over manufacturer's instructions.
- .2 Ensure that proper access and service clearances are maintained around equipment, and, where applicable, access space for future equipment removal or replacement is not impeded. Remove and replace any equipment which does not meet this requirement.

### **1.14 PERMITS, FEES, AND CERTIFICATES**

- .1 Apply for, obtain and pay for all permits required to complete the electrical work.
- .2 Submit to the Consultant, all approval/inspection certificates issued by governing authorities to confirm that the work as installed is in accordance with the rules and regulations of the governing authorities. Pay any costs associated with issue of the certificates.
- .3 Include a copy of all approval/inspection certificates in each operating and maintenance manual.

### **1.15 WORKPLACE SAFETY**

- .1 Comply with requirements of the Workplace Hazardous Materials Information System (WHMIS) regarding the use, handling, storage and disposal of hazardous materials. Submit WHMIS MSDS (Material Safety Data Sheets) for all products where required, and maintain one copy at the site in a visible and accessible location available to all personnel.
- .2 Comply with all requirements of Occupational Health and Safety Regulations and all other regulations pertaining to health and safety, including worker's compensation/ insurance board and fall protection regulations.

### **1.16 SHOP DRAWINGS AND PRODUCT DATA SHEETS**

- .1 Prior to supplying any products to the site, submit for review, shop drawings and/or product data sheets indicating in detail the design, construction, and performance of products as requested in Sections of this Specification. The number of copies of shop drawings and/or product data sheets will be as later directed.
- .2 Shop drawings are those prepared specifically for the Project. Product data sheets are copies of manufacturer's standard catalogue, etc., literature.
- .3 Unless otherwise specified or required, submit shop drawings/product data sheets via email in

AutoCAD or PDF format only.

- .4 Wherever possible, shop drawings and/or product data sheets are to be digital electronic PDF format; 215 mm x 280 mm (8½" x 11"), 215 mm x 356 mm (8½" x 14"), or 356 mm x 432 mm (11" x 17") single side white bond paper with sufficient clear space for review stamps, comments, and identification as specified below.
- .5 Shop drawings and product data sheets must confirm that the product proposed meets all requirements of the Contract Documents.
- .6 Each shop drawing or product data sheet is to be properly identified with the project name and the product drawing or specification reference, i.e. "Lighting Fixture F1", and all shop drawing or product data sheet dimensions are to be either SI or Imperial to match dimensions on the drawings.
- .7 Carefully review each shop drawing and product data sheet prior to submittal to ensure that the proposed product is correct and meets with all requirements of the Project. Endorse each copy of each shop drawing or product data sheet "Correct for Review By Consultant", or "Certified to Be In Accordance With All Requirements" and include your company name, the submittal date, and the signature of an officer of your company to indicate your review and approval as above.
- .8 The Consultant will review shop drawings and product data sheets and will indicate the review status by stamping the shop drawings and product data sheets as follows:
  - .1 **"Reviewed" or "Reviewed As Noted"** to indicate that his review is final and no re- submittal is required
  - .2 **"Returned For Correction"** to indicate that the submission is rejected and is to be revised in accordance with comments marked on the shop drawings and product data sheets by the Consultant and re-submitted
- .9 The Consultant will retain one digital electronic PDF copy of each shop drawing or product data sheet submission. Copy of shop drawings in digital and hard copy format shall be kept on site for the duration of the construction.
- .10 The following is to be read in conjunction with the wording on the Consultant's review stamp applied to each and every electrical work shop drawing or product data sheet submitted:

"This review is for the sole purpose of ascertaining conformance with the general design concept. This review does not approve the detail design inherent in the product data/shop drawings, responsibility for which remains with the Contractor, and such review does not relieve the Contractor of the responsibility for errors or omissions in the product data/shop drawings or of his responsibility for meeting all requirements of the Contract Documents. Be responsible for dimensions to be confirmed and correlated at the job site, for information that pertains solely to fabrication processes or to techniques of construction and installation, and for coordination of the work of all sub-trades."

#### 1.17 N I L ( NOT IN LIST)

#### 1.18 SCAFFOLDING, RIGGING, AND HOISTING

- .1 Unless otherwise specified or directed, supply, erect and operate all scaffolding, rigging, hoisting

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equipment and associated hardware required for your work. Immediately remove from the site all scaffolding, rigging, and hoisting equipment when no longer required.

## 1.19 PROJECT CLOSEOUT SUBMITTALS

- .1 Prior to application for Substantial Performance, submit all required items and documentation specified, including the following:
  - .1 Operating and Maintenance Manuals
  - .2 as-built record drawings and associated data.
  - .3 extended warranties for equipment as specified.
  - .4 all operating test certificates, i.e. Fire Alarm System Test Certificate.
  - .5 identified keys for electrical equipment and/or panels for which keys are required, and all other items required to be submitted.
  - .6 other data or products specified.
- .2 **Operating and Maintenance Manuals:** Submit (2) two hard copies and (1) one digital electronic PDF of operating and maintenance manuals consolidated in hardcover three "D" ring binders, each binder sized to include approximately 25% spare space for future data, and identified permanently with the Project name, "ELECTRICAL OPERATING AND MAINTENANCE MANUAL" wording, and the date. Manuals are to include the following:
  - .1 an Introduction sheet listing the Consultant's, Contractor's, and Subcontractor names, street addresses, telephone and fax numbers, and e-mail addresses.
  - .2 a Table of Contents sheet, and corresponding index tab sheets
  - .3 a copy of each "Reviewed" or "Reviewed As Noted" shop drawing or product data sheet, with manufacturer's/supplier's name, telephone and fax numbers, email address, and the email address for local source of parts and service
  - .4 test reports, and certificates issued by governing authorities.
  - .5 **Operating Data:** Operating data is to include:
    - .1 a description of each system and its controls
    - .2 operation instruction for each system and each component
    - .3 description of actions to be taken in event of emergencies and/or equipment failure
  - .6 **Maintenance Data:** Maintenance data is to include:
    - .1 servicing maintenance, operation and trouble-shooting instructions for each item of equipment and each system
    - .2 schedules of tasks, frequency, tools required, and estimated task time.



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- .3 complete parts list with numbers
  - .7 **Performance Data:** Performance data is to include:
    - .1 equipment and system start-up data sheets
    - .2 equipment performance verification test results, and final commissioning report
  - .8 **Review Submittal:** Assemble one copy of the O & M Manual and submit to the Consultant for review prior to Owner training and instructions and assembling the remaining copies. Incorporate all comments into the final submission.
  - .9 **Digital O & M Manuals:** Submit four digital versions of the hard copy manual using the latest version of Adobe Acrobat Portable Document Format and enhanced with bookmarks, internet links, and internal document links. The digital copies are to be copied to CDR with custom labels which indicate the project name, date, the Consultant's name, and "Operating & Maintenance Manual for Electrical Systems".
  - .3 **Record "As-Built" Drawings and Data:** As work progresses at the site, clearly mark in red in a neat and legible manner on a set of white prints of the Contract Drawings, all significant changes and deviations from the routing of services and locations of equipment shown on the Contract Drawings and resulting from the issue of Addenda, Site Instructions, Change Orders, and job conditions. Use notes marked in red as required. Maintain the white print red line as-built set at the site for the exclusive use of recording as-built conditions, keep the set up-to-date at all times, and ensure that the set is always available for periodic review. The as-built set is also to include the following:
    - .1 the dimensioned location of all inaccessible concealed work
    - .2 the locations of control devices with identification for each
    - .3 the location of all junction boxes, terminal cabinets, etc.
    - .4 for underground conduit, ducts, etc., record dimensions, invert elevations, all offsets, fittings, and accessories if applicable, and locate dimensions from benchmarks that will be preserved after construction is complete.
    - .5 the location of all concealed services terminated for future extension.
  - .6 **Digital Record "As-Built" Drawings:** When work on site is complete, transfer all the as-built red line information from the site as-built drawings to a recordable and identified CAD disc with CAD work of equal quality to the Contract Drawings. Obtain a CAD disc as described below.
  - .7 **Obtaining CAD Discs:** The electrical drawings have been prepared on a CAD system using the latest Release of AutoCad software. For the purpose of producing final as-built drawings, discs of the Contract Drawings will be supplied free of charge by the Consultant.
  - .8 **Review and Submittal:** Prior to inspection for Substantial Performance of the work, submit for review, the red line site as-built white prints, a CAD disc of the as-built drawings, and a bound set of white prints (of equal quality to the Contract Drawings) made from the disc. The Consultant
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will review the drawings and, if necessary, return the disc and the marked-up white prints for corrections or further revisions, in which case complete the corrective and/or revision work and

resubmit the disc and white prints until they are determined to be acceptable, all prior to issue of a Certificate of Substantial Performance.

**1.20 (NOT IN LIST)****1.21 (NOT IN LIST)****1.22 EXTENDED WARRANTIES**

- .1 Unless otherwise specified, all extended warranties specified in electrical work Sections of the Specification are to be full parts and labour warranties, at the site, and in accordance with requirements of the Contract warranty, but direct from the equipment manufacturer/supplier to the Owner. Submit signed and dated copies of extended warranties which clearly state requirements specified above.

**1.23 EQUIPMENT AND MATERIAL MANUFACTURER REQUIREMENTS**

- .1 Equipment and materials scheduled or specified on the drawings or in the Specification have been selected to establish a performance and quality standard.
- .2 In most cases acceptable equipment and material manufacturers are listed for any product specified by manufacturer's name and model number. Unless otherwise stated the bid price may be based on products supplied by any of the manufacturers or an approved equivalent named as acceptable for the particular product. If acceptable manufacturers are not listed for a particular product, base the bid price on the products supplied by the specified manufacturers or an approved equivalent.
- .3 If products supplied by a manufacturer named as acceptable or approved equivalent are used in lieu of the products specified by manufacturer's name and model number, ensure that the product is equivalent in performance and operating characteristics (including energy efficiency if applicable) to the specified product. Pay for any additional costs and changes to associated or adjacent work resulting from the use of products supplied by a manufacturer other than the specified manufacturer. In addition, in equipment spaces where products named as acceptable are used in lieu of the specified products and the dimensions of such products differ from the specified products prepare and submit for review, if requested, accurately dimensioned layouts of the rooms affected to prove that all the equipment in the room will fit properly.

**1.24 LIST OF ACCEPTABLE MANUFACTURERS AND SUPPLIERS**

- .1 Refer to the contract and the City of Barrie Supplementary Conditions to the CCDC2-2020 contract for acceptable alternative procedure.

**1.25 (NOT IN LIST)****1.26 (NOT IN LIST)****1.27 EQUIPMENT AND SYSTEM MANUFACTURER'S CERTIFICATION**

- .1 When equipment/system installation is complete, but prior to start-up procedures, arrange and pay for the equipment/system manufacturer's authorized representative to visit the site to examine the installation, and when any required corrective measures have been made, to certify in writing to the Consultant that the equipment/system installation is complete and in accordance with the equipment/system manufacturer's instructions.

**1.28 EQUIPMENT AND SYSTEM START-UP**

- .1 When installation of equipment/systems is complete but prior to commissioning, perform start-up for equipment/systems as specified in electrical work Sections in accordance with the following requirements:
  - .1 submit a copy of each equipment/system manufacturer's start-up report sheet to the Consultant for review, and incorporate any comments.
  - .2 under direct on-site supervision and involvement of the equipment/system manufacturer's representative, start-up the equipment/systems, make any required adjustments, document the procedures, leave the equipment/systems in proper operating condition, and submit a complete set of start-up documentation sheets signed by the manufacturer/supplier and the Contractor.

**1.29 EQUIPMENT AND SYSTEM COMMISSIONING**

- .1 After successful start-up and prior to Substantial Performance, commission the electrical work using approved commissioning sheets. Submit final commissioning data sheets. Include for equipment manufacturer's representation at the site to assist in the commissioning process.

**1.30 EQUIPMENT AND SYSTEM O & M DEMONSTRATION & TRAINING**

- .1 Refer to equipment and system operational and maintenance training requirements specified in Division 01.
- .2 Train the Owner's designated personnel in all aspects of operation and maintenance of equipment and systems as specified in electrical work Sections of the Specification. All demonstrations and training is to be performed by qualified technicians employed by the equipment/system manufacturer/supplier.
- .3 For each item of equipment and for each system for which training is specified, prepare training modules as specified below. Operating and Maintenance Manuals are to be used during the training

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sessions, and training modules are to include:

- .1 **Operational Requirements and Criteria:** requirements and criteria are to include but not be limited to equipment function, stopping and starting, safeties, operating standards, operating characteristics, and limitations.
- .2 **Troubleshooting:** troubleshooting is to include but not be limited to diagnostic instructions, test and inspection procedures.
- .3 **Documentation:** documentation is to include but not be limited to equipment/system warranties, and manufacturer's/supplier's parts and service facilities, telephone numbers, email addresses, and the like
- .4 **Maintenance:** maintenance requirements are to include but not be limited to inspection instructions, types of cleaning agents to be used as well as cleaning methods, preventive maintenance procedures, and use of any special tools.
- .5 **Repairs:** repair requirements are to include but not be limited to diagnostic instructions, disassembly, component removal and repair instructions, instructions for identifying parts and components, and review of any spare parts inventory.
- .4 Assemble the training modules into a training manual and submit a copy to the Consultant for review prior to scheduling training. Ensure that each participant in each training session has all required training material.
- .5 Schedule demonstrations and training at mutually agreed to times with a minimum of 7 working days notice.
- .6 **Demonstration and Training Confirmation:** Obtain a list of personnel to receive demonstration and training from the Consultant, and have each participant sign the list to confirm that he/she understood the demonstration and training session.

**End of Section**

**1 GENERAL**

**1.01 APPLICATION**

- .1 This Section specifies products, common criteria and characteristics, and methods and execution that are common to one or more electrical work Sections of the Specification, and it is intended as a supplement to each Section and is to be read accordingly.

**1.02 SUBMITTALS**

- .1 Submit the following for review:
  - .1 **product data sheets:** submit for:
    - .1 firestopping and smoke seal products
    - .2 waterproofing seal assemblies
    - .3 electrical work identification products
  - .2 **access door locations:** submit white prints of architectural reflected ceiling plan drawings and elevation drawings to indicate proposed access door locations in walls and ceilings in finished areas
  - .3 **samples:** submit a sample of each proposed type of access door, and samples of materials and any other items as specified in electrical work Sections of the Specification
  - .4 **list of equipment nameplates:** submit a list of equipment identification nameplates indicating proposed wording and sizes
  - .5 **conduit & conductor identification:** submit a list of conduit and conductor identification colour coding and wording
  - .6 **sleeve and formed opening location drawings:** submit, prior to concrete pours, accurately dimensioned drawings to locate all required sleeves, formed openings, and recesses required in poured concrete
  - .7 **waste management and reduction plan:** submit a waste management and reduction plan prior to commencing work and as per requirements specified in this Section
  - .8 **additional submittals:** submit any other submittals specified in this Section or other electrical work Sections of the Specification

## **2 PRODUCTS**

### **2.01 SLEEVES**

- .1 **Galvanized Sheet Steel:** Minimum #16 gauge galvanized steel with an integral flange at one end to secure the sleeve to formwork construction.
- .2 **Polyethylene:** Factory fabricated, flanged, high density polyethylene sleeves with reinforced nail bosses.
- .3 **Waterproof Sleeves:** Schedule 40 mild galvanized steel pipe with a welded-on square steel anchor and water stop plate at the sleeve midpoint, or PSI-Thunderline "Century-Line" Model CS HDPE sleeves or approved equivalent.
- .4 **Galvanized Steel:** Schedule 40 mild galvanized steel.

### **2.02 MULTI-CABLE TRANSITS**

- .1 UL/ULC listed and labelled multi-cable transits sized to suit the fire barrier opening and the number of cables/conduits involved and to facilitate a minimum 2 hour water-tight fire and smoke seal. Each assembly is to be complete with a stainless steel frame, cadmium plated compression bolts, proper end packing, compression plates, steel stay plates, and fire rated neoprene insert blocks.

### **2.03 FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Firestopping and smoke seal system materials for electrical penetrations through fire rated construction are specified in the electrical work Section entitled Firestopping and Smoke Seal Systems and the work is to be done as part of the electrical work.

### **2.04 WATERPROOFING SEAL MATERIALS**

- .1 Modular, mechanical seal assemblies consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and the pipe sleeve or wall opening, assembled with stainless steel bolts and pressure plates and designed so that when the bolts are tightened the links expand to seal the opening watertight. The seal assemblies are to be selected to suit the pipe size and the sleeve size or wall opening size. Acceptable products are as listed below or approved equivalent.
  - .1 Thunderline Corp. (Power Plant Supply Co.) "LINK SEAL" Model S-316;
  - .2 The Metraflex Co. "MetraSeal" type ES.

### **2.05 ESCUTCHEON PLATES**

- .1 One-piece chrome plated brass or #4 finish type 302 stainless steel plates with matching screws for attachment to the building surface, each plate sized to completely cover the conduit/cable sleeve or building surface opening, and to fit tightly around the conduit or cable.

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## 2.06 ACCESS DOORS

- .1 Prime coat painted steel (unless otherwise specified) flush access doors, each complete with a minimum #16 gauge frame, minimum #18 gauge door panel, heavy-duty rust-resistant concealed hinges, a positive locking screwdriver lock, and mounting and finishing features to suit the particular construction in which it is to be installed.
- .2 Access door sizes are to suit the concealed work for which they are supplied, and wherever possible they are to be of a standard size for all applications, but in any case they are to be minimum 300 mm x 300 mm (12" x 12") for hand entry and 600 mm x 600 mm (24" x 24") for body entry.
- .3 Access doors in fire rated construction are to be ULC listed and labelled and of a rating to maintain the fire separation integrity.
- .4 Where access doors are located in surfaces where special finishes are required, they are to be of a recessed door type capable of accepting the finish in which they are to be installed so as to maintain the final building surface appearance throughout, and constructed of stainless steel with a #4 finish.

## 2.07 IDENTIFICATION MATERIALS

- .1 **Equipment Nameplates:** Minimum 1.6 mm (1/16") thick 2-ply laminated coloured plastic plates, minimum 12 mm x 50 mm (½" x 2") for smaller items such as single phase starters and switches, minimum 25 mm x 65 mm (1" x 2½") for equipment, and minimum 50 mm x 100 mm (2" x 4") for control panels and similar items. Additional requirements are as follows:
  - .1 unless otherwise specified or required, each nameplate is to be white, complete with bevelled edges and black engraved capital letter wording to completely identify the equipment and its use with no abbreviations;
  - .2 wording is generally to be as per the drawings, i.e. Lighting Panel A, and is to include equipment service and building area/zone served, but must be reviewed prior to engraving;
  - .3 supply stainless steel screws for securing nameplates in place
  - .4 nameplates for equipment suspended above floor level or generally not within easy viewing from floor level are to be increased in size so as to be easily readable from floor level
- .2 **Self-Adhesive Labels:** Equal to Brother "P-Touch" or Thomas & Betts Canada Ltd. "EZCODE" Model EZL500 electronic labelling system self-adhesive labels with size and colour as directed, and permanently printed circuit identification nomenclature which is to be approved by the Consultant prior to producing the labels.
- .3 **Warning Signs:** Equal to Thomas & Betts Canada Ltd. "BP" Series 250 mm x 355 mm (10" x 14") semi-rigid vinyl signs with corner screw holes, the required printed wording (generally red on a white background with black trim), pressure sensitive adhesive on

the back, and stainless steel screws.

- .4 **Conduit and Armoured Cable Identification:** Equal to Brady Canada minimum 50 mm (2") wide self-adhesive coloured vinyl tape.
- .5 **Conductor Terminations:** Equal to Electrovert Ltd. Slip-on "Z" type
- .6 **Conductor Colour Coding:** As specified with the conductors.

## **2.08 ELECTRICAL ENCLOSURES**

- .1 Unless otherwise specified electrical enclosure are to be wall mounting NEMA/EEMAC/CSA enclosures as follows:
  - .1 indoor in sprinkler protected areas, Type 2
  - .2 indoor in high humidity/washdown areas, Type 4
  - .3 indoor in corrosive environments, Type 4X, 316 stainless steel
  - .4 indoor explosion-proof, Class 1, Groups C & D, Type 7
  - .5 outdoor, Type 3R
  - .6 indoor in non-hazardous areas except as noted above, Type 1

## **2.09 ENCLOSURE BACKBOARDS**

- .1 Construction grade Fir plywood, G1S, 20 mm ( $\frac{3}{4}$ ") thick with width and length to suit enclosure dimensions, coated on all surfaces with a ULC listed water based latex intumescent flame retardant paint, ASTM E-84 Class A rated.

## **3 EXECUTION**

### **3.01 GENERAL ELECTRICAL WORK INSTALLATION REQUIREMENTS**

- .1 Unless otherwise specified, locate and arrange horizontal conduits, raceways, and conductors above or at the ceiling on floors on which they are shown, arranged so that under consideration of all other work in the area, the maximum ceiling height and/or usable space is maintained.
- .2 Unless otherwise specified, install all conduits and conductors concealed in finished spaces, and concealed to the degree possible in partially finished and unfinished spaces. Refer to and examine the Architectural drawings and room finish schedules to determine finished, partially finished, and unfinished areas. Note that walls which are painted are considered finished.
- .3 Unless otherwise specified conduits and main distribution conductors may be exposed in equipment rooms.
- .4 Install all exposed conduits, raceways, and conductors parallel to building lines and to each other.



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- .5 Do not install conduit, raceway, or conductors within 150 mm (6") of "hot" piping or equipment.
  - .6 All conduit, raceway, conductors, etc., must be supported from the structure, not from ceiling hangers, piping, ductwork, cable tray, and similar mechanical or electrical products.
  - .7 Neatly group and arrange all exposed work. Do not install conduit to prevent access into equipment.
  - .8 **Access:** Locate all work to permit easy access for service or maintenance as required and/or applicable. Locate all products which will or may need maintenance or repairs and which are installed in accessible construction so as to be easily accessible from access doors. Where such products occur in vertical services in shafts, pipe spaces or partitions, locate the accessories at the floor level.
  - .9 **Manufacturer's Instructions:** Ensure that equipment and material manufacturer's installation instructions are followed unless otherwise specified herein or on the drawings, and unless such instructions contradict governing codes and regulations.
  - .10 **Cleaning:** Carefully clean all conduits, raceway, fittings prior to installation. Temporarily cap or plug ends of conduit which are open and exposed during construction.
  - .11 **Surfaces To Receive Your Work:** Inspect surfaces and structure prepared by other trades before performing your work. Verify that surfaces or the structure to receive your work have no defects or discrepancies which could result in poor application or cause latent defects in installation and workmanship. Report defects in writing. Installation of your work will constitute acceptance of such surfaces as being satisfactory.
  - .12 **Repair of Finished Surfaces:** For factory applied finishes, repaint or refinish all surfaces damaged during shipment and installation. The quality of the repair work is to match the original finish. This requirement also applies to galvanized finishes.
  - .13 **Work In High Humidity Areas:** Where electrical work is located in high humidity areas where ferrous metal products will be subject to corrosion and protection for such products is not specified, provide finishes on the products to protect against corrosion or provide products which will not corrode in the environment.
  - .14 **Work In Health Care Facility Patient Care Areas:** Provide conduit, conductors, and similar work in health care facility patient care areas in accordance with the Ontario Electrical Safety Code, including amendments, and test branch circuits in accordance with CAN/CSA Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities.

### 3.02 INSTALLATION OF SLEEVES

- .1 Where conduits, round ducts, and armoured cable pass through concrete and/or masonry surfaces provide sleeves as follows:

- .1 **in poured concrete slabs:** unless otherwise specified - minimum 16 gauge flanged galvanized steel or, where permitted by governing authorities, factory fabricated plastic sleeves
- .2 **in concrete or masonry walls:** Schedule 40 galvanized steel pipe
- .2 **Waterproof Sleeves:** Provide waterproof sleeves in the following locations:
  - .1 in mechanical room floor slabs, except where on grade
  - .2 in slabs over mechanical, fan, electrical and telephone equipment rooms or closets
  - .3 in all floors equipped with waterproof membranes.
  - .4 in the roof slab
  - .5 in waterproof walls
- .3 Size sleeves, unless otherwise specified, to leave 12 mm ( $\frac{1}{2}$ ") clearance around the conduit, duct, cable, etc.
- .4 Pack and seal the void between the sleeves and the conduit, duct, cable, etc., in non-fire rated construction for the length of the sleeves as follows:
  - .1 **interior construction:** pack sleeves in interior construction with mineral wool and seal both ends of the sleeves with non-hardening silicone base caulking compound
  - .2 **exterior walls above grade:** pack sleeves in exterior walls above grade with mineral wool and seal both ends of the sleeves water-tight with approved non-hardening silicone base caulking compound unless mechanical type seals have been specified
  - .3 **exterior walls below grade:** seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified below.
- .5 Where sleeves are required in masonry work, accurately locate and mark the sleeve location, and hand the sleeves to the mason for installation.
- .6 Terminate sleeves that will be exposed so that the sleeve is flush at both ends with the building surface concerned so that the sleeve may be completely covered by an escutcheon plate, except for sleeves in waterproof floors which are to terminate 100 mm (4") above the finished floor.
- .7 "Gang" type sleeving will not be permitted.
- .8 Where sleeves are provided in non-fire rated construction for future services, or where conduit, ducts, cable, etc., has been removed from existing sleeves, cap and seal both ends of the sleeved opening.

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### 3.03 RECTANGULAR OPENINGS

- .1 Rectangular openings for cable tray, raceways, multiple conduits and/or cables and similar rectangular openings will be provided in new poured concrete work, masonry, drywall and other building surfaces by the trade responsible for the particular construction in which the opening is required.
- .2 **Waterproof Openings:** Provide watertight link type mechanical seals in exterior wall openings where shown or specified. Assemble and install each mechanical seal in accordance with the manufacturer's instructions. After installation, periodically check each mechanical seal installation for leakage and, if necessary, tighten link seal bolts until the seal is completely watertight.
- .3 **Openings In Non-Fire Rated Construction:** For all rectangular openings in non-fire rated construction pack and seal the space between the conduits, ducts, cables, etc., with mineral wool for the full thickness of the building surface penetrated, and seal both ends.
- .4 **Openings In Fire Rated Construction:** Provide multi-cable transits in all fire rated openings and install in accordance with the manufacturer's instructions.

### 3.04 SLEEVE AND FORMED OPENING LOCATION DRAWINGS

- .1 Prepare and submit for review, white print drawings indicating the size and location of all required sleeves, recesses and formed openings in poured or precast concrete work.
- .2 Such drawings are to be completely and accurately dimensioned and relate sleeve, recesses, and formed openings to suitable grid lines and elevation datum, and are to take into account structural items such as grade beams, column caps, and column drop slabs
- .3 Begin to prepare such drawings immediately upon notification of acceptance of bid and award of Contract.

### 3.05 INSTALLATION OF ESCUTCHEON PLATES

- .1 Provide escutcheon plates suitable secured over all exposed conduits, ducts, armoured cable, etc., passing through finished building surfaces. A finished building surface is any surface with a factory finish or that receives a site applied finish.
- .2 Install the plates so that they are tight against the building surface concerned, and ensure that the plates completely cover sleeves and/or openings, except where waterproof sleeves extend above floors, in which case the plate is to fit tightly around the sleeve.

### 3.06 INSTALLATION OF FASTENING AND SECURING HARDWARE

- .1 Provide fastening and securing hardware required for electrical work to maintain installations attached to the structure or to finished floors, pads, walls, and ceilings in a secure and rigid manner capable of withstanding the dead loads, live loads, superimposed dead loads, and any vibration of the installed products.

- .2 Use fasteners compatible with structural requirements, finishes and types of products to be connected. Do not use materials subject to electrolytic action or corrosion where conditions are liable to cause such action.
- .3 Where floor, wall, or ceiling construction is not suitable to support the loads, provide additional framing or special fasteners to ensure proper securement to the structure. Provide reinforcing or connecting supports where required to distribute loading to structural components.
- .4 Obtain written consent before using explosive actuated fastening devices. If consent is given comply with requirements of CAN3-Z166.1 and .2.
- .5 Do not attach fasteners to steel deck without written consent from the Consultant.

### **3.07 SUPPLY OF ACCESS DOORS**

- .1 Supply access doors to give access to all electrical work which may need maintenance or repair but which is concealed in inaccessible construction, except as otherwise specified herein or on the drawings.
- .2 Locate access doors as inconspicuously as possible in walls and partitions and arrange electrical work such that it is clearly within view and accessible for inspection and servicing, and to suit access door locations shown on the reviewed and approved white prints of reflected ceiling plan and elevation drawings submitted as per Part 1 of this Section.
- .3 Group services to ensure the minimum number of access doors is required. Access doors will be installed by the trades responsible for the particular type of construction in which the doors are required.
- .4 Submit a sample of each proposed access door for review prior to ordering.

### **3.08 ELECTRICAL WORK IDENTIFICATION**

- .1 Identify all new/relocated electrical work in accordance with existing identification standards at the site.
- .2 Identify all electrical work, including conduit systems and wiring, as follows:
  - .1 the size and wording of identification nameplates must be approved by the Consultant
  - .2 identification wording for equipment is to follow drawing nomenclature unless otherwise specified
  - .3 secure nameplates to equipment with stainless steel screws unless such a practice is prohibitive, in which case use epoxy cement applied to cleaned surfaces
  - .4 locate nameplates in the most conspicuous and readable location

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- .5 for multi-cell or multiple component equipment provide a main nameplate and a smaller nameplate for each cell or component
  - .6 where electrical work is to be identified in conjunction with mechanical work, coordinate with the mechanical trades to ensure identical tagging
  - .7 all identification wording is to be in English
  - .8 all identification and colour coding is to be indicated on "as-built" record drawings
  - .2 **Terminal Cabinets, Pull Boxes, Junction Boxes, Etc.:** Clearly identify terminal cabinets, main pull and junction boxes by neatly spray painting the outside surface of the cover with a paint colour as specified below for conduit and conductor identification. Provide a nameplate on terminal boxes, main pull and junction boxes in communication systems specified in Division 27.
  - .3 **Transformers:** Transformer nameplate must identify the transformer capacity as well as primary and secondary voltages.
  - .4 **Branch Circuit Panelboards:** Panelboard nameplates must identify the electrical source connected to the panelboard, each circuit breaker, and, neatly typed on the door directory card, the load connected to each breaker.
  - .5 **Motor Starters and Disconnect Switches:** Provide nameplates for each motor starter and disconnect located in a motor control centre or on a motor starter panel, and on each individually mounted starter and disconnect provided as part of the electrical work. Nameplates must also indicate the voltage and phase.
  - .6 **Luminaires On Emergency Circuits:** Identify all luminaires on emergency circuit by means of a 15 mm (½") diameter self-adhesive red label secured to the T-bar ceiling component adjacent to the luminaire, or if not in a T-bar ceiling, to the frame of the luminaire.
  - .7 **Lighting Switches & Receptacles:** Identify each lighting switch and each receptacle by means of a permanent self-adhesive label indicating the source panelboard and circuit number and secured to the device faceplate.
  - .8 **Communication Equipment/Systems:** Identify all "head end" equipment with nameplates and all "downstream" devices with self-adhesive labels indicating circuit numbers.
  - .9 **Warning Signs:** Provide appropriately worded warning signs secured in place with stainless steel hardware in locations as follows:
    - .1 on all doors into transformer vaults
    - .2 on all doors into high voltage switchgear rooms
    - .3 on all collector bus enclosures
    - .4 on pad mounted transformer enclosures

.5 wherever else required by Code

- .10 **Conduit & Armoured Cable:** Colour code conduit and armoured cable by means of 25 mm (1") wide primary colour plastic adhesive backed tape or neatly applied suitable paint with, where scheduled, a 20 mm (¾") wide auxiliary colour at all points where the conduit or cable penetrates a wall, ceiling, floor, at 6 m (20') intervals or at least once in each room or accessible ceiling space, at each access door location, and elsewhere at 15 m (45') intervals. Unless otherwise indicated/specified, colours are to be as follows:

Service	Primary Colour	Secondary Colour
up to 250 volts	yellow	
250 to & including 600 volts	yellow	green
above 600 volts to 5 kV	yellow	blue
above 5 kV to 28 kV	yellow	red
telephone	green	
fire alarm	red	
emergency voice	red	blue
security systems	red	yellow
other communication systems	green	
isolated power	orange	

- .11 **Wire & Cable Terminations:** Identify both end of wire and cable terminations with the same unique number. Where numbers are not indicated or specified, assign a number and record them.
- .12 **Buried Cable/Duct Runs:** Identify buried cable/duct runs under paved and landscaped areas with appropriate concrete markers, flush with grade at each change in direction, at least twice on runs less than 60 m (200') and on 60 m (200') centres on longer runs.
- .13 **Overhead Wiring Service Poles:** Unless otherwise indicated on the drawings identify poles with wording such as "HV#1". For wooden poles use 50 mm (2") high non-corrosive embossed aluminium pole markers. For concrete poles use non-corrosive metal plated secured to the pole with metal strapping.
- .14 **Health Care Patient Care Area Circuits:** For dedicated circuits provide identification as previously specified plus engraved "Dedicated Circuit" nameplates on the device faceplate, or provide faceplates with "Dedicated Circuit" engraved wording. For 20 ampere corridor housekeeping receptacles provide "20A Housekeeping" nameplates on the device faceplate.
- .15 **Distribution System Schematic Diagrams:** Prepare AutoCAD, coloured, 1200 mm x 900 mm (48" x 36") schematic diagrams of electrical distribution systems to identify all equipment and circuits. Install framed and glazed diagrams in electrical rooms housing the system equipment. Confirm location prior to installation. Include reduced size copies of the diagrams in each copy of the O & M Manuals.

**3.09 INSTALLATION OF TERMINAL BACKBOARDS**

- .1 Provide properly sized plywood backboards for wiring terminals in terminal cabinets and enclosures where shown/specified/required.

**3.10 GENERAL ELECTRICAL WORK TESTING**

- .1 Perform testing in accordance with the Electrical Work Testing Section, and, in addition, any tests required by governing Codes, Standards.

**3.11 BRANCH CIRCUIT BALANCING**

- .1 Connect all branch circuits to panelboards so as to balance the actual loads (wattage) to within 5%. If required, transpose branch circuits to achieve this requirement.
- .2 After the building is occupied and if requested by the Consultant, demonstrate that branch circuit balancing has been achieved.

**3.12 FINISH PAINTING OF ELECTRICAL WORK**

- .1 Finish paint exposed electrical work as specified and/or scheduled in accordance with requirements of the painting Section in Division 09.
- .2 Touch-up paint all damaged factory applied finishes on electrical work products.
- .3 Finish painting of exposed electrical work is specified in Division 09 and is part of the work of Division 09.

**3.13 SUPPLY OF MOTOR STARTERS AND ACCESSORIES**

- .1 Motor starters for mechanical equipment will be supplied as part of the mechanical work.

**3.14 ELECTRICAL WIRING WORK FOR MECHANICAL WORK**

- .1 Unless otherwise specified or indicated, the following electrical wiring work for mechanical equipment is to be done as part of the electrical work:
  - .1 "line" side power wiring to motor starters or disconnect switches in motor control centres and starters or disconnects on motor starter panels, and "load" side wiring from the starters or disconnects to the equipment
  - .2 mounting of individual starters, "line" side power wiring to individual wall mounted starters, and "load" side wiring from the starters to the equipment
  - .3 "line" side power wiring to pre-wired power and control panels and variable frequency drives, and "load" side power wiring from the panels and VFD's to the equipment
  - .4 provision of receptacles for plug-in equipment
  - .5 provision of disconnect switches for all motors that are in excess of 10 m (30') from the starter location, or that cannot be seen from the starter location, and all associated power wiring
  - .6 all motor starter interlocking in excess of 24 volts



- .7 wiring from motor winding thermistors in motors 30 HP and larger to motor starter contacts
- .8 provision of dedicated 120 volt, 15A-1P circuits terminated in junction boxes in mechanical equipment rooms for automatic control and building automation system wiring connections to be made as part of the automatic controls work
- .9 120 volt power connections to electrical receptacles integral with small ceiling exhaust fans, including wiring through light switches or speed controllers;
- .10 120 volt wiring connections to lighting fixture/switch combinations integral with air handling units
- .11 120 volt wiring connections to duplex receptacles integral with air handling unit control panels
- .2 Mechanical wiring work not listed above or specified herein or on the drawings will be done as part of the mechanical work in accordance with wiring requirements specified for the electrical work.

### 3.15 EQUIPMENT BASES AND SUPPORTS

- .1 **Concrete Housekeeping Pads:** Unless otherwise specified or required, set all floor mounted equipment on minimum 100 mm (4") high reinforced concrete housekeeping pads 200 mm (8") clear of the equipment on each side and end, or a minimum of 200 mm (8") from the centreline of equipment anchor bolts to the edge of the base, whichever is larger. Conform to the following requirements:
  - .1 supply dimensioned drawings and equipment base templates, and provide anchor bolts for proper setting and securing of equipment on pads
  - .2 place anchor bolts during the concrete pour and be responsible for all required levelling, alignment, and grouting of the equipment
  - .3 as a minimum, use wire mesh reinforcement, however, for pads for large heavy equipment, use reinforcement as per structural drawing details
- .2 **Structural Steel Stands/Supports:** For equipment not designed for base mounting, where required, provide welded, cleaned and prime coat painted structural steel stands or supports conforming to the following requirements:
  - .1 all stands and supports, except those for small equipment, are to be designed by a structural engineer registered in the jurisdiction of the work, and stamped and signed design drawings with calculations are to be submitted as shop drawings for review
  - .2 all steel stands are to be flange bolted to concrete housekeeping pads
  - .3 all stands and supports are to be seismically restrained in accordance with applicable requirements

### 3.16 CONCRETE WORK FOR EQUIPMENT BASES/PADS

- .1 Provide all poured concrete work, including reinforcing and formwork, required for electrical equipment bases/pads. Perform concrete work in accordance with requirements specified in Division



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- .2 Concrete is to be minimum 20,700 kPa ready-mix concrete in accordance with CAN/CSA- A23.1 and the Building Code.
- .3 Ensure that bases and pads are keyed into the structure to meet seismic restraint requirements.

### 3.17 EXCAVATION AND BACKFILL WORK

- .1 Do all excavation, backfill and related work required for your work. Perform such work in accordance with requirements of the Excavation and Backfill Section, except as modified by this Article. Obtain a copy of the soil test report and review during the bidding period.
- .2 Grade the bottom of trench excavations as required.
- .3 In firm, undisturbed soil, lay ducts, conduits, etc., directly on the soil, unless otherwise directed.
- .4 Unless otherwise specified, backfill trenches within the building with clean sharp sand in individual layers of maximum 150 mm (6") thickness compacted to a density of 100% Standard Proctor. Hand compact the first layers up to a compacted level of minimum 300 mm (12") above the top of the service. Hand or machine compact the balance up to grade.
- .5 Unless otherwise specified, backfill trenches outside the building (not under roads, parking lots or traffic areas), up to a compacted level of 450 mm (18") thick above the service, hand compacted to a density of 95% Standard Proctor, using granular "A" gravel. Backfill the balance in 150 mm (6") layers with approved excavated material, compacted to 95% Standard Proctor density.
- .6 Unless otherwise specified, backfill trenches outside the building under roads, parking lots or traffic areas with crushed stone or granular "A" gravel in layers not exceeding 150 mm (6") thickness, compacted to 100% Standard Proctor density up to grade level.
- .7 The location and inverts of existing underground site services shown on the drawings are based on available information and are assumed to be correct, however, prior to excavation, carefully check inverts and locations and report any serious discrepancy, and contact Utilities to accurately locate their services.
- .8 You will be held responsible for any damage done to existing underground services caused by neglect to determine and mark out the location of such services prior to excavation work commencing.
- .9 After the first lift of backfill has been compacted, mark the entire path of pipe using continuous 75 mm (3") wide detectable identified marking tape equal to SMS Ltd. D- UGMT.
- .10 Engage the services of an independent soils testing agency to test the final backfill compaction density of each backfilled location. Compact the backfill to the satisfaction of the testing agency and in accordance with the Specification. Submit a copy of the testing agency's report to the Consultant for review.

### 3.18 CUTTING, DRILLING, AND PATCHING

- .1 Do all cutting, drilling and patching of the existing building for the installation of your work.

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- Perform all cutting and drilling with proper tools and equipment. Confirm the exact location of cutting and drilling with the Consultant prior to commencing the cutting and/or drilling work.
- .2 Patch surfaces, where required, to exactly match existing finishes using tradesmen skilled in the particular trade or application worked on.
  - .3 Where new conduits, conductors, etc., pass through existing construction, core drill an opening. Size openings to leave 12 mm (½") clearance around the product involved.
  - .4 Prior to drilling or cutting an opening in poured concrete construction, determine the location, if any, of existing services concealed in the construction to be drilled or cut. X- ray or Ferro Scan Test the walls or slabs if required.
  - .5 You will be responsible for the repair of any damage to existing services, exposed or concealed, caused as a result of your cutting or drilling work.
  - .6 Where drilling is required in waterproof slabs, size the opening to permit snug and tight installation of a sleeve which is sized to leave 12 mm (½") clearance around the product involved. Provide a sleeve in the opening. Sleeves are to be Schedule 40 galvanized steel pipe with a flange at one end and a length to extend 100 mm (4") above the slab. Secure the flange to the underside of the slab and caulk the void between the sleeve and slab opening with proper non-hardening silicone base caulking compound to produce a water- tight installation.

### 3.19 PACKING AND SEALING CORE DRILLED OPENINGS

- .1 Pack and seal the void between the core drilled opening and the service insulation for the length of the opening as follows:
  - .1 **non-fire rated interior construction:** pack openings in non-fire rated interior construction with mineral wool and seal both ends of the opening with non-hardening silicone base caulking compound to produce a water-tight seal;
  - .2 **exterior walls above grade:** pack sleeves in exterior walls above grade with mineral wool and seal both ends of the sleeves water-tight with approved non- hardening silicone base caulking compound unless mechanical type seals have been specified;
  - .3 **exterior walls below grade:** seal sleeves in exterior walls below grade (and any other wall where water leakage may be a problem) with link type mechanical seals as specified below.

### 3.20 FLASHING FOR ELECTRICAL WORK PENETRATING THE ROOF

- .1 Do all required flashing work, including counter-flashing, for electrical work penetrating and/or set in the roof.
- .2 Perform flashing work in accordance with requirements of drawing details, and requirements specified in Division 07.

**3.21 CLEANING ELECTRICAL WORK**

- .1 Refer to cleaning requirements specified in Division 01.
- .2 Clean **all** electrical work prior to application for Substantial Performance of the work.

**3.22 MAINTAINING EQUIPMENT PRIOR TO ACCEPTANCE**

- .1 Maintain all equipment in accordance with the manufacturer's printed instructions prior to start-up, testing and commissioning.

**3.23 WASTE MANAGEMENT AND DISPOSAL**

- .1 Separate and recycle waste materials in accordance with requirements specified in Division 01.
- .2 Separate and recycle waste materials in accordance with requirements of Canadian Construction Association Standard Document CCA 81, A Best Practices Guide to Solid Waste Reduction.
- .3 Prepare a waste management and reduction plan and submit a copy for review prior to work commencing at the site.
- .4 Place materials defined as hazardous or toxic waste in designated containers.
- .5 Ensure emptied containers are sealed and stored safely for disposal.

**3.24 SEISMIC RESTRAINT ANCHOR POINTS FOR EQUIPMENT**

- .1 All electrical equipment requiring seismic restraint (see the electrical work Section entitled Seismic Control and Restraint) is to be complete with manufacturer designed and rated seismic restraint anchor points and attachments, certified by the equipment manufacturers, so that the equipment may be bolted down or restrained in the field.
- .2 The equipment to be restrained must be designed such that the strength and anchorage of the internal components of the equipment exceeds the force level used to restrain and anchor the equipment itself to the supporting structure.

**3.25 REQUIREMENTS FOR BARRIER-FREE ACCESS**

- .1 Include for all applicable requirements for barrier-free access to electrical devices in accordance with governing Codes and Regulations, whether shown on the drawings, specified, or not

**End of Section**

## **1 GENERAL**

### **1.01 APPLICATION**

- .1 This Section specifies seismic control and restraint requirements that are common to electrical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

### **1.02 SEISMIC CONSULTANT**

- .1 Retain and pay for the services of an experienced Seismic Consultant who is a registered professional engineer licensed in the area of the work and a member in good standing of a Professional Engineers Association in the area of the work.
- .2 The Seismic Consultant is to:
  - .1 determine the proper seismic hazard level, design, recommend, and review all proposed electrical work seismic restraint shop, placement and securing drawings, and sign and stamp all drawings prior to submittal for review as specified below
  - .2 supervise installation of all electrical work seismic restraint and, when work is complete, certify in writing that the seismic restraint work has been installed in accordance with signed, stamped and reviewed drawings
  - .3 prepare and submit to the Municipality and authorities having jurisdiction, on a form approved by the Municipality and authorities having jurisdiction, at the beginning of seismic restraint work and when the work is complete, original signed and sealed Letters of Assurance for the design, installation and field review of all seismic restraint work

### **1.03 SUBMITTALS**

- .1 **Shop Drawings/Product Data Sheets:** Obtain all required equipment information and submit manufacturer's shop drawings/product data sheets for all restraining devices and steel bases. Include placement data, and details of attachment to both the equipment and the structure meeting requirements of the forces involved. All product data sheets and drawings are to be signed and stamped by the Seismic Consultant referred to above.
- .2 **Seismic Consultant's/Seismic Control Product Manufacturer's Certification Letters:** Submit copies of the Seismic Consultant's Letters of Assurance as specified above. Submit copies of the Seismic Consultant and seismic control manufacturer's certification letters as specified in Part 3 of this Section.
- .3 **Samples:** If requested, submit samples of seismic restraint materials for review.

## **1.04 QUALITY ASSURANCE**

- .1 Seismic restraints are to be designed by a Seismic Consultant as specified above, and are to be installed by qualified tradesmen under the supervision of and to the approval of the Seismic Consultant.
- .2 Unless otherwise specified seismic control and restraints are to be designed in accordance with
  - .1 National Building Code of Canada
  - .2 CAN/CSA-S832, Seismic Risk Reduction of Operational and Functional Components (OFC's) of Buildings
  - .3 local Code requirements
- .3 All restraint products must be tested in an independent testing laboratory, or certified by the Vibration Isolation and Seismic Control Manufacturer's Association and Seismic Consultant, to confirm that the restraint products meet all requirements of this Section, i.e. dynamic ultimate limit load state as required by the Code, "Fail Safe" design, etc. If particular tests are carried out to represent a restraint type, the test is to be valid for the full load range of the restraint. Submit such tests or certification when requested.
- .4 Seismic control and restraint product manufacturers are to provide all required assistance during the installation, and, when the installation is complete, submit written reports from the manufactures listing any deficiencies to the installation.

## **2 PRODUCTS**

### **2.01 GENERAL**

- .1 Isolation, anchors, bolts, bases, restraints, etc., are to be designed to withstand without failure or yielding, the dynamic G load as specified in the Code for the seismic zone in which the building is located. Design loads are ultimate limit state loads (1.5 times working load) acting through the centre of gravity of the anchored or restrained equipment. "Fail Safe" designs are acceptable.
- .2 For both isolated and non-isolated floor mounted equipment, design and provide anchors and bolts to withstand, without failure or yielding, a dynamic ultimate limit state load as defined in the Code, of the greater of 0.3 g or as required by the Code, applied horizontally through the centre of gravity.
- .3 Where impact forces may be significant, use ductile materials.
- .4 Seismic restraining devices which are factory supplied with equipment are to meet all requirements of this Section.

### **2.02 ACCEPTABLE MANUFACTURERS OR APPROVED EQUIVALENT.**

- .1 Acceptable seismic restraint product manufacturers are:
  - .1 Mason Industries Inc.

.2 Kinetics Noise Control

.3 Vibro-Acoustics Ltd.

.4 The VCM Group

### **2.03 SLACK CABLE RESTRAINTS**

- .1 Galvanized steel aircraft cable slack cable restraints meeting all current requirements of the Building Code, sized to suit the application and complete with all required cable ties, anchor hardware (selected for a load equal to twice the weight of the equipment), and similar connection accessories.

### **2.04 ANCHOR BOLTS**

- .1 Equal to Mason Industries type SAB seismic anchor bolts.

## **3 EXECUTION**

### **3.01 INSTALLATION OF SEISMIC RESTRAINT MATERIALS**

- .1 Provide seismic restraint for all electrical equipment, conduit, raceways, lighting fixtures, etc., as per the requirements of the current edition of the Building Code and this Section of the Specification.
- .2 Provide structural steel bases for all equipment unless the equipment manufacturer certifies direct attachment capabilities.
- .3 Space restraints under equipment so that the minimum distance between adjacent corner restraints is at least equal to the height of the centre of gravity of the equipment. Include the height of the centre of gravity on shop drawings, otherwise, design for increased forces on the supports and submit design calculations with shop drawings.
- .4 Floor mounted isolated equipment is to be installed on concrete housekeeping pads (design and thickness as selected by the Seismic Consultant) with at least 200 mm (8") clearance between drilled inserts and the edges of the pads. Ensure that all housekeeping pads are keyed to the structure to resist seismic displacement.
- .5 Requirements pertaining to seismic control work are as follows:
  - .1 execute seismic control and restraint work in accordance with drawing details and reviewed product data and shop drawings
  - .2 seismic control systems are to work in all directions
  - .3 fasteners and attachment points are to resist the same maximum load as the seismic restraint
  - .4 drilled or power driven anchors and fasteners are not permitted
  - .5 no equipment, equipment supports or mounts are to fail before failure of the structure
  - .6 seismic control measures are not to interfere with the integrity of firestopping

- .7 all equipment is to be bolted to the structure, and all bolts are to fitted with isolation washers
- .8 the number, size, type, and installation of anchor bolts are to be as recommended by the anchor bolt manufacturer and the Seismic Design Consultant
- .9 where more than a 3 mm (1/8") differential exists between an anchor or attachment bolt diameter, an anchor and attachment point hole, or an isolator gap attachment bolt and equipment anchor attachment hole, pack the air gap with Mason type 0.5 FastSteel reinforced epoxy putty
- .10 all hung equipment and hangers are to be fitted with a means of preventing upward movement, and non-isolated equipment and hanger rods are to be fitted with oversized steel washers and nuts above and below the hanger or equipment attachment point, locked tight to prevent uplift of the equipment or hanger
- .11 where suspended equipment hanger rod length exceeds 50 rod diameters between the structure and the equipment attachment point, reinforce the rods with angle iron to prevent bending due to uplift forces
- .12 seismic control measures are not to jeopardize noise and vibration isolation systems, and 6 mm (¼") to 9 mm (3/8") clearance during normal operation of equipment and systems is to be provided between seismic restraint and equipment
- .13 where hold-down bolts for seismic restraint equipment penetrate roofing membranes coordinate with roofing trade for installation of pitch pockets/"gum cups" and sealing compound to maintain the water-tight integrity of the roof
- .14 where friction type clamps are used for support of equipment and connecting services, secure clamps to steel work by means of welding or other positive means to prevent slippage or loosening of the clamps due to seismic force

### **3.02 SITE INSPECTION AND LETTERS OF CERTIFICATION**

- .1 When all seismic control products have been installed, arrange for the seismic control product manufacturer and Seismic Consultant to examine the installation of all seismic control products and to certify in writing (separate letters) that the products have been properly installed in accordance with governing Codes and Regulations, and recommendations and instructions. The Seismic Consultant is to apply his signed and dated professional stamp to the letter.

**End of Section**

## **1 GENERAL**

### **1.01 APPLICATION**

- .1 This Section specifies fire stopping and smoke seal requirements that are common to electrical work Sections of the Specification and it is a supplement to each Section and is to be read accordingly.

### **1.02 SUBMITTALS**

- .1 **Firestop & Smoke Seal System Samples:** At least four weeks prior to work commencing, submit a sample of each type of firestop and smoke seal system in applied form, for approval. Identify each system with the manufacturer's name and type, the ULC designation, and the proposed use. When the samples are approved, all work is to conform to the approved samples.
- .2 **Product Data & WHMIS Sheets:** Submit a product data sheet and a WHMIS sheet for each firestopping and smoke seal product.
- .3 **Name & Experience of Proposed Applicator:** Submit for approval the full company name and experience of the proposed firestopping and smoke seal system applicator.
- .4 **Letter of Certification:** Submit a letter of proper firestopping and smoke seal certification as specified in Part 3 of this Section.

### **1.03 QUALITY ASSURANCE**

- .1 **Applicator:** The applicator is to have a minimum of three years of successful experience on projects of similar size and complexity, and is to be approved by the Consultant.
- .2 **Environment Conditions:** Comply with the firestopping and smoke seal product manufacturer's recommendations regarding suitable environment conditions for product installation.

## **2 PRODUCTS**

### **2.01 FIRESTOPPING AND SMOKE SEAL SYSTEM MATERIALS**

- .1 Asbestos-free elastomeric materials tested, listed and labelled by ULC in accordance with CAN4-S115, Standard Method of Fire Tests of Firestop Systems and CAN/ULC-S101, Standard Method of Fire Endurance Tests of Building Construction and Materials for installation in ULC designated firestopping and smoke seal systems to provide a positive fire, water and smoke seal, and a fire-resistance rating (flame, hose stream and temperature) not less than the fire resistance rating of surrounding fire rated construction.
- .2 Materials are to be compatible with abutting dissimilar materials and finishes and complete with primers, damming and back-up materials, supports, and anchoring devices in accordance with the firestopping manufacturer's recommendations and the ULC tested assembly.

### **2.02 ACCEPTABLE MANUFACTURERS**

- .1 Acceptable firestop and smoke seal manufacturers are as specified in front end documents, or:



- .1 A/D Fire Protection Systems "FIREBARRIER"
- .2 Tremco Inc. Fire Protection Systems Group "TREMstop"
- .3 3M Canada "Fire Barrier"
- .4 Hilti (Canada) Ltd. Firestop Systems
- .5 Approved Equivalent

### **3 EXECUTION**

#### **3.01 INSTALLATION OF FIRESTOPPING AND SMOKE SEAL MATERIALS**

- .1 Where electrical work penetrates fire rated construction, provide ULC listed and labelled firestopping and smoke seal materials installed in accordance with requirements of CAN4- S115 (ratings F, FT, FH, and FTH as required), CAN/ULC-S101, and all other governing authorities to seal the penetrations.
- .2 **Preparation:** Abide by the following requirements:
  - .1 examine substrates, openings, voids, adjoining construction and conditions under which the firestop and smoke seal system is to be installed, and confirm compatibility of surfaces
  - .2 verify penetrating items are securely fixed and properly located with the proper space allowance between penetrations and surfaces of openings
  - .3 report any unsuitable or unsatisfactory conditions to the Contractor and Consultant in writing, prior to commencement of work, and note that commencement of work will mean acceptance of conditions and surfaces
  - .4 mask where necessary to avoid spillage and over coating onto adjoining surfaces, and remove stains on adjacent surfaces
- .3 **Application:** Conform to the following application requirements:
  - .1 use an experienced applicator approved by the manufacturer of the firestopping material manufacturer
  - .2 prime substrates in accordance with the product manufacturer's written instructions
  - .3 provide temporary forming as required and remove only after materials have gained sufficient strength and after initial curing
  - .4 tool or trowel exposed surfaces to a neat, smooth, consistent finish
  - .5 remove excess compound promptly as work progresses and upon completion
  - .6 at all cable transit locations, seal the perimeter of the angle iron framing on both sides of the wall or slab with ULC listed and labelled sealant materials to provide a positive smoke seal

- .4 **Inspection:** Notify the Consultant when the work is complete and ready for inspection, and prior to concealing or enclosing firestopping and smoke seal materials and service penetration assemblies. Arrange for final inspection of the work by the Municipal Building Inspector prior to concealing or enclosing work. Make any corrections required.
- .5 **Certification:** On completion of the firestopping and smoke sealing installation submit a letter of assurance to the Consultant certifying that the firestopping and smoke sealing installation has been carried out throughout the building to all electrical service penetrations and that the installation has been done in strict accordance with the requirements of the Provincial Building Code, any applicable local Municipal Codes, ULC requirements, and the manufacturer's instructions.

**End of Section**

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## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Test Reports:** Submit signed test reports for all testing work specified.
- .2 **Approval Certificates:** Submit Certificates of Approval as issued by governing authorities.
- .3 **Electrical Distribution System Coordination Study:** Submit copies of the electrical distribution system protective device coordination study specified in Part 3 of this Section, prior to energizing the electrical distribution equipment.

## **2 PRODUCTS**

**NOT APPLICABLE**

## **3 EXECUTION**

### **3.01 GENERAL ELECTRICAL WORK TESTING REQUIREMENTS**

- .1 Satisfactorily perform all testing required by governing authorities, Codes, Regulation and the Specification, including general testing specified below. Prepare and sign test reports to confirm satisfactory completion of testing and submit as specified in Part 1 of this Section.
- .2 Perform testing to suit phasing of the work, as applicable.
- .3 **Leaks, Grounds, and Crosses:** After luminaries, switches, receptacles, motors, signals, and similar equipment has been installed, whether or not the work has been installed as part of the work of this Division of the Specification or by other Divisions (telephone system excepted), test the work to ensure that there are no leaks, grounds, or crosses.
- .4 **Motor Operation:** Test and establish proper motor rotation, measure full load running currents, and check overload elements. Report to the Consultant any discrepancies that are found. Existing motors that have been disconnected and reconnected as part of the electrical work must be checked with rotation meter, and be responsible for any damage caused by reverse rotation.
- .5 **Branch Circuit Voltage Drop:** Demonstrate to the Consultant that branch circuit voltage drop is within specified limits.

### **3.02 GROUNDING AND BONDING SYSTEM**

- .1 Provide visual and mechanical inspection of the grounding and bonding system and verify that the system is in compliance with all requirements.

### **3.03 DISTRIBUTION SYSTEM TESTING AND COORDINATION STUDY**

- .1 The electrical distribution system protective devices have been selected such that protection is adequate and proper coordination is possible, however, since differences do exist between manufacturers of equipment, some changes in trip ratings or relay settings may be necessary and are to be performed as part of the work, prior to energizing the electrical distribution system.

To determine the above, a testing and coordination study of the electrical distribution system equipment is to be performed by one of the following companies:

- .1 G.T. Wood Co. Ltd.
  - .2 Brosz and Associates Ltd.
  - .3 Rondar Inc.
  - .4 Haronitis & Associates Ltd.
  - .5 Enkompass
  - .6 Approved equivalent company with experience in testing and coordination of the electrical distribution system.
- .2 Conform to requirements of CAN/CSA Z32, Electrical Safety and Essential Systems in Health Care Facilities.
- .3 **Short Circuit and Coordination Study:** Immediately upon notification of award of Contract, arrange for the testing company to perform the following:
- .1 cooperate with and obtain from manufacturers of the distribution system equipment a list of equipments requiring protective devices to be used, and along with the manufacturers, ensure that proper control and protective devices are selected such that they can be properly coordinated
  - .2 prepare, as soon as possible, a set of coordination curves on proper time current characteristic graph paper and submit to the Consultant, accompanied by supporting symmetrical as well as asymmetrical fault current calculation data with tabulations to very protection of the various distribution system elements under maximum and minimum fault conditions at the various points in the system
  - .3 plot the time current characteristic curves for the following:
    - .1 main and feeder protective devices at voltage levels used in the distribution system
    - .2 protective devices associated with the largest motor in each motor control centre, the refrigeration machine compressors (as applicable), and the largest lead fed from each distribution panelboard
    - .3 emergency power engine generator set protective devices, damage curves, and current decrement curves
    - .4 where relays, breakers, etc., do not perform to approved coordination curves they are to be revised at no cost as part of the work
  - .4 Review the existing distribution equipment and, where possible, obtain the existing distribution system coordination study to determine the best coordination between the existing and new equipment. If an existing coordination study is not available, survey the existing equipment and prepare calculations of proper coordination between the new and existing equipment. Where

- 
- defective or incorrectly applied relays or breakers are found, clearly identify the problem on curves submitted with the report and suggest a recommended course of action.
- .5 The on-site test and coordination study of distribution system protective devices is to include, as applicable:
- .1 testing, cleaning when necessary, and calibrating relays and circuit breaker trip devices (calibration) of protective devices is to conform to requirements of approved coordination (curves).
  - .2 a function test of associated control device
  - .3 replacement of any fuses destroyed during tests
  - .4 an acceptance test in the presence of and to the satisfaction of the Consultant
  - .5 the presence at the site, for the length of time required, of qualified equipment manufacturer's representatives
  - .6 an insulation resistance test of "load" side feeders with respect to ground
  - .7 testing of motor control centres, motor starters, and where supplied as part of the electrical work, viable speed drives
  - .8 witnessing EMI testing and signing test reports as verification of result
- .6 **Arc Flash Hazard Analysis:** Perform an arc hazard analysis and prepare and submit a report with calculations to determine the flash protection boundary and the incident energy at locations in the electrical distribution system (switchboards, switchgear, motor control centres, distribution panelboards, bus duct, splitters), and other equipment where work could be performed on energized equipment. Include significant locations in systems fed from transformers 125 kVa and greater, and specify safe working distances for calculated fault locations based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm<sup>2</sup>. Provide minimum 90 mm x 125 mm (3½" x 5") thermal transfer type high adhesion polyester warning labels at each work location and piece of equipment analyzed. Labels are to have an orange header with machine printed wording warning, ARC FLASH HAZARD, and the following information:
- .1 nominal voltage
  - .2 flash protection boundary
  - .3 hazard risk category
  - .4 incident energy
  - .5 working distance

**End of Section**

## **1 GENERAL**

### **1.01 APPLICATION**

- .1 This Section specifies mounting height requirements that are common to electrical work Sections of the Specification, and it is a supplement to each Section and is to be read accordingly.
- .2 Reference 26 05 00 – ELECTRICAL WORK GENERAL INSTRUCTIONS

## **2 PRODUCTS**

### **2.01 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting heights of equipment are not specified or indicated, verify with the Consultant prior to rough-in and installation.
- .3 Unless indicated otherwise on the drawings or within the specifications, install electrical equipment at following heights;
  - .1 Local switches – no lower than 900mm and no higher than 1100mm
  - .2 Wall receptacles:
    - .1 General – 400mm (to bottom of receptacle)
    - .2 Above top of continuous baseboard heater – 200mm
    - .3 Above top of counters or counter splash backs – 175mm
    - .4 In mechanical rooms – 1000mm
    - .5 In equipment storage rooms – 1000mm
  - .3 Panelboards – 2000mm to top of panel and as required by Electrical Safety Code
  - .4 Telephone and interphone outlets – 400mm (to bottom of receptacle)
  - .5 Wall mounted telephone and interphone outlets – no lower than 900mm and no higher than 1100mm
  - .6 Thermostats – 1200mm to the point of controls
  - .7 Fire Alarm stations – 1200mm to the top of point of operating action
  - .8 Wall Mounted Fire Alarm Audible Devices – 2300mm
  - .9 Television outlets not mounted behind a wall mounted television – 400mm (to bottom of receptacle)
  - .10 Wall mounted speakers – 2100mm
  - .11 Clocks – 2100mm
  - .12 Handicap pushbuttons – no lower than 900mm and no higher than 1100 mm

.13 Wall mounted Exit Signs

- .1 For ceilings up to 2500mm height – 2100mm
- .2 For all ceilings greater than 2500mm – 2400mm

.14 Wall mounted Battery Packs and Emergency Heads

- .1 For ceiling up to 2500mm height – 2100mm
- .2 For all ceilings greater than 2500mm – 2400mm

.15 Wall mounted occupancy sensors – no lower than 900mm and no higher than 1100mm

.16 Wall mounted visible signal devices – entire lens shall be no less than 2000mm and no more than 2400mm

Note: In all applications the visible signal device shall be located to provide optimal viewing by the occupants. There may be applications where mounting heights outside of the range described would be more suitable and should be reviewed based on space layout and brought up to Engineer as construction progresses.

.17 Top of remote annunciator and passive graphic panels shall be no more than 1800mm above finished floor

**3 EXECUTION**

**3.01 NOT USED**

**End of Section**

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## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for all products specified in this Section. Indicate compatibilities and limitations, and application instructions.
- .2 **Samples:** If requested, submit identified conductor samples.
- .3 **MSDS Sheets:** Submit Material Safety Data Sheets for conductor pulling lubricants.
- .4 **Type "MI" Cable Certifications:** Submit a minimum of four copies of a letter from the cable manufacturer certifying proper cable installation and successful testing as specified in Part 3 of this Section, and include cable test sheets.

## **2 PRODUCTS**

### **2.01 DISTRIBUTION AND BRANCH CIRCUIT CONDUCTORS**

- .1 Conductors to and including No. 10 AWG are to be solid. Conductors larger than No. 10 AWG are to be stranded. All conductors are to be constructed from 98% conductive copper and are to be approved for 600 volts. Conductors are to be colour coded, factory identified on the insulation with the manufacturer's name, conductor size and metal, voltage rating, and CSA type and designation. Conductors are to be as follows:
  - .1 "T-90 Nylon" single conductor in accordance with CSA C22.2 No. 75, Thermoplastic- Insulated Wires and Cables, 90° C (195° F) rated, PVC insulated and nylon covered
  - .2 "RW-90" single conductor in accordance with CAN/CSA C22.2 No. 38, Thermoset- Insulated Wires and Cable, 90° C (195° F) rated, X-link polyethylene insulated
  - .3 "TWU" single conductor in accordance with CSA C22.2 No. 75, -40° C (-40° F) rated, PVC insulated
  - .4 "AC90" flexible cable to CSA C22.2 No. 51, Armoured Cable, with 90° C (195° F) rated, X-linked polyethylene insulated conductors, a concentric ground conductor, and an interlocking aluminium armour jacket
  - .5 "A90 ISO-BX" flexible cable to CSA C22.2 No. 51, Armoured Cable, with 90° C (195° F) rated, X-linked polyethylene insulated conductors, a concentric bare ground conductor, an insulated ground conductor, and an interlocking aluminium armour jacket
  - .6 equal to Nexans Canada "Corflex" II" RA90 flexible cable in accordance with requirements of CSA C22.2 No. 123, Aluminium Sheathed Cable, consisting of single or multiple copper conductors with X-link polyethylene insulation enclosed in a liquid and vapour-tight solid corrugated aluminium sheath and, as required, an overall PVC jacket



- .7 equal to Nexans Canada "Firex II" TECK 90 cable in accordance with requirements of CSA C22.2 No. 131, Type TECK 90 Cable, consisting of single or multiple copper conductors with X-link polyethylene insulation enclosed in a liquid and vapour-tight solid corrugated aluminium sheath and, where required, an overall PV C jacket

## **2.02 LOW VOLTAGE (24 VOLT) CONDUCTORS**

- .1 "T-90" or "RW90" stranded copper conductors as specified above.
- .2 Equal to Nexans Canada "Securex II" FAS/LVT/FT1300 volt wire to CSA C22.2 No. 208, Fire /Alarm and Signal Wire, 105° C (220° F) rated, consisting of solid copper conductors (stranded for control wiring), flame retardant PVC insulation, an aluminium/Mylar optional shield with a #22 AWG tinned copper insulation and a drain wire, and, if required for the application, interlocking aluminium armour with or without an overall jacket.

## **2.03 CONNECTORS**

- .1 **Conductors In Conduit:** Except as noted, equal to Ideal Industries Inc. "Wing Nut" CSA certified, 60 volt rated pressure type twist connectors.
- .2 **Conductors 3/0 AWG and Larger:** Long barrel, double crimp, compression type lug connectors, unless otherwise specified.
- .3 **Armoured Cable:** Except as noted, proper squeeze type connectors and plastic anti- short bushings at terminations in accordance with requirements of CSA C22.2 No. 18.3, Conduit, Tubing and Cable Fittings.
- .4 **Mineral Insulated Conductors:** Tyco/Pyrotenax "Pyropak" connectors, complete with brass plates with drilled and tapped mounting holes for connections to ferrous cabinets or approved equivalent.
- .5 **Corflex/Teck Cable:** Connector and termination hardware supplied by the cable manufacturer to suit the application.

## **2.04 CONDUCTOR PULLING LUBRICANT**

- .1 Equal to Ideal Industries Inc. "Yellow 77" or "ClearGlide", as required.
- .2 French Chalk or Talcum Powder conductor pulling lubricant.

## **3 EXECUTION**

### **3.01 Conform to the following conductor installation requirements:**

- .1 **Conductor Routing:** Conductor routing indicated on the drawings is schematic and approximate. Determine exact routing and conductor lengths at the site. Route conductors to avoid interference with other work. Unless otherwise specified or shown install conductors parallel to building lines.
- .2 **Conductor Pulling:** When pulling conductors into conduit use lubricant and ensure that the

conductors are kept straight and are not twisted. For isolated power centre “load” side power wiring, use only French Chalk pulling lubricant.

**.3 Securing/Supporting Conductors:** Conform to the following requirements:

- .1 neatly secure exposed conductors in equipment enclosures with proper supports and/or ties
- .2 support flexible armoured cable in ceiling spaces and stud walls with steel two-hole cable straps to Code requirements

**.4 Conductor Splicing:** Generally, conductor splicing is not permitted unless otherwise approved by the Consultant, and if approved splicing is subject to the following conditions:

- .1 splicing is permitted to extend existing conductors
- .2 for thermoplastic insulated conductors, splices are to be made within an approved electrical box with mechanical compression connectors to suit the type and size of conductors, and the box(es) are to be properly identified and locations are to be indicated on “as-built” drawings
- .3 do not splice mineral insulated “MI” cable
- .4 do not splice “Corflex” cable unless justified by cable pulling tension calculations and when approved by the Consultant, and, if approved, locate splices where directed by the Consultant

### 3.02 INSTALLATION OF DISTRIBUTION AND BRANCH CIRCUIT CONDUCTORS

**.1** Provide all required conductors.

**.2 Non-Fire Rated Conductors:** Unless otherwise specified herein or on the drawings, non- fired rated conductors are to be used as follows:

- .1 conductors underground inside or outside the building, and in non-climate controlled areas – **TWU**
- .2 unless otherwise specified, conductors in accessible ceiling spaces, within stud wall construction, and in furniture systems to luminaries and wiring devices – **AC90 (BX) flexible armoured cable, maximum 6 m (20') run permitted**
- .3 for isolated power system wiring – **RW90**
- .4 for conductors in medical headwalls and service consoles, and as per drawing details – **T90 Nylon or RW90 in flexible conduit, or AC90 ISO-BX to Code requirements**
- .5 for conductors except as specified above or elsewhere in the Specification or on the drawings – **T90 Nylon or RW90**

**.3 “Corflex” or approved equivalent Cable Installation Requirements:** Install “Corflex” cable in accordance with the manufacturer’s instructions, including the following requirements:

- .1 support and secure overhead suspended “Corflex” cable on a system of cable tray where indicated

- 
- .2 secure individual cables to cable tray, or where shown, directly to building surfaces by means of single screw non-ferrous clamps
  - .3 ground and bond single conductor cable at both ends where the sheath currents do not affect the cable ampacity
  - .4 for certain areas, where the sheath currents will reduce the cable ampacity, ground and bond the cable at the supply end and isolate the cable at the load end as recommended by the cable manufacturer, and provide a No. 3/0 AWG green TW ground conductor for each cable, all as per Section No. 10 of the Ontario Electrical Safety Code
- .4 **“Teck” Cable Installation Requirements:** Install “Teck” cable in accordance with the manufacturer’s instructions, including the following requirements:
- .1 support and secure overhead suspended “Teck” cable tray where indicated
  - .2 secure individual cables to cable tray or, where shown, directly to building surfaces by means of single screw non-ferrous clamps
  - .3 terminate cable with lugs and termination kits supplied with the cable
- .5 **Conductor Sizing:** Generally, conductor sizes are indicated on the drawings. Unless otherwise specified, do not use conductors smaller than No. 12 AWG in systems over 30 volts. Unless otherwise specified, do not use conductors smaller than No.6 AWG for exterior luminaire wiring. Conductor sizes indicated on the drawings are minimum sizes and must be increased, where required, to suit length of run and voltage drop in accordance with the voltage drop schedule found at the end of this Section.
- .6 **Conductor Colour Coding:** Unless otherwise specified, colour code conductors to identify phases, neutral, and ground by means of self-laminating coloured vinyl tape, coloured conductor insulation, or properly coloured plastic discs. Colours are to be as follows:
- .1 phase A – red
  - .2 phase B – black
  - .3 phase C – blue
  - .4 neutral – white
  - .5 control – orange
- .7 **Communication System Colour Coding:** Unless otherwise specified, colour code conductors for communication systems in accordance with the system manufacturer’s recommendations.

**MAX. BRANCH WIRING DISTANCE FOR 120 VOLT SYSTEM AT 2% VOLTAGE DROP**

Wire Size	Breaker Size (AMPERES)	15	20	30	40	50	60	70	80	100
	MAX LOAD AT 80% (AMPERES)	12	16	24	32	40	48	56	68	80
No 12.	-----	16.8	12.2	-----	-----	-----	-----	-----	-----	-----
No 10	-----	25.9	19.0	-----	-----	-----	-----	-----	-----	-----
No. 8	-----	39.6	30.4	12.9	-----	-----	-----	-----	-----	-----
No. 6	-----	62.4	47.2	32.0	23.6	19.0	16.0	-----	-----	-----
No.4	-----	99.0	73.1	50.2	38.1	30.4	24.3	21.3	19.0	-----
No. 2	-----	-----	114.3	77.2	57.9	47.2	38.8	33.5	28.9	22.8
No. 1	-----	-----	-----	96.0	73.1	57.9	47.2	42.6	36.5	27.4
No.1/0	-----	-----	-----	-----	85.3	68.5	56.3	48.7	41.9	33.5
No. 2//0	-----	-----	-----	-----	102.8	80.7	67.0	57.9	50.2	40.3
No. 3/0	-----	-----	-----	-----	-----	95.2	79.2	68.5	59.4	47.2
No. 4/0	-----	-----	-----	-----	-----	-----	92.9	79.2	70.1	56.3
250 MCM	-----	-----	-----	-----	-----	-----	102.8	86.8	76.2	60.9
300 MCM	-----	-----	-----	-----	-----	-----	-----	100.5	88.3	70.1

NOTE: DISTANCES INDICATED IN METRES FROM PANEL TO LOAD FOR SINGLE PHASE

**MAX. BRANCH WIRING DISTANCE FOR 120 VOLT SYSTEM AT 3% VOLTAGE DROP**

Wire Size	Breaker Size (AMPERES)	15	20	30	40	50	60	70	80	100
	MAX LOAD AT 80% (AMPERES)	12	16	24	32	40	48	56	68	80
No 12.	-----	24.4	18.3	-----	-----	-----	-----	-----	-----	-----
No 10	-----	38.1	29.0	19.1	-----	-----	-----	-----	-----	-----
No. 8	-----	59.4	44.2	30.5	22.9	-----	-----	-----	-----	-----
No. 6	-----	91.4	70.1	47.2	35.1	28.2	23.6	-----	-----	-----
No.4	-----	-----	109.7	73.2	54.9	42.7	38.1	32.0	27.4	-----
No. 2	-----	-----	-----	114.3	85.3	68.6	57.9	50.3	41.1	35.0
No. 1	-----	-----	-----	-----	103.6	85.3	73.2	61.0	54.9	43.4
No.1/0	-----	-----	-----	-----	128.0	102.9	85.3	73.2	64.0	48.8
No. 2//0	-----	-----	-----	-----	-----	122.9	100.6	86.9	74.7	60.9
No. 3/0	-----	-----	-----	-----	-----	-----	118.1	102.1	88.4	70.1
No. 4/0	-----	-----	-----	-----	-----	-----	-----	120.4	102.9	83.8
250 MCM	-----	-----	-----	-----	-----	-----	-----	-----	114.3	91.4
300 MCM	-----	-----	-----	-----	-----	-----	-----	-----	-----	103.6

NOTE: DISTANCES INDICATED IN METRES FROM PANEL TO LOAD FOR SINGLE PHASE

**End of Section**

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## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for all products specified in Part 2 of this Section except for copper wire/cable conductors.

### **1.02 QUALITY ASSURANCE**

- .1 Grounding and bonding work is to be in accordance with requirements of the following:
  - .1 CSA C22.2 No. 41, Grounding and Bonding Equipment (Tri-National Standard with UL 467)
  - .2 CSA C22.2 No. 0.4, Grounding and Bonding of Electrical Equipment
  - .3 requirements of the Electrical Safety Authority and any other governing authority
  - .4 CAN/CSA Z32, Electrical Safety and Essential Electrical Systems in Health Care Facilities

### **1.03 COORDINATION**

- .1 Coordinate the installation of grounding hardware and conductors associated with concrete with the trades providing the concrete work.

## **2 PRODUCTS**

### **2.01 GROUND RODS**

- .1 Copper clad solid steel round rods, 20 mm ( $\frac{3}{4}$ ") diameter, 3 m (10') long, each complete with driving cap, pointed bronze tip, and a #14 gauge hot dipped galvanized steel or PVC, 250 mm (10") diameter, 300 mm (12") long ground rod box with a vandal-proof removable identified cover.

### **2.02 GROUND PLATES**

- .1 Copper plates, 1 m<sup>2</sup> (11 ft.<sup>2</sup> surface area, 6 mm ( $\frac{1}{4}$ ") thick.

### **2.03 GROUND MAT**

- .1 Copper mesh gradient control mat, 1.5 m (5') square, 2 mm ( $\frac{3}{32}$ ") thick, 50 x 50 mesh.

### **2.04 GROUND BUS**

- .1 Solid electrical grade copper, minimum 50 mm x 6 mm (2" x  $\frac{1}{4}$ ), minimum 600 mm (24") long but with lengths as required (continuous lengths for health care and data centre projects), predrilled for two-hole lug connections, suitable for wall or backboard mounting and complete with corner angles, tamper-proof stainless steel hex head bolts, nuts, and spring lock washers, standoff insulators, and all connection hardware.

**2.05 FLEXIBLE GROUND BRAID**

- .1 Flat 98% conductivity tinned copper grounding braid with dimensions to suit the application.

**2.06 GROUND CONDUCTORS**

- .1 Unless otherwise specified and/or shown. Stranded un-tinned soft annealed copper wire, bare or green PVC insulated conforming to requirement of the Section entitled Wire and Box Connectors (0-1000volts).

**2.07 GROUNDING AND BONDING CONNECTIONS**

- .1 **Below Grade:** Equal to Erico International Corp. "CADWELD" exothermic welded connections.
- .2 **Above Grade:** Compression type connectors with zinc-plated fasteners and external tooth lock washers, or, if approved by the Consultant, exothermic Erico International Corp. "CADWELD" welded connections.

**2.08 COMMUNICATIONS, ACCESS CONTROL, & ELECTRONIC SAFETY SYSTEM GROUND BUS**

- .1 Solid electrical grade copper bus bars, minimum 6 mm x 20 mm ( $\frac{1}{4}$ " x  $\frac{3}{4}$ ") designed for mounting on the framework of open or cabinet enclosed equipment racks.

**2.09 LAN ROOM GROUND BUS**

- .1 Solid electrical Grade copper bus bars, 300 mm x 50 mm x 9 mm (12" x 2" x  $\frac{3}{8}$ ") with 8 drilled holes, suitable for wall mounting and equipped with standoff insulators.

**3 EXECUTION**

**3.01 GENERAL RE: GROUNDING AND BONDING**

- .1 Perform all required grounding and bonding work in accordance with the Contract Documents and requirements of governing Codes and Standards, including the Electrical Safety Authority.
- .2 Bond metallic conduits, boxes, cable tray, ducts, and non-current carrying metal parts of equipment together to form a continuous ground system. In electrical equipment rooms, solidly bond circuits, panelboards, conduits, equipment enclosures, and other equipment to perimeter ground bus using bronze connectors and hardware.
- .3 Protect exposed conductors from injury. Install underground conductors a minimum of 450 mm (18") below grade.
- .4 Use tinned copper conductors for aluminium structures.
- .5 Do not use bare copper conductors adjacent to un-jacketed lead sheath cables.

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### **3.02 GENERAL PRIMARY GROUNDING AND BONDING REQUIREMENTS**

- .1 Grounding and bonding work associated with primary electric service work is to be performed only by qualified journeyman electricians employed by the subcontractor doing the primary electric service work.
- .2 Provide a separate ground conductor in all PVC conduits.

### **3.03 INSTALLATION OF GROUND ROD GRIDS**

- .1 Construct ground rod grids consisting of copper clad steel ground rods as indicated/specified where indicated, each consisting of the number of rods shown, driven into the earth a minimum of 300 mm (12") below grade and terminated with a galvanized steel box enclosing the ground conductor clamp, and interconnected with minimum #3/0 AWG bare copper conductor. Flush with grade at each ground rod, provide an identification monument.

### **3.04 INSTALLATION OF PLATE ELECTRODE GRID**

- .1 Provide a plate electrode ground grid where indicated/specified.
- .2 Bury the plate electrode level a minimum of 765 mm (30") below grade and connect with minimum #3/0 AWG bare copper conductor. Flush with grade at each plate electrode, provide an identification monument.

### **3.05 INSTALLATION OF GROUND BUS**

- .1 Provide ground bus where shown/specified. Wall mount 300 mm (12") above finished floor level on standoff insulators and follow the outline of door frames and room corners using 90° bus angles to form continuous bus. Connect the ground bus to the ground rod grid by means of two minimum #3/0 copper conductors terminated with approved fittings.
- .2 Provide flexible braided copper ground straps from the ground bus to each steel door frame and door in the room, each securely bolted in place.
- .3 Tighten all bus bar joint connection bolts and lug using a torque wrench to the bus manufacturer's prescribed tension, then coat the bus with two 100% covering coats of shellac to prevent copper oxidization.

### **3.06 NEUTRAL GROUNDING**

- .1 Connect transformer neutral and distribution neutral together using 1000 volt insulated conductor to one side of a ground test link, the other side of the test link being connected directly to the main station ground. Ensure that distribution neutral and neutrals of potential transformers and service banks are bonded directly to the transformer neutral and not to the station ground.
- .2 Connect the neutral of the station transformer to the main neutral bus with a tap of the same size as the secondary neutral.



- .3 Ground the transformer tank with a continuous conductor from the tank ground lug through the connector on the ground bus to the primary neutral. Connect the neutral bushing at the transformer to the primary neutral in the same manner.

### **3.07 ELECTRICAL MANHOLE GROUNDING**

- .1 Provide a conveniently located ground stud, electrode, and ground conductor in each electrical manhole. Install the ground rod with the lug for the ground connection so that the top of the rod projects through the bottom of the manhole.

### **3.08 CABLE SHEATH GROUNDING**

- .1 Bond single conductor metallic sheathed cables together at one end only. Break the sheath continuity in an approved manner, and provide #6 AWG flexible copper ground conductor soldered (not clamped) to the cable sheath.

### **3.09 LOCAL AREA NETWORK (LAN) ROOM GROUNDING**

- .1 Provide minimum 3/0 AWG insulated copper ground conductors and wall mounted copper ground bus in each LAN Room. Connect the ground bus to computer equipment racks and to the building ground system.

### **3.10 TELECOMMUNICATIONS SYSTEMS GROUNDING**

- .1 Provide all required conductors and hardware to properly ground and bond communication system raceways, cable tray, metallic cable shields, and equipment to a ground source in accordance with requirements of TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

**End of Section**

**1 GENERAL**

**1.01 SUBMITTALS**

- .1 **Product Data:** If requested, submit product data sheets for products specified in this Section.
- .2 **Samples:** If requested, submit samples of products specified in this Section.

**2 PRODUCTS**

**2.01 SPLITTER TROUGH**

- .1 Formed #16 gauge steel Type 1 splitter trough in accordance with CSA C22.2 No. 76, Splitters, finished inside and outside with ANSI 61 gray heat cured powder epoxy paint, and complete with welded seams ground smooth, various size knockouts on each side, back mounting holes, removable doors with stainless steel hinges and hinge pins, terminal blocks for conductor connections, a single point ground lug
- .2 **Enclosures:** Unless otherwise specified, enclosures are to be in accordance with the following NEMA/EEMAC ratings:
  - .1 all enclosures located in sprinklered areas – Type 2
  - .2 all enclosures except as noted above – Type 1

**2.02 PULL BOXES AND JUNCTION BOXES**

- .1 Each box is to be CSA certified, sized to suit the number and size of conduit and conductors, and complete with connecting and securing facilities. Unless otherwise specified, pull boxes and junction boxes are to be as follows:
  - .1 galvanized or prime coat plated steel, suitable in all respects for the application and complete with screw-on or hinged covers as required and connectors suitable for the connected conduit
  - .2 “Condulet”, threaded galvanized cast iron or cast aluminium pull boxes and junction boxes of an exact type to suit the application, each complete with screw-on gasketed cover
  - .3 rigid plastic (PVC), junction boxes and access fittings with solvent weld type joints and screw-on PVC covers
  - .4 equal to Square D (Schneider Canada) Catalogue No. 970 cast bronze water-proof junction box for underwater lighting

### **3 EXECUTION**

#### **3.01 INSTALLATION OF SPLITTER TROUGH**

- .1 Provide all required splitter trough in accordance with drawing plans, schedules, details, and requirements of the Specification.
- .2 Rigidly secure that the splitter trough in place, level and plumb.
- .3 Ensure that the splitter trough itself, and all branch circuits are properly identified.

#### **3.02 INSTALLATION OF PULL BOXES AND JUNCTION BOXES**

- .1 Provide pull boxes in conduit systems wherever shown on the drawings, and/or wherever necessary to facilitate conductor installations. Generally, conduit runs exceeding 30 m (100') in length, or with more than three 90° bends, are to be equipped with a pull box installed at a convenient and suitable intermediate accessible location.
- .2 Provide junction boxes wherever required and/or indicated on the drawings.
- .3 Unless otherwise specified, boxes are to be as follows:
  - .1 in rigid conduit and EMT inside the building – stamped galvanized or prime coated steel
  - .2 in exterior rigid conduit – “Condulet” cast aluminium gasketed boxes unless otherwise noted
  - .3 in plastic conduit – rigid PVC boxes
  - .4 in bronze underwater conduit – cast bronze boxes
- .4 All pull boxes and junction boxes must be accessible after the work is complete.
- .5 Accurately locate and identify all concealed pull boxes and junction boxes on “as-built” record drawings.
- .6 Cover boxes in fire walls with aluminium tape and seal with caulking.

**End of Section**

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## GENERAL

### 1.01 SUBMITTALS

- .1 **Product Data:** If requested, submit product data sheets for products specified in this Section.
- .2 **Samples:** If requested, submit samples of products specified in this Section.

## 2 PRODUCTS

### 2.01 OUTLET BOXES

- .1 Each box is to be CSA certified, suitable in all respects for the application, and be complete with suitable securing lugs, connectors suitable for the connected conduit, knockouts, and, where necessary, suitable plaster rings, concrete rings, covers and any other required accessory. Unless otherwise specified, outlet boxes are to be as follows:
  - .1 stamped, electro-galvanized steel outlet boxes
  - .2 zinc coated cast malleable iron or cast aluminum "FS and "FD" boxes with threaded inlet/outlet hubs
  - .3 rigid PVC outlet boxes
  - .4 equal to Hubbell Canada Inc. UL/ULC or ETL or listed fully adjustable both vertical and angular, formed galvanized cast iron, round, rectangular, or square as required flush concrete floor boxes complete with adjustable collars and brass screw-on hinged flip-open cover with provisions for installation of duplex power receptacles, telephone data jacks, and, for boxes containing both power and communication system outlets, proper barriers are to be provided
  - .5 Hubbell or Legrand-Wiremold flush, fire rated "poke-through" box assemblies to suit the devices required, with gray, black or brass flanges and covers as selected by the Consultant.
  - .6 Approved equivalent.

## 3 EXECUTION

### 3.01 INSTALLATION OF OUTLET AND CONDUIT BOXES

- .1 Provide an outlet box or back box for each luminaire, wiring device, telephone outlet, fire alarm system component, communications systems components, and all other such outlets.
- .2 **Stamped Galvanized Steel:** Outlet boxes flush mounted in interior construction, surface mounted in concealed interior locations, and surface mounted in exposed interior locations where the connecting conduit is EMT are to be stamped galvanized steel outlet boxes unless otherwise noted.
- .3 **"FS" and "FD" Series Boxes:** Outlet boxes for surface mounted for exterior lighting, receptacles, and other device outlets, boxes flush mounted in exterior building surfaces, and boxes mounted in interior device locations where the connecting conduit is rigid, and for boxes in perimeter walls where insulation and vapour barrier is present, are to be "FS" or "FD" Series cast boxes unless otherwise noted, cast iron inside the building, cast aluminium outside the building.

**3.02 Rigid PVC Boxes In New Concrete Slabs:** Provide rigid PVC outlet boxes in locations as follows:

- .1 in underground polyethylene conduit systems
- .2 for devices connected to isolated power system panelboards
- .3 for rigid PVC conduit systems where permitted
- .5 **Flush Floor Boxes:** Provide water-tight flush floor boxes where shown, installed in accordance with the manufacturer's instructions, and ensure that the boxes are not dislodged during the concrete pour.
- .6 **Flush Floor Boxes In Existing Concrete Slabs:** Flush "poke-through" box assemblies installed in 75 mm (3") diameter core drilled openings and connected with conduit at the underside of the slab.
- .7 Outlet boxes for special wiring devices, for special equipment and special applications if required, are specified hereinafter in other Sections or on the drawings.
  - .8 The size and arrangement of outlet boxes are to suit the device which they serve.
- .9 Generally, mounting heights and locations for outlets are indicated on the drawings, however, confirm the exact location and arrangement of all outlets prior to roughing-in. Architectural drawings and the Consultant's instructions have precedence over electrical drawing diagrammatic layouts and specified mounting height and locations. In addition, abide by the following requirements:
  - .1 locate flush mounting boxes in masonry walls to require cutting of the masonry unit corner only, and coordinate masonry cutting to achieve a neat opening
  - .2 position outlet boxes to locate luminaires as shown on reflected ceiling plans
  - .3 coordinate mounting heights and locations of outlets mounted above counters, benches and backsplashes
- .10 Do not install outlet or back boxes "back-to-back" in walls and partitions. Stagger such outlets and seal against noise transmission with acoustic insulation. "Thru-wall" type boxes will not be permitted for any application.
- .11 Where boxes are multi-ganged or grouped together, mount boxes level and spaced consistently.
- .12 Temporarily pack all open boxes located in concrete and masonry to prevent debris from entering the box.
- .13 Include all costs for installed boxes that have not been covered by wall/ceiling finishes, to be relocated up to 1 m (3') to suit final device location coordination.

- .14 Provide blank coverplates over all boxes left empty for future installation of devices. Clearly identify each box as to its intended use to the Consultant's approval. Generally, blank overplates are to be stainless steel.

**End of Section**

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**1 GENERAL**

**1.01 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for all products where submittal is specified in Part 2 or Part 3 of this Section.
- .2 **Colour Coated EMT Colour Chart:** Submit the colour coated EMT manufacturer's standard colour chart for colour selection(s) by the Consultant.
- .3 **Drawing(s) of Conduit Locations/sizes In Structural Poured Concrete:** As specified in Part 3 of this Section, submit drawings to indicate the proposed location, size, and length of run for conduit proposed to be installed in structural poured concrete work.

**2 PRODUCTS**

**2.01 EMT**

- .1 Galvanized steel to CSA C22.2 No. 83, Electrical Metallic Tubing, complete with factory made bends where site bending is not possible, and joints and terminations made with steel couplings and set screw type connectors, concrete tight where required.

**2.02 RIGID GALVANIZED STEEL CONDUIT**

- .1 Rigid galvanized steel to CSA C22.2 No. 45, Rigid Metal Conduit, with an enamel interior coating, galvanized threads where factory threaded, red lead coated threads where site threaded, factory made bends where site bending is not possible, factory made threaded fittings and connectors, and terminations made with rigid couplings, concrete tight where required.

**2.03 FLEXIBLE GALVANIZED STEEL LIQUID-TIGHT CONDUIT**

- .1 Flexible galvanized steel liquid-tight conduit to CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, complete with Ideal Industries Inc. "Steel Tough" liquid-tight connectors at terminations or approved equivalent.

**2.04 FLEXIBLE GALVANIZED STEEL CONDUIT**

- .1 Galvanized steel flexible conduit to CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit, complete with proper and suitable squeeze type connectors at terminations.

**2.05 RIGID ALUMINUM CONDUIT**

- .1 Factory or site threaded rigid aluminium to CSA C22.2 No. 45, Rigid Metal Conduit, with bending, threading, fitting, coupling, etc., requirements as specified for rigid galvanized steel conduit.

## **2.06 RIGID PVC CONDUIT**

- .1 Rigid PVC conduit to CSA C22.2 No. 211.1, Rigid Types EB1 and DB2/ES2 PVC Conduit, FT-4 rated, complete with site made heat gun bends for conduit to and including 50 mm (2") diameter, factory made fittings for conduit larger than 50 mm (2") diameter, solvent weld joints, factory made expansion joints where required, and terminations made with proper and suitable connectors and adaptors.

## **2.07 FISH CORD**

- .1 Polyethylene or nylon fish cord/tape with cable pull accessories to suit the application.

## **3 EXECUTION**

### **3.01 GENERAL RE: INSTALLATION OF CONDUIT**

- .1 Refer to the article entitled General Conduit and Conductor Installation Requirements in the electrical work Section entitled Basic Electrical Materials and Requirements.
- .2 Ensure that all open empty conduit ends are properly protected against dirt and debris during the construction process.

### **3.02 CONDUIT INSTALLATION REQUIREMENTS**

- .1 Unless otherwise specified, provide conduit for all conductors except armoured cable, mineral insulated fire rated cable, and except where cable tray, cable duct, or a similar raceway is used.
- .2 **Conduit Types:** Conduit is to be as follows:
  - .1 for main distribution wiring in electrical rooms and similar areas – rigid galvanized steel
  - .2 for exposed conduit from floor level to 1.2 m (4") above the floor in mechanical and other service rooms – rigid galvanized steel
  - .3 for concealed conduit in exterior walls – rigid galvanized steel
  - .4 for explosion-proof wiring – rigid galvanized steel
  - .5 for conduit exposed outside the building, except where rigid PVC conduit is permitted – rigid galvanized steel
  - .6 for conduit associated with pool area outlets but not submerged in water – rigid galvanized steel
  - .7 as an alternative to rigid galvanized steel, except in poured concrete construction – rigid aluminium conduit
  - .8 for conduit in corrosive areas – epoxy coated rigid galvanized steel



- .9 for short (minimum 450 mm (18"), maximum 600 mm (24"), with a 180° loop wherever possible) runs of conduit to electric motors, distribution transformers, and vibration isolated equipment – flexible galvanized steel liquid-tight conduit
- .10 at points where exposed conduit crosses building expansion joints – flexible galvanized steel conduit
- .11 for branch circuit conductors underground inside the building, and underground outside the building beneath structures and concrete or asphalt paving – rigid PVC
- .12 for branch circuit conductors outside the building at roof level – rigid PVC
- .13 for branch circuit conductors in concrete slabs on grade, and in concrete and masonry walls except exterior walls - rigid PVC
- .14 for branch circuit conductors in concrete slabs above grade – flexible PVC
- .15 for underwater conduit – rigid bronze
- .17 for all conduit except as specified above – EMT
- .18 communications/security systems conductors – EMT
- .3 **Conduit Fittings:** Unless otherwise specified, conduit fittings are to be of the same material as the conduit and suitable in all respects for the application. Provide proper adaptors for joining conduit of different materials.
- .4 **Conduit Bends:** Site made bends for conduit must be made using proper bending equipment, bends must maintain the full conduit diameter with no kinking, and conduit finishes and lining must not flake or crack when the conduit is bent.
- .5 **Site Cutting Conduit:** Cut square and ream all site cut conduit ends.
- .6 **Conduit Threads:** Site cut rigid steel conduit using proper thread cutting equipment, in an approved area. Protect the area and building surfaces from being soiled/damaged by the threading process. Clean and lubricate threads and coat threads with red lead or other zinc rich coating.
- .7 **Conduit Sizes:** Generally, conduit is sized on the drawings. Conduit not sized on the drawings is to be sized in accordance with the governing Codes/Regulations. The sizes of branch circuit conductors shown/specified are minimum sizes and must be increased to suit length of run and voltage drop, and where this occurs, increase the conduit size to suit. Do not use conduit less than 15 mm (½") diameter.
- .8 **Empty Conduit:** Ensure that all conduit left empty for future wiring is clean, capped, and properly identified. Provide end bushings and fish cord in all such conduit.
- .9 **Empty Conduit At Panelboards:** Where a suspended ceiling occurs, provide 4, empty, 20 mm (¾") diameter conduits from each flush wall mounted panelboard terminated in the suspended ceiling above, capped and identified.

### 3.03 CONDUIT INSTALLED IN POURED CONCRETE

- .1 Where conduit is to be embedded in structural poured concrete, obtain the Consultant's approval. Submit a drawing indicating the location and size of the conduit, the length of run, and any other required details. Obtain the Consultant's written approval prior to conduit installation. The Consultant's decision regarding conduit in structural poured concrete is final and is not the basis of a claim for additional costs.
- .2 When and where conduit is permitted in structural poured concrete, abide by the following requirements:
  - .1 install the conduit in accordance with requirements of CAN/CSA-A23.1, Concrete Materials and Methods of Concrete Construction
  - .2 the conduit must be secured in a manner such that the conduit will not be displaced when the concrete is poured, and during the concrete pour, monitor the conduit installation to prevent displacement or damage, and immediately report any misplacement or damage observed
  - .3 where conduit extends adjacent to a column, stay away from the column a minimum of 2 times the thickness of the slab and drop away from the column
  - .4 where conduits terminate adjacent to a column or wall, bring the conduit in toward the column/wall as close to 90° to the face of the column/wall as possible
  - .5 where more than 2 conduits are adjacent to each other they are to be spaced the greater of 3 conduit diameters or 100 mm (4") apart
  - .6 place conduit in the middle third of the slab thickness, and do not in any case lay conduit directly on reinforcing steel
  - .7 do not locate conduit adjacent to parallel reinforcing bars
  - .8 the maximum size of any conduit is 1/5<sup>th</sup> of slab thickness
  - .9 do not install conduit longitudinally in a beam without specific approval of the Consultant, and extend conduit through a beam at right angles to the beam span
  - .10 where conduits extend through beams stay a minimum of twice the depth of the beam away from the supports
  - .11 do not install conduit in the slab beside a drop or beam within twice the depth of the slab from the edge of the drop or beam
  - .12 do not install conduits through shear walls or columns without written approval from the consultant
  - .13 do not install conduit in parking garage structures, garage ramps, water retaining structures, or any other concrete subject to the application of de-icing products
  - .14 in areas where installation of conduit embedded in concrete is not permitted, extend

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conduit through beams in sleeves, if the installation of the sleeves is permitted

- .15 slope all underground conduit to drainage points and ensure that the conduit can be drained

### 3.04 CONDUIT UNDER SLAB ON GRADE

- .1 Where conduit is to be installed under a slab on grade, the system is to be a pull-in system, must consider and address any effects of magnetic fields, and the following is to apply:
  - .1 concrete encased duct bank with non-ferrous conduits is to be used
  - .2 conduit is to be sloped to a proper drainage pit
  - .3 20% spare conduit (minimum 1) is to be provided

### 3.05 SEALED CONDUIT PENETRATIONS

- .1 For isolation rooms, any conduit penetration any surface of the room is to be sealed with a suitable elastomeric and intumescent material to ensure complete isolation of the room/area. The sealing material must be non-hazardous and suitable in all respects for the specific application, including a fire rating if required. Submit product data for the proposed sealing material as well as WHMIS sheets and product installation instructions

### 3.06 CONDUIT SUPPORT

- .1 **Underground Conduit:** Unless otherwise shown or specified, support underground conduit on a well tamped bed of earth or sand, free from rocks or protrusions of any kind.
- .2 **Surface Mounted & Suspended Single/Double Conduit Runs:** Support and secure single and double runs of conduit at support spacing in accordance with Code requirements by means of galvanized steel pipe straps, conduit clips, ring bolt type hangers with galvanized steel hanger rods, or by other approved manufactured devices.
- .3 **Support of Multiple Conduit Runs:** Support multiple conduit runs by means of Electrovert Ltd. "CANTRUSS" or Burndy Ltd. "FLEXIBLE" conduit racks and galvanized steel rods with support spacing to suit requirements of the smallest diameter conduit in the group or approved equivalent.
- .4 **Conduit Expansion Facilities:** Abide by the following:
  - .1 wherever concealed or surface mounted conduit extends across a building expansion joint, provide expansion facilities to permit free movement without imposing additional stress or loading on the support system, and to prevent excessive movement at joints and connections
  - .2 provide manufactured expansion joint fittings in rigid PVC conduit at spacing recommended by the expansion joint fitting manufacturer
  - .3 make "snaked" bends in underground flexible polyethylene conduit

**End of Section**

## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for all products specified in this Section.
- .2 **Colour Chart:** Submit a colour chart with product data and do not order raceway until the colour selection has been confirmed by the Consultant.

### **1.02 QUALITY ASSURANCE**

- .1 Wireways and auxiliary gutters are to be in accordance with requirements of CAN/CSA C22.2 No. 26, Construction and Test of Wireways, Auxiliary Gutters and Associated Fittings.

## **2 PRODUCTS**

### **2.01 WIREWAYS AND GUTTERS**

- .1 Wireways and gutters are to be of sheet steel construction with no sharp edges, sized for the wiring as required and/or indicated, complete with all required fittings and accessories, and a baked grey enamel finish. Covers are to be hinged and bolted to give uninterrupted access to wiring.

## **3 EXECUTION**

### **3.01 INSTALLATION OF WIREWAYS AND GUTTERS**

- .1 Provide wireway/gutters where shown. Confirm exact locations and routing prior to installation. Provide supports, fittings, adaptors, and accessories as required but keep the number of elbows, offsets, and connections to the minimum.
- .2 Provide barriers in wireways/gutters where different voltage wiring is required.
- .3 Install gutter to full length of equipment.
- .4 Identify wireways/gutters with engraved nameplates as specified in the Section entitled Basic Electrical Materials and Methods.

**End of Section**

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## GENERAL

### 1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for wiring devices. Ensure that the sheets indicate colours and faceplate finishes.
- .2 **Wiring Device Samples:** Submit identified samples in original packaging of the following wiring devices:

### 1.02 QUALITY ASSURANCE

- .1 All wiring devices are to be CSA certified as a minimum, in accordance with the following standards, as applicable:
  - .1 CAN/CSA C22.2 No. 42, General Use Receptacle, Attachment Plugs and Similar Wiring Devices
  - .2 CAN/CSA C22.2 No. 42.1, Cover plates for Flush Mounted Devices
  - .3 CSA C22.2 No. 111, General Use Snap Switches
- .2 Wherever possible, all wiring devices are to be supplied by the same manufacturer.
- .3 **Acceptable Manufacturers:** Unless otherwise specified in this Section or on the drawings, acceptable manufacturers are:
  - .1 Hubbell Canada LP
  - .2 Cooper Industries (Arrow Hart)
  - .3 Legrand/Pass & Seymour
  - .4 Leviton Canada
  - .5 Pass & Seymour
  - .6 Approved Equivalnet.

### 1.03 WIRING DEVICE AND PLATE COLOURS

- .1 Unless otherwise specified, wiring device colours will be as specified in Part 3 of this Section.

## 2 PRODUCTS

### 2.01 SWITCHES

- .1 Unless otherwise specified, Specification Grade, Premium Quality, back and side wired, 20 ampere, 120-277 volt A.C. quiet action toggle switches, single pole, 2-pole, 3-way, or key type as indicated on the drawings, each complete with a nickel plated steel ground terminal, brass power wiring terminals and screws, silver cadmium oxide contacts with a moveable brass contact arm, and nylon toggle with colour as specified below. Switch types are as follows:

- .1 **Standard Wall Toggle Switches:** As above.
- .2 **Illuminated Handle Standard Wall Toggle Switch:** As above for standard switches but with a clear red or green polycarbonate toggle which is illuminated when the switch is on or off. Confirm toggle colour and position when illuminated prior to ordering.
- .3 **Decorative Wall Rocker Switch:** Generally as specified above for standard toggle switches but rectangular decorative rocker type with rocker handles.
- .4 **Illuminated Decorative Wall Rocker Switch:** Generally as specified above for decorative toggle switches but with a rocker type illuminated handle.
- .5 **Door Switch:** Box, switch and plate assemblies with a 125 volt 3 ampere illuminated switch which is on or off when the door is open (confirm prior to ordering), a 34 mm x 94 mm x 40 mm (1 11/32" x 3 11/16" x 1 1/2") box, cover plate, and mounting screws.
- .6 **Hazardous Location Switch:** Explosion-proof, surface mounting, front operated switches suitable for use in Class 1 Division 2 locations with exact classification and configuration to suit the mounting location and the equipment the switch is provided for.
- .7 **Motor Control Snap Action Switch:** Illuminated handle snap action horsepower rated switch, CSA certified for motor control and sized to suit the application.
- .8 **Occupancy Sensor Switch:** Digital ultrasonic sensor type, 120-277 volt A.C. with integral photo sensor and selected to suit the area and occupancy of the room served.

## 2.02 SPECIFICATION GRADE STANDARD RECEPTACLES

- .1 Back or side wired, U-ground, 2 pole receptacles as follows:
  - .1 **15 Amp. 125 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 5-15R
  - .2 **15 Amp. 250 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 6-15R
  - .3 **20 Amp. 125 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 5-02R
  - .4 **20 Amp. 250 Volt Duplex Receptacle:** 3-wire receptacles, NEMA configuration 6-20R
  - .5 **30 Amp. 250 Volt Simplex Receptacle:** 3-wire receptacles, NEMA configuration 6-30R
  - .6 **30 Amp. 125/250 Volt Simplex Receptacle:** 3-wire receptacles, NEMA configuration 14-30R
  - .7 **50 Amp. 250 Volt Simplex Receptacle:** 3-wire receptacles, NEMA configuration 6-50R

- .8 **50 Amp. 125/250 Volt Simplex Receptacle:** 4-wire receptacles, NEMA configuration 14-50R

## **2.03 SPECIFICATION GRADE LOCKING RECEPTACLES**

- .1 Specification Grade, back or side wired, U-ground 2-pole, 3-wire locking type receptacles as follows:

- .1 **15 Amp. 125 Volt Duplex Receptacle:** NEMA configuration L6-15R
- .2 **15 Amp. 250 Volt Duplex Receptacle:** NEMA configuration L6-15R
- .3 **20 Amp. 125 Volt Duplex Receptacle:** NEMA configuration L5-20R
- .4 **20 Amp. 250 Volt Duplex Receptacle:** NEMA configuration L6-20R

## **2.04 SPECIFICATION GRADE GROUND FAULT RECEPTACLES**

- .1 Heavy-duty, 15/20 ampere, 125 volt, ULC Class A, Group 1. automatic ground fault circuit interrupting duplex receptacles with a 10 kA short circuit current rating automatic self-test diagnostics, green power on LED, and red ground fault LED. Ground fault receptacles for indoor climate controlled and outdoor or non-climate controlled areas are to be as follows:

- .1 indoor climate controlled areas: equal to Hubbell Canada No. GFST15/GFSTt20 "AUTOGUARD"
- .2 outdoor areas and indoor non-climate areas: equal to Hubbell Canada No. GFR5262TR/GFR 4362TR "AUTOGUARD"

## **2.05 EXPLOSION-PROOF RECEPTACLES**

- .1 Equal to Cooper Crouse-Hinds ENR Series "Ark-Gard" dead front, simplex, interlocking circuit breaking receptacles suitable for installation Class 1 Division 1 and 2 explosion- proof receptacles, 15 ampere or 20 ampere, 125 volt or 250 volt as indicated on the drawings, each complete with a die-cast copper-free aluminium housing and spring door with stainless steel hinge and neoprene gasket, and fiberglass reinforced polyester receptacle.

## **2.06 SPECIFICATION GRADE TAMPER-RESISTANT DUPLEX RECEPTACLES**

- .1 Specification Grade, back or side wired, U-ground, 2-pole, 3-wire tamper-resistant duplex receptacles as specified above, 15 ampere or 20 ampere, 125 volt as indicated on the drawings, each with thermoplastic shutters to limit access to energized contacts.

## **2.07 CLOCK HANGER RECEPTACLES**

- .1 Equal to Legrand/Pass & Seymour #S3713W 15 ampere, 125 volt white recessed simplex receptacle with smooth white wall plate.

## **2.08 PHOTO ELECTRIC SWITCH**

- .1 Equal to Tork 2100 Series weather-proof, 12 mm (½") dia. conduit mounting photoelectric SPST control switch with model number to suit the voltage and connected load, complete with an adjustable slide for on-off adjustment, a turn-on of one to five fc and a turn-off of three to five fc without the slide in position, a die-cast zinc gasketed enclosure, cadmium sulphide epoxy coated cell, normally closed contacts which fail in the open position, a delay of up to four minutes to prevent false switching due to light from vehicles, lightning, etc., three colour coded 150 mm (6") # 16 AWG leads, a fixed base for conduit connection, and, if required, an accessory bracket for wall mounting the device.

## **2.09 TIME SWITCH**

- .1 Flush wall mounting spring wound ivory time switch with matching faceplate, equal to Tork A500 Series with exact catalogue number to suit the connected load.

## **2.10 DEVICE FACEPLATES**

- .1 Device faceplates are to be ULC listed and CSA certified and, unless otherwise specified, supplied by the device manufacturer. Where two or more devices are installed in a common box, a common one-piece faceplate is to be used. Faceplate colours are specified in Part 3. Faceplates, unless otherwise specified, are to be as follows:
  - .1 type 302 stainless steel switch and receptacle faceplates, brush finish or satin finish as directed, with stainless steel screws
  - .2 high impact smooth finish switch and receptacle faceplates
  - .3 hot dipped galvanized steel switch and receptacle faceplates
  - .4 NEMA 3 rated, single gang, horizontal/vertical mounting, weather-proof in use, gasketed cast aluminium, receptacle faceplates to suit the type of receptacle used
  - .5 weather-proof, gasketed, water-tight single gang type 302 stainless steel switch plate with clear silicone rubber bubble over the switch toggle

## **3 EXECUTION**

### **3.01 GENERAL RE: INSTALLATION OF WIRING DEVICES**

- .1 Provide all required wiring devices and faceplates
- .2 Confirm exact locations, including mounting heights prior to roughing-in.
- .3 For barrier-free mounting heights for devices, conform to requirements of the governing code or regulation.
- .4 Ensure that switches located adjacent to doors are located at the strike side of the door.



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Confirm door swings prior to roughing-in.

- .5 Install single throw switches with the handle in the up position when the switch is closed.
- .6 Confirm all switch, receptacle and faceplate types, colours and finishes prior to ordering
- .7 Provide a separate insulated ground conductor for each isolated ground receptacle.
- .8 Faceplates for computer equipment receptacles are to be permanently identified with "Computer Equipment Only" wording.
- .9 Faceplates for housekeeping receptacles are to be permanently identified with "Housekeeping Only" wording.
- .10 Do not install faceplates for flush devices until wall, etc., finishing work is complete
- .11 Where devices are to be installed in casework, millwork, or similar construction, carefully coordinate device installations and device openings with the trade providing the casework, millwork, etc.
- .12 Device locations indicated on the drawings are approximate, and, if requested, relocate the device up to 3 mm (10') away from the location shown at no additional cost.
- .13 All receptacles within 1.5m of a sink or shower/tub are to be GFCI type.
- .14 Label all receptacles and light switches with panel & circuit number. Use clear P-Touch label or approved equivalent with black letters.

### 3.02 WIRING DEVICE AND FACEPLATE TYPES AND COLOURS

- .1 Unless otherwise specified, wiring devices colours and faceplate types and colours are to be as follows:

#### **standard switches & receptacles in finished areas – stainless steel faceplates**

- .1 **"Decorator" switches & receptacles in finished areas** – stainless steel faceplates
- .2 **switches & receptacles in finished areas:** stainless steel faceplates
- .3 **switches & receptacles in unfinished areas-non-essential circuits:** stainless steel faceplates or hot dipped galvanized
- .4 **weather-proof switches:** weather-proof stainless steel faceplates with clear silicone bubble over the switch toggle

### 3.03 TESTING

- .1 When installation is complete, test operation of all devices.

**End of Section**

## **GENERAL**

### **1.01 REFERENCES**

- .1 American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE).
- .2 Underwriters Laboratories of Canada (ULC)
- .3 International Electrotechnical Commission
- .4 International Organization for Standardization (ISO)
- .5 National Electrical Manufacturers Association (NEMA)

### **1.02 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for occupancy sensors.
- .2 Submit composite wiring diagrams and control schedule for each room control circuit type as proposed to be installed. Include load type, sequence of operation, sensor parameters, time delays, sensitivities and daylighting set points.

### **1.03 MOCK-UP**

- .1 Include for providing a sensor mock-up installation in a typical washroom to verify proper operation prior to installation of other sensors.

### **1.04 SCOPE**

- .1 This contractor is responsible to supply and install all equipment and control wiring as specified for the digital occupancy and daylight control systems. This contractor must coordinate these control systems with the lighting fixtures being supplied for the project to ensure intended function as specified.
- .2 Control Intent: Control Intent includes, but is not limited to:
  - .1 Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
  - .2 Initial sensor and switching zones
- .3 All equipment must be CSA approved or approved at this contractor's expense by the Special Inspection Division of the Electrical Safety Authority

### **1.05 SYSTEM DESCRIPTION**

- .1 Permanently installed
  - .1 Wall switch occupancy sensors
  - .2 Ceiling mounted occupancy sensors

- .3 Switch packs (relays)

#### **1.06 WARRANTY**

- .1 Provide a five (5) years complete manufacturer's warranty on ALL products to be free of manufacturer's defects.

#### **1.07 QUALITY ASSURANCE**

- .1 Manufacturer: Minimum five (5) years' experience in manufacture of lighting controls
- .2 All occupancy sensors are to be solid-state design, UL/ULC listed and labelled and CSA certified in accordance with CAN/CSA C22.2 No. 184, Solid-State Lighting Controls, and designed specifically for energy conservation.
- .3 Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who is specialized in installation of work similar to that required for this project.
- .4 Source Limitations: To assure compatibility, obtain occupancy sensors from a single source with complete responsibility over all lighting controls, including accessory products. The use of subcontracted component assemblers is not acceptable.

#### **1.08 ACCEPTABLE MANUFACTURERS:**

- .1 Basis of design product: Eaton Lighting Systems (formerly Cooper Controls-Greengate).
- .2 Equal manufactured by one of the following:
  - .1 Hubbell Control Solutions
  - .2 Watt Stopper/Legrand
  - .3 Lutron Electronics Co. Inc.
  - .4 Leviton Manufacturing Co. Inc.
- .5 Approved Equivalent

### **2 PRODUCTS**

#### **2.01 SENSORS**

- .1 Sensing mechanism:
  - .1 Infrared – utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
  - .2 Ultrasonic
    - .1 Utilize and operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
    - .2 Utilize Doppler shift ultrasonic detection technology

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- .3 Dual technology
    - .1 Utilize multiple segmented lens, with internal grooves to eliminate dust and residual build-up
    - .2 Utilize and operating frequency of 32 kHz or 40 kHz that shall be crystal controlled to operate within plus or minus 0.005% tolerance.
    - .3 Incorporate Doppler shift ultrasonic and passive infrared motion detection technologies. Products to react to noise and ambient sound shall not be considered.
  - .2 Power failure memory:
    - .1 Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and parameters saved in protected memory shall not be lost.
  - .3 Designed and tested to withstand discharges without impairment of performance when subjected to discharges of 15,000 volts per IEC 801-2.
  - .4 Products tested in identical manner, compliant to NEMA WD 7-2011 Occupancy Motion Sensor Standards.
  - .5 Sensors shall have time delays from 5 to 30 min
  - .6 When specified, sensors shall automatically adjust time delay and sensitivity settings
  - .7 All sensors shall provide an LED as visual means of indication at all times to verify that motion is being detected during both testing and normal operation.
  - .8 All sensors shall have readily accessible, user adjustable settings for time delay and sensitivity. Settings shall be located on the sensor (not the control unit) and shall be recessed to limit tampering.
  - .9 Where specified, sensor shall have an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options. Sensors utilizing separate components or specially modified unit to achieve this function are NOT acceptable.

## **2.02 LOW VOLTAGE CEILING MOUNTED VACANCY AND OCCUPANCY SENSORS**

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Sensors shall be Class 2 devices
- .4 When requested, be able to provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
- .5 When requested on drawings, provide an internal additional isolated relay with Normally Open, Normally Closed outputs for use with HVAC control, Data Logging and other control options.

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## **2.03 LINE VOLTAGE CEILING MOUNTED OCCUPANCY SENSORS**

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Provide a mechanical air-gap on/off function for all sensors
- .4 Capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet
- .5 Shall accommodate loads from 0-800 watts at 120 volts and shall have a minimum 180 degree coverage capability.
- .6 Shall be able to have their visible plastic parts replaced, for colour changes in the field, without removing the body of the control from the wall and without requiring special tools.
- .7 Shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- .8 Shall have no leakage current to load, in manual or in Auto/Off Mode for safety purposes and shall have voltage drop protection.
- .9 Where specified, sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.
- .10 Where specified, dual relay sensors shall offer daylighting foot-candle adjustment control for either or both relays.
- .11 Where specified, dual relay sensors shall offer a Bathroom Mode which keeps the second relay ON for an addition 8 minutes after the first relay has been turned off.
- .12 Sensor packaging shall be 100% recycled as well as 100% recyclable.
- .13 Sensors shall be RoHS ( Restriction of Hazardous substances ) compliant
- .14 Where specified, sensors shall offer integral Bi-level Automatic On (just one lighting level comes on automatically when occupancy is detected)

## **2.04 WALL/CORNER MOUNTED SENSORS**

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Sensors shall be Class 2 devices
- .4 When requested on drawings, provide an internal additional isolated relay with Normally Open, Normally Closed outputs for use with HVAC control, Data Logging and other control options
- .5 Where specified, sensors shall offer daylighting footcandle adjustment control
- .6 Sensor packaging shall be 100% recycled as well as 100% recyclable.

- .7 Sensors shall be RoHS compliant.
- .8 Where specified, sensors shall offer integral Bi-level Automatic On (just one lighting level comes on automatically when occupancy is detected).

## **2.05 VACANCY OR OCCUPANCY WALL SWITCHES**

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Requires Manual On to activate lighting (Vacancy Sensor only)
- .4 Cannot be modified to provide Automatic ON capabilities (Vacancy Sensor only)
- .5 Provide a mechanical air-gap on/off function for all sensors
- .6 Capable of detection of occupancy at desktop level up to 300 square feet, and gross motion up to 1000 square feet
- .7 Shall accommodate loads from 0-800 watts at 120 volts and shall have 180 degree coverage capability.
- .8 Shall be able to have their visible plastic parts replaced, for colour changes in the field, without removing the body of the control from the wall and without requiring special tools.
- .9 Shall utilize Zero Crossing Circuitry which increases relay life, protects from the effects of inrush current, and increases sensor's longevity.
- .10 Shall have no leakage current to load, in manual or in Auto/Off Mode for safety purposes and shall have voltage drop protection.
- .11 Where specified, wall switch sensors shall provide a field selectable option to convert sensor operation from Automatic On to Manual On.
- .12 Where specified, sensors shall offer daylighting foot-candle adjustment control and be able to accommodate dual level lighting.
- .13 Where specified, dual relay sensors shall offer daylighting foot-candle adjustment control for either or both relays.
- .14 Where specified, dual relay sensors shall offer a Bathroom Mode which keeps the second relay On for an addition 8 minutes after the first relay has been turned off.
- .15 Where specified, sensors shall feature a universally recognized light bulb icon for end user ease of identification of use.
- .16 Where specified, dual relay sensors shall feature universally recognized light bulb and fan icons for end user ease of identification of use.
- .17 Sensor packaging shall be 100% recycled as well as, 100% recyclable.

- .18 Sensors shall be RoHS compliant.
- .19 Where specified, sensors shall have an EcoMeter that provides a visual indicator of energy usage, increasing end user awareness and reminding individuals to take control of their lighting to maximize energy savings.
- .20 Where specified, low voltage sensors shall have a Tracking/HVAC Mode that allows the load connected to the Form C BAS relay to remain on when the lights are turned off manually.
- .21 Where specified, sensors shall have a tamper-proof Automatic Only Mode that automatically turns lighting ON and OFF without requiring a user to push a button

## **2.06 SENSOR SWITCHPACK**

- .1 Product: provide switchpack as required for low voltage sensors to suit and shall be of same manufacturer
- .2 Control wiring between sensors and control units shall be Class 2, 18-24 AWG, stranded U.L. Classified.
- .3 Integrated, self-contained unit consisting internally of an isolated load switching control relay and a power supply to provide low voltage power.
- .4 Shall be compatible with incandescent, magnetic or electronic low voltage, and magnetic or electronic fluorescent, as well as motor loads.

## **2.07 LOW TEMPERATURE SENSOR**

- .1 Product: as specified on drawings
- .2 Provide all necessary mounting hardware and instructions
- .3 Sensors shall be Class 2 devices
- .4 Provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology.
- .5 When requested on drawings, provide an internal additional isolated relay with Normally Open, Normally Closed outputs for use with HVAC control, Data Logging and other control options

## **2.08 DIGITAL TIME SWITCHES**

- .1 Product: TSM-MV or approved equivalent.
- .2 Provide all necessary mounting hardware and instructions.

## **2.09 SOURCE QUALITY CONTROL**

- .1 Perform full-function testing on 100% of all system components and panel assemblies at the factory.

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### **3 EXECUTION**

#### **3.01 INSTALLATION OF OCCUPANCY SENSORS**

- .1 Install in accordance with manufacturer's printed instruction unless noted otherwise.
- .2 When using wire for connection other than the digital local network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colours to simplify contractor termination requirements
- .3 Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings
  - .1 Adjust time delay so that controller area remains lighted for predetermined time as outlined on drawing schedule after occupant leaves area. If time is not indicated on drawing schedules set for 5 minutes.
  - .2 Program all room control systems to function in vacancy mode. User must manually turn lighting on with automatic delay to off.
- .4 Install power packs in accessible maintenance areas unless noted otherwise. Provide access doors if power packs are installed above drywall ceilings.
  - .1 Provide power packs for 24 volt DC sensors and locate where accessible for maintenance. Ensure that panelboard breakers serving power packs are equipped with lock-on devices. Unless otherwise indicated install power packs in 150 mm x 150 mm x 100 mm (6" x 6" x 4") utility boxes painted white and identified with a Lamacoid nameplate, and connect to sensors with armoured cable with 1.5 m (5") of slack cable for location adjustment if required.
- .5 Provide occupancy sensors, generally where shown but with exact locations in accordance with reflected ceiling plans and the sensor manufacturer's instructions. Include for all required site assembly, and provide all required installation and support hardware.
- .6 It shall be contractor's responsibility to locate and aim sensors in the correct location required for complete and proper coverage within the range of coverage as per manufacturer's recommendations. The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective rooms.
- .7 Confirm exact locations prior to roughing-in.
- .8 Connect sensors to circuits indicated with wiring in conduit.
- .9 Provide computer generated documentation on the commissioning of the system including room by room description including;
  - .1 Sensor parameters, time delays, sensitivities and daylighting setpoints
  - .2 Sequence of operation, (eg. Manual ON, Auto OFF, etc.)
  - .3 Load Parameters (eg. Blink warning, etc.)



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- .10 Re-commissioning – after 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirement. Provide a detailed report to the Architect/Owner of re-commissioning activity.
  - .11 Assist the Owner's operating personnel in the location and adjustment of sensors to suit the location and application.
  - .12 Include for a 4 hour on-site training session for the Owner's personnel to demonstrate operation and adjustments of sensors, and trouble-shooting procedures.

### **3.02 FACTORY COMMISSIONING**

- .1 Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system
- .2 The electrical contractor shall provide both the manufacturer and the electrical Engineer with ten (10) working days written notice of the system start-up and adjustment date.
- .3 Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.
- .4 Factory commission shall include functional testing and documentation of the control system conforming to ASHRAE 9.4.4. This cost shall be included in the Tender Price.
- .5 Include for the following manufacturer representative site visits:
  - .1 Pre-wiring visit
  - .2 System set-up visit
  - .3 Third party ASHRAE functional testing visit
  - .4 System commissioning visit

**End of Section**

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## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Shop Drawings/Product Data:** Submit shop drawings/product data sheets for all equipment specified in this Section. Both shop drawings and product data sheets must confirm that the equipment proposed meets all requirements of the Contract Documents. Shop drawings/product data is to include:
  - .1 equipment dimensions and details
  - .2 a single line diagram and a schematic diagram, if applicable
  - .3 component nameplate and warning sign data
  - .4 short circuit ratings, voltage ratings, continuous current ratings, and interrupt ratings
  - .5 any additional information requested by the Consultant
- .2 **Test Reports:** Submit signed copies of all test reports, and include a copy of each report with O & M Manual project close-out data.
- .3 **Spare Fuses:** Submit as specified in Part 3 of this Section.
- .4 **Manufacturer's Installation Certification Letter:** Submit a service entrance board manufacturer's installation certification letter as specified in Part 3 of this Section.

## **2 PRODUCTS**

### **2.01 FUSED DISCONNECT SWITCH**

- .1 In accordance with Section 26 28 23, Disconnect Switches, with rating as indicated on the drawings.

### **2.02 ENCLOSED CIRCUIT BREAKER**

- .1 In accordance with Section 26 28 16, Moulded Case Circuit Breakers, with rating as indicated on the drawings.

### **2.03 PANELBOARD**

- .1 In accordance with Section 26 24 16, Branch Circuit Panelboards, with capacity and branch circuit details as per the drawings.

### **2.04 METERING CABINET**

- .1 Utility approved wall mounting enamelled steel metering cabinet with backboard.

### **2.05 GROUND FAULT EQUIPMENT**

- .1 In accordance with Section 26 28 20, Ground Fault Circuit Interrupters-Class A.

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## 2.06 METERING CURRENT AND POTENTIAL TRANSFORMERS

- .1 Supplied with metering equipment **by** the Utility

## 2.07 SERVICE ENTRANCE BOARD

- .1 Metal enclosed, factory assembled, dead front service entrance board assembly in accordance with the drawing plan, elevations, schedule, and any details, and in accordance with CAN/CSA-C22.2 No. 31 and all other applicable Codes and Standards.
- .2 **Enclosure:** Tamper-resistant enclosure consisting of individual sections cubicles constructed of cold rolled steel and bolted together and reinforced as necessary to form a self-contained structure with the necessary louvres for proper ventilation. The enclosure is to be NEMA/EEMAC Type 1 if the room is not sprinkler protected, NEMA/EEMAC Type 2 if the room is sprinkler protected, and finished with ANSI #61 grey enamel. The enclosure is to be complete with:
  - .1 **hinged access panels** where required, of formed sheet steel and equipped with gasketing, concealed steel hinges with stainless steel hinge pins, and a captive knurled thumb screws
  - .2 **metering cubicle**, for Utility metering equipment, full height and barriered to isolate the cubicle from adjoining cubicles
  - .3 **Utility metering CT's and PT's** as specified above in this Section
  - .4 **fused disconnect switch** as specified above in this Section
  - .5 **enclosed circuit breaker** as specified above in this Section
  - .6 **panelboard** as specified above in this Section
  - .7 **ground fault equipment** as specified above in this Section
  - .8 **power bus** from the load terminal of the main breaker or disconnect switch via the metering cubicle to main lugs of the distribution panelboard, consisting of rectangular, square edge, hard temper, high electrical conductivity copper with colour coded phasing
  - .9 **cable** with colour coded phasing from the load terminal of the main breaker or disconnect switch via the metering cubicle to lugs of the distribution panelboard
  - .10 **ground bus**, electrical grade copper extending the full width of the assembly at the bottom, with lugs at each end for attachment of ground conductors
- .3 **Acceptable Manufacturers:** Acceptable manufacturers are:
  - .1 Schneider Electric Canada

- .2 Eaton Electric Canada
- .3 Siemens Canada
- .4 Approved Equivalent

### **3 EXECUTION**

#### **3.01 INSTALLATION OF SERVICE ENTRANCE EQUIPMENT**

- .1 Provide electric service entrance equipment where shown.
- .2 Wall mount the equipment where indicated but confirm exact location prior to installation.
- .3 Secure the service entrance board in place, level, and plumb, on a concrete housekeeping pad.
- .4 Make "line" and "load" side connections as indicated.
- .5 Check protective devices against the coordination study results to ensure proper operation of the devices.
- .6 Ground and bond as indicated and as per the electrical work Section entitled Grounding- Secondary.
- .7 If service entrance equipment identification is not factory installed, install at the site using stainless steel screws.
- .8 Supply a complete set of identified fuses for the disconnect switch and store in an identified wall mounted steel cabinet adjacent to the service entrance equipment.
- .9 **Equipment and System Manufacturer's Certification:** Refer to the article entitled Equipment and System Manufacturer's Certification in the Electrical Work General Instructions Section.
- .10 **Start-Up:** Refer to the article entitled Equipment and System Start-up in the Electrical Work General Instructions Section.

**END OF SECTION**

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## 1 GENERAL

### 1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for all products specified in this Section.
- .2 **Panelboard Door Keys:** Submit an identified key (minimum 3) for panelboards equipped with doors.

### 1.02 QUALITY ASSURANCE

- .1 Distribution panelboards are to be rated to interrupt and withstand short circuit faults greater than the available fault current. Indicate conformance with this requirement on product data sheets submitted for review.

## 2 PRODUCTS

### 2.01 DISTRIBUTION PANELBOARDS

- .1 **General Re: Panelboards:** Distribution panelboards are to be dead front, factory assembled panelboards designed for sequence phase connection of branch circuit devices, as per the drawing schedule and plans, and in accordance with requirements of CAN/CSA- C22.2 No. 29, Panelboards and Enclosed Panelboards Industrial Products. Comply with OESC Rule 14-014 with regards to series rated combinations of over-current protective devices and ensure that equipment in which the lower rated devices are installed are marked with a series combination interrupting rating at least equal to the available fault current. Each panelboard is to be complete with:
  - .1 silver plated, electrical grade, 95% conductivity copper bus mains for the full length of each enclosure
  - .2 main and branch circuit conductor solderless lugs approved for copper conductors
  - .3 neutral bus and main lugs at the same end, and a removable cover for main lugs
  - .4 for panelboards in Elevator and/or Escalator Machine Rooms, hardware to permit padlocking the switch or breaker in the open position
- .2 **Panelboard Enclosures:** Panelboard enclosures, unless otherwise specified, are to be EEMAC 2 sprinkler-proof, constructed of Code gauge galvanized sheet steel, equipped with drip shields, and factory cleaned, primed, and finished with ASA-61 light gray equipment enamel. Each enclosure is also to be equipped with:
  - .1 wiring gutter space on all sides in accordance with CAN/CSA-C22.2 No.29 requirements
  - .2 space for future breakers/switches as applicable and as per the drawing schedule, and where spare beaker space is scheduled, breaker connector kits

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- .3 for panelboards in areas other than secure Electrical, etc., Rooms, a concealed hinged door and flush latch with keyed alike lock
  - .4 for free-standing floor mounted panelboards, reinforcement as required for a rigid enclosure
  - .3 **Circuit Breaker Panelboards:** Breakers are to be moulded case, bolt-on breakers in accordance with CSA-C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures, calibrated for operation in a 40° C (150° F) ambient temperature, sized in accordance with the drawing schedules, and complete with:
    - .1 a top main breaker
    - .2 for breakers 225 amperes and larger, a solid-state adjustable trip unit with long time, short time, and instantaneous time functions and time delays, set at ratings in accordance with the distribution coordination study
  - .4 **Switch and Fuse Panelboards:** Fusible switches are to be quick-make, quick-break, visible contact bolt-on switches in accordance with CSA-C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures, sized in accordance with the drawing schedules, and complete with:
    - .1 a top main switch
    - .2 operating handles which protrude through the dead front enclosure, interlocked with the switch mechanism, and equipped with facilities for padlocking in either the "ON" or "OFF" position
    - .3 fuse clips, and HRC fuses as per the drawing schedule
  - .5 **Modifications & Accessories:** Panelboards are to be factory equipped with modifications and accessories as follows:
    - .1 200% rated neutral
    - .2 insulated ground bus assembly
    - .3 isolated ground bus assembly
    - .4 sub-feed lugs
    - .5 through-feed lugs
    - .6 entry plates for Corflex cable
    - .7 a barriered main breaker or switch
    - .8 a main breaker/switch through the cover key interlock
    - .9 an electrically held contactor in the mains, installed in a separate compartment with removable cover
    - .10 a shunt trip for the main breaker

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- .11 undervoltage release for the main breaker
  - .12 an alarm switch for the main breaker
  - .13 a surge protection package with audible alarm and silence button, From "C" relay contact, and EMI/RFI filtering providing 50 dB noise attenuation at 100 kHz
- .6 **Acceptable Manufacturers:** Acceptable manufacturers are:
- .1 Eaton Canada
  - .2 Schneider Electric Canada
  - .3 Siemens Electric Canada
  - .4 Approved Equivalent

### **3 EXECUTION**

#### **3.01 INSTALLATION OF DISTRIBUTION PANELBOARDS**

- .1 Provide distribution panelboards where shown. Ensure adequate operation and maintenance clearance on all sides of each panelboard as per Code requirements.
- .2 Wall mount panelboards independent of connected conduit.
- .3 Secure each free-standing panelboard, level and plumb, to a concrete housekeeping pad.
- .4 Connect neutral conductors to common neutral bus with respective neutral identified.
- .5 Identify each panelboard and each panelboard component with an engraved Lamacoid nameplate in accordance with requirements of the Section entitled Basic Electrical Materials and Methods. Confirm nameplate wording with the Consultant prior to manufacture. Include a printed circuit directory card in a frame with acetate cover.

**END OF THE SECTION**

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## 1 GENERAL

### 1.01 SUBMITTALS

- .1 **Product Data:** Submit product data sheets for products specified in this Section.
- .2 **Panelboard Door Keys:** Submit identified keys (minimum 6) for panelboard doors.

## 2 PRODUCTS

### 2.01 BRANCH CIRCUIT PANELBOARDS

- .1 **General Re: Panelboards:** Breaker type branch circuit panelboards are to be dead front, factory assembled panelboards designed for sequence phase connection of branch circuit breakers, as per the drawing schedule and plans, and in accordance with requirements CAN/CSA-C22.2 No. 29, Panelboards and Enclosed Panelboards Industrial Products. Comply with OESC Rule 14-014 with regards to series rated combinations of over-current protective devices and ensure that equipment in which the lower rated devices are installed are marked with a series combination interrupting rating at least equal to the available fault current.
- .2 Each panelboard is to be complete with:
  - .1 electrical grade, 95% conductivity copper sequence phase bus mains for the full length of each enclosure
  - .2 a fully capacity neutral unless otherwise specified
  - .3 main and branch circuit conductor solderless set-screw type lugs approved for copper conductors
  - .4 neutral bus and main lugs at the same end, and a removable cover for main lugs
  - .5 a manufacturer's nameplate which indicates panelboard characteristics including the fault current that the panelboard, including breakers, has been constructed to withstand
- .3 **Panelboard Enclosures:** Panelboard enclosures, unless otherwise specified, are to be EEMAC 2 sprinkler-proof, flush or surface mounted as indicated, constructed of Code gauge galvanized sheet steel, equipped with drip shields, and factory cleaned, primed, and finished with ASA-61 light gray equipment enamel. Each enclosure is also to be equipped with:
  - .1 wiring gutter space on all sides in accordance with CAN/CSA-C22.2 No. 29 requirements
  - .2 space for future breakers as applicable and as per the drawing schedule
  - .3 a concealed hinged door and flush latch with keyed alike lock, and a frame with acetate cover and a circuit directory card on the inside face of the panel door
  - .4 mylar circuit breaker identification strips secured in place



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- .4 **Circuit Breakers:** Breakers are to be moulded case, bolt-on breakers in accordance with CSA/C22.2 No. 5, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures, calibrated for operation in a 40° C (105° F) ambient temperature, sized in accordance with the drawing schedules, and as follows:
- .1 branch circuit breaker interrupting capacity is to suit the panelboard voltage and be as scheduled, or in accordance with Code requirements to suit the application
  - .2 odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number
  - .3 for ground fault breakers, CSA Class A, Group 1 combination thermal magnetic trip breakers with solid-state ground default interrupters
  - .4 for breakers 225 amperes and larger, a solid-state adjustable trip unit with long time, short-time, and instantaneous time functions and time delays, set a ratings in accordance with the distribution coordination study
  - .5 for dedicated breakers, handle lock devices
  - .6 as scheduled or shown, spare breakers or space for future breakers
- .5 **Modification & Accessories:** Where indicated on the drawings or scheduled, panelboards are to be factory equipped with modifications and accessories as follows:
- .1 A factory installed, maintenance free surge protective device (SPD) in accordance with ANSI/UL 1449, connected to bussing through a disconnected device and equipped with a diagnostic package with status indicators on each phase, LCD six- digit surge counter display, EMI/RFI filtering, audible alarm with silence button, and Form C alarm contacts
  - .2 200% neutrals for panelboards equipped with SPD units and other panels as scheduled
  - .3 insulated ground bus assembly
  - .4 sub-feed lugs
  - .5 through-feed lugs
  - .6 a non-automatic or automatic (as schedule) main breaker
- .6 **Power Xpert Branch Circuit Monitor:** Where indicated on the drawings or schedules, supply CSA listed microprocessor-based Branch Circuit Monitoring System (Eaton PXBCM), or approved equal having the specified features.
- .1 System shall consist of meter base and meter modules as described below;
  - .2 The Branch Circuit Monitor shall measure the following operational data for up to 84 branch load circuits:
    - .1 Forward and Reverse kWh
    - .2 Watts, VA, Amps, Power Factor

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- .3 Present and Peak demand readings for Amps, Forward and Reverse Watts
  - 4 Maximum Watts, VA, Amps
  - .3 The Branch Circuit Monitor shall support alarms for current that can be set based on percent of Breaker Rating and alarms for voltage based on percent of nominal voltage.
    - .1 High, High-High, Low, Low-Low non-latching alarms for current.
    - .2 High and Low latching alarms for current, resettable via Modbus or the WEB interface
    - .3 High and Low latching and non-latching voltage alarms for each meter module input voltage.
    - .4 Alarm Status and alarm counters shall be available via Modbus communications
  - .4 Branch Circuit monitor shall support upgradeable firmware via communications.
  - .5 The Branch Circuit Monitor shall have the following ratings
    - .1 Elevation: 0 – 9843 ft (0 – 3000M)
    - .2 Pollution degree: 2 (IEC 60644-1)
    - .3 Ambient temperature range: -20°C – +70°C (-4° – +158°F)
    - .4 Storage temperature range: -40°C to +85°C (-40°F - +185°F)
    - .5 Humidity: 5% – 95% non-condensing.
    - .6 PXBCM as a component shall have a NEMA 1 rating. When installed in an enclosure it shall have the same rating as its enclosure.
    - .7 Housing ingress protection: IP20 as a component, in an enclosure the same as the enclosure
    - .8 CE Mark
    - .9 EMC (Electromagnetic Compatibility)
      - .1 IEC61326: EMI IEC61000-4-X level 3
      - .2 CISPR 11: Class B emissions, CISPR 22 (Ethernet) class B emissions
      - .3 FCC part 15 Class B emissions
      - .4 UL/cUL 61010-1 3rd edition
      - .5 EN61010-1

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- .6 PXBCM Meter Base or approved equivalent.
- .1 Each PXBCM-MB Meter Base or approved equivalent shall support connection of up to 4 Meter Modules in either a MMS Strip or MME External configuration monitoring a total of up to 100 single-phase two-wire AC loads, 48 single-phase three-wire AC loads or 32 three-phase four-wire AC loads or combinations not to exceed 25 poles per meter module.
  - .2 The PXBCM-MB or approved equivalent shall be equipped with 4 meter module ports. Each port shall provide control power and communications to either a PXBCM-MMS Meter Module Strip or a PXBCM-MME Meter Module External with a maximum cable length of 28ft between each Meter Base and each Meter Module.
  - .3 Each PXBCM-MB or approved equivalent shall support connection to up to 4 PXBCM-MMS Meter Module Strip or 4 PXBCM-MME Meter Module External, or a combination of up to 4 total PXBCM-MMS and PXBCM-MME each meter module with independent single or three phase voltage metering circuits with inputs up to 277V L-N and 480V L-L.
  - .4 PXBCM-MB or approved equivalent Power Supply shall be rated for 100-277VAC L:N +/-10% CAT III, 47-63 Hz , 6W
  - .5 The PXBCM-MB or approved equivalent shall include a 3 terminal RS-485 serial port for Modbus RTU communications and an RJ-45 port for Ethernet communications. The Ethernet port shall support Modbus TCP communications as well as an Embedded WEB server.
  - .6 The PXBCM-MB or approved equivalent embedded WEB server shall support device configuration for to up to 4 PXBCM-MMS Meter Module Strip or 4 PXBCM-MME Meter Module External, or a combination of up to 4 total PXBCM-MMS and PXBCM-MME and display of up to 100 points of metering data. It shall be possible to save device configuration information to a file for archiving and for uploading to PXBCM.
  - .7 The PXBCM-MB or approved equivalent shall support connection to a pre-configured HMI via RS-485 serial port. The HMI shall not require configuration
  - .8 The PXBCM-MB or approved equivalent shall be equipped with LED's to indicate communications activity and Device/Alarm Status. An LED shall also indicate if Ethernet is configured for DHCP (automatically assigned IP address) or Fixed IP (manually assigned IP address). The PXBCM-MB shall be equipped with 2 rotary switches to assign Modbus Slave ID 1-99.
  - .9 The PXBCM-MB or approved equivalent shall be equipped with security mode switches to enable the device to operate in a secure mode to prevent tampering with device configuration and resets over comms.
  - .10 The PXBCM Meter Base or approved equivalent shall automatically sense the type of PXBCM Meter Module connected to each of its 4 meter module ports.
  - .11 The Configuration wizard shall support naming and configuration of up 100 virtual meters by assigning 1-3 channels of current to 1, 2 or 3 pole meters. Virtual meters shall

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aggregate the channel data assigned to each virtual meter and report the aggregated virtual meter values for:

- .1 Forward and Reverse Energy
  - .2 Watts, VA, Average Amps and Power Factor
  - .3 Average and Peak demand for Watts and VA
- .7 PXBCM-MMS Meter Module Strip or approved equivalent
- .1 PXBCM-MMS Meter Module Strips shall be available in configurations to mount on either the left or right of a panelboard and contain 9, 15, or 21 CTs. Four additional 333mV connections shall be provided on each PXBCM-MMS for Auxiliary 333mV CT connections which can be used to monitor the panel mains or branch circuits. The MMS shall include both load current and voltage metering circuits providing meter data to the Meter Base.
  - .2 The PXBCM Meter Module Strip shall be available with either 9 CT's, 15 CT's or 21 CT's per assembly for factory assembly into Panelboards with 18, 30 or 42 poles. PXBCM MMS CT's shall have be rated for up to 100A continuous current monitoring and designed to mount in an Eaton PRL-1a, or PRL-2a Panelboard with 1 inch breaker pole spacing.
  - .3 PXBCM Meter Module Strip 1 inch center CTs shall have a window opening sufficient for insulated Aluminum conductor rated for 100A capacity
  - .4 The PXBCM Meter Module Strip shall support direct connection of one set of 3 phase nominal metering voltage inputs up to 277V L-N and 480V L-L voltages and shall be rated as Cat III.
  - .5 The Meter Modules can also monitor voltage in the following configurations:
    - .1 Three Phase, four wire wye
    - .2 Three phase, three wire delta
    - .3 Three phase, center tapped delta
    - .4 Three phase, three wire
    - .5 Single phase, two wire
  - .6 Power and Energy metering shall be performed based on the voltage assignment for each 100A strip mounted CT and 333mV Aux CT current input as configured using the embedded WEB server.
  - .7 PXBCM MMS Accuracy of kWh metering on branch circuits shall be rated for ANSI C12.20 0.5 accuracy class as a system, including 100A rated strip mounted solid core current transformers. kWh accuracy for 333mV input auxiliary circuits shall satisfy ANSI C12.20 0.5 class excluding external 333mV sensor performance.
  - .8 The PXBCM MMS shall be UL approved for mounting to the panelboard interior with no interference. Strip placement shall line up 1 inch center CT's with breaker poles and not impede the normal routing of branch circuit conductors in the panel enclosure.

- .1 The PXBCM MMS shall connect to the PXBCM MB using factory supplied cables.
- .2 PXBCM-MME Meter Module External
- .3 The PXBCM-MME provides the same metering functionality as the PXBCM- MMS but is used for retrofit or non-uniform/high-mix load applications where the PXBCM-MMS strip mounted 100A CT's cannot be applied.
- .4 The PXBCM Meter Module external shall support 25 channels of current using external 333mV current sensors connected to terminal strips on the PXBCM- MME.
- .5 The PXBCM Meter Module External shall support direct connection of one set of 3 phase nominal metering voltage inputs up to 277V L-N and 480V L-L voltages and shall be rated as Cat III.
- .6 The Meter Modules can also monitor voltage in the following configurations:
  - .1 Three Phase, four wire wye
  - .2 Three phase, three wire delta
  - .3 Three phase, center tapped delta
  - .4 Three phase, three wire
  - .5 Single phase, two wire
- .7 Power and Energy metering shall be performed based on the voltage assignment for each 333mV current sensor input as configured using the embedded WEB server.
- .8 PXBCM MMS Accuracy of kWh metering on 333mV input circuits shall satisfy ANSI C12.20 0.5 class excluding external 333mV sensor performance.
- .9 Optional HMI Display shall display data for all configured sub-meters.
  - .1 HMI configuration shall not be required for each sub-meter. The HMI shall discover the configuration information automatically.
  - .2 Displayed information shall include;
    - .1 Sub-meter name, current, voltage, energy consumption, demand, and power factor for up to 100 load circuits. Aggregated Power and Energy readings for any 1, 2 or 3 pole meters.
- .7 **Acceptable Manufacturers:** Acceptable Manufacturers are:
  - .1 Eaton Canada

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- .2 Schneider Electric Canada
  - .3 Siemens Electric Canada
  - .4 Approved Equivalent

### **3 EXECUTION**

#### **3.01 INSTALLATION OF BRANCH CIRCUIT PANELBOARDS**

- .1 Provide breaker type branch circuit panelboards where shown. Ensure adequate operation and maintenance clearance on all sides of each panelboard as per Code requirements.
- .2 Unless otherwise specified, supply panelboards from a single manufacturer only.
- .3 Wall mount panelboards independent of connected conduit. Accurately install with reference to wall finish and confirm exact locations prior to roughing-in.
- .4 Where two or more panelboards are installed in one enclosure equip the panelboards with double lugs and increase gutter capacity to accommodate additional cabling.
- .5 In addition to load circuit breakers scheduled and indicated for each normal power panelboard, provide five 15A-1P additional breakers for small power and miscellaneous mechanical loads, each connected with 30 m (100') of 12 mm (½") diameter EMT and two # 12 AWG plus ground, with terminations as directed during construction.
- .6 Provide additional devices and accessories for panelboards as indicated and/or scheduled.
- .7 For each GFI breaker demonstrate in the presence of the Consultant that the protected circuit will trip when a simulated ground fault is applied to the "load" side of the breaker, and meggar the "load" side neutral to ensure that the neutral is not grounded on the "load" side of the GFI.

**End of Section**

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**1 GENERAL**

**1.01 SUBMITTALS**

- .1 **Shop Drawings/Product Data:** Submit shop drawings and product data sheets for all equipment specified in this Section.
- .2 **Test Reports:** Submit signed test reports for all testing work specified in Part 3 of this Section.
- .3 **Manufacturer's Installation Certification Letter:** Submit an installation certification letter from the equipment manufacturer as specified in Part 3 of this Section.

**1.02 QUALITY ASSURANCE**

- .1 **Codes and Standards:** Each ground fault unit is to be in accordance with requirements of the following Codes and Standards:
  - .1 CAN/CSA C22.2 No.144, Ground Fault Circuit Interrupters
  - .2 NEMA PG 2.2, Application Guide to Ground Fault Protection Devices for Equipment
- .2 **Training and Instructions:** As specified in Part 3 of this Section.

**2 PRODUCTS**

**2.01 GROUND FAULT PROTECTION EQUIPMENT**

- .1 Panel mounting (unless otherwise indicated) ground fault protection units(s) supplied by one manufacturer, designed to operate instantaneously at the ground current setting, and with characteristics as indicated on the drawings. Each unit is to be complete with:
  - .1 a ground fault sensing relay for operation at the setting indicated on the drawings, and with 120 volt control voltage
  - .2 an ammeter with a 0 to 5 ampere scale to indicate the ground fault current
  - .3 a 3 position sensitivity control switch to select the value of leakage current at which the relay will operate

an identified indicating LED which is illuminated when no ground fault exists and is extinguished when a ground fault occurs or the unit is tested

- .5 a manual reset switch with manual target indication and SPDT contacts for alarm and trip, and a reset button for the contacts and target
- .6 a zero sequence transformer of a type to suit the conductors involved, with 300 to 3000 mA range
- .7 an artificial neutral and grounding resistor or a neutral ground resistor unit to suit the system

**2.02 ACCEPTABLE MANUFACTURERS:** Acceptable manufacturers are:

- .1 Schneider Electric Canada
- .2 Eaton Canada
- .3 Siemens Canada
- .4 Approved Equivalent

**3 EXECUTION**

**3.01 INSTALLATION OF GROUND FAULT PROTECTION EQUIPMENT**

- .1 Provide ground fault protection equipment for electric service entrance and distribution equipment where shown.
- .2 Where ground fault equipment is to be part of an assembly such as switchgear, arrange for the ground fault equipment to be shipped to the distribution equipment manufacturer's plant for factory installation.
- .3 Ensure that the neutral on the load side of the sensor is not grounded, and that phase conductors including the neutral are installed through the zero sequence transformer.
- .4 Make all required conductor connections with proper terminations in accordance with the ground fault unit manufacturer's instructions and requirements.
- .5 When installation is complete but before the system is energized, arrange for the manufacturer's authorized service representative to visit the site to inspect the installation, check trip settings, test operation of the units including simulated ground faults, and, when the inspections and reports have been satisfactorily completed, checked, and the equipment operates as intended, submit a copy of an inspection certification letter to the Consultant.

**3.02 TRAINING AND INSTRUCTION**

- .1 Ground fault protection equipment operation and maintenance training is to be done by qualified manufacturer's personnel in accordance with requirements specified in the electrical work section entitled Electrical Work General Requirements, and is to consist of a minimum of 2 on-site 4 hour sessions for 6 people per session.

**END OF SECTION**



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**1 GENERAL**

**1.01 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for Solar Photovoltaic (PV) system and each type of product. Ensure that the sheets indicate construction details, material descriptions, dimensions of individual components and profiles, and finished for PV panels.  
Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- .2 **Samples:** If requested, submit samples of products specified in this Section.
- .3 **Shop Drawing:**
  - .1 Include plans, elevations, sections and mounting details.
  - .2 Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - .3 Detail fabrication and assembly.
  - .4 Include diagrams for power, signal and control wiring.

**1.02 QUALITY ASSURANCE**

- .1 All products and equipment are to be CSA certified as a minimum, in accordance with the following standards, as applicable:
  - .1 ANSI/UL 1703 – Flat-Plate Photovoltaic Modules and Panels
  - .2 ANSI/UL 1741 – Standard for Static Inverters and Charge Controllers for use in Photovoltaic Systems – current edition
  - .3 AMSE PTC 50 – Solar PV performance
  - .4 ANSI Z21.83 – Solar PV performance and safety
  - .5 NFPA 853 – Solar PVs near buildings
  - .6 All inverters comply to:
    - .1 CSA-C22.2 No. 107.1-01
    - .2 UL CRD
    - .3 UL 1699B
    - .4 CSA TIL M-07

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- .7 IEEE 929-2000 – Recommended Practice for Utility Interference of Photovoltaic Systems
  - .8 IEEE 1262 – Recommended Practice for Qualification of Photovoltaic Modules
  - .9 IEEE 1547 – Interconnections
  - .10 All applicable National/Provincial Building Codes and requirements (latest edition)
  - .11 Ontario Electrical Safety Code (latest edition)
  - .2 **Acceptable Manufacturers:** Unless otherwise specified in this Section or on the drawings, acceptable manufacturers are:
    - .1 Canadian Solar – PV panels (or approved equal)
    - .2 Fronious Canada – inverters (or approved equal)
  - .3 **Warranty:**
    - .1 Manufacturer’s Special Materials and Workmanship Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
      - .1 Manufacturer’s materials and workmanship warranties include, but are not limited to the following:
        - .1 Faulty operation of PV modules.
        - .2 Faulty operation of Inverters
      - .2 Warranty Period: Five (5) years from date of Substantial Completion.
    - .2 Manufacturer’s Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
      - .1 Manufacturer’s minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:
        - .1 Specified minimum power output of eighty percent (80%) or more, for a period of twenty five (25) years.

## **2 PRODUCTS**

### **2.01 GENERAL**

- .1 Power provided must be compatible with the onsite distribution system, 120/208 VAC.
- .2 Power capacity should be measured at the inverter AC output using the PVUSA Test Conditions (PTC), i.e. 1,000 Watts/m at 22°C ambient temperature and wind speed of 1 m/s.

- .3 The systems must include all hardware needed for the solar PV.
- .4 All systems must be installed in accordance with all applicable requirements of local electrical codes and the Ontario Electrical Safety Code, including but not limited to Article 690, "Solar Photovoltaic Systems" and Article 705, "Interconnected Electrical Power Production Sources".
- .5 Systems must be designed and installed using UL/ULC or ETL listed components, including mounting systems.
- .6 All Balance of Systems (wiring, component, conduits, and connections) must be suited for conditions for which they are to be installed.
- .7 System shall be supplied with lockable DC and AC disconnect switches.
- .8 The AC panel connected to the PV system, as well as the main switchboard and/or metering centre and all branch circuits fed from the same circuit breaker as the PV system shall be clearly labelled with a compliant label indicating the possible danger from alternate power sources.

## **2.02 PV MODULES**

- .1 Acceptable Manufacturers:
  - .1 Canadian Solar – CS3U-365P
  - .2 Or approved equal
- .2 Manufactured Units
  - .1 Cell Materials: Amorphous silicon (a-Si)
  - .2 Cell Materials: Copper indium (di)selenide (CIS)
  - .3 Cell Materials: Copper indium gallium (di)selenide (CIGS)
  - .4 Cell Materials: Cadmium telluride (CdTe)
  - .5 Cell Materials: Cadmium sulphide
  - .6 Cell Materials: Poly Crystalline
    - .1 C-Si
    - .2 Gallium arsenide (GaAs)
  - .7 Module Construction
    - .1 Nominal Size 982mm wide by 1954mm long by 40mm thick (38.7 inches by 76.93 inches by 1.57 inches)
    - .2 Weight: 48.5 lbs (22 kg).

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.8 Module framing:

- .1 PV laminates mounted in anodized extruded-aluminium frames.

**2.03 INVERTERS**

.1 General

- .1 Inverter shall be Non-Islanding type designed to shut down on loss of utility power
- .2 Inverter shall be installed in all-weather enclosure (NEMA 4 or 3R) suitable for exterior location
- .3 Inverters shall be located as indicated on drawings on supporting structures.
- .4 The AC output of all inverters in one building shall be connected to the same distribution panel.

.2 Acceptable Manufacturers:

- .1 Fronious Canada – Symo 10.0-3/208 and Symo 15.0-3/208
- .2 Or approved equal.

.3 Enclosure

- .1 NEMA 250, Type 3R
- .2 Enclosure material: Galvanized steel and/or Steel
- .3 Cooling Methods:
- .1 Fan convection cooling
- .2 Passive cooling
- .4 Protective Functions:
- .1 AC over/under voltage
- .2 AC over/under frequency
- .3 Ground over current
- .4 Over-temperature
- .5 AC and DC overcurrent
- .6 DC over voltage

.4 Disconnects

- .1 Low-voltage disconnect

- 
- .2 Low-voltage reconnect
  - .3 High-temperature disconnect
  - .4 High-temperature reconnect

## **2.04 MOUNTING STRUCTURES**

- .1 General:
  - .1 All structures, including array structures, shall be designed to resist dead load, live load, plus wind and seismic loads to the geographic area.
  - .2 PV system must be able to withstand wind speed of at least 95 mph (150 kph), exposure 4.
  - .3 Thermal loads caused by fluctuations of components and ambient temperatures must be combined with all the above load combinations.
  - .4 All structural components, including array structures, shall be designed in a manner commensurate with attaining a minimum 30 year design life. Particular attention shall be given to the prevention of corrosion at the connections between dissimilar metals.

## **2.05 MONITORING**

- .1 Acceptable Manufacturers
  - .1 Not applicable.
- .2 Enclosure
  - .1 Indoor, NEMA 1
- .3 Power Requirements
  - .1 120 VAC, 60Hz
- .4 Warranty
  - .1 One (1) year
- .5 Programming
  - .1 All programming shall be performed by Authorized Installer and/or by the equipment manufacturer.

## **3 EXECUTION**

### **3.01 INSTALLATION**

- .1 Prior to installation, all design drawings and specifications shall be submitted and approved by the end user.

- .2 Examine substrate areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- .3 Installer shall coordinate work with general building contractor to minimize effect on building construction or operation.
- .4 Installer is responsible for properly sealing all roof and wall penetrations associated with PV system.
- .5 Installer shall not begin installation until mounting surfaces have been properly prepared.
- .6 If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- .7 Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mould damaged.
- .8 Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.
- .9 Installer is responsible for removing all unused material and restoring the location to acceptable condition.

### **3.02 FIELD QUALITY CONTROL**

- .1 The photovoltaic installation shall be performed by Authorized Installer recognized by the photovoltaic manufacturer.
- .2 Perform tests and inspections.
- .3 PV module will be considered defective if it does not pass tests and inspections.
- .4 Prepare test and inspection reports.
- .5 The installing contractor shall designate eight (8) hours for Owner training. Four (4) hours shall be reserved during construction and four (4) hours shall be reserved for Owner maintenance training after construction.
- .6 Acceptance testing shall be done mid-day in sunny conditions.
- .7 Acceptance testing shall verify that all components are functioning correctly and system will produce at least 90% of the expected output for solar conditions at the time of the test.
- .8 Advise Engineer at least 5 working days prior to test. Engineer may be present at acceptance testing and may install their own testing equipment during test.

### **END OF SECTION**

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## **PART 1 GENERAL**

### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.
- B. Generator is pre-tendered and procured by the owner including the engine-generator set, engine, fuel oil storage, control and monitoring, remote cloud monitoring, alternator, breaker, exciter, voltage regulator and enclosure. General Contractor to coordinate with the manufacturer and arrange to receive the generator from the manufacturer on a flat bed, General contractor to arrange for hoisting and installation of the Generator.

### **1.2 SUMMARY**

- A. The Generator Manufacturer shall provide and deliver the Diesel Generator to the site on a flatbed, successful general contractor will be responsible for the lifting, hoisting and installation of the Diesel Generator.

### **1.3 DEFINITIONS**

- A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the engine manufacturer.
- B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
  - 1. Thermal damage curve for generator.
  - 2. Time-current characteristic curves for generator protective device.
  - 3. Sound test data, based on a free field requirement.
  - 4. Prototype Testing Report
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.
  - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.

2. Wiring Diagrams: Control interconnection, Customer connections.

C. Certifications:

1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary emergency application.

### **1.5 INFORMATIONAL SUBMITTALS**

A. Source quality-control test reports.

1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.
2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
3. List of factory tests to be performed on units to be shipped for this project.
4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.

B. Warranty:

1. Submit manufacturer's warranty statement to be provided for this project.

### **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100km of project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer. The supplier must be a reputable manufacturer with a minimum of 50-years of experience in building, designing, and manufacturing generators. The generator manufacturer shall be the original equipment manufacturer (OEM) for the diesel engine, alternator, and all the generator mounted controls.
- D. Comply with the follow local and national code requirements:
  1. NFPA 37 (Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines).
  2. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).



3. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.
  4. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
  5. CSA 282-19 Emergency Electrical Power Supply for Buildings
  6. CSA, B139-19 – Installation Code for Oil-Burning Equipment
  7. NEMA MG1-1998 part 32. Alternator shall comply with the requirements of this standard.
  8. ULC S601-14 – Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids
    - a. ULC S661-10 – Standard for Overfill Protection Devices For Flammable and Combustible Liquid Storage Tanks
  9. ULC S675.2-14 – Standard for Nonvolumetric Precision Leak Detection Devices for Underground and Aboveground Storage Tanks and Piping For Flammable and Combustible Liquids
  10. ULC-S663-11(R2016) – Standard for Spill Containment Devices for Flammable and Combustible Liquid Above Ground Storage Tanks
  11. UL1236 – Battery Chargers
  12. UL2200. The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed. The generator set and all accessories shall be CSA certified.
  13. ANSI S1.13-1971—Measurement of Sound Pressure Levels in Air
- E. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- F. Noise Emission: Comply with Ministry of Environment for maximum noise level at 75dBA@7m due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.
- G. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

## **1.7 PROJECT CONDITIONS**

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
1. Ambient Temperature: -30.0 deg C (-22.0 deg F) to 50.0 deg C (122.0 deg F)

2. Relative Humidity: 0% to 95%
3. Altitude: Sea level to 1640.42 feet (500.0m)

## **1.8 WARRANTY**

- A. . Base Warranty: Manufacturer shall provide base warranty coverage on the material and workmanship of the generator set for a minimum of twenty-four (24) months from completion of generator commissioning. Warranty coverage will be comprehensive and cover all parts, labour and travel. The owner is not to incur any expenses for approved warranty repairs during the 24-month period.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

1. Manufacturers: The equipment shall be produced by a manufacturer who is ISO 9001 certified for design, development, The power system shall be produced by a manufacturer who has produced this type of equipment for a period of at least 10 years and who maintains a service organization available twenty-four hours a day throughout the year.
2. **The generator shall be fully compatible with Power Command Cloud Remote Monitoring System.**

### **2.2 ENGINE-GENERATOR SET**

- A. Factory-assembled and tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
  1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- C. Capacities and Characteristics:
  1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 175kW, at 80 percent lagging power factor, 347/600, Series Wye, Three phase, 3 -wire, 60 hertz.
  2. Alternator shall be capable of accepting a motors starting load of 516.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
  3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.

D. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than **33%** variation for 100% step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within **5** seconds.
3. Steady-State Frequency Operational Bandwidth: 0.25% of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Not more than **20%** variation for 100 % step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within **5** seconds.
6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: Generator sets must use a PMG-excited alternator. For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components.
8. Start Time: Comply with CSA 282, 15-second requirement.
9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

## 2.3 ENGINE

- A. Fuel: ASTM D975 #2 Diesel Fuel
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
  1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
  2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
  3. Crankcase Drain: Arranged for complete gravity drainage with no disassembly and without use of pumps, siphons, special tools, or appliances.

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- D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions.
  - E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
  - F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system.
    - 1. Designed for operation on a single 240 VAC, 3-phase, 60Hz power connection. Heater voltage shall be selected by the generator manufacturer for proper operation based on the engine size.
    - 2. Provided with a thermostat, installed at the engine thermostat housing
  - G. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
  - H. Cooling System: Closed loop, liquid cooled
    - 1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 50 deg C.
    - 2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
    - 3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
    - 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
    - 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  - I. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.
  - J. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
  - K. Starting System: **12V**, as recommended by the engine manufacturer; electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Cycle: As required by CSA C282.
3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.
6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger rated at a minimum of **10A**. It will include the following features:
  - a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
  - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
  - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
  - d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of AC input or DC output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel. These outputs are to be wired to the building's SCADA by the site's contractors if required for the project's scope.
  - e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
  - f. Enclosure and Mounting: NEMA, Type 1, wall-mounted enclosure.

## **2.4 FUEL OIL STORAGE**

- A. Comply with CSA B139-19 code requirements.

- B. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 142 and ULC S601 listed and labeled. The fuel tank shall include the following features:
1. Capacity: Minimum of 2,793 Liters of usable fuel for 48-hours of operation at 100% load.
  2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
  3. Electrical stub up(s)
  4. Normal & emergency vents
  5. Mechanical fuel level gauge
  6. Low-level Switch
    - a. Low level switch is to be wired to the generator's controller to provide a warning alarm if the fuel tank level is below 40%.
  7. High Fuel Alarm Panel
    - a. Fuel alarm panel is to be ULC approved per the code requirements in Section 1.6.
    - b. High-level float switch is to be provided and wired to the panel to indicate the fuel level has reached 90% of the fuel tank capacity during filling.
  8. Leak detector switch
    - a. Leak detector switch is to be wired to the generator's controller to provide a warning alarm if the fuel tank level is below 40%.
  9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
  10. 3.5-gallon (13.24L) spill container with lockable/tamper proof fuel fill access.
    - a. Spill container is to be ULC approved per the code requirements in Section 1.6.
    - b. Container must be made of 16 gauge spun steel and power coated to prevent rusting.
  11. Tank design shall meet CSA B139 (latest edition) and the regional requirements for the project location.

## **2.5 CONTROL AND MONITORING**

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- B. Automatic Starting System Sequence of Operation: When mode-selector button on the control panel is pressed for "Auto", remote-control contacts in one or more separate automatic transfer switches initiate

starting and stopping of generator set. The “STOP” button initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

- C. Manual Starting System Sequence of Operation: Selecting the “Manual” then “Start” button on the generator control panel starts generator set. The “STOP” button initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.
- E. Indicating and Protective Devices and Controls:
  - 1. AC voltage (3-phase, line to line and line to neutral values).
  - 2. AC amperage (3-phases).
  - 3. AC frequency
  - 4. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
  - 5. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
  - 6. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
  - 7. DC voltage (alternator battery charging).
  - 8. Engine-coolant temperature gauge.
  - 9. Engine lubricating-oil pressure gauge.
  - 10. Engine hour-meter.
  - 11. Fuel tank alarms:
    - a. Low fuel level
    - b. Leak detection/Rupture basin

12. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR over current, loss of voltage reference, and over excitation shut down protection. There shall be a overload warning, and overcurrent warning alarm.
13. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
14. A display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
15. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
16. Data Logging: The control system shall log the latest 32 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
17. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

## **2.6 REMOTE CLOUD MONITORING**

- A. Provide a cloud based remote monitoring system/module with the supply of the generator.
  1. The system shall provide means of remote monitoring generator sets and transfer switches via a website and an APPLE IOS/ANDROID phone app.
    - a. The device shall support monitoring a minimum of 2 and up to a maximum of 5 individual devices per customer location.
    - b. Access to the cloud-based website or app shall be free of charge to the end user. There shall be no fees, set-up charges or monthly subscriptions associated with this service.
  2. The hardware shall be 4G LTE cellular (with 2G or 3G fallback), LAN and Wi-Fi (WPA2/PSK/CCMP, 2.4GHZ, AES-128 encryption) capable.
    - a. Dynamic Host Configuration Protocol (DHCP) capability is required.
    - b. Communication from the device to the generator and ATS shall be over Modbus RS-485. Shielded twisted pair cable, Belden 9729 or equivalent wiring must be compatible with the device.
    - c. Any additional protocol conversion modules that may be required to communicate between the cloud monitoring device and the generator/transfer switch shall be included.



- d. Power requirements for the device must be 9 – 32VDC and is to be provided via B+ connections from the generator's batteries.
  - e. Firmware updates by the manufacturer must be available via Firmware over the Air (FOTA) protocol. Firmware is to be pushed via the cloud network and updates are to be installed either during the next power cycle or automatically after two weeks.
  - f. Device shall have five configurable digital inputs and four configurable analog inputs available for monitoring customer equipment or additional generator and transfer switch information.
3. The cloud-based website or APP shall provide the following functionalities for the end user:
- a. A single account that has a list and a live location map on the home page of the different individual locations/sites where the monitored equipments are installed.
    - i. The status (warning, fault/shutdown, online/offline) of each generator or transfer switch shall be easily identifiable on the equipment list or map without the need to click on each individual equipment and navigating to another page.
  - b. The customer's accounts shall have the following user role capabilities and permissions:
    - i. Account Owner –View, add, edit, and delete access for various account and site permissions.
    - ii. Account Manager – View, add, edit, and delete access for various account permissions (except Account Owner) and site permissions.
    - iii. Service Operator – View only access for account permissions. View, add, edit, and delete access for site permissions.
    - iv. Read Access – View only access for account and site permissions.
  - c. A list of active and past/acknowledged events per device that records warning, shutdowns, and information per generator or transfer switch. Acknowledged events shall be available for a minimum of 30-days. Active events shall display and store a minimum of 100 events. All data logs shall be exportable for reports and records purposes.
  - d. Readouts of the analog and digital inputs that are connected to the remote monitoring device.
  - e. The remote monitoring device's model number, software version and recent loss of communication event logs.
    - i. Additional capabilities include remotely restarting the gateway, manual software update installations, and password resets.
  - f. Individually listed generator or transfer switch with model and serial number information per equipment. Each individual equipment shall have its's own product page with the following capabilities:

- i. The capability to manually start/stop the generator and reset any faults at the generator controller.
- ii. Live display of alternator data including but not limited to: Voltage (L-L & L-N), Current, Frequency, Total KVA, Total kW, Total kWh, and Total Power Factor
- iii. Live display of engine data including but not limited to: Battery Voltage, Engine Speed, Coolant Temperature, Oil Temperature, Oil Pressure, Fuel Level (if configured), Fuel Rate and Engine Run Time.
- iv. The capability to perform a transfer test to the generator and back to utility and reset any faults on the transfer switch controller.
- v. Live display of the current connected source (Source 1 – Utility or Source 2 – Generator), and the status of each source's availability.
- vi. Live display of Source 1 and Source 2 data including but not limited to: Voltage (L-L & L-N), Frequency, Current, Total Power Factor, Total KVA, and Total KVAR.
- vii. Each equipment page shall have an annunciator data with displays of NFPA110 and NFPA110 Extended alarms and warning listed. Each alarm or warning shall have the ability for colour identification based on the severity of the alarm (green for normal events, amber for warning alarms and red for faults).
- g. Data trending to graphically plot or create reports for generator and transfer switch parameters over a preset duration (past 1-hour, past 24-hours, 7-days or 30-days).
- h. Exercise scheduler to start and stop the generator with no load. Schedule can be set for: one time, daily, weekly biweekly, and monthly. Start date and timer selection capabilities shall be available for this function.
- i. Maintenance reminders that can be programmed based on date/time or engine run hours. This function shall have the capability to email selected users of the account with details of the maintenance requirement.

## **2.7 ALTERNATOR, BREAKER, EXCITER, AND VOLTAGE REGULATOR**

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 105°C / Class F environment.

- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125% of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Enclosure: Drip-proof.
- H. Voltage Regulator: SCR type, Separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 10% maximum, based on the rating of the engine generator set.
- K. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).
- L. A comprehensive monitoring and control system integral to the generator's control system that guards the electrical integrity of the alternator and power system by providing protection against a wide array of fault conditions in the generator set or in the load. It also provides single and three phase fault current regulation so that downstream protective devices have the maximum current available to quickly clear fault conditions without subjecting the alternator to potentially catastrophic failure conditions. Thermal damage curve (3-Phase short) or fixed timer (2 sec for 1-Phase short, 5 sec for 2-Phase short). The system is a time-based generator protection applicable to both line-to-line and line-to-neutral, that can detect an unbalanced fault condition and swiftly react appropriately. Balanced faults can also be detected by the system and appropriately acted upon.
- M. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current at 0.8pF of the generator set on a continuous basis. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided. The breaker shall be provided  
  
based on the size and electronic trip requirements (thermal magnetic available for a 150kW) as shown in the single line diagram.
- N. The generator shall be provided with a second load bank circuit breaker used for load testing purposes only at 1.0PF. The breaker shall be provided with a 12V shunt trip contact. This contact is to be wired to the site's transfer switch "Loss of Utility" output contact to automatically trip the load bank breaker in the case

of a utility power loss during testing and to prevent a shutdown of the generator due to overload conditions.

## **2.8 OUTDOOR GENERATOR-SET ENCLOSURE**

- A. Description: Sound attenuated aluminum housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- B. Construction:
  - 1. Hinged Doors with padlocking provisions.
  - 2. Exhaust System:
    - a. Muffler to be located within the enclosure but in a separate compartment located behind the radiator discharge area.
    - b. Exhaust shall terminate within the enclosure housing with adequate grates above to allow for proper exhaust flow dispersion.
  - 3. Hardware: All hardware and hinges shall be stainless steel.
  - 4. Wind Rating: Wind rating shall be 150 mph
  - 5. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
  - 6. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 50 deg C.
  - 1. Radiator discharge shall be vertical.
  - 2. Louvers shall be motorized on the air inlet.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 75 dBA measured at any location 7 m from the engine generator in a free field environment.
- E. Site Provisions:
  - 1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.
- F. Enclosure Electrical:
  - 1. Provide circuit breakers within the enclosure to isolate or disconnect power to the various generator auxiliary equipment. Breaker quantity and size as recommended by the generator manufacturer's

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engineered calculations for the items below – including battery charger, coolant heater, oil heater and high fuel alarm panel.

- a. Main power supply to be 50A, 120V/240V, single phase that is to be terminated at a designated terminal block within the AC electrical section of the generator controller.
- b. DC light meeting CSA C282 requirements with its own battery back-up or wired to the generator batteries. DC light to have a switch for manual operation.
- c. Space heater, rated at 240V, to adequately keep the enclosure at 10°C at all times.

## **2.9 VIBRATION ISOLATION DEVICES**

- A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

## **2.10 FINISHES**

- A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color will be provided.

## **2.11 SOURCE QUALITY CONTROL**

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
  1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110.
- B. Project-Specific Equipment Tests: Before shipment, the generator shall have a factory certified test report completed and available for engineering review. Prior to shipment of the generator to site – a factory witness test of the generator set manufactured specifically for this project will be conducted. Perform tests at rated load and unity power factor. If a certified test report is not provided showing the alternator had been tested at 0.8pF then a reactive load bank test will be required. Include the following tests:
  1. Test engine generator set manufactured for this project to demonstrate compatibility and functionality.
  2. Full load run for 4-hours.
  3. Transient load steps for voltage, frequency, and kW. Load steps are as follows:
    - a. 0% - 25% - 0%
    - b. 0% - 50% - 0%
    - c. 0% - 75% - 0%
    - d. 0% - 100% - 0%

- 4. Simulated safety shutdowns.
- C. Factory testing may be witnessed by the owner and consulting engineer. Costs for travel, meals, and overnight accommodation expenses will be the responsibility of the owner and consulting engineer. Generator supplier is responsible to provide two weeks' notice for testing.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with CSA C282.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the generator manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.
- H. All CSA B139 and TSSA approvals/variances required for filling of the fuel tank is to be arranged by the contractor.

### **3.2 ON-SITE ACCEPTANCE TEST**

- A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system.

B. Tests shall include:

1. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
  2. Installation acceptance tests to be conducted on site shall include a “cold start” test, a four hour full load (resistive) test, and safety shutdown testing. Provide a resistive load bank and make temporary connections for full load test.
- C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service and observing proper operation of the system for at least 1-hour per CSA C282. Coordinate timing and obtain approval for start of test with site personnel.

### **3.3 TRAINING**

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

### **3.4 FIELD QUALITY CONTROL**

- A. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

**End of Section**

## **1 GENERAL**

- .1 ATS is pre-tendered and procured by the owner, General Contractor to coordinate with the manufacturer and arrange to receive the ATS from the manufacturer on a flat bed, General contractor to arrange for hoisting and installation of the ATS as per manufacturer's instructions.

### **1.02 REFERENCES**

- .2 CSA International
  - .1 CSA C22.2 No.5-, Moulded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, NMX-J-266-ANCE-2010).
  - .2 CSA C22.2 No.178.1-, Automatic Transfer Switches.
  - .3 CAN/CSA C60044-1-, Instrument Transformers.
- .3 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA ICS 2-, Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC, Part 8: Disconnect Devices for Use in Industrial Control Equipment.

### **1.03 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Submit in accordance with Section 01330 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for transfer switches and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
  - .1 Submit drawings

## **2 PRODUCTS**

### **2.01 SYSTEM DESCRIPTION**

- .1 Automatic load transfer equipment to:
  - .1 Monitor voltage on phases of normal power supply.
  - .2 Initiate cranking of standby generator unit on normal power failure or abnormal voltage on any one phase below preset adjustable limits for adjustable period of time.
  - .3 Transfer load from normal supply to standby unit when standby unit reaches rated frequency and voltage pre-set adjustable limits.
  - .4 Transfer load from standby unit to normal power supply when normal power restored, confirmed by sensing of voltage on phases above adjustable pre-set limit for adjustable time period.
  - .5 Shut down standby unit after running unloaded to cool down using adjustable time delay relay.



## **2.02 MATERIALS**

- .1 Instrument transformers: to CAN/CSA C60044-1.
- .2 Contactors: to NEMA ICS2.

## **2.03 CONTACTOR TYPE TRANSFER EQUIPMENT**

- .1 Contact Type Transfer Equipment: to CSA C22.2 No.178.1.
- .2 Two - 4 pole contactors mounted on common frame, in double throw arrangement, mechanically and electrically interlocked, motor solenoid operated, open type with CSA enclosure.
- .3 Rated: 208 V, 60Hz, 400 A. 4 wire, solid neutral.
- .4 Main contacts: silver surfaced, protected by arc disruption means.
- .5 Switch and relay contacts, coils, spring and control elements accessible for inspection and maintenance from front of panel without removal of switch panel or disconnection of drive linkages and power conductors.
- .6 Auxiliary contact: gold plated, to initiate emergency generator start-up on failure of normal power.
- .7 Fault withstand rating: 35 kA symmetrical for 3 cycles with maximum peak value of 35 kA.
- .8 Lever to operate switch manually when switch is isolated.
- .9 Neutral bar, solid rated: 400 A.
- .10 Overlapping neutral contacts on contactor type transfer equipment.

## **2.04 CIRCUIT BREAKER TYPE TRANSFER EQUIPMENT**

- .1 Circuit Breaker Type Transfer Equipment: to CSA C22.2 No.5.
- .2 Rated: 208 V, 60Hz, 400 A, 4 wire, solid neutral.
  - .1 Fault withstand rating: 35 kA symmetrical for 3 cycles with maximum peak value of 35 kA.
  - .2 One normal - 3 pole moulded-case circuit breaker with thermal magnetic, mounted on common base, designed for double throw action, motor operated, mechanically held and interlocked.
  - .3 One emergency - 3 pole moulded-case circuit breaker with thermal magnetic trip, motor operated, and interlocked.
  - .4 Circuit breakers:
    - .1 Trip free in closed position.
    - .2 Interrupting rating: 35 A symmetrical.
  - .5 Dead front construction with access to relays and controls for inspection and maintenance, and manual operating lever for transfer switch.

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- .6 Auxiliary contact: to initiate emergency generator start-up on failure of normal power.
  - .7 Solid neutral bar, rated: 400 A.
  - .8 Overlapping switchable neutral pole on circuit breaker type equipment.

## **2.05 CONTROLS**

- .1 Selector switch - 4 position "Test", "Auto", "Manual", "Engine start".
  - .1 Test position - normal power failure simulated. Engine starts and transfer takes place. Return switch to "Auto" to stop engine.
  - .2 Auto position - normal operation of transfer switch on failure of normal power; retransfers on return of normal voltage and shuts down engine.
  - .3 Manual position - transfer switch may be operated by manual handle but transfer switch will not operate automatically and engine will not start.
  - .4 Engine start position - engine starts but unit will not transfer unless normal power supply fails. Switch must be returned to "Auto" to stop engine.
- .2 Control transformers: dry type with 120 V secondary to isolate control circuits from:
  - .1 Normal power supply.
  - .2 Emergency power supply.
- .3 Relays: continuous duty, industrial control type, with wiping action contacts rated 10 A minimum:
  - .1 Voltage sensing: 3 phase for normal power and on one phase only for emergency, solid state type, adjustable drop out and pick up, close differential, 2 V minimum undervoltage and over voltage protection.
  - .2 Time delay: normal power to standby, adjustable solid state, 0 to 60 s to 180 s 20 s to 10 minutes.
  - .3 Time delay on engine starting to override momentary power outages or dips, adjustable solid state, 0 to 60 s 3 to 20 s delay.
  - .4 Time delay on retransfer from standby to normal power, adjustable 0 to 60 s 5 to 180 s 20 s to 10 minutes.
  - .5 Time delay for engine cool-off to permit standby set to run unloaded after retransfer to normal power, adjustable solid state, 0 to 60 s 5 s intervals to 180 s 20 s intervals to 10 minutes.
  - .6 Time delay during transfer to stop transfer action in neutral position to prevent fast transfer, adjustable, 5 s intervals to 180 s.
  - .7 Frequency sensing, to prevent transfer from normal power supply until frequency of standby unit reaches preset adjustable values.
  - .8 Neutral disconnected position delay: allow time for motors to delay between live sources, adjustable, 0 to 5 s.
- .4 Solid state electronic in-phase monitor.

## **2.06 ACCESSORIES**

- .1 Ensure pilot lights indicate power availability normal and standby, switch position, green for normal, red for standby, mounted in panel.
- .2 Auxiliary relay to provide 2 N.O. and 2 N.C. contacts for remote alarms.
- .3 Manual bypass and isolator: to normal supply.

## **2.07 EQUIPMENT IDENTIFICATION**

- .1 Identify equipment in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Control panel:
  - .1 For selector switch and manual switch: size 5 nameplates.
  - .2 For meters, indicating lights, minor controls: use size 3 nameplates.

## **2.08 SOURCE QUALITY CONTROL**

- .1 Complete equipment, including transfer mechanism, controls, relays and accessories factory assembled and tested in presence of Consultant.
- .2 Notify Consultant 10 days minimum in advance of date of factory test.
- .3 Tests:
  - .1 Operate equipment both mechanically and electrically to ensure proper performance.
  - .2 Check selector switch, in modes of operation Test, Auto, Manual, Engine Start and record results.
  - .3 Check voltage sensing and time delay relay settings.
  - .4 Check:
    - .1 Automatic starting and transfer of load on failure of normal power.
    - .2 Retransfer of load when normal power supply resumed.
    - .3 Automatic shutdown.

## **3 EXECUTION**

### **3.02 INSTALLATION**

- .1 Locate, install and connect transfer equipment as indicated.
- .2 Check relays solid state monitors and adjust as required to ensure correct operation.
- .3 Install and connect battery and remote alarms.
- .4 Connect to Solar Inverters to disable inverters when generator is running.

### **3.03 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Energize transfer equipment from normal power supply.
- .3 Set selector switch in "Test" position to ensure proper standby start, running, transfer, retransfer. Return selector switch to "Auto" position to ensure standby shuts down.

- .4 Set selector switch in "Manual" position and check to ensure proper performance.
- .5 Set selector switch in "Engine start" position and check to ensure proper performance. Return switch to "Auto" to stop engine.
- .6 Set selector switch in "Auto" position and open normal power supply disconnect. Standby should start, come up to rated voltage and frequency, and then load should transfer to standby. Allow to operate for 10 minutes, then close main power supply disconnect. Load should transfer back to normal power supply and standby should shutdown.
- .7 Repeat, at 1 hour intervals, 3 times, complete test with selector switch in each position, for each test.

**End of Section**

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## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for lighting fixtures. Include certified fixture photometric data which includes total input watts, candlepower summary, candela distribution zonal lumen summary, CIE type coefficient of utilization, and lamp type and lumen rating in accordance with CSA IESNA testing procedures.
- .2 **Lighting Fixture Colour(s):** For all lighting fixtures where the colour is to be selected after award of the Contract, submit colour charts and obtain fixture colour information in writing prior to ordering.
- .3 **Spare Lamps:** Submit spare lamps as specified in Part 3 of this Section.

### **1.02 QUALITY ASSURANCE**

- .1 All lighting fixtures are to be ULC listed and/or CSA certified and labelled.

## **2 PRODUCTS**

### **2.01 GENERAL RE: LIGHTING FIXTURES AND LAMPS**

- .1 Lighting fixtures and lamps are scheduled on the drawings.
- .2 **Lighting Fixture Construction:** Unless otherwise specified the following requirements apply to lighting fixture construction:
  - .1 bodies are to be constructed of minimum #20 gauge cold rolled prime coat steel, of rigid construction and complete with knockouts as required
  - .2 fixtures are to be suitable in all respects for the mounting locations indicated on the drawings, and are to be complete with all required mounting hardware
  - .3 any fixture located in a high humidity area, i.e. swimming pool areas, must be gasketed and corrosion-resistant, regardless of what is selected on the fixture schedule
  - .4 unless otherwise specified, any fixture operated by means of a ballast must be equipped with its own ballast
- .3 **Lighting Fixture Finish:** Unless otherwise specified, lighting fixtures are to be finished in two coats of spray applied baked white enamel applied to chemically degreased and neutralized surfaces. Reflecting surfaces are to be white with a reflectance of minimum 85%. Confirm exact colour and finish of fixtures at the submittals stage and prior to ordering.
- .4 **Lamps:** Unless otherwise specified, lamps are specified/scheduled with the fixtures they are associated with. Lamps are specified in the Section entitled Ballasts, Lamps, Lenses and Louvres.

- .5 **Lenses/Louvres:** Unless otherwise specified, lenses/louvres are scheduled with the fixtures they are associated with. Lenses/louvres are specified in the Section entitled Ballasts, Lamps, Lenses and Louvres.

### **3 EXECUTION**

#### **3.01 INSTALLATION OF LIGHTING FIXTURES**

- .1 **General Installation Requirements:** Provide lighting fixtures and lamps where shown. Include for all required site assembly, and provide all required installation and support hardware. Additional requirements are as follows:
  - .1 confirm exact lighting fixture locations prior to roughing-in
  - .2 in finished areas, refer to architectural reflected ceiling plans and/or wall elevations
  - .3 in equipment rooms, shafts, and similar unfinished areas, install fixtures after the equipment is roughed-in, and shelving and similar items are installed, and do not suspend fixtures from piping, ductwork, conduit equipment, or similar items
  - .4 prior to roughing-in for lighting fixture installations, examine drawings and site conditions to determine that suitable space is available for the fixture installation as shown. If sufficient space is not available, notify the Consultant immediately and, if required, relocate the fixtures within reasonable distances without additional cost
  - .5 locate recessed downlights, troffers, and surface mounted fixtures in or on suspended tile ceilings in or on full tiles, and where ceiling tile openings are cut for fixtures, cut to exact sizes so that there are no gaps, and fixture trim completely covers the perimeter of the opening
  - .6 provide plaster frames for fixtures in suspended plaster or drywall ceilings
  - .7 use clean gloves when handling reflector cones, louvres, halogen lamps, glass sconces, and all exposed surfaces of fixtures.

#### **3.02 SUSPENDED LIGHTING FIXTURES**

- .1 Support all lighting fixtures in suspended ceilings from the slab or building construction above, independent of the suspended ceiling construction. Support 1.2 m (4') fluorescent fixtures with a minimum of 2 aircraft type cable supports or 2 #3 Tensos Chains. Support HID or incandescent fixtures with 1 #3 Tensos Chain or 1 aircraft type cable. All supports are to be in accordance with requirements of governing Codes and Regulations.
- .2 Support continuous rows of fixtures at minimum 1.2 m (48") centres.

### **3.03 LIGHTING FIXTURES IN FIRE RATED CEILING CONSTRUCTION**

- .1 Where lighting fixtures penetrate a fire rated ceiling they are to be enclosed in an enclosure with a rating to match that of the ceiling. The enclosure is to be constructed by the trade constructing the ceiling. Ensure that conductors connecting the fixtures are fire rated type and that ceiling penetrations for conductors are properly sealed with fire stopping and smoke seal material. Fixtures installed in the fire rated enclosures are to be equipped with thermal overload protection.

### **3.04 LIGHTING FIXTURES ALIGNMENT**

- .1 Align lighting fixtures mounted in continuous rows to form straight uninterrupted lines. Alignment variation is not to exceed 6 mm ( $\frac{1}{4}$ " ) in any 5 m (15') run.
- .2 Align lighting fixtures mounted individually parallel and/or perpendicular to building lines.
- .3 Aim accent and spot lighting as indicated and/or as directed by the Consultant, and secure the fixture positions after the Consultant's approval.

### **3.05 LIGHTING FIXTURES CIRCUIT WIRING**

- .1 Connect lighting fixtures to circuits indicated with wiring as shown/specified.
- .2 Minimize the number of splices required.

### **3.06 CLEANING**

- .1 When all lighting fixture installation work is complete, clean all fixtures and lamps, and any ceiling, wall, etc., surfaces soiled as a result of the fixture installation work.
- .2 If wall and ceiling surfaces are damaged as a result of the fixture installation, replace the wall or ceiling surface to the Consultant's approval.

**END OF SECTION**

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## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Product Data:** Product data submittal requirements are as follows:
  - .1 submit product data sheets for lighting fixtures, and include certified horizontal and vertical beam spread, beam lumens, beam efficiency, complete photometric data which includes total input watts, candlepower summary, candela distribution zonal lumen summary, CIE type, coefficient of utilization, and lamp type and lumen rating in accordance with CSA IESNA testing procedures.
  - .2 for floodlighting fixtures, computer printout for aiming angles.
  - .3 for pole mounted fixtures, submit documentation to confirm that the poles proposed are suitable for the steady wind velocity and wind gust velocity data for the area of installation, and for the total weight and project area of the fixtures.
  - .4 submit complete design and construction shop drawings for pole mounted fixture concrete bases, prepared, stamped and signed by a Professional Structural Engineer registered in the place of the work.
- .2 **Lighting Fixture and Accessory Colour(s):** For all lighting fixtures and accessories where the colour is to be selected after award of the Contract, submit colour charts and obtain fixture and accessory colour information in writing prior to ordering.
- .3 **Spare Lamps:** Submit spare lamps as specified in Part 3 of this Section.

### **1.02 QUALITY ASSURANCE**

- .1 All lighting fixtures and lamps are to be ULC listed and/or CSA certified and labelled.

## **2 PRODUCTS**

### **2.01 GENERAL RE: LIGHTING FIXTURES**

- .1 Lighting fixtures and lamps are scheduled on the drawings.
- .2 All lighting fixtures are to be completely weatherproof, non-corrosive, suitable in all respects for the mounting locations indicated on the drawings and are to be complete with all required mounting hardware.
- .3 Unless otherwise specified, any fixture operated by means of a ballast must be equipped with its own ballast.
- .4 Confirm exact colour and finish of lighting fixtures at the submittals stage and prior to ordering.

### **2.02 POLES**

- .1 **Concrete Poles:** Reinforced, pre-stressed, round, tapered, spun concrete pole, plain grey finish, designed for underground wiring and for direct bury, sized as indicated on the drawings, and



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complete with an access hand hole with frame and cover for wiring connections 450 mm (18") above grade, and a suitably sized grounding lug.

- .2 **Steel Poles:** Hot dipped galvanized, minimum 4.5 mm (  $\frac{1}{8}$ " ) thick steel, round or octagonal monotube style poles sized as indicated on the drawings, designed for underground wiring and mounting on a concrete base. Unless otherwise specified poles are to be tapered and complete with an access hand hole with frame and cover for wiring connections 450 mm (18") above grade, a minimum of four non-corrosive anchor bolts and nuts with shims and tamper-proof covers, and a suitably sized grounding lug.
- .3 **Aluminium Poles:** G063-T6 aluminium, minimum 3 mm (3/16") thick, round or octagonal monotube style poles sized as indicated on the drawings, designed for underground wiring and mounting on a concrete base. Unless otherwise specified poles are to be tapered and complete with an access hand hole with frame and cover for wiring connections 450 mm (18") above grade, a minimum of four non-corrosive anchor bolts and nuts with shims and tamper-proof covers, and a suitably sized grounding lug.

## **2.03 LIGHTING FIXTURE MOUNTING BRACKETS**

- .1 Corrosion-resistant metal brackets, cantilevered without under-braces, of sizes and styles specified with the fixtures they are required for, and complete with all required non- corrosive mounting and connection hardware.

## **3 EXECUTION**

### **3.01 INSTALLATION OF EXTERIOR LIGHTING FIXTURES**

- .1 Provide exterior lighting fixtures where shown and in accordance with the drawing schedule. Include for all required site assembly, and provide all required installation and support hardware.
- .2 Confirm exact lighting fixtures locations prior to roughing-in.
- .3 Secure grade mounted building floodlighting fixtures to concrete pads set flush with finished grade.

### **3.02 INSTALLATION OF LIGHTING FIXTURES POLES**

- .1 Provide poles with mounting brackets for pole mounted lighting fixtures. For direct bury concrete poles, backfill the excavation around the pole with concrete.
- .2 Secure metal poles to reinforced concrete bases. Install pole anchor bolt support hardware in the base concrete during the pour, and ensure that the hardware is properly positioned and remains properly positioned until concrete has set. Provide vandal-proof anchor bolt covers.
- .3 Refer to pole concrete base detail indicated on the drawings.
- .4 Ensure that all poles are true and plumb.

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**3.03 CONCRETE, EXCAVATION AND BACKFILL WORK**

- .1 Carefully coordinate concrete and excavation and backfill work with the trades performing the work.
- .2 Perform all required concrete and excavation and backfill work in accordance with requirements of Division 03 and Division 31.

**3.04 LIGHTING FIXTURES ALIGNMENT**

- .1 Aim and align building floodlighting and/or spotlighting during evening hours under the direction and to the approval of the Consultant, and secure the fixture positions after the Consultant's approval.

**3.05 LIGHTING FIXTURES CIRCUIT WIRING**

- .1 Connect lighting fixtures to circuits indicated with wiring as specified. Install wiring in conduit.
  - .2 Minimize the number of splices required.
- .3 Connect metal parts of poles with ground conductors connected to the building grounding system.

**3.06 CLEANING**

- .1 When all lighting fixtures installation work is complete, clean all fixtures and lamps, and surfaces soiled as a result of the fixture installation work.
- .2 If building surfaces are damaged as a result of the fixture installation, repair the surface to the Consultant's approval.

**END OF SECTION**

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## **1 GENERAL**

### **1.01 SUBMITTALS**

- .1 **Product Data:** Submit product data sheets for emergency lighting. Include complete battery charger data, battery charger and discharge voltage/time characteristics, and, where required, certified wiring diagrams.
- .2 **Battery Warranty:** Submit a copy of the battery warranty specified below, and include a copy in the O & M Manual.
- .3 **Letter of Certification:** As per Part 3 of this Section, submit a letter from the representative of the emergency lighting manufacturer to certify that the installation has been tested and adjusted and operates as intended.

### **1.02 QUALITY ASSURANCE**

- .1 All emergency lighting is to be CSA certified in accordance with:
  - .1 CSA C22.2 No. 141, Unit Equipment for Emergency Lighting
  - .2 UL 924, Standard for Emergency Lighting and Power Equipment
  - .3 CSA C22.2 No. 107.2, Battery Chargers

### **1.03 WARRANTY**

- .1 For batteries, the Contract warranty is to be extended to ten years with no-charge replacement during the first five years, and a pro-rate charge during the last five years. Submit a signed copy of the warranty in the name of the Owner.

## **2 PRODUCTS**

### **2.01 SELF-CONTAINED EMERGENCY LIGHTING UNITS**

- .1 Lumacell Inc. Model RG123S200 solid-state, factory assembled and tested, 120 volt AC input, 12 volt DC output, battery operated emergency lighting units, each capable of supplying the specified load for the length of time indicated, and to automatically shut-off. Or approved equal. Each unit is to be complete with:
  - .1 a white enamelled steel cabinet suitable for shelf or direct wall mounting, with conduit knock-outs and a removable or hinged front panel for battery access
  - .2 white enamelled steel mounting and support hardware to suit installation locations indicated
  - .3 a sealed, maintenance-free battery in a high-impact, heat resistant translucent plastic casing
  - .4 a multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected pulse type battery charger with a regulated output of  $\pm 0.01$  volts

for  $\pm 10\%$  input variations, transfer circuit, solid-state modular low voltage disconnect to operate at 80% battery output voltage, and a suitable length of 3-wire power cord with "twist-lock" plug

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- .5 signal lights for "AC POWER ON" and red "HIGH CHARGE", an ammeter and a voltmeter, a test switch, time delay relay, battery disconnect device, RFI suppressors, and AC input and DC output terminal blocks inside the cabinet
  - .6 cabinet mounted, dual, adjustable (345° horizontal and 180° vertical) lamp heads, integral with the cabinet and/or remote mounting as indicated, each complete with a 13 watt tungsten-halogen glare-free lamp
  - .7 Lumacell Inc. Model MT1 remote surface mounted lamp head with a 12 volt DC 9 watt tungsten-halogen lamp or approved equal.
  - .8 Lumacell Inc. Model MT1 remote recess mounted lamp head with a 12 volt DC 25 watt tungsten-halogen lamp or approved equal.
  - .9 where indicated, a wire guard
- .2 Acceptable manufacturers are:
- .1 Lumacell Inc.
  - .2 Emergi-Lite Ltd.
  - .3 Hubbell Inc. "Dual-Lite"
  - .4 Philips "LightGuard"
  - .5 Beghelli
  - .6 Approved Equivalent

### **3 EXECUTION**

#### **3.01 INSTALLATION OF SELF-CONTAINED EMERGENCY LIGHTING UNITS**

- .1 Provide self-contained emergency lighting units where shown. Include for all required site assembly, provide all required installation and support hardware, and plug the assemblies into adjacent receptacles. Confirm exact locations prior to installation.
- .2 Where remote lamp heads are indicated, install and connect to the battery unit with conductors (sized as indicated) in conduit. Ensure that panelboard breakers serving battery units are equipped with lock-on devices.
- .3 Connect exit light 12 volt DC lamp holders to battery units with wiring in conduit as indicated.
- .4 Provide all required lamps.
- .5 Aim all adjustable lamp heads to the Consultant's approval.
- .6 When all installation work is complete, clean all battery units, lamp heads, and lamps, and any ceiling, wall, etc., surfaces soiled as a result of the installation work.

- .7 If wall and ceiling surfaces are damaged as a result of the installation, replace the wall or ceiling surface to the Consultant's approval.
- .8 Test operation of each battery unit, including charge rate after discharge, in the presence of the manufacturer's representative, and submit a letter from the manufacturer's representative to certify that all battery units and lamp heads have been tested and operate as intended.

**END OF SECTION**

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**1 GENERAL**

**1.01 SUBMITTALS**

- .1 **Shop Drawings/Product Data:** Submit product data sheets for exit lighting fixtures.

**1.02 QUALITY ASSURANCE**

- .1 All exit lighting fixtures are to be CSA certified in accordance with:
- .1 CAN/CSA- C22.2 No. 141, Unit Equipment for Emergency Lighting
  - .2 CAN/CSA- C860, Performance of Internally-Lighted Exit Signs

**2 PRODUCTS**

**2.01 EXIT LIGHTS**

- .1 Recessed, wall end to wall, or ceiling mounted, single or double face exit lights as indicated, complete with directional arrows as shown, 120 volt maximum five watt LED'S designed for a minimum of 50,000 hours of continuous operation without re-lamping and located so as to be visible, all required mounting accessories, and the following:
- .1 an average exit legend illumination level of 15 cd/m<sup>2</sup>
  - .2 an emergency power source
  - .3 unless otherwise specified, a 1.0 mm (1/25") thick satin aluminium, enamel finish cold rolled steel, or brush finish extruded or die-cast aluminium housing, all as per the drawing schedule
  - .4 unless otherwise specified, white enamelled die-formed cold rolled steel or cast aluminium alloy back and/or face plates, as per the drawing schedule
  - .5 minimum 150 mm (6") high, 20 mm (¾") wide red "EXIT" lettering, or "EXIT" and "SORTIE" lettering as specified
  - .6 a white glass or translucent acrylic downlight in the bottom of the fixture
  - .7 a third lamp socket for an emergency lamp lighting circuit
  - .8 a wire guard where indicated
  - .9 for self-powered exit lights, a dust-tight relay transfer and maintenance free nickel- cadmium battery with low voltage disconnect, charger, high charge rate and brownout features
  - .10 for water-proof exit lights, a gasketed water-tight housing

**.2 Acceptable Manufacturers:** Acceptable manufacturers are:

- .1 Lumacell Inc.
- .2 Emergi-Lite Ltd.
- .3 Hubbell Inc. "Dual-Lite"
- .4 Luxnet Corp.
- .5 Beghelli
- .6 Approved Equivalent

**3 EXECUTION**

**3.01 INSTALLATION OF EXIT LIGHTS**

- .1 Provide exit lights where shown. Include for all required site assembly, and provide all required installation and support hardware.
- .2 Confirm exact exit light locations prior to roughing-in, and in any case, ensure that exit lights are not less than 2 m (6½') from the underside of the fixture to the finished floor.
- .3 For ceiling mounted exit lights in areas with unfinished ceilings, mount the fixture alongside a junction box, with or without canopy, and connect the fixture laterally with conduit (or with embedded conduit where permitted or specified) or by using the exit light canopy as a junction box where permitted.
- .4 Connect exit lights to circuits indicated with wiring as specified. Install wiring in conduit. Ensure that panelboard breakers serving exit lights are equipped with lock-on devices.
- .5 Connect emergency power sockets to the emergency power source as indicated and/or specified.
- .6 Provide all required lamps. Lamps are specified in the Section entitled Ballasts, Lamps, Lenses and Louvres.
- .7 When all exit light installation work is complete, clean all fixtures and lamps, and any ceiling, wall, etc., surfaces soiled as a result of the installation work.
- .8 If wall and ceiling surfaces are damaged as a result of the installation, replace the wall or ceiling surface to the Consultant's approval.

**END OF SECTION**

## **1 GENERAL**

1. The purpose of the grounding system is to create a low impedance path to earth ground for electrical surges and transient voltages. Lightning, fault currents, circuit switching (motors turning on and off), and electrostatic discharge are common causes of these surges and transient voltages. An effective grounding system minimizes the detrimental effects of these electrical surges, which include degraded network performance and reliability and increased safety risks.
2. The grounding system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment. As such, grounding must be purposeful in its design and installation. Four issues require special consideration:
  - 2.1 Although AC powered equipment typically has a power cord that contains a ground wire, the integrity of this path cannot be easily verified. Thus, many equipment manufacturers require grounding above and beyond that which is specified by local electrical codes, such as the National Electrical Code, etcetera. Always follow the grounding recommendations of the manufacturer when installing equipment.
  - 2.2 While the building steel and metallic water piping must be bonded to the grounding system for safety reasons, neither may be substituted for the telecommunications bonding backbone (TBB).
  - 2.3 Electrical continuity throughout each rack or cabinet is required to minimize safety risks. Hardware typically supplied with bolt-together racks is not designed for grounding purposes. Additionally, most racks are painted. Paint is an insulator. Unless rack members are deliberately bonded, continuity between members is incidental, and in many cases, unlikely.
  - 2.4 Any metallic component that is part of the data center, including equipment, racks, ladder racks, enclosures, cable trays, etc. must be bonded to the grounding system
3. Provide grounding & bonding in accordance with good industry practices and in accordance with the following codes and standards.
4. The ground system must be designed for high reliability. Therefore, the grounding system shall meet following criteria:
  - CSA Standard C22.2 No.41-M1987 – Grounding & Bonding Equipment
  - CSA Standard T527 (ANSI/TIA/EIA-607)
  - CSA Standard T 530 - Telecommunications Pathways and Spaces
  - Ontario Hydro Electrical Safety Code
  - Ontario Building Code
  - Local Codes & Bylaws
  - BICSI requirements



5. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and CSA Certified and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion. Antioxidant shall be used when making bonding connections in the field.
6. All grounding conductors shall be copper
7. Wherever possible, two-hole lugs shall be used because they resist loosening when twisted (bumped) or exposed to vibration. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion (battery rooms are an exception where windowless lugs may be used).
8. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
9. Cable assemblies shall be UL Listed and CSA Certified. Cables shall be a distinctive green or green/yellow in color, and all jackets shall be UL, VW-1 flame rated.

## 2 PRODUCTS

### TBB Sizing

1. The Telecommunications Grounding Busbar (TGB) in each telecommunications space will be grounded to the Telecommunications Main Grounding Busbar (TMGB) located at the service entrance. The gauge of the connecting ground cable, known as the Telecommunications Bonding Backbone (TBB) will follow J-STD-607-A guidelines, as is shown in the table below.

Sizing of the TBB	
TBB Length in Linear meters (feet)	TBB Size (AWG)
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
Greater than 20 (66)	3/0

### Busbars

Part Number	Bar Size	No. of 5/16" hole sets, 5/8" spacing	No. of 7/16" hole sets, 1" spacing	Std. Pkg. Qty.
<b>Telecommunications Grounding Busbars (TGB)</b>				
GB2B0304TPI-1	¼" x 2" x 10"	4	3	1
GB2B0306TPI-1	¼" x 2" x 12"	6	3	1
GB2B0312TPI-1	¼" x 2" x 20"	12	3	1
<b>Telecommunications Main Grounding Busbars (TMGB)</b>				
GB4B0612TPI-1	¼" x 4" x 12"	4	3	1
GB4B0624TPI-1	¼" x 4" x 20"	6	3	1

### Copper Code Cable Sizes

- The TMGB will be bonded to building steel and grounded to the electrical service ground according to BICSI TDM Manual and J-STD-607-A guidelines. Local codes may supersede these requirements. In telecommunications spaces with only one rack, the rack jumper cable can be connected directly to the TGB.

Cable Sizes for Other Grounding Applications	
Purpose	Copper Code Cable Size
Aisle grounds (overhead or under floor) of the common bonding network	#2 AWG or larger (1/0 preferred)
Bonding conductor to each PDU or panel board serving the room.	Size per NEC 250.122 & manufacturer recommendations
Bonding conductor to HVAC equipment	6 AWG
Building columns	4 AWG
Cable ladders and trays	6 AWG
Conduit, water pipe, duct	6 AWG

## 3 EXECUTION

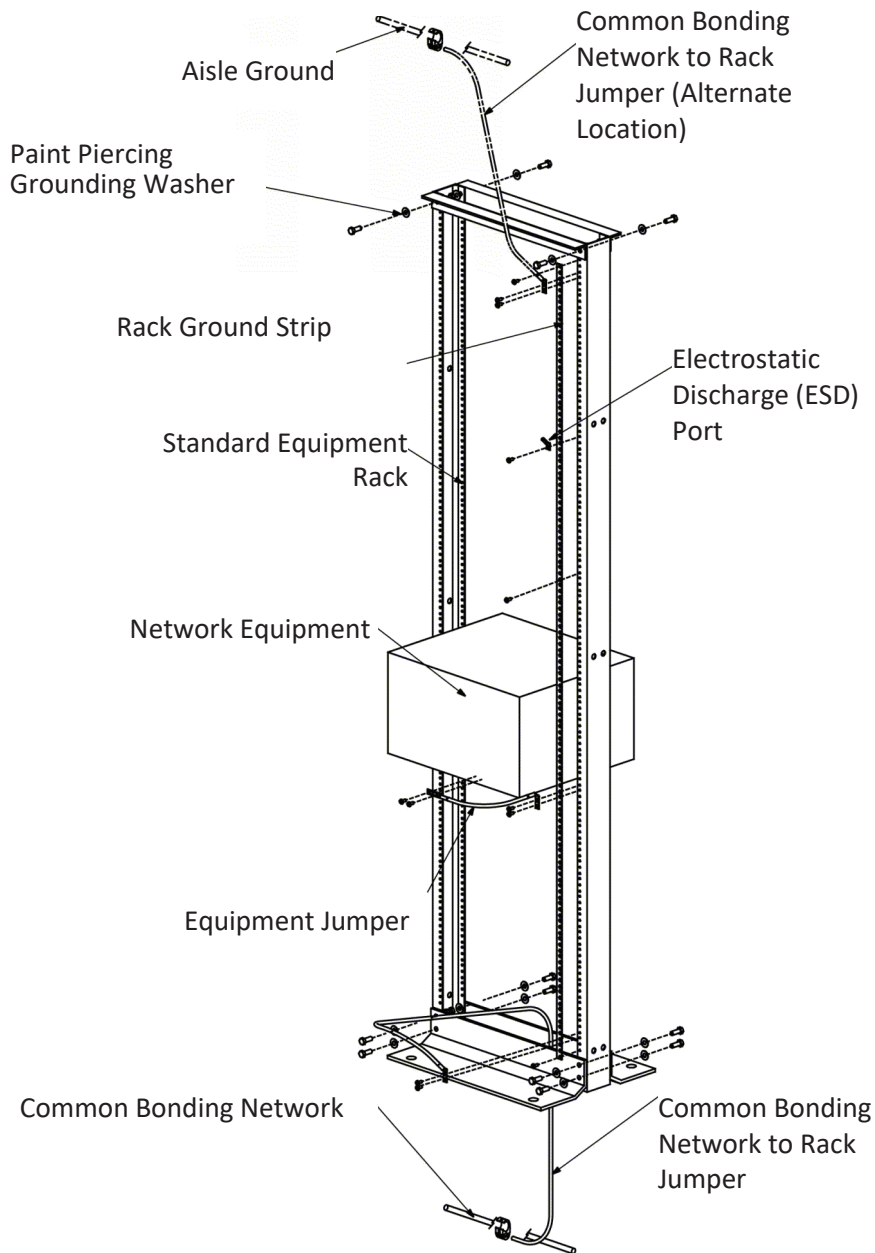
### 3.01 INSTALLATION

- PANDUIT STRUCTUREDGROUND* grounding system or approved equivalent, kits, components, and hardware shall be used to construct the grounding/earthing system.
- Use PANDUIT GB4 series or approved equal BICSI/J-STD-607-A telecommunications grounding busbars for the TMGB, which is ideally located at the AC service entrance. Use a PANDUIT GB2 series or approved equal busbar for the TGB in each of the other telecommunications/equipment spaces throughout the building. Use PANDUIT LCC-W series or approved equal lugs when connecting conductors to the TMGB and TGB.
- Route the TBB to each TGB in as straight a path as possible. The TBB should be installed as a continuous conductor, avoiding splices where possible. Use PANDUIT HTAP kits, or approved equal, family HTWC, to provide a tap from the TBB to each TGB. When more than one TBB is used, bond them together using the TGBs on the top floor and every third floor in between with a conductor known as a grounding equalizer (GE). Use the J-STD-607-A guidelines for sizing of the TBB when sizing the GE (shown in the table above).
- Avoid routing grounding conductors in metal conduits. If the grounding conductor must be routed through a metal conduit, bond each end of the conduit to the grounding conductor. Use PANDUIT GPL series, or approved equal, grounding clamps to bond to the conduit, a PANDUIT HTWC HTAP, or approved equal, with clear cover to bond to the grounding conductor, and a #6 AWG copper conductor to connect the GPL grounding clamp to the HTWC HTAP.
- Equipment and racks shall be bonded in accordance with the methods prescribed in ANSI/TIA-942 draft 7.0 as shown in figure below. To provide electrical continuity between rack elements, PANDUIT, or approved equal, paint piercing grounding washers, series RGW, shall be used where

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rack sections bolt together, on both sides, under the head of the bolt and between the nut and rack.

6. All racks shall utilize a full-length rack ground strip, PANDUIT part number RGS134, or approved equal, attached to the rear of the side rail with the thread-forming screws provided to ensure metal-to-metal contact.
7. Mount an electrostatic discharge (ESD) port kit, PANDUIT part number RGEDS-1, or approved equal, directly to the rack grounding strip on the back of the rack at approximately 48 inches from the floor. Mount a second RGEDS-1, or approved equal, directly to the vertical mounting rail of the rack in the front at approximately the same height. Use the thread-forming screws provided to form a bond to the rack. Place the ESD protection identification stickers directly above the ESD ports.
8. When the equipment manufacturer provides a location for mounting a grounding connection, that connection shall be utilized. Use the appropriate PANDUIT RG series jumper, or approved equal, for the equipment being installed and the thread-forming screws provided in the kit.
9. Use PANDUIT part number **RGCBNJ660P** (Common Bonding Network to Rack Jumper), or approved equal, to attach the rack ground strip to the common bonding network. Do not bond racks or cabinets serially. Use the copper compression HTAP that comes with the kit to bond the conductor to the common bonding network.
10. Patch panels will be bonded to racks using the PANDUIT bonding screws, part number **RGTBSC** for racks having #12-24 equipment mounting holes, and **RGTBSM6-C** for racks having M6 equipment mounting holes, or approved equal.



**END OF SECTION**

## **1 GENERAL**

### **1.1 General**

1. Division 26 specification documents shall be followed in conjunction with the following specs.
2. The Telecommunications Cabling Contractor shall not use any mechanical or electrical fittings to support the telecommunications cabling. All telecommunications cabling shall be independently supported.
3. The Telecommunications Cabling Contractor shall independently support the cables above all ceiling tiles and in a manner where the cables do not interfere with the removal of the ceiling tiles. A minimum of 75 mm 3"(in) of clear vertical space above the ceiling tiles shall be maintained.
4. The General Contractor/Project Manager/The Consultant must approve all deviations from the contract documents and drawings in relation to cable routing, outlet and equipment locations.

### **1.2 Hangers**

1. Anchors for hangers must not be drilled into post-tensioned beams under any circumstances.
2. The Telecommunications Cabling Contractor is responsible for coordinating the best time to install the anchors with the General Contractor/Project Manager/The Consultant. After hours work may be required for this portion of the work.
3. Hangers & supports shall be sized to accommodate the number of cables in each run. Other hardware such as hammer on clamps, screw on clamps and angled hanger brackets to support the backbone and/or horizontal cabling shall be included.

### **1.3 Conduit**

1. Division 26 specification documents shall be followed in conjunction with the following specs.
2. Electrical Metallic Tubing (EMT) of the sizes indicated shall be installed.
3. Conduit extending from outlet to cabletrough/raceway shall be a minimum of 1"(in) unless the cables exceed a 40% fill ratio.
4. No EMT shall be smaller than 1"(in) unless specifically detailed in this document.
5. No more than two - 90° bends in conduit between pull points. Provide a pull box for every 30 m 100'(ft) of conduit. Pull boxes are not to be used as bends.
6. Conduits of 50mm 2"(in) or less to have a bend radius of six (6) times the conduit diameter. A conduit greater than 50mm 2"(in) to have a bend radius of ten (10) times the conduit diameter.
7. Bush, ream and remove any sharp projections on all conduits.
8. All conduit shall be labelled at each end indicating the destination.
9. Run all conduit parallel or perpendicular to building grid lines.

10. Slots and sleeves to extend a minimum of 50 mm 2"(in) above the finished floor.  
Conduits shall protrude a minimum of 76 mm 3"(in) into rooms through walls.
11. Conduits shall not compromise existing HVAC ducting or sheet metal work.
12. Division 26 specification documents shall be followed in conjunction with the following specs.
13. Innerduct shall be sized appropriately to maintain the 40% fill ratio and allow for a proper bend radius of the cable(s) within.
14. Acceptable Manufacturers, or other approved equivalent:

<u>Size</u>	<u>Non-Plenum Orange</u>	<u>Non-Plenum Yellow</u>
1"	Panduit Part# CLT125F-L3....	Panduit Part# CLT150F-X4
2"	Panduit Part# CLT188F-X3	Panduit Part# CLT188-X4

#### **1.4 Cable Trough**

1. Division 26 specification documents shall be followed in conjunction with the following specs.
2. The Telecommunications Cabling Contractor shall be responsible for coordinating the installation with Division 26.
3. Cable trough shall be sized (including 10% growth) as per the drawings and will accommodate all horizontal and/or backbone cabling within the Telecommunications Room as well as entering/existing the Telecommunications Room.
4. All material to properly install the cable trough shall be provided. The cable trough system shall accommodate the weight of the horizontal and/or backbone cabling including 10% growth.
5. Provide horizontal elbows, end plates, vertical risers and drops, tees, wyes, expansion joints and reducers where required.

## **2 PRODUCTS**

### **2.1 Hangers**

<u>Description</u>	<u>Panduit Part#</u>
Wall Mount	JP2W-L20
Ceiling Mount	JP2CM-L20
Drop Wire & Threaded Rod Clip	JP2DW-L20
Screw-On Beam Clamps	JP2SBC50-L20 or JP2SBC50R-L20
Hammer On Beam Clamps	JP2HBC25R-L20 or JP2HBC50R-L20 or JP2HBC75R- L20
Purlin Clips	JP2ZP-L20 or JP2CP-L20
Under Floor Pedestal Support Clamp	JP2UF100-L20

### **2.2 Conduit Fastening**

1. One hole malleable iron, hot dipped galvanized straps to secure surface mounted conduits.
2. Beam clamps to secure conduits to exposed steel members.

3. Provide 12 gauge galvanized steel channel type supports for two or more conduits on minimum 1500 mm centres. Use suitable conduit clamps in channel.
4. Threaded rod with a minimum dia. of 6mm shall be used to support the suspended channels.
5. Gray flame retardant polyethylene Threaded Rod Covers shall be installed to protect the cables from abrasion. **Panduit Part# TRC18FR-X8** or approved equivalent.

### 2.3 Conduit Fittings

1. Fittings manufactured for use with the conduit specified with the same coating as conduit.
2. Provide insulated steel Rain Tight connectors and couplings for all EMT conduits 50 mm 2"(in) and smaller.
3. All 4"(in) conduit shall have conduit water falls installed. **Panduit Part# CWF400** or approved equivalent.

## 3 EXECUTION

### 3.01 INSTALLATION

1. The Telecommunications Cabling Contractor shall run all pathways including conduits, innerduct and cable trough parallel or perpendicular to building lines.
2. The Telecommunications Cabling Contractor shall maintain the following minimum clearances from electrical and heat sources when routing copper cables.

Item	Minimum Separation Distances		
	(<2kVA)	(2-5kVA)	(>5kVA)
Unshielded power lines or electrical equipment in proximity to open or non-metallic pathway.	127 mm (5"(in))	305 mm (12"(in))	610 mm (24"(in))
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	64 mm (2.5"(in))	152 mm (6"(in))	305 mm (12"(in))
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	---	76 mm (3"(in))	152 mm (6"(in))
Motors	1.2 m (4'-0")		
Transformers	1.2 m (4'-0")		
Conduit and cables used for electrical distribution less than 1kV	0.3 m (1'-0")		



Conduit and cables used for electrical distribution greater than 1kV	1.0 m (3'-0")
Fluorescent Luminaires	300 mm (12")
Pipes (gas, oil, water, etc.)	120 mm (5")
HVAC (equipment, ducts, etc.)	150 mm (6")

3. Supply and install Caddy hangers, hanger supports and any other miscellaneous hardware required to support telecommunications cabling where conduit/ladder tray has not been provided.
4. Panduit J-Pro hangers are to be used every 4'(ft) 1.2 m.
5. All conduit shall have 3mm polypropylene, minimum, fish cords installed.
6. Supply and install innerduct along the full length of the fibre optic cable.
7. The innerduct shall be fastened to the building support when installed in the ceiling space.
8. The innerduct shall be fastened to the backboard, rack or cabinet by utilizing cradle mounts and plastic permanent cable ties.
9. Install cable tray as indicated on the drawings.
10. Support cable tray every 10'(ft).
11. All sharp burrs and projections to prevent damage to cables, ladders or personnel.

**End of Section**

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## **1 GENERAL**

### **1.01 GENERAL**

1. Adhesive cable labels to meet the legibility, defacement, and adhesion requirements specified in UL 969 (Ref. D-16). In addition, the labels shall meet the general exposure requirements in UL 969 for indoor use.
2. Self-laminating vinyl construction cable labels with a white printing area and a clear tail that self laminates the printed area when wrapped around a cable. The clear area should be of sufficient length to wrap around the cable at least one and one-half times.
3. CSA T528 9(ANSI/EIA/TIA-606) for colour codes shall be followed. Labels are to be mechanically printed using a laser printer. Hand written labels will not be acceptable.

## **2 PRODUCTS**

1. PanAcea – LS7 hand-Held Printer. Part# LS7 or PanAcea – LS8 hand-Held Printer. Part# LS8.
2. Easy-mark labeling software. Part# PROG-EMCD.
- .3 Approved equivalent.

## **3 EXECUTION**

### **3.01 MANUFACTURER'S INSTRUCTIONS**

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

### **3.02 INSTALLATION**

1. Cable identification labels should appear at the following locations with the numbers indicated on the cable schedule and drawings:
  - 102 mm 4”(in) from each end of the cable – after termination.
  - Front of patch panels.
  - Front of IDC termination blocks.
  - Front of workstation/communications outlet faceplates.
  - Each end of each Telecommunications Conduit.
2. Fibre Optic safety Labels shall appear at the following locations:
  - Along the length of the conduit or innerduct at 3m 10’(ft) intervals.
  - At all junction boxes
  - At all pull boxes.
  - On all fibre optic patch panels.

3. Provide 25% additional labels to be left in each telecommunications room on site for future growth.

**Horizontal Cables**

1. Refer to Division 26

**END OF SECTION**

## 1 GENERAL

### 1.01 GENERAL

1. The Consultant shall withhold 15% of the telecommunications project value from the Telecommunications Cabling Contractor until all accurate close-out documentation is forwarded to the General Contractor/Construction Manager or The Consultant. In addition, this value will be withheld until all deficiencies are resolved.
2. Upon completion of the testing, the Consultant may ask the Telecommunications Cabling Contractor to perform a random test of up to 10% of the cables.
3. All deficiencies must be corrected before the Consultant will forward authorization to release the Holdback.

## 2 EXECUTION

### 2.01 INSTALLATION

1. Bi-directional testing of all horizontal Category 3 backbone copper cables are to be completed in accordance with the follow test criteria:
 

- continuity	- grounds
- shorts	- correct
- opens	- length
2. Testing of all horizontal Category 6 copper cables are to be completed in accordance with the follow test criteria:
 

- Basic Link	- grounds	- NEXT	- ELFEXT
- continuity	- correct polarity	- PSNEXT	- PSELFEXT
- shorts	- length	- ACR	- Return Loss
- opens	- attenuation	- PSACR	- resistance
3. Fibre strands in excess of 122m 400'(ft) shall be tested with an Optical Time Domain Reflectometer for length and attenuation.
4. Test each stand of fibre, bi-directionally, with a Power Meter / Light Source combination operating at wavelengths of 850 nm and 1300 nm for multimode fibres.
5. Maximum multi-mode passive link loss (including patch cords) is not to exceed - 2.35dB.
6. Maximum single-mode passive link loss (including patch cords) is not to exceed - 1.0dB.

### 2.02 DOCUMENTATION

1. The Telecommunications Cabling Contractor is required to submit test results in native tester format or a format which can be read with a text reader (i.e. ".txt" extension). Paper results shall not be submitted for projects with 100 or more horizontal cable drops and/or fibre cables.
2. The Telecommunications Cabling Contractor is required to provide the software required to view the results.
3. The report should be divided into sections by Telecommunications Room.

4. The report should indicate for each cable when it was tested successfully, the result, and the length.
5. The Telecommunications Cabling Contractor shall sign off on the entire test report prior to submitting to the General Contractor/Construction Manager or The Consultant.
6. The test result documentation is to be submitted to the General Contractor/Construction Manager or The Consultant for review no later than ten (10) working days following the completion of the installation.
7. All deficiencies must be corrected before the General Contractor/Construction Manager or The Consultant will provide a certificate to release the Holdback on the project.
8. Record Drawings
9. The Telecommunications Cabling Contractor is required to maintain one (1) set of correct and accurate record drawings on-site at all times. These drawings are to be made available to the General Contractor/Construction Manager or the Consultant for review during the project.
10. The Telecommunications Cabling Contractor is required to provide record drawings of the telecommunication cabling installation in relation to the drawings provided in this specification.
11. The record drawings shall be updated electronically and include, but are not limited to;
  - Horizontal cable numbers on the floor plans
  - Horizontal Cable Routing on the floor plans
  - Changes on the floor plans
  - Backbone cable Routing between Telecommunications Rooms
  - Paging Speaker Locations including daisy chain cable run
  - Wireless Access Points and Cell coverage
  - Cabinet/Rack Elevation drawings
  - Backboard Elevation Drawing
12. The Telecommunications Cabling Contractor shall provide one (1) soft copy in AutoCAD 2010 and one (1) plotted copy for the General Contractor/Construction Manager or The Consultant to review prior to complete close-out documentation submission.
13. After approval, the Telecommunications Cabling Contractor shall submit one (1) plotted copy of the drawings for;
  - The Main Computer Room
  - Each Telecommunications Room
  - The Consultant
14. All close-out documentation must be submitted to the Consultant within ten (10) working days of the completion of the project before the documentation holdback will be released.

**END OF SECTION**

## 1 GENERAL

### 1.01 CABLE MANAGEMENT

1. The Cable Management System shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures. The system shall be a complete cable management system comprised of vertical cable managers, horizontal cable manager, and cable management accessories used throughout the cabling system. The system shall protect network investment by maintaining system performance, controlling cable bend radius and providing cable strain relief.

## 2 PRODUCT

### 2.01 RACKS

1. The Rack system shall meet all EIA requirements as defined EIA-310-D.
2. Racks as indicated on plans.

### 2.02 VERTICAL CABLE MANAGEMENT

1. Vertical cable managers shall include components that aid in routing, managing and organizing cable to and from patch panels and/or equipment. Managers shall protect network equipment by controlling cable bend radius and providing cable strain relief. Managers shall be a universal design mounting to EIA 19" or 23" racks and constructed of a base with cable management fingers. The fingers shall include retaining tabs to keep cables in place during cover removal. The covers shall be hinged to open in either direction allowing for quick moves, adds, and changes.

PART # or Approved Equals	Type	Rack Spaces	Type	Max. Side Extension
PRV12	Front and Rear	45	High Capacity	12.0
PRVF12	Front only	45	High Capacity	12.0
PRD12	Hinged Door	-	-	12.0
PRV8	Front and Rear	45	Standard	8.0
PRVF8	Front only	45	Standard	8.0
PRD8	Hinged Door	-	-	8.0
PRV6	Front and Rear	45	Standard	6.0
PRVF6	Front only	45	Standard	6.0
PRD6	Hinged Door	-	-	6.0
PRSP5	Rear Slack Spool, 5"	-	-	-
PRSP7	Front Slack Spool,	-	-	-

### **3 EXECUTION**

1. Install racks and cable management in communication room(s) as indicated on drawings.

**END OF SECTION**

## 1 GENERAL

### 1.01 TERMINATION EQUIPMENT

1. All termination mounts shall be fully loaded with the appropriate connectors.
2. Blank labeling strips are required for connectors that are not in use.
3. IDC block quantities shall accommodate the number of terminated cable pairs.
4. IDC 250-pair and 300-pair blocks shall be complete with labeling strips.
5. Material and equipment shall be new, and conform to grade, quality and standards specified.
6. Backboard layout will be as per manufacturer's recommendations unless expressly written otherwise by the General Contractor/Construction Manager or the Consultant

## 2 PRODUCT

### 2.01 CATEGORY 6 ANGLED PATCH PANEL

1. *MINI-COM*® Angled Modular Faceplate Patch Panels or approved equivalent shall allow cable to flow to each side of the rack and shall eliminate the need for horizontal cable managers by enabling patch cords to be routed directly into vertical cable managers. The angled design shall allow the labeling scheme and port identification to be visible at all times.

Vertical cable managers in the *PANDUIT*® PatchRunner Cable Management System or approved equivalent shall utilize moulded cable management fingers and integral bend radius control. These features coupled with the Angled Patch Panels shall provide the ultimate high-density cable management system.

Part Number	Number of Ports	Rack Spaces
CPPLA24WBL	24	1
CPPLA48WBL	48	2

*MINI-COM*® High Density Modular Faceplate Patch Panels or approved equivalent

Part Number	Description	Number of Ports	Rack Spaces
DPA24688TGY	Cat 6	24	1
DPA48688TGY	Cat 6	48	2

*MINI-COM*® High Density 110 termination Back Panel Patch Panels or approved equivalent

**Panduit Minicom TX6 Plus Category 6 Module**, or approved equal

Part Number	Style	Configuration	Category	Colors
CJ688TG**	RJ45	Universal	6	11

\*\* Designates color

2. Colours:

- i. Phone: White
- ii. Data: Blue



**Panduit Opticom Rack Mount Fibre Optic Enclosures** , or approved equal.

1. Can be mounted to any standard 19" or 23" EIA rack or cabinet.
2. Includes fiber optic cable routing kits (grommets, cable ties, saddle clips, spools, strain relief and ID/caution labels) for various cable management solutions.
3. Multiple cable entry locations provided in rear of enclosure on top, bottom, and side  
Holds Opticom® or approved equivalent Fiber Adapter Panels.
4. Durable molded hinged front and rear lockable doors

Part Number or approved equals	Rack Spaces
FRME1	1
FRME2	2
FRME3	3

**Frames for Modular Jacks**

1. Frames shall be 4-port Frames which will accommodate RJ45 Style, RJ12, ST Compatible or SC jacks.
2. Where applicable, use recessed blanks for all unused ports. Blanks to match Frame colour.

Part #: 4-port .....CFG4\*\* (\*\* denotes colour)

3. Colour: IW (International White).

**SC OptiCam Fibre Optic Connector**

1. *PANDUIT or approved equivalent* ® *OPTI-CAM or approved equivalent* ® LC Fiber Optic Connectors shall be field terminable (mechanical crimp termination) simplex fiber optic connectors for multimode glass fiber that fully complies with the fiber optic connector performance requirements specified in TIA/EIA-568-B.3 and the intermatability requirements specified by the TIA 604-2 FOCIS-2 document.

Part Number	Style	Fiber Type	Termination	Simplex/ Duplex	Colour
FLCSMCXAQY, or approved equal	LC	10 Gig 50/125µm Multimode 3mm jacketed	Pre-polished, mechanical crimp	Simplex	Aqua
FLCDMCXAQY, or approved equal	LC	10 Gig 50/125µm Multimode 3mm jacketed	Pre-polished, mechanical crimp	Duplex	Aqua

### 3 EXECUTION

#### 3.01 INSTALLATION

1. Refer to Section 27 15 00 Horizontal Cabling.

**END OF SECTION**

## **1 GENERAL**

### **1.01 GENERAL**

1. The Telecommunications Cabling Contractor shall ensure ANSI/EIA/TIA-568-B installation practices are followed.
2. The Telecommunications Cabling Contractor shall terminate all pairs of cable. Terminate all spare cables at the Telecommunication Room end.
3. The Telecommunications Cabling Contractor shall run all horizontal cables parallel to building grid lines with no splices.
4. Provide 3m (10'-0") of slack at the workstation end of the cable to permit future outlet relocation. Neatly coil slack in ceiling space or on the side of the cable tray.
5. Provide 1m (3'-0") of slack at the Telecommunications Room end of the cable to permit future relocation. Neatly coil the cable in the cable tray or in the ceiling space.
6. Inform The Consultant immediately of any horizontal cable runs exceeding 90 m 295' (ft.).
7. When terminating copper cables remove cable jacket only enough to perform termination and untwist pairs a maximum of 13 mm (1/2") for Category 6 cables.
8. The Consultant shall determine the quality of workmanship during installation. Cables that have not been properly installed will be reinstalled by the Telecommunications Cabling Contractor at no additional expense to the client.
9. Maintain a minimum of four (4) times cable diameter as a bend radius if no bend radius is specified.

## **2 PRODUCT**

### **2.01 CATEGORY 6 CABLES**

1. Data - 4-pair UTP cable shall exceed Category 6A requirements per ANSI/TIA/EIA-568-B.
2. The PANDUIT or approved equivalent<sup>®</sup> TX Copper Plenum Rated Cable or approved equivalent shall be used for the horizontal cabling subsystem. These requirements are for cables of unshielded 24 AWG bare copper conductors, insulated with thermoplastic, twisted into pairs and enclosed in a thermoplastic jacket. The finished cable shall meet or exceed the following requirements of ANSI/EIA/TIA-568-B.
3. All cable shall conform to the requirements for communications circuits defined by the National Electrical Code (Article 800) and the Canadian Building Code. Cable listed to NEC Article 800-51(a) will be used for "Plenum" installations and carry labeling of CMP. Cable listed to NEC Article 800-51(b) shall be installed in vertical runs penetrating more than one floor and carry the labeling of CMR.

Part # or approved equal	Category	Colours
PUP6004**-U	6 Plenum	4

\*\* Denotes colour

- 
4. Colour:
    - a. Phone: White
    - b. Data: Blue

### **3 EXECUTION**

#### **3.01 INSTALLATION**

1. All horizontal cables shall be bundled on the Telecommunications Racks using Panduit Velcro straps or approved equivalent. Bundles shall be wrapped at a maximum of 203 mm 8" (in) separation.
2. All exposed cabling at the workstation between wall/floor-input point locations and systems furniture are to be wrapped with Panduit Pan-Wrap Split Harness Wrap or Panduit Polyethylene Spiral Wrap or approved equivalent, size and length as required to suit.
3. Provide blank filler plates for all unused modular jack positions on faceplates.
4. Supply and install Category 6 CMP cables to the outlets outlet indicated on the drawings. The Telecommunications Cabling Contractor shall refer to the legends on the drawing to determine the number of cables to each outlet location.
5. Terminate test and label each Cat6 cable in accordance to the parameters stated in this specification document.

**END OF SECTION**

## 1 GENERAL

### 1.01 GENERAL

1. None.

## 2 PRODUCT

### 2.01 Panduit TX6 Plus Category 6 Patch Cord (Data) or approved equivalent

1. Category 6 Patch Cords shall be factory terminated with enhanced performance Pan- Plug <sup>TM</sup> modular plugs featuring a one-piece, tangle-free latch design eliminating the need for strain-relief boots to provide easy moves, adds and changes. Each patch cord shall be 100% verified for wiring sequence and continuity at the factory. The patch cords shall come in standard lengths of three, five, seven, 10 14, and 20 feet and six standard colors of Off White, Black, Blue, Green, Red and Yellow.

Part Number or approved equals	Length (ft)	Length (M)
UTPSP3**	3	0.91
UTPSP5**	5	1.52
UTPSP7**	7	2.13
UTPSP10**	10	2.74
UTPSP14**	14	4.27
UTPSP20**	20	6.10

\*\* Designates colour

2. Provide a 7' patch cord for each data outlet indicated on the drawings.
3. Colour:
  - .1 Phone: White
  - .2 Data: Blue

#### Fiber Optic Patch Cords

1. Dual fiber optic patch cables to meet same performance criteria as fiber optic cabling.
2. Cables to be FL Plug to an SC.
3. Connectors to be;

Part # or approved equal	Category	Plug Config	Length
FXE10-10M3Y	10G 50/125 $\mu$ m	LC to LC	10'-3m

4. Patch cords positions (i.e. A & B) to be in accordance with ANSI/TIA/EIA-568-B.3.
5. Colours: Multimode: Aqua

### **3 EXECUTION**

#### **3.01 INSTALLATION**

1. Refer to Section 27 15 00 Horizontal Cabling for quantities and installation details.

**END OF SECTION**

## **1 GENERAL**

### **REFERENCES**

- .1 Abbreviations:
  - .1 Electronic Access Control (EAC): control of people through entrances and exits of controlled area. Security utilizing hardware systems and specialized procedures to control and monitor movements within a controlled area.
  - .2 CPVX: Central Station Burglar Alarm Systems.
  - .3 CVSG: Mercantile Burglar Alarm Systems.
  - .4 CVWX: Proprietary Burglar Alarm Systems.
  - .5 DRS: Door Release System.
  - .6 PIN: Personal Identification Number.
- .2 Reference Standards:
  - .1 Health Canada / Workplace Hazardous Materials Information System (WHMIS)
    - .1 Material Safety Data Sheets (MSDS).
  - .2 Underwriters Laboratories of Canada (ULC)
    - .1 CAN/ULC-S301-09, Standard for Signal Receiving Centre Burglar Alarm System and Operations
    - .2 CAN/ULC-S302-M91(R1999), Standard for Installation and Classification of Burglar Alarm Systems for Financial and Commercial Premises, Safes and Vaults.
    - .3 CAN/ULC-S304-06, Signal Receiving Centre and Premise Burglar Alarm Control Units.
    - .4 CAN/ULC-S310-M91(R1999), Installation and Classification of Residential Burglar Alarm Systems.
    - .5 ULC-S318-96, Standard for Power Supplies for Burglar Alarm Systems.
    - .6 ULC-C634-86, Guide for the Investigation of Connectors and Switches for Use with Burglar Alarm Systems.
  - .3 Underwriters' Laboratories (UL)
    - .1 UL 294-2009, Access Control System Units.
    - .2 UL 603-08, Power Supplies for Use with Burglar Alarm Systems.
    - .3 UL 681-1999, Installation and Classification of Burglar and Holdup Alarm Systems.
    - .4 UL 827-2008, Central-Station Alarm Services.
    - .5 UL 1023-2009, Household Burglar Alarm System Units.
    - .6 UL 1076-2005, Safety for Proprietary Burglar Alarm Units and Systems.
    - .7 UL 1641-1999, Safety for Installation and Classification of Residential Burglar Alarm Systems.

### **1.02 ACTION AND INFORMATIONAL SUBMITTALS**

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

- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature and data sheets for access controls and equipment and include product characteristics, performance criteria, physical size, finish and limitations.
  - .2 Submit 2 copies of WHMIS MSDS in accordance with Section 01 35 29.06 - Health and Safety Requirements 01 35 43 - Environmental Procedures.
  - .3 Submit:
    - .1 Functional description of equipment.
    - .2 Technical data for all devices.
    - .3 Device location plans and cable lists.
    - .4 Devices mounting location detail drawings.
    - .5 Typical devices connection detail drawings.
- .3 Shop Drawings:
  - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Ontario, Canada.
  - .2 Shop drawings to indicate project layout, including details.
    - .1 Shop drawings to indicate, mounting heights and locations, wiring diagrams.
    - .2 Submit zone layout drawing indicating number and location of zones and areas covered.
    - .3 Submit wiring diagrams.
    - .4 Submit complete equipment list.
- .4 Samples:
  - .1 Submit for review and acceptance of each unit.
  - .2 Samples will be returned for inclusion into work.
  - .3 Submit 1 sample of each component proposed for inclusion into system.  
Components will be returned for incorporation into work.
- .5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
  - .1 Submit ULC/UL Product Safety Certificates.
  - .2 Submit verification Certificate that service company is ULC/UL List alarm service company.
  - .3 Submit verification Certificate that monitoring facility is ULC/UL "Listed central station".
  - .4 Submit verification Certificate that security access system is "Certified alarm system".
- .6 Test and Evaluation Reports:
  - .1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.
- .7 Manufacturer's Instructions: submit manufacturer's installation instructions.
- .8 Manufacturer's Field Reports: submit manufacturer's written reports within 3 days of review, verifying compliance of Work, as described in PART 3 - FIELD QUALITY CONTROL.

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### 1.03 WARRANTY

- .1 Project Warranty: refer to Section 1 for project warranty provisions.
- .1 .2 Manufacturer's Warranty: submit, for Consultant's acceptance, manufacturer's standard warranty document executed by authorized company official.

## 2 PRODUCTS

### MATERIALS

- .1 Design Criteria:
  - .1 Design access control and security access systems using only ULC/UL listed products.
  - .2 Design security access system using ULC/UL listed alarm service company, company specializing in security access systems.
  - .3 Design security access system as a non certified alarm system
  - .4 Design access control systems to meet safety requirements to UL 294.
  - .5 Design system to provide door manual and automatic control functions from locations indicated to central monitoring system.
  - .6 Design system to allow for addition of future Door Release System (DRS) controls and activation units by adding appropriate transmission lines and equipment at each location.
  - .7 Design system to consist of homed run control to activation unit connections.
  - .8 Each activation unit must have door panel control function/equipment item located as indicated.
  - .9 Design system to provide ease of operation, servicing, maintenance, testing and expansion of additional services.
- .10 Door activation units:
  - .1 Fully complement and function and match door manufacturer's magnetic controls and hardware.
  - .2 Fully function with OEM supplied door controls and hardware to activate system in routine and emergency conditions.
  - .3 Fully function within supplied electrical supervision circuits as specified.
- .11 Control Panel:
  - .1 Fully compatible, compliment and operate door magnets provided by door manufacturer of system or OEM supplied door operating hardware.
  - .2 Complete with push button or electronic key pad to release and secure each door.
  - .3 Identify each door control function with lamp electronically identified on panel or associated display unit.
  - .4 Permanently label (paper labels are not acceptable) or electronically identified each door location on panel or associated display unit.
  - .5 Fully function within supplied electrical supervision circuits as specified.
- .12 Control Signal Standards:
  - .1 Input and Output Signal: 0.0 dBmV + 1.0 dBmV Level.
  - .2 Input and Output Signals: terminated on each control unit.
  - .3 Input and Output Impedance: 120 Ohms, BAL.
  - .4 Channel Bandwidth:
    - .1 Data: 300 Hz to 3.5 kHz (9.6 kilo bits per second rate).
    - .2 DC: 0.5 Hz to 100 Hz, + 5.0%, MIN.



- 
- .5 S/N Ratio: 60 dBmV + 1.0 dBmV.
- 
- .2 Door controls items and panels:
    - .1 Include standard "off the shelf" equipment items to form a complete and operating DRS system.
    - .2 Include: equipment cabinets, equipment panels, AC power strips, power line conditioner, system power supply, junction box, door control panels, door activation units, electronic supervising master panel, electronic supervising remote panel s, system connectors, and system cables.
  - .3 Provide system cables including coaxial cable, multiconductor control cable, audio and AC power cable required.
  - .4 Power supplies: to CAN/ULC-S318.
  - .5 Connectors and switches: to ULC-C634.
  - .6 Basic System Criteria:
    - .1 Card readers:
      - .1 Type: proximity.
      - .2 Quantity of card readers required: as shown on plans
      - .3 Proximity technology.
      - .4 Fitted with LED indicator light.
      - .5 Reading distance 50 - 200 mm.
      - .6 Compatible with access card model.
      - .7 Personal Identification Number (PIN) number access: 4 user codes.
    - .2 Keypads:
      - .1 Quantity of keypads required: as shown on plans
      - .2 Fitted with LED indicator light.
    - .3 Combination card readers and keypad:
      - .1 Quantity of units required: as shown on plans
      - .2 Proximity technology.
      - .3 Fitted with LED indicator light.
      - .4 Reading range: 50 mm (2") 75 mm (3").
      - .5 Compatible with access card model.
    - .4 Cards: key tag, plastic, credit-card size, sealed and highly resistant to normal handling and weather, fitted with vertical slot punched hole.
      - .1 Quantity of cards required: 100
      - .2 Guaranteed for 5 years against all defects and protected against:
        - .1 Magnetic encoded cards.
        - .2 Metal objects including coins and keys.
        - .3 Retail shoplifting detection equipment.
        - .4 Communication equipment.
      - .3 Coding:
        - .1 Designed with highly secure codification of card information.
        - .2 Card life: minimum period of 10 years for cards in same family.
        - .3 Use 1 series of cards for all areas protected by access control system.
    - .5 Quantity of alarm monitoring points required: as shown on plans.
    - .6 Quantity of outputs required.

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- .7 Number of access levels (assigned to cardholders): .
  - .8 Schedules:
    - .1 Number of date schedules required: 100.
    - .2 Number of holiday schedules required: 180.
    - .3 Allow full schedule description label of 30 alphanumeric characters.
    - .4 Include 4-time intervals/day.
  - .9 Groups:
    - .1 Design system to include possibility of group association in following categories:
      - .1 Controller groups : 100.
      - .2 Door groups: 100.
      - .3 Relay groups: 100.
      - .4 Input groups: 100.
      - .5 Access groups: 100.
    - .2 Design groups with fully customizable field of 30 alphanumeric characters for easy renaming of associated group.
  - .10 Operating system: Windows 10.
  - .11 Connection: local.
  - .12 Language: English.
  - .13 Off site monitoring of alarm conditions.
  - .8 System Accessories:
    - .1 Door strike: latch, UL approved complete with mounting hardware.
    - .2 Magnetic lock: holding force 1200 lbs, UL approved complete with mounting hardware.
  - .3 Request to exit motion detector device:
    - .1 Infrared detection.
    - .2 Continuous low-voltage operation.
    - .3 Fitted with indicator light.
    - .4 Integrated with local audio alarm (electronic buzzer).
    - .5 Adjustable coverage.
  - .4 Request to exit motion push button device:
    - .1 Heavy duty assembly.
    - .2 Size: square, 50 x 50 mm.
    - .3 Sturdy and attractive finishing plate with security screws.
  - .5 Pull station power interrupt.
  - .6 Power supplies:
    - .1 Continuous low-voltage operation output.
    - .2 Equipped with secondary protection for each output.
    - .3 Individual outputs for connection of devices.
    - .4 AC power failure output.
    - .5 DC power failure output and low battery output.
    - .6 Fitted with tamper contact.
    - .7 Wall mounted cabinet with locked door complete with 2 keys.
  - .7 Voltage: 24 volt DC.

### **3 EXECUTION**

#### **3.01 INSTALLATION: SECURITY ACCESS**

- .1 Install security access systems and components in accordance with CAN/ULC- S302 CAN/ULC-S310.
- .2 Install components in accordance with manufacturer's written installation instructions to locations, heights and surfaces shown on reviewed shop drawings.
- .3 Install components secure to walls, ceilings or other substrates.
- .4 Install required boxes in inconspicuous accessible locations.
- .5 Conceal conduit and wiring.

#### **3.02 SITE TEST AND INSPECTION**

- .1 Perform verification inspections and test in presence of Consultant.
  - .1 Provide all necessary tools, ladders and equipment.
  - .2 Ensure appropriate subcontractors, and manufacturer's representatives and security specialists are present for verification.
- .2 Pretesting procedure:
  - .1 Verify (utilizing an approved spectrum analyzer and test equipment) that system is fully operational and meets all system performance requirements of this specification.
  - .2 Measure and record, control (and/or voice) carrier levels of every system channel at each of following points in the system:
    - .1 Door located actuating devices.
    - .2 Door control panel functions.
    - .3 Electronic supervisory control units inputs and outputs.
    - .4 Distribution system input and output.
    - .5 Telephone system interface input and output.
- .3 Performance testing:
  - .1 Test procedure: perform test on a "go-no-go" basis.
  - .1 Make only operator adjustments required to show proof of performance.
  - .2 Test to demonstrate and verify that installed system complies with installation and technical requirements of this specification under operating conditions.
  - .3 Test results to be evaluated by Consultant as either acceptable or unacceptable using following procedures.
  - .2 Documentation review:
    - .1 This review will determine if information provided is sufficient to meet requirements of this specification.
    - .2 Provide for review all System manuals, as installed drawings, pretest forms, antenna radiation patterns, equipment cabinet pictorials, antenna pictorial, antenna mount pictorial, video and audio equipment details.
  - .3 Mechanical inspection:
    - .1 Consultant and Contractor to tour areas to ensure that Systems and Subsystems are installed in place for proof of performance testing.

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- .2 Take system inventory at this time. Verify following items before beginning proof of performance tests:
    - .1 Electrical power circuits designated for system equipment are properly labeled, wired, phased, protected and grounded.
    - .2 Conductor ends are protected by heat shrink wrap; audio spade lugs, barrier strips and punch blocks are used.
    - .3 Dust, debris, solder splatter, etc. are cleaned and removed from site.
    - .4 Equipment is properly labelled.
    - .5 Equipment identified in system's equipment lists are in- place and properly installed.
    - .6 Each lightning and System ground method are installed in accordance with manufacturer's instructions and this specification.
  - .4 Subsystem functional test:
    - .1 Conduct operational testing after review of documentation and mechanical inspection completed. Proceed as follows.
      - .1 Perform operational test of each Subsystem to verify that all equipment is properly connected, interfaced and is functionally operational to meet requirements of this specification.
    - .2 Control units:
      - .1 Take S/N readings from control unit's input and output in manual (and/or automatic) mode. Check output of DC/Data converter for S/N. Evaluate entire signal quality at baseband connector output of control unit and remote equipment.
    - .3 Audio:
      - .1 Take S/N readings from transmitter input and receiver output with equipment placed in manual gain mode. Check output of the audio converter, modulator or demodulator for S/N. Evaluate entire audio signal at baseband connector input and output of control unit.
    - .4 Distribution (or interface) system:
      - .1 Check each door utilizing a volt/ohm (or signal level) meter to confirm each function and to ensure that system meets all performance requirements.
      - .2 Test each interconnection point (i.e.: door unit, junction box "cross connection", control unit, etc.) to ensure compliance with this specification.
    - .5 Total system test:
      - .1 Proceed with testing when system and subsystems are functionally tested and accepted. Total system tests to verify that requirements have been met for DC (and/or audio), sub carrier, and control signals in accordance with this specification.
    - .6 Safety:
      - .1 Demonstrate with documentation that access control system meets safety requirements specified in UL 294.
  - .5 Visual verification: objective is to assess quality of installation and assembly and overall appearance to ensure compliance with Contract Documents. Visual inspection to include:
    - .1 Sturdiness of equipment fastening.
    - .2 Non-existence of installation related damages.
    - .3 Compliance of device locations with reviewed shop drawings.
    - .4 Compatibility of equipment installation with physical environment.
    - .5 Inclusion of all accessories.

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- .6 Device and cabling identification.
  - .7 Application and location of ULC approval decals.
  - .6 Technical verification: purpose to ensure that all systems and devices are properly installed and free of defects and damage. Technical verification includes:
    - .1 Validate sensitivity of readers and applicability and application of cards.
    - .2 Connecting joints and equipment fastening.
    - .3 Compliance with manufacturer's specification, product literature and installation instructions.
  - .7 Operational verification: purpose to ensure that devices and systems' performance meet or exceed established functional requirements. Operational verification includes:
    - .1 Operation of each device individually and within its environment.
    - .2 Operation of each device in relation with programmable schedule and or/specific functions.

### **3.03 FIELD QUALITY CONTROL**

- .1 Manufacturer Services:
  - .1 Manufacturer of products, supplied under this Section, to review Work involved in the handling, installation/application, protection and cleaning, of its products and submit written reports, in acceptable format, to verify compliance of Work with Contract.
  - .2 Manufacturer's Field Services:
    - .1 Obtain written reports from manufacturer verifying compliance of Work, in handling, installing, applying, protecting and cleaning of product.
    - .2 Submit manufacturer's field services consisting of product use recommendations and periodic site visits for inspection of product installation in accordance with manufacturer's instructions.
    - .3 Ensure manufacturer's representative is present before and during critical periods of installation and testing.
      - .4 Schedule site visits to review Work at stages listed:
        - .1 After delivery and storage of products, and when preparatory Work on which Work of this Section depends is complete, but before installation begins.
        - .2 Twice during progress of Work at 25% and 60% complete.
        - .3 Upon completion of Work, after cleaning is carried out.
  - .3 Clean components free from dirt and fingerprints.

### **3.04 PROTECTION**

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

**END OF SECTION**

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## **FIRE DETECTION AND ALARM SYSTEM**

### **3180 POINT INTELLIGENT FIRE ALARM DETECTION SYSTEM**

#### **PART 1 GENERAL**

##### **1.1 RELATED SECTIONS**

- A. Building Automation and Control.
- B. Fire Suppression.

##### **1.2 DESCRIPTION:**

- A. This section of the specification includes the furnishing, installation, and connection of an intelligent reporting, microprocessor controlled, addressable, fire detection and emergency voice alarm communication system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.
- B. The fire alarm system shall comply with requirements of CAN/ULC Standards. The system shall be electrically supervised and monitor the integrity of all conductors.
- C. The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main fire alarm control panel (FACP) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACP shall result in a trouble indication as specified hereinafter for the particular input.
- D. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.
- E. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- F. The system and its components shall be Underwriters Laboratories of Canada listed under the appropriate ULC testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the CAN/ULC-S524-06 Standard.
- G. The installing company shall employ qualified Fire Alarm Technicians on site to guide the final checkout and to ensure the systems integrity.
- H. Fire Alarm System shall be tested as an integrated system as per CAN/ULC-S1001.

**1.3 SCOPE:**

- A. A new intelligent reporting, microprocessor controlled fire detection system shall be installed in accordance with the specifications and drawings.
- B. The system shall be designed such that each Data Communication Link (DCL) is limited to only 80% of its total capacity at initial installation.
- C. Basic Performance:
  - 1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on Class A Data Communication Link (DCLA).
  - 2. Initiation Device Circuits (IDC) shall support Class A or Class B wiring as part of an addressable device connected by the DCLA Circuit
  - 3. Notification Appliance Circuits (NAC) shall support Class A or Class B wiring as part of an addressable device connected by the DCL Circuit.
  - 4. On Class A configurations a single ground fault or open circuit on the system Signalling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
  - 5. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
- D. Basic System Functional Operation

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

- 1. The System Alarm LED shall flash.
- 2. A local piezo electric signal in the control panel shall sound.
- 3. The 640 character LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- 4. Printing and history storage equipment shall log the information associated each new fire alarm control panel condition, along with time and date of occurrence.
- 5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

## **1.4 SUBMITTALS**

### **A. General:**

1. At least two copies of all submittals shall be submitted to the Architect/Engineer for review.
2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible ULC listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
3. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

### **B. Shop Drawings:**

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Show annunciator layout, configurations, and terminations.

### **C. Manuals:**

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.
4. Approvals will be based on complete submissions of manuals together with shop drawings.

### **D. Software Modifications**

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and



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software shall place no limit on the type or extent of software modifications onsite. Modification of software shall not require power down of the system or loss of system fire protection while modifications are being made.

E. Certifications:

Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

**1.5 GUARANTY:**

All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least 12 months from the date of acceptance. The full cost of maintenance, labour and materials required to correct any defect during this one year period shall be included in the submittal bid.

**1.6 POST CONTRACT MAINTENANCE:**

- A. Complete maintenance and repair service for the fire alarm system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of five (5) years after expiration of the guaranty.
- B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of five (5) years after expiration of the guaranty.
- C. Maintenance and testing shall be on an annual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:
  - 1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.
  - 2. Each circuit in the fire alarm system shall be tested annually.
  - 3. Each smoke detector shall be tested in accordance with the requirements of CAN/ULC S-536.

**1.7 POST CONTRACT EXPANSIONS:**

- A. The contractor shall have the ability to provide parts and labour to expand the system specified, if so requested, for a period of five (5) years from the date of acceptance.

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- B. As part of the submittal, include a quotation for all parts and material, and all installation and test labour as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).
- C. The quotation shall include installation, test labour, and labour to reprogram the system for this 10% expansion. If additional FACP hardware is required, include the material and labour necessary to install this hardware.
- D. Do not include cost of conduit or wire or the cost to install conduit or wire.
- E. Submittals that do not include this estimate of post contract expansion cost will not be accepted.

#### **1.8 APPLICABLE PUBLICATIONS:**

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

- A. Government of Canada:

Canadian Building Code as adopted by the Provincial Building Code

The Canadian Electrical Code, Part 1

- B. Underwriters Laboratories of Canada (ULC):

CAN/ULC-S524, Installation of Fire Alarm Systems.

CAN/ULC-S525, Audible Signal Appliances for Fire Alarm.

CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.

CAN/ULC-S527, Control Units.

CAN/ULC-S528, Manual Pull Stations.

CAN/ULC-S529, Smoke Detectors.

CAN/ULC-S530, Heat Actuated Fire Detectors.

CAN/ULC-S531, Smoke Alarms.

CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.

CAN/ULC-S537, Verification of Fire Alarm Systems.

C. National Fire Protection Association (NFPA):

No. 12 CO2 Extinguishing Systems (low and high)

No. 12B Halon 1211 Extinguishing Systems

No. 13 Sprinkler Systems

No. 13A Halon 1301 Extinguishing Systems

No. 15 Water Spray Systems

No. 16 Foam/Water Deluge and Spray Systems

No. 17 Dry Chemical Extinguishing Systems

No. 17A Wet Chemical Extinguishing Systems

No. 72 National Fire Alarm Code

No. 101 Life Safety Code

No. 2001 Clean Agent Fire Extinguishing Systems

D. Local and Provincial Building Codes.

E. All requirements of the Authority Having Jurisdiction (AHJ).

**1.9 APPROVALS:**

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

ULC Underwriters Laboratories Canada.

B. The Fire Alarm Control Panel and all transponders shall meet the modular listing requirements of Underwriters Laboratories of Canada. Each subassembly, including all printed circuits, shall include the appropriate ULC modular label. This includes all printed circuit board assemblies, power supplies, and enclosure parts. Systems that do not include modular labels may require return to the factory for system upgrades, and are not acceptable.

C. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low pressure CO2.

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## **PART 2.0 PRODUCTS**

### **2.1 EQUIPMENT AND MATERIAL, GENERAL:**

- A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signalling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.
- B. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
- D. All equipment shall be supplied by Notifiers Authorizes Engineered Systems  
Distributor CONTROL FIRE SYSTEMS LTD (i.e. 416-236-2371) which is the  
Authorized Engineered Systems representative for this project.

### **2.2 CONDUIT AND WIRE:**

#### **A. Conduit:**

1. Conduit shall be in accordance with Canadian Electrical Code as adopted by the local Province
2. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors.
4. Wiring for 24 volt control, alarm notification, emergency communication and similar power limited auxiliary functions may be run in the same conduit as initiating and signalling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

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5. Conduit shall not enter the fire alarm control panel or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.

**B. Wire**

1. All fire alarm system wiring must be new.
2. Wiring shall be in accordance with local, provincial and national codes and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signalling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signalling system.
4. Wiring used for the multiplex communication circuit (DCL) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the DCL communication circuit.
5. The system shall permit the use of IDC and NAC wiring in the same conduit with the multiplex communication loop.
6. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; A trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

**C. Terminal Boxes, Junction Boxes and Cabinets:**

All boxes and cabinets shall be CSA listed for their intended purpose.

- D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on Data Communication Link connected to intelligent reporting devices.
- E. The fire alarm control panel shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labelled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

**2.3 MAIN FIRE ALARM CONTROL PANEL OR NETWORK NODE:**

- A. The main FACP Central Console shall be a NOTIFIER Model NFS2-3030 or approved equivalent by CONTROL FIRE SYSTEMS, or approved equal, and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system controlled devices.
- B. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:

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1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
  2. Supervise all initiating signalling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
  3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all DCL loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding DCL loop control modules and associated detection devices as conventional two wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.
  4. Visually and audibly annunciate any trouble, supervisory, security or alarm condition on operator's terminals, panel display, and annunciators.
  5. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
    - a. The system alarm LED shall flash.
    - b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
    - c. The 640 character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
    - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
    - e. All system outputs assigned via pre-programmed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
    - f. When a trouble condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
      - g. The system trouble LED shall flash.
      - h. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
      - i. The 640character backlit LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.
      - j. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
      - k. All system outputs assigned via pre-programmed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.
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6. When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
    - a. The system trouble LED shall flash.
    - b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
    - c. The 640 character backlit LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.
    - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
    - e. All system outputs assigned via pre-programmed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.
  7. When a security alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
    - a. The system security LED shall flash.
    - b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
    - c. The 640 character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
    - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.
    - e. All system outputs assigned via pre-programmed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
  8. When a pre-alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:
    - a. The system pre-alarm LED shall flash.
    - b. A local piezoelectric audible device in the control panel shall sound a distinctive signal.
    - c. The 640character backlit LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
    - d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

- e. All system outputs assigned via pre-programmed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

C. Operator Control

1. Acknowledge Switch:

- a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the LCD display to the next alarm or trouble condition. In addition, the FACP shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single depression of this switch.
- b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.

2. Signal Silence Switch:

- a. Depression of the Signal Silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto silence timers.

3. Drill Switch:

- a. Depression of the Drill switch shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4. System Reset Switch:

- a. Depression of the System Reset switch shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall report if active. Active notification appliance circuits shall not silence upon Reset. Systems that deactivate and subsequently reactivate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re report upon reset.

5. Lamp Test:

- a. The Lamp Test switch shall activate all local system LEDs, light each segment of the liquid crystal display and display the panel software revision for service personal.



6. Scroll Display Keys:

- a. There shall be Scroll Display keys for FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. Depression of the Scroll Display key shall display the next event in the selected queue allowing the operator to view events by type.

7. Print Screen:

- a. Depression of the PRINT SCREEN switch shall send the information currently displayed on the 640 character display to the printer.

D. System Capacity and General Operation

1. The control panel shall be capable of expansion via up to 10 DCL modules. Each module shall support a maximum of 318 analogue/addressable devices for a maximum system capacity of 3,180 points. The system shall be capable of 3072 annunciation points per system regardless of the number of addressable devices.
2. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640 character liquid crystal display, individual, colour coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.
3. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
4. The FACP or each node shall be able to provide the following software and hardware features:
  - a. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15 second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
  - b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
  - c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
  - d. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed

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with either heat or smoke detectors shall automatically activate on action Pre Alarm level, with general evacuation on Alarm level.

- e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
- f. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
- g. Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the requirements of CAN/ULC-S527.
- h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
- i. Online or Offline programming: The system shall provide means to allow panel programming either through an offline software utility program away from the panel or while connected and online. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop.
- j. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.
- k. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet CAN/ULC-S527 and the National Building Code of Canada and HVAC mode to meet the National Building Code of Canada.
- l. The system shall provide means for all DCL devices on any DCL loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
- m. Drill: The system shall support means to activate all silenceable fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.
- n. Passwords and Users: The system shall support two password levels, master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.
- o. Two Wire Detection: The system shall support standard two wire detection devices specifically all models of System Sensor devices, Fenwal PDS7125/ 7126 and CPD7021, Hochiki model SLK24F/ 24FH, Edwards 6250B/6270B and 6264B and Simplex models 20989201/ 9202 and 9576 or approved equivalent.

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- p. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions
  - q. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
  - r. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.
  - s. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
  - t. Print Functions: The system shall provide means to obtain a variety of reports listing all event, alarm, trouble, supervisory, or security history. Additional reports shall be available for point activation for the last Walk Test performed, detector maintenance report containing the detector maintenance status of each installed addressable detector, all network parameters, all panel settings including broad cast time, event ordering, and block acknowledge, panel timer values for Auto Silence, Silence Inhibit, AC Fail Delay time and if enabled, Proprietary Reminder, and Remote Reminder timers, supervision settings for power supply and printers, all programmed logic equations, all custom action messages, all non fire and output activations (if pre-programmed for logging) all active points filtered by alarms only, troubles only, supervisory alarms, pre-alarms, disabled points and activated points, all installed points filtered by DCL points, logic zones, annunciators, releasing zones, special zones, and trouble zones.
  - u. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the DCL and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.
  - v. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will Re-sound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will Re-sound the panel sounder.
  - w. Read status preview enabled and disabled points: Prior to re enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
  - x. Custom Graphics: When fitted with an LCD display, the panel shall permit uploading of a custom bitmapped graphic to the display screen.

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- y. Multi Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.
  - z. Tracking/Latching Duct (ion and photo): The system shall support both tracking and latching duct detectors either ion or photo types.
  - aa. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control by Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4) Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.
  - bb. NONFIRE Alarm Module Reporting: A point with a type ID of NONFIRE shall be available for use for energy management or other non fire situations. NONFIRE point operation shall not affect control panel operation nor shall it display a message at the panel LCD. Activation of a NONFIRE point shall activate control by event logic but shall not cause any indication on the control panel.
  - cc. Security Monitor Points: The system shall provide means to monitor any point as a type security.
  - dd. One Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.
  - ee. Control-By-Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.
  - ff. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non Alarm or Supervisory points shall not activate the general alarm zone.

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- gg. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
  - hh. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.
  - ii. 10 trouble equations per device: The system shall provide support for up to 10 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
  - jj. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24 hour time schedule on any day of the week or year.
  - kk. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross zone and four abort options to satisfy any local jurisdiction requirements.
  - ll. Alarm Verification, by device, with timer and tally: The system shall provide a user defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

#### E. Central Processing Unit

1. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.
2. The Central Processing Unit shall contain and execute all control by event (including Boolean functions including but not limited to AND, OR, NOT, ANY, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control by event programs shall be held in non-volatile programmable memory, and shall not be lost with system primary and secondary power failure.

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3. The Central Processing Unit shall also provide a real time clock for time annotation, to the second, of all system events. The time of day and date shall not be lost if system primary and secondary power supplies fail.
  4. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
  5. Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.
  6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.
  7. The CPU shall provide an EIA232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
  8. The CPU shall provide two EIA485 ports for the serial connection to annunciation and control subsystem components.
  9. The EIA232 serial output circuit shall be optically isolated to assure protection from earth ground.
  10. The CPU shall provide one high speed serial connection for support of network communication modules.
  11. The CPU shall provide double pole relays for FIRE ALARM, SYSTEM TROUBLE, SUPERVISORY, and SECURITY. The SUPERVISORY and SECURITY relays shall provide selection for additional FIRE ALARM contacts.

F. Display

1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones.
3. The system display shall provide a 640character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide ten Light Emitting Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and CPU FAILURE.

4. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.
5. The system display shall include the following operator control switches: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of events by event type including, FIRE ALARM, SECURITY, SUPERVISORY, TROUBLE, and OTHER EVENTS. A PRINT SCREEN button shall be provided for printing the event currently displayed on the 640character LCD.

G. Loop (Signalling Line Circuit) Control Module:

1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 monitor or control modules.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This DCL Loop shall be capable of operating as a Class B circuit.
4. The DCL interface board shall be able to drive a Class A or B twisted unshielded circuit up to 12,500 feet in length. The DCL Interface shall also be capable of driving a Class A or B, no twist, no shield circuit for limited distances determined by the manufacturer. In addition, DCL wiring shall meet the listing requirements for it to exit the building or structure. "T" tapping shall be allowed in either case.
5. The DCL interface board shall receive analogue or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each DCL Loop shall be isolated and equipped to annunciate an Earth Fault condition. The DCL interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analogue information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

H. Enclosures:

1. The control panel shall be housed in a ULC listed cabinet suitable for surface or semi flush mounting. The cabinet and front shall be corrosion protected, given a rust resistant prime coat, and manufacturer's standard finish.
2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.



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3. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left hand side.
  4. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

I. Power Supply:

1. The Addressable Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP.
2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 25 - 200 amp hours within a 48 hour period.
4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
5. The Addressable Main Power Supply shall be power limited.

K. System Circuit Supervision

1. The FACP shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communication with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.
2. Transponders that lose communication with the CPU shall sound an audible trouble and light an LED indicating loss of communications.
3. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off normal position.

L. Field Wiring Terminal Blocks

1. All wiring terminal blocks shall be the plug in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

M. Remote Transmissions:

1. Provide local energy or polarity reversal or trip circuits as required.



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2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.
  3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
  4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

N. System Expansion:

Design the main FACP and required components so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.

O. Field Programming

1. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
2. It shall be possible to program through the standard FACP keyboard all system functions.
3. All field defined programs shall be stored in non-volatile memory.
4. Two levels of password protection shall be provided in addition to a key lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
5. The system programming shall be "backed" up via an upload/download program, and stored on compatible removable media. A system backup disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.
6. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input to Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.

P. Specific System Operations

1. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analogue intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed ULC window.
2. Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or anytime after system turn on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

Q. System Point Operations:

1. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
2. System output points shall be capable of being turned on or off from the system keypad or the video terminal.
3. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
  - a. Device Status.
  - b. Device Type.
  - c. Custom Device Label.
  - d. Software Zone Label.
  - e. Device Zone Assignments.
  - f. Analog Detector Sensitivity.
  - g. All Program Parameters.
4. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system statuses:
5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
6. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
8. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated

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on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

9. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

## **2.4 SYSTEM COMPONENTS:**

### **A. Programmable Electronic Sounders:**

1. Shall be a System Sensor SpectrAlert Advance which is listed to CAN/ULC-S525, Audible Signal Appliances, Fire Alarm.
2. Shall operate on 24 VDC nominal.
3. Shall be field programmable with three audibility options and an option to switch between a temporal three-pattern and a non-temporal (continuous) pattern without the use of special tools.
4. Shall produce a sound level of at least 90 dBA measured at 10 feet from the device.
5. Shall be flush or surface mounted as shown on plans.

### **B. Strobe lights shall meet the requirements of CAN/ULC-524, Installation of Fire Alarm, and be fully synchronized, and shall meet the following criteria:**

1. Shall be a System Sensor SpectrAlert Advance which consists of a xenon flash tube and associated lens/reflector system, is listed to CAN/ULC-S526 and shall be approved for fire protective service.
2. Strobe intensity shall meet the requirements of CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
3. The flash rate shall meet the requirements of CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
4. Shall have field-selectable candela settings including 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, 185.

### **C. Manual Fire Alarm Stations**

1. Manual fire alarm stations shall be non-coded, non-breakglass type, equipped with key lock so that they may be tested without operating the handle.
2. Stations must be designed such that after an actual activation, they cannot be restored to normal except by key reset.
3. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet (30.5 m) front or side.
4. Manual stations shall be constructed of high impact Lexan, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters one half inch (12.7 mm) in size or larger.

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D. Conventional Photoelectric Area Smoke Detectors

1. Photoelectric smoke detectors shall be a 24 VDC, two-wire, ceiling mounted, light scattering type using an LED light source.
2. Each detector shall contain a remote LED output and a built in test switch.
3. Detector shall be provided on a twist lock base.
4. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall flash at least every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not go into alarm when exposed to air velocities of up to 3000 feet (914.4 m) per minute.
7. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
8. All field wire connections shall be made to the base through the use of a clamping plate and screw.

E. Conventional Ionization Type Area Smoke Detectors

1. Ionization type smoke detectors shall be a two wire, 24 VDC type using a dual uni-polar chamber.
2. Each detector shall contain a remote LED output and a built in test switch.
3. Detector shall be provided on a twist lock base.
4. It shall be possible to perform a calibration sensitivity and performance test on the detector without the need for the generation of smoke.
5. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs) over 360 degrees, on the detector, which may be seen from ground level. This LED shall flash every 10 seconds, indicating that power is applied to the detector.
6. The detector shall not alarm when exposed to air velocities of up to 1,200 feet (365.76 m) per minute. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
7. All field wire connections shall be made to the base through the use of a clamping plate and screw.

F. Duct Smoke Detectors

1. Duct smoke detectors shall be a 24 VDC type with visual alarm and power indicators, and a reset switch.
2. Each detector shall be installed upon the composite supply air ducts(s), with properly sized air sampling tubes.

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G. Projected Beam Detectors

1. The projected beam type shall be a 24 VDC device.
2. The detector shall be ULC listed and shall consist of a separate transmitter and receiver capable of being powered separately or together.
3. The detector shall operate in either a short range (30' - 100') or long range (100' - 330') mode.
4. The temperature range of the device shall be 22 degrees F (-5.5 Celsius) to 131 degrees F (55 Celsius).
5. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.
6. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.
7. The unit shall be both ceiling and wall mountable.
8. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

H. Automatic Conventional Heat Detectors

1. Automatic heat detectors shall have a combination rate of rise and fixed temperature rated at 135 degrees Fahrenheit (57.2 Celsius) for areas where ambient temperatures do not exceed 100 degrees (37.7 Celsius), and 200 degrees (93.33 Celsius) for areas where the temperature does not exceed 150 degrees (65.5 Celsius).
2. Automatic heat detectors shall be a low profile, ceiling mount type with positive indication of activation.
3. The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 degrees F (9.4 degrees C) per minute.
4. The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.
5. Automatic heat detectors shall have a smooth ceiling rating of 900 square feet (87 meters square).

I. Waterflow Indicator:

1. Waterflow Switches shall be an integral, mechanical, non coded, non accumulative retard type.
2. Waterflow Switches shall have an alarm transmission delay time which is conveniently adjustable from 0 to 60 seconds. Initial settings shall be 30 - 45 seconds.
3. All waterflow switches shall come from a single manufacturer and series.

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4. Waterflow switches shall be provided and connected under this section but installed by the mechanical contractor.
  5. Where possible, locate waterflow switches a minimum of one (1) foot from a fitting which changes the direction of the flow and a minimum of three (3) feet from a valve.

J. Sprinkler and Standpipe Valve Supervisory Switches:

1. Each sprinkler system water supply control valve riser, zone control valve, and standpipe system riser control valve shall be equipped with a supervisory switch. Standpipe hose valves, and test and drain valves shall not be equipped with supervisory switches.
2. PIV (post indicator valve) or main gate valves shall be equipped with a supervisory switch.
3. The switch shall be mounted so as not to interfere with the normal operation of the valve and adjusted to operate within two revolutions toward the closed position of the valve control, or when the stem has moved no more than one fifth of the distance from its normal position.
4. The supervisory switch shall be contained in a weatherproof aluminum housing, which shall provide a 3/4 inch (19 mm) conduit entrance and incorporate the necessary facilities for attachment to the valves.
5. The switch housing shall be finished in red baked enamel.
6. The entire installed assembly shall be tamper proof and arranged to cause a switch operation if the housing cover is removed, or if the unit is removed from its mounting.
7. Valve supervisory switches shall be provided and connected under this section and installed by mechanical contractor.
  - a. This unit shall provide for each zone: alarm indications, using a red alarm a yellow trouble long-life LEDs and control switches for the control of fire alarm control panel functions. The annunciator will also have an ONLINE LED, local piezo electric signal, local acknowledge/lamp test switch and custom slide in zone/function identification labels.
  - b. Switches shall be available for remote annunciation and control of output points in the system, system acknowledge, global signal silence, and global system reset within the confines of all applicable standards.

## **2.5. SYSTEM COMPONENTS ADDRESSABLE DEVICES**

A. Addressable Devices General

1. Addressable devices shall provide an address setting means using rotary decimal switches.

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2. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches. Devices which use a binary address or special tools for setting the device address, such as a dip switch are not an allowable substitute.
  3. Detectors shall be Analogue and Addressable, and shall connect to the fire alarm control panel's Signalling Line Circuits.
  4. Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed off via the fire control panel program.
  5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time of day basis.
  6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by ULC as meeting the calibrated sensitivity test requirements of CAN/ULC-S529 Smoke Detector.
  7. The detectors shall be ceiling mount and shall include a separate twist lock base which includes a tamper proof feature.
  8. The following bases and auxiliary functions shall be available:
    - a. Sounder base rated at 85 dBA minimum.
    - b. Form C Relay base rated 30VDC, 2.0A
    - c. Isolator base
  9. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
  10. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (example: ION, PHOTO, THERMAL).

**B. Addressable Manual Fire Alarm Box (manual station)**

1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

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3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analogue level of smoke density.

D. Intelligent Laser Photo Smoke Detector

1. The intelligent laser photo smoke detector shall be a spot type detector that incorporates an extremely bright laser diode and an integral lens that focuses the light beam to a very small volume near a receiving photo sensor. The scattering of smoke particles shall activate the photo sensor.
2. The laser detector shall have conductive plastic so that dust accumulation is reduced significantly.
3. The intelligent laser photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.
4. The laser detector shall not require expensive conduit, special fittings or PVC pipe.
5. The intelligent laser photo detector shall support standard, relay, isolator and sounder detector bases.
6. The laser photo detector shall not require other cleaning requirements than those listed in CAN/ULC-S529 Smoke Detector. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.
7. The laser photo detector shall include two bi-colour LEDs that flash green in normal operation and turn on steady red in alarm.

E. Intelligent Ionization Smoke Detector

1. The detectors shall use the dual chamber ionization principal to measure products of combustion and shall, on command from the control panel, send data to the panel representing the analogue level of products of combustion.

F. Intelligent Multi Criteria Acclimating Detector

1. The intelligent multi criteria Acclimate detector shall be an addressable device that is designed to monitor a minimum of photoelectric and thermal technologies in a single sensing device. The design shall include the ability to adapt to its environment by utilizing a built in microprocessor to determine its environment and choose the appropriate sensing settings.  
The detector design shall allow a wide sensitivity window, no less than 1 to 4% per foot obscuration. This detector shall utilize advanced electronics that react to slow smouldering fires and thermal properties all within a single sensing device.



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2. The microprocessor design shall be capable of selecting the appropriate sensitivity levels based on the environment type it is in (office, manufacturing, kitchen etc.) and then have the ability to automatically change the setting as the environment changes (as walls are moved or as the occupancy changes).
  3. The intelligent multi criteria detection device shall include the ability to combine the signal of the thermal sensor with the signal of the photoelectric signal in an effort to react hastily in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a false alarm condition by examining the characteristics of the thermal and smoke sensing chambers and comparing them to a database of actual fire and deceptive phenomena.

G. Intelligent Thermal Detectors

1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate of rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signalling line circuit.

H. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analogue monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

I. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel DCLs.
2. The IDC zone shall be suitable for Class A or B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 23/ 4 inch (70 mm) x 11/ 4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include an LED.

J. Two Wire Detector Monitor Module

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2wire smoke detectors or alarm initiating devices (any N.O. dry contact device).

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2. The IDC zone may be wired for Class A or B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

K. Addressable Control Module

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered polarized audio/visual notification appliances.
2. The control module NAC may be wired for Class A or B with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation.
3. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised ULC listed remote power supply.
4. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.

L. Addressable Relay Module

1. Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

M. Addressable 4-20mA Monitor Module

1. Addressable 4-20mA monitor modules shall be available to connect supervised industry-standard, linear-scale, 4–20 mA protocol sensors.
2. Addressable 4-20mA monitor modules shall support up to five programmable thresholds and a 500 mA current limiter and a cut-off circuit protecting the module's electrical supply from short circuits.
3. Addressable 4-20mA monitor modules shall accept both 3-wire (device sink) and 2-wire configurations.
4. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

N. Isolator Module

1. Isolator modules shall be provided to automatically isolate wire to wire short circuits on a DCL Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the DCL loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire to wire short occurs, the isolator module shall automatically open circuit (disconnect) the DCL. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

3. The isolator module shall not require address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

O. Projected Beam Detectors

1. The detector shall consist of a separate transmitter and receiver capable of being powered separately or together.
2. The detector shall operate in either a short range (30' - 100') or long range (100' - 330') mode.
3. The temperature range of the device shall be 22 degrees F (-5.5 Celsius) to 131 degrees F (55 Celsius).
4. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.
5. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.
6. The unit shall be both ceiling and wall mountable.
7. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

P. Smoke Control Annunciator

1. On/Auto/Off switches and status indicators (LEDS) shall be provided for monitoring and manual control of each fan, damper, HVAC control unit, stairwell pressurization fan, and smoke exhaust fan. To ensure compliance the units supplied shall meet the National Building Code of Canada, and CAN/ULC-S527.
2. The OFF LED shall be Yellow, the ON LED shall be green, the Trouble/Fault LED shall be Amber/Orange for each switch. The Trouble/Fault indicator shall indicate a trouble in the control and/or monitor points associated with that switch. In addition, each group of eight switches shall have two LEDS and one momentary switch which allow the following functions: An Amber LED to indicate an OFFNORMAL switch position, in the ON or OFF position; A Green LED to indicate ALL AUTO switch position; A Local Acknowledge/Lamp Test momentary switch.
3. Each switch shall have the capability to monitor and control two addressable inputs and two addressable outputs. In all modes, the ON and OFF indicators shall continuously follow the device status not the switch position. Positive feedback shall be employed to verify correct operation of the device being controlled. Systems that indicate on/off/auto by physical switch position only are not acceptable.
4. All HVAC switches (i.e., limit switches, vane switches, etc.) shall be provided and installed by the HVAC contractor.
5. It shall be possible to meet the requirements mentioned above utilizing wall mounted custom graphic.

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Q. Serially Connected Annunciator Requirements

1. The annunciator shall communicate to the fire alarm control panel via an EIA 485 (multi drop) two wire communications loop. The system shall support two 6,000 ft. EIA485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,072 points of annunciation.
2. An EIA485 repeater shall be available to extend the EIA485 wire distance in 3,000 ft. increments. An optional version shall allow the EIA485 circuit to be transmitted over fibre optics. The repeater shall be ULC listed.
3. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long life programmable colour LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Panel functions. The annunciator will also have an "ONLINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.
4. The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.
5. Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.
6. An optional module shall be available to utilize annunciator points to drive EIA485 driven relays. This shall extend the system point capacity by 3,072 remote contacts.
7. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

**2.6 BATTERIES AND EXTERNAL CHARGER:**

A. Battery:

1. Shall be 12 volt, Gel Cell type.
2. Battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure.
3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

B. External Battery Charger:

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240volt 50/60 hertz source.

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2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.
  3. Shall have protection to prevent discharge through the charger.
  4. Shall have protection for overloads and short circuits on both AC and DC sides.

## **PART 3.0 EXECUTION**

### **3.1. INSTALLATION:**

- A. Installation shall be in accordance with the CAN/ULC S-524 Installation of Fire Alarm standard, local and provincial codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- D. Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 1200mm, nor more than 1400mm above the finished floor.

### **3.4. TYPICAL OPERATION:**

- A. Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:
  1. Activate all programmed NAC circuits.
  2. Actuate all strobe units until the panel is reset.
  3. Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.
  4. Return all elevators to the primary or alternate floor of egress.
  5. A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.
  6. Smoke detectors in the elevator machine room or top of hoist way shall return all elevators in to the primary or alternate floor.
  7. Duct type smoke detectors shall, in addition to the above functions shut down the ventilation system or close associated control dampers as appropriate.

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8. Activation of any sprinkler system low pressure switch or valve tamper switch shall cause a system supervisory alarm indication.

**3.5. TEST:**

- A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with CAN/ULC S537.
- B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
- C. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
- D. Verify activation of all flow switches.
- E. Open initiating device circuits and verify that the trouble signal actuates.
- F. Open Data Communication Link and verify that the trouble signal actuates.
- G. Open and short notification appliance circuits and verify that trouble signal actuates.
- H. Ground initiating device circuits and verify response of trouble signals.
- I. Ground Data Communication Link and verify response of trouble signals.
- J. Ground notification appliance circuits and verify response of trouble signals.
- K. Check presence and audibility of tone at all alarm notification devices.
- L. Check installation, supervision, and operation of all intelligent smoke detectors during a walk test.
- M. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
- N. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

**3.6 FINAL INSPECTION:**

- A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

**3.7 INSTRUCTION:**

- A. Provide instruction as required for operating the system. Hands on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

**END OF SECTION**

## **SECTION 6.2 PORTABLE EXTINGUISHERS**

### **Subsection 6.2.1. General**

6.2.1.1. Listed portable extinguishers shall be installed when adding new extinguishers.

#### **Maintenance**

6.2.1.2. Portable extinguishers shall be kept operable and fully charged.

#### **Location**

6.2.1.3. (1) Portable extinguishers shall be located so that they are easily seen and shall be accessible at all times, except as permitted in Sentences (2) and (3).

(2) A lockable, break-front glazed cabinet may be used for security purposes to store portable extinguishers and where portable extinguishers are located in a fire hose cabinet, an approved lockable, scored glass break-front cabinet may be used.

6.2.1.4. Portable extinguishers shall be located in or adjacent to corridors or aisles that provide access to exits.

#### **Signs**

6.2.1.5. The location of portable extinguishers shall be prominently indicated by signs or markings in large floor areas and in locations where visual obstructions cannot be avoided.

#### **Proximity to Fire Hazards**

6.2.1.6. Portable extinguishers in proximity to a fire hazard shall be located so as to be accessible without exposing the operator to undue risk.

#### **Corrosive Atmosphere**

6.2.1.7. Portable extinguishers that are subject to corrosion shall not be installed in a corrosive environment unless they are provided with appropriate corrosion protection.

#### **Temperature Range Requirements**

6.2.1.8. (1) Where a portable extinguisher is to be located in an area subject to temperatures outside the range 4°C to 49°C, it shall be

- (a) placed in an enclosure where the temperature is maintained within this range, or
- (b) of a type labelled for the temperatures to which it will be exposed.

#### **Mounting Brackets**

6.2.1.9. When portable extinguishers are located on vehicles or in areas where they are subject to jarring or vibration, brackets designed to accommodate these effects shall be used.



### **Subsection 6.2.2. Classification**

#### **Rating of Portable Extinguishers**

6.2.2.1. Portable extinguishers shall be rated and identified in conformance with CAN/ULC-S508, "Standard for the Rating and Fire Testing of Fire Extinguishers".

### **Subsection 6.2.3. Selection Requirements**

#### **Multiple Ratings**

6.2.3.1. Where portable extinguishers have been tested and are rated as being acceptable for fighting more than one class fire, each class of fire for which they are acceptable shall be designated on each extinguisher.

### **Subsection 6.2.4. Installation Requirements**

#### **Distance Above Floor**

6.2.4.1. Portable extinguishers with a gross weight greater than 18 kg shall be installed so that the top of the extinguisher is not more than 1.1 m above the floor when the extinguisher is not equipped with wheels.

6.2.4.2. Portable extinguishers having a gross weight of 18 kg or less shall be installed so that the top of the extinguisher is not more than 1.5 m above the floor.

#### **Operating Instructions**

6.2.4.3. The operating instructions of portable extinguishers shall face outward when the extinguishers are located in cabinets, in wall recesses or on shelves.

### **Subsection 6.2.5. Grading of Hazards**

#### **Light Hazard Occupancy**

6.2.5.1. Where the quantity of combustible material present is such that fires of small size may be expected, such as in offices, schoolrooms, churches, assembly halls and telephone exchanges, the occupancy shall be graded as light hazard.

6.2.5.2.

#### **Ordinary Hazard Occupancy**

6.2.5.3. Where the quantity of combustible material present is such that fires of moderate size may be expected, such as in mercantile occupancies, display rooms, auto showrooms, parking garages, light manufacturing, warehouses not classified as extra hazard and school shop areas, the occupancy shall be graded as ordinary hazard.

### **Extra Hazard Occupancy**

6.2.5.4. Where the quantity of combustible material present is such that fires of severe magnitude may be expected, such as in woodworking, auto repair, aircraft servicing, mercantile storage areas, warehouses with high-piled combustibles and processes incorporating flammable liquids or combustible liquids, the occupancy shall be graded as extra hazard.

### **Subsection 6.2.6. Distribution**

6.2.6.1. (1) Portable extinguishers required in Article 6.2.4.1. shall be located in conformance with this Subsection.

(2) Despite Sentence (1), in an unoccupied warehouse equipped with a fixed fire protection system, provision shall be made for portable extinguishers to be available for use by responding personnel.

(3) The location and number of portable extinguishers required under Sentence (2) shall be approved.

### **Building Protection**

6.2.6.2. Portable extinguishers that are provided to protect a building shall be suitable for fighting Class A fires and be available for use at all times.

### **Occupancy protection**

6.2.6.3. Portable extinguishers that are provided to protect a hazardous occupancy shall be those required in this Section for fighting Class A fires, Class B fires, Class C fires, Class D fires or Class K fires.

### **Extinguishers for Class A fires**

6.2.6.4. Except as required in Article 6.2.6.5., portable extinguishers for Class A fires shall be provided in conformance with Table 6.2.6.A.

6.2.6.5. Where a floor area is less than that shown in Table 6.2.6.A., one portable extinguisher not less than the minimum size permitted shall be provided.

**TABLE 6.2.6.A.**

**Forming Part of Article 6.2.6.4.**

Basic Minimum Extinguisher Rating for Area Specified	Maximum Travel Distance to Extinguisher, m	Maximum Area to be Protected per Extinguisher for Class A Fires, m2		
		Light Hazard Occupancy	Ordinary Hazard Occupancy	Extra Hazard Occupancy
2A	25	600	300	Not Acceptable
3A	25	900	400	300
4A	25	1100	600	400
6A	25	1100	900	600
10A	25	1100	1100	900
20A	25	1100	1100	1100
40A	25	1100	1100	1100

### Hose Stations in Lieu of Extinguishers

6.2.6.6. Up to one half of the number of portable extinguishers required in Table 6.2.6.A. may be replaced by hose stations.

### Extinguishers for Class B fires

6.2.6.7. Except as required by Article 6.2.6.9., portable extinguishers for Class B fires shall be provided as required in Table 6.2.6.B.

6.2.6.8. (1) Where up to three portable extinguishers rated for Class B fires are used to satisfy the extinguisher rating specified in Table 6.2.6.B., the sum of the basic extinguisher ratings shall satisfy the requirements in Table 6.2.6.B.

(2) No more than three portable extinguishers shall be used to satisfy the requirements of Table 6.2.6.B.

**TABLE 6.2.6.B.**  
**Forming Part of Article 6.2.6.7.**

Grade of Hazard	Basic Minimum Extinguisher Rating per Unit	Maximum Travel Distance to Extinguishers, m
Light	5B	9
	10B	15
Ordinary	10B	9
	20B	15
Extra	20B	9
	40B	15

### **Supplementary Protection**

6.2.6.9. Portable extinguishers shall supplement fixed fire protection in Part 5 in accordance with Article 6.2.6.9. where a flammable liquid or combustible liquid is stored in an open container and where the liquid surface area exceeds 0.4 m<sup>2</sup>.

### **Extinguishers for Class C fires**

6.2.6.10. Portable extinguishers suitable for Class C fires shall be provided in or near service rooms containing electrical equipment.

### **Distribution**

6.2.6.11. Distribution of portable extinguishers for Class C fires shall conform to the applicable provisions for the distribution of extinguishers for Class A fires or Class B fires in the vicinity of the electrical equipment.

6.2.6.12. Reference shall be made to Parts 2, 3, 4 and 5 for requirements of portable extinguishers for flammable liquids and combustible liquids, hazardous materials, processes and operations.

### **Subsection 6.2.7. Inspection, Testing and Maintenance**

6.2.7.1. (1) Maintenance and testing of portable extinguishers shall be in conformance with NFPA 10, "Portable Fire Extinguishers".

(2) Portable extinguishers that are inspected in conformance with NFPA 10, "Portable Fire Extinguishers", are deemed to satisfy the inspection requirements of this Subsection.

### **Examination**

6.2.7.2. Portable extinguishers shall be inspected monthly.

### **Tags**

6.2.7.3. (1) Each portable extinguisher shall have a tag securely attached to it showing the maintenance or recharge date, the servicing agency and the signature of the person who performed the service.

(2) Sentence (1) does not apply where other approved records are maintained that show the maintenance or recharge date, the servicing agency and the signature of the person who performed the service.

### **Maintenance Records**

6.2.7.4. A permanent record containing the maintenance date, the examiner's name and a description of any maintenance work or hydrostatic testing carried out shall be prepared and maintained for each portable extinguisher.

### **Maintenance After Use**

6.2.7.5. Portable extinguishers shall be replaced or recharged after use in conformance with instructions given on the extinguisher nameplate.

6.2.7.6. Extinguisher shells, cartridges or cylinders that show leakage or permanent distortion in excess of specified limits or that rupture shall be removed from service.

6.2.7.7. Hydrostatic pressure tests shall be conducted at the original test pressure as stated on the nameplate.

### **Test Labels**

6.2.7.8. (1) Where a portable extinguisher is tested, a label shall be fixed to the extinguisher after testing that indicates the month and year the hydrostatic pressure test was performed, the test pressure used and the name of the person or agency performing the test.

(2) Sentence (1) does not apply where a permanent record of the test is kept and is available to the fire department.

**END OF THE SECTION**

1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for earthwork Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM D698, Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort.
- .2 ASTM D4253, Test Method for Maximum Index Density and Unit Weight of Soil Using a Vibratory Table.
- .3 OPSS, Ontario Provincial Standard Specification.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit copies of manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard, characteristics, limitations of insulation boards, vibration isolator, filter fabric and other specified non-granular items.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings:
  - .1 Submit shop drawings in accordance with Section 01 30 00 indicating:
    - .1 Adjacent construction, elevations, sections and details, dimensions, and relationship to adjacent construction.
    - .2 Include design calculations, design concept, construction method, sequence and means by which existing structures, utilities and equipment will be protected; Location of in-use, maintained, re-routed and abandoned underground lines.
- .3 Reports:
  - .1 Submit written laboratory test reports.
  - .2 Submit written field inspection and test report results after each inspection.
- .4 Submit dewatering methods 30 days in advance for review by Consultant. If well point system is required, Engineer shall design system and supervise installation.
- .5 Submit to Consultant details of locations where surplus soils and other materials are to be disposed of or reused. Include each disposal/reuse Site and type of surplus soil or other material, location of the disposal/reuse Site, operator's name and business address, type of license under which Site operates, and criteria used by Site to access suitability of surplus material for disposal.

- .6 Submit to Consultant, within 48 hours of a load of surplus soil or other material leaving the Site, a daily register recording the time and place of disposal/reuse of each load signed by a representative of the disposal site. Such documentation must be submitted before payment for excavation will be made.

#### 1.4 **QUALITY ASSURANCE**

- .1 Have shop drawings signed and sealed by a Professional Engineer licensed in Province of Ontario and having experience in design and inspection of shoring, bracing, underpinning and dewatering (if required) required to complete Work.

#### 1.5 **SITE CONDITIONS**

- .1 Geotechnical conditions: For information on subsurface conditions refer to document appended to Section 02 32 00.
- .2 Cultural heritage resources: If Cultural Heritage Resources (such as archaeological sites, artifacts, building and structural remains, and/or human burials) are encountered during performance of Work, contact Consultant immediately and suspend Work in immediate area until assessment has been completed by Ministry of Culture, Tourism and Recreation. Perform required measures to mitigate negative impacts on found resources to acceptance of Consultant.

#### 1.6 **PROTECTION**

- .1 Existing buried utilities and structures:
  - .1 Size, depth and location of known existing utilities and structures are indicated for guidance only. Completeness and accuracy is not guaranteed.
  - .2 Prior to commencing any excavation Work, have authorities stake out utility locations to prevent disturbance during Work.
  - .3 Confirm locations of buried utilities by careful test excavations. Hand dig test excavations as necessary.
  - .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain permission of Consultant before moving or otherwise disturbing utilities or structures.
- .2 Existing buildings and surface features:
  - .1 Conduct with Consultant, a condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks and paving, survey bench marks and monuments which may be affected by Work.
  - .2 Protect existing buildings and surface features which may be affected by Work from damage while Work is in progress and repair damage resulting from Work.
  - .3 Where excavation necessitates root or branch cutting, perform Work in accordance with Authorities having Jurisdiction.
  - .4 Confirm with Consultant, condition Survey of buildings and structures undertaken by Consultant.



- .3 Temporarily cover local existing catch basins and maintenance holes to prevent entry of earth or debris. Ensure adequate surface drainage in affected area is maintained.
- .4 Protect Work or work of other Contracts in progress or completed and protect existing properties, stored Products, services, utilities, trees, landscaping and natural features from damage.
- .5 Protect excavations against flooding and damage and install and maintain appropriate warning devices during construction and during time when Work is closed down for any cause.
- .6 Protect bottom of excavations that will support foundations, slabs, pavements etc. from frost or freezing.
- .7 Keep access roads clear of debris and dirt resulting from Work of this Section to acceptance of Authorities having jurisdiction.
- .8 Shoring, bracing and underpinning: Comply with local regulations, authorities having jurisdictions and requirements specified.

2 Products

2.1 **MATERIALS**

- .1 Select fill: Subject to approval of Consultant consisting of reusable fill excavated from Site or imported fill that is free of organic matter, rubble and material other than soil. Maximum particle size of half thickness of lift specified, moisture content at time of placing 2% maximum over its optimum moisture content and is either non plastic or has a plasticity index of 25% maximum.
- .2 Granular A fill: Imported Granular A fill, free of organic matter and, in accordance with OPSS 1010.
- .3 Granular B Fill: Imported Granular B fill free of organic matter and in accordance with OPSS 1010.
- .4 Clear Stone fill: 19 mm clear stone in accordance with OPSS 1004, free of organic material.
- .5 Unshrinkable fill: 0.7 MPa cement stabilized backfill conforming to requirements of CAN/CSA A23.1/A23.2-M.
- .6 Dewatering equipment: Equip submersible pumps with filters and/or screens to prevent ground loss. Maintain filters in good operating condition.

3 Execution

3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

3.2 **LINES AND ELEVATIONS**

- .1 Establish lines and elevations from Control Points shown on Contract Drawings.
- .2 Have lines and elevations established by Registered Ontario Land Surveyor or qualified Civil Engineer registered in Province of Ontario.
- .3 Protect and maintain Control Points and Bench Marks as long as they are required.

3.3 **STRIPPING**

- .1 Do not handle topsoil while in wet or frozen condition or in manner in which soil composition is adversely affected.
- .2 Strip topsoil from working area in locations shown.
- .3 Strip topsoil to depths indicated. Avoid mixing topsoil with subsoil.
- .4 Stockpile topsoil in locations directed by Consultant. Stockpile to height not exceeding 2 m. Remove excess topsoil from Site.

3.4 **REMOVAL OF WATER**

- .1 Obtain letter of conditional approval from Authorities having Jurisdiction to dispose of ground water into sewer drainage system. Apply for and pay for water disposal permit.
- .2 Keep excavations and trenches free of water throughout construction period.
- .3 Groundwater removal:
  - .1 Lower groundwater level and maintain at depth below lowest point of excavation to ensure a dry stable surface.
  - .2 Dewater to prevent loss of soil and maintain stability of sides and bottom of excavation and of adjacent structures.
  - .3 Dispose of water in conformance with applicable by-laws and in a manner not detrimental to public and private property, or portion of Work completed or under construction.

- .4 Supply and install flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to sewers, water courses or drainage areas in accordance with authorities having jurisdiction. Perform testing on settlement tank discharge to confirm that effluent meets sewer bylaw requirements. Locate tanks to acceptable area determined by Consultant.
- .5 Should method of dewatering fail to achieve conditions specified above, Consultant reserves right to revise methods and procedures at no cost to Owner.
- .4 Surface water removal:
  - .1 Remove surface run-off in a manner that will prevent loss of soil and maintain stability of sides and bottom of excavation. Obtain Consultant's approval of dewatering method to be used.
  - .2 Discharge surface water into existing storm drainage system to acceptance of Consultant and local authorities.
- .5 Do not obstruct flow of surface drainage or natural water courses.

### 3.5 **EXCAVATION**

- .1 Remove concrete, masonry, paving, demolished foundations and rubble and other obstructions encountered during excavation Work.
- .2 Do not disturb soil within drip line of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw in a manner acceptable to authorities having jurisdiction.
- .3 Excavate to required lines and grades shown on Contract Drawings with allowance for subsequent Work including shoring, bracing and formwork. Make excavation clean and clear of loose material and true to size.
- .4 Protect stockpiles of fill against contamination and moisture absorption.
- .5 Do not undermine adjacent structures. Where it is necessary to have footings at different levels, found upper footing below imaginary 10-horizontal-to-7 vertical line, or as otherwise indicated, drawn up from base of lower footing. Protect adjacent foundations from frost.
- .6 Have excavations in excess of 1200 mm in depth conform to requirements of Occupational Health and Safety Act, and Regulations for Construction Projects.
- .7 Do not expose shale at subgrade elevation to drying cycles and in any case, following inspection, cover with minimum 50 mm of lean concrete within four (4) hours after exposure.
- .8 Fill excavations for foundations which are, through error, carried below elevation shown or approved depth, with 15 MPa concrete, or as directed by Consultant.

- .9 Trim, and remove loose material, debris and organic material from excavations. Where material at bottom of excavation is disturbed, remove disturbed material and re-compact to density equal to or better than undisturbed soil or backfill with lean concrete as directed by Consultant.
- .10 When excavations are complete, prior to commencement of subsequent Work, request Consultant for inspection of excavation Work.

### 3.6 **TRENCHING**

- .1 Excavate trenches to lines and grades indicated and to a depth of 75 mm minimum below invert elevation and slope established for pipe, and backfill to invert elevation of pipe with specified granular material.
- .2 Unless otherwise authorized by Consultant, 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. Remove unsuitable material from trench bottom to extent and depth as directed by Consultant.
- .3 Backfill over-excavation with granular material and compact.
- .4 If unstable soil conditions are encountered, excavate trenches to depth directed by Consultant and backfill to correct elevation with backfill material.
- .5 Remove loose material from bottom of trenches to ensure granular material is placed against undisturbed soil.
- .6 Compact bedding and grade as required for even and uniform support on each length of pipe.
- .7 Where excavating is required adjacent to and parallel with and below any footing, submit excavation and backfill procedures to Consultant for review prior to start of excavating.
- .8 Keep width of trenches to a minimum to ensure minimum span for pipe to be supported.
- .9 Make excavations for fire hydrants of sufficient size and depth to accommodate a minimum 0.75 m<sup>3</sup> of crushed stone. Hand place stone and tamp around and below hydrant elbow to ensure proper drainage of hydrant.

### 3.7 **EXCAVATED MATERIAL DISPOSAL**

- .1 Except for material to be used as select fill, immediately remove and dispose of excavated material from Site.

- .2 Remove and dispose of construction rubble, abandoned gas, water and sewer pipes, valves, valve boxes and fittings, maintenance holes, frames and covers and other material which may be encountered during excavation but not indicated on Contract Drawings.

### 3.8 **BACKFILLING**

- .1 Do not proceed with backfilling operations until walls, slabs, waterproofing and below grade Work has been inspected and accepted by Consultant.
- .2 Backfill areas which are 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 Do not backfill on or against any membrane or protection board covered waterproofing with jagged rock or other sharp objects which might damage waterproofing.
- .5 Limit vertical drop of backfill material to 2000 mm.
- .6 To avoid pockets and voids, remove sheathing and shoring materials that require removal, as backfilling progresses.
- .7 Prior to backfilling or placing concrete on exposed soil subgrade, proof roll subgrade to identify soft or loose areas. Proceed with placing backfill or concrete only after inconsistencies identified by above procedure have been reworked and compacted or excavated, backfilled and compacted as required to eliminate such conditions to acceptance of Consultant.
- .8 Place backfill material, grade and compact to levels shown on Contract Drawings.
- .9 Place backfill materials in uniform layers 200 mm maximum loose thickness unless specified otherwise.
- .10 Ensure each layer is compacted, and accepted by Consultant, before placing succeeding layers.
- .11 Unless otherwise indicated, use specified granular material from bottom of trench to 300 mm above top of pipe or 150 mm above top of electrical conduits. Hand place in 150 mm layers and compact carefully to ensure proper backfilling and compaction around bottom quadrants and sides of pipe.
- .12 For backfill from 300 mm above top of pipe or 150 mm above electrical conduits to sub-grade level, use select fill unless otherwise noted. Compact either by hand or by machine.
- .13 Do not backfill trenches until piping, conduits and cables therein have been inspected, tested, and approved by inspection authorities having jurisdiction and Consultant.

- .14 Prior to backfilling of trenches, remove wood block or wedges used to prevent movement of piping during tests.
- .15 Where there is a common boundary between select fill and granular fill or unshrinkable fill, place select fill after granular fill has been compacted. Place and compact fill around free standing structures evenly on all sides of structure simultaneously in layers sloping away from structure.
- .16 During backfilling, take care to avoid displacing or damaging Utilities Work and Services.
- .17 Notify Consultant prior to commencement of backfilling and compacting operations.

### 3.9 **COMPACTION**

- .1 Compaction densities for select fill, granular fill, and sand fill materials will be determined by ASTM D698. Compaction densities for clear stone and pea gravel will be determined by ASTM D4253.
- .2 Add water if necessary to obtain required densities. Correct irregularities or depressions that may develop during compaction by removing or adding material to form a smooth and uniform surface.
- .3 Shape and roll alternately to obtain smooth, even and uniformly compacted base.
- .4 If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.
- .5 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers acceptable to Consultant.
- .6 Compact backfill materials as follows:
  - .1 Imported fill: 98% standard Proctor maximum dry density (SPMDD).
  - .2 Under slabs, walks and pavements: 100% (SPMDD).
  - .3 All other areas: 95% (SPMDD).

### 3.10 **GRADING**

- .1 Prior to placing fill over existing ground, scarify surface to depth of 150 mm. Maintain fill and existing surface at approximately same moisture content to facilitate bonding.
- .2 Place material only on clean unfrozen surface, properly shaped and compacted and free from snow and ice. Ensure no frozen material is used in placing.
- .3 Grade as necessary to bring Work areas to required elevations. Supply additional material required to obtain new grade levels. Place and compact as specified.
- .4 Grade drainage ditches to elevations indicated on Contract Drawings.

- .5 Maintain positive drainage.
- .6 Grade materials using methods which do not lead to segregation or degradation of aggregate.
- .7 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.
- .8 Remove and replace that portion of layer in which material becomes segregated during spreading.
- .9 Slope grade away from buildings 1:50 minimum.
- .10 Make graded areas smooth to profile, free of debris, with local excavations and depressions filled and compacted.
- .11 Do not disturb soil within branch spread of trees and shrubs remaining.
- .12 Cultivate entire area which is to receive topsoil to a depth of 100 mm. Repeat cultivation in those areas where equipment used for hauling and spreading has compacted soil.
- .13 Remove surface debris, roots, vegetation, branches and stones in excess of 50 mm in diameter.

**3.11 UNSHRINKABLE FILL**

- .1 Place unshrinkable fill in locations indicated on Contract Drawings or where Work area is too limited to permit proper placing and compaction. Obtain Consultants approval prior to placing unshrinkable fill. Place in accordance with supplier's written instructions.
- .2 If embedded items occur in area being backfilled, coordinate with appropriate trades to ensure that disturbance of embedded items during backfilling is prevented.

END OF SECTION

1 General

1.1 **SECTION INCLUDES**

- .1 Design, labour, Products, equipment and services necessary for concrete curbs and pavements Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM A185/A185-M, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
- .2 ASTM C260, Specification For Air-Entraining Admixtures For Concrete.
- .3 ASTM C309, Specification For Membrane-Forming Compounds for Curing Concrete.
- .4 ASTM C494/C494-M, Specification For Chemical Admixtures For Concrete.
- .5 ASTM D994, Specification For Preformed Expansion Joint Filler For Concrete (Bituminous Type).
- .6 CAN/CSA A23.1/A23.2-M, Concrete Materials and Methods of Concrete Construction/Methods of Tests For Concrete.
- .7 CAN/CSA A3000, Cementitious Materials Compendium.
- .8 CAN/CSA G30.18-M, Billet-Steel Bars for Concrete Reinforcement.
- .9 CSA O121, Douglas Fir Plywood.
- .10 CAN/CSA S269.3-M, Concrete Formwork.

1.3 **DESIGN REQUIREMENTS**

- .1 Concrete: 30 Mpa unless otherwise indicated on drawings. Exterior concrete to have 5-7% entrained air.
- .2 Design concrete so that material will not segregate and excessive bleeding will not occur.
- .3 Comply to the MTC Manual of Uniform Traffic Control Devices for signs and flagging when working within existing road ways. Any requirements to restrict local traffic due to the contractors works, must be reviewed and approved by the Consultant.



**1.4 SUBMITTALS**

- .1 Product data:
  - .1 Submit duplicate copies of manufacturer's Product data in accordance with Section 01 30 00 for each material indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), and characteristics.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Shop drawings: Submit shop drawings in accordance with Section 01 30 00 indicating elevations, sections, details, materials, joint assemblies, finishes and relationships to adjacent construction.

**1.5 QUALITY ASSURANCE**

- .1 Inspection and testing:
  - .1 Materials: CAN/CSA A23.1/A23.2-M; Inspect and test for conformance to requirements of this Standard and to Specifications.
  - .2 Tests will be made in accordance with CAN/CSA A23.2-M.
  - .3 Remove defective materials and completed Work which do not conform to the Contract Documents.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- .1 Deliver and store materials on Site in accordance with CAN/CSA A23.1/A23.2-M.

**1.7 SITE CONDITIONS**

- .1 Conform to CAN/CSA A23.1/A23.2-M.
- .2 Do not deposit concrete on frozen ground. When deposited in forms concrete shall have a temperature between 10°C and 30°C and these limits shall be maintained for 72 hours.

**2 Products**

**2.1 MATERIALS**

- .1 Forms: Plywood to CSA O121, G1S; Douglas Fir plywood, seven ply, exterior grade, waterproof glue, edges sealed with oil based sealer.
- .2 Form ties: Adjustable snap ties, formed to break 25 mm or more from surface of concrete after form removal, with a minimum working strength of 1360 kg.
- .3 Form release agent: 100% biodegradable, chemically active, VOC compliant, 'Bioform' by Universal Building Product or approved equivalent.
- .4 Reinforcing steel: CAN/CSA G30.18-M; Billet-steel bars, deformed unless indicated otherwise, Grade 400R.

- .5 Welded steel wire fabric: ASTM A185/A185-M; Resistance welded in size and spacing shown for smooth wire fabric, in flat sheets only.
- .6 Chairs, bolsters, supports, spacers: CAN/CSA A23.1-M with sufficient strength to rigidly support weight of reinforcement and construction loads. Manufactured by NCA/Acrow - Richmond or Dayton Superior or approved equivalent.
- .7 Cement: CAN/CSA A3000; Portland, Type 10.
- .8 Coarse and fine aggregate: CAN/CSA A23.1/A23.2-M.
- .9 Water: CAN/CSA A23.1/A23.2-M.
- .10 Water reducing admixture: ASTM C494/C494-M, Type A.
- .11 Set retarding admixture: ASTM C494/C494-M, Type D.
- .12 Air entraining admixture: CAN/CSA A23.1/A23.2-M and ASTM C260.
- .13 Pigmented curing compound: ASTM C309, Type 2, Class B; White pigmented resin based.
- .14 Joint filler: ASTM D994, Asphalt impregnated; 'Asphalt Joint Expansion Joint Filler' by W. R. Meadows Ltd. or approved equivalent, in thickness shown on Contract Drawings. Furnish kraft paper or polyethylene sheet as bond breaker between sealant and joint filler
- .15 Joint Sealant: Two component, non-tracking, chemically reactive urethane/coal tar modified sealant; 'Sealtight Gardox' by W. R. Meadows Ltd. or 'Vulkem 202' by Tremco or approved equivalent.
- .16 Bonding Agent: Furnish 'Sika-Dur' by Sika, or 'Intralock' by W. R. Meadows or approved equivalent.

## 2.2 MIXES

- .1 Acceptance of any concrete mix proportion or material, does not preclude its future rejection if it is subsequently found to lack uniformity, or if it fails to conform to requirements specified, or if its field performance is found to be unacceptable.
- .2 Mix concrete and concrete proportions in accordance with CAN/CSA A23.1/A23.2-M.

## 2.3 ADMIXTURES

- .1 Use admixtures for concrete from single manufacturer, unless otherwise acceptable to Consultant.
- .2 Have manufacturer certify that admixtures are compatible.
- .3 Add admixtures to concrete mix in accordance with manufacturer's recommendations.

- .4 Except as specified otherwise, comply with requirements of CAN/CSA A23.1/A23.2-M.
- .5 Use of calcium chloride or additional admixtures, other than those specified, is not acceptable.

### 3 Execution

#### 3.1 **GENERAL**

- .1 Give Consultant at least two (2) working days notice prior to placement of concrete to permit a review of compaction, placement of formwork, reinforcing steel, and associated items embedded in concrete for conformance to reviewed shop drawings and Contract Documents.
- .2 Do not place concrete on surfaces which contain frost, water or debris.
- .3 Provide concrete curb cuts and sidewalk handicap access ramps as indicated, in accordance with the authorities having jurisdiction.

#### 3.2 **PREPARATION**

- .1 Verify grades of items set in paving area for conformity with elevations and sections before placing granular base and subbase material.
- .2 Obtain approval of subgrade by Consultant before placing granular subbase and base.
- .3 Set out work from lines and levels shown on drawings.
- .4 Prevent damage to adjacent and/or existing buildings and/or properties, and existing curbs, sidewalks and asphalt paving.
- .5 Accurately saw-cut and modify existing sidewalks to nearest adjacent dummy/expansion joint as directed on site by Consultant.
- .6 Remove and dispose of debris from the work of this section in accordance with authorities having jurisdiction.
- .7 Fine grade, shape and compact subgrade to minimum of 95% Standard Proctor Density.
- .8 Wet base immediately in advance of concreting to ensure a firm moist surface without ponding.
- .9 Repair damage to base resulting from hauling or equipment operations.

#### 3.3 **FORMWORK**

- .1 Construct formwork in accordance with CAN/CSA S269.3-M to produce finished concrete conforming to shape, dimensions, locations and elevations indicated. Ensure no lumber remains in concrete.

- .2 Set forms true to line and grade, join neatly and tightly, and stake securely to resist concrete pressure and impact from tampers without springing.

- .3 Apply release agent by spray in accordance with manufacturer's recommendations. Ensure form surfaces receive a uniform coating.

### 3.4 **REINFORCING**

- .1 Place reinforcing steel as shown on reviewed shop drawings and in accordance with CAN/CSA A23.1-M. Make bars as long as possible.

- .2 Make splices in locations shown on Drawings. Lap lengths in accordance with CSA A23.3 unless otherwise shown.

- .3 Lap ends and sides of wire fabric not less than 150 mm.

### 3.5 **PLACING OF CONCRETE**

- .1 Before placing fresh concrete against set or partially set concrete, clean surfaces to remove dirt, scum, shavings, debris, laitance, etc. on set surfaces, brush generously with bonding agent.

- .2 Place concrete in accordance with CAN/CSA A23.1/A23.2-M.

- .3 Slope concrete to levels shown on Contract Drawings.

- .4 Do not place concrete at such a rate as to endanger formwork or to prevent proper compaction.

- .5 Place concrete to prevent cold joints and segregation and vibrate sufficiently to ensure thorough compaction, maximum density in accordance to CAN/CSA A23.1/A23.2-M

- .6 Check Work frequently with accurate instruments during placing of concrete.

- .7 When completing concrete placement for day, carry placement through to a scheduled joint location.

- .8 Where concrete placement is stopped for more than 30 minutes due to breakdowns, weather or any other reasons, construct extra bulkhead and construction joint as directed.

### 3.6 **CONCRETE CURBS**

- .1 Align concrete curbs with curves and tangents indicated on drawings. Concrete curb to be in accordance to details indicated on drawings.

- .2 Where existing curb is met, the contractor must make the required transition to style and grade of existing curb to the satisfaction of the Consultant.

- .3 Curbs shall have expansion joints at minimum 4500 mm o.c. and in accordance with authorities having jurisdiction. Place reinforcing bars at top and base of curb, with minimum 50 mm concrete cover.
- .4 All restoration of the existing road structure for the transition to existing curb is the responsibility of the contractor.
- .5 Finish edges of dummy joints and expansion joints with three (3) mm radius edging tool.

### 3.7 **CONCRETE PAVEMENTS**

- .1 Concrete sidewalk to be in accordance with details indicated on drawings.
- .2 Concrete for standard sidewalk to be 150 mm thick, except through entrances where the concrete shall be 200 mm thick with wire mesh. The compacted granular 'A' is to be 150 mm thick at all locations.
- .3 Where existing sidewalk is met, make the required transition to grade, to the satisfaction of the Consultant. Furthermore, co-ordinate with the City and Consultant, to insure compatibility of existing and or future adjacent works by City forces.
- .4 All structural concrete, such as but not limited to, concrete walkway adjacent to building, concrete pads for loading docks, and concrete slabs for loading areas to be constructed in accordance with reviewed shop drawings.
- .5 Dummy joints: six (6) mm deep at 1500 mm o.c. Tool joints with six (6) mm wide steel trowel, radiusing edges six (6) mm.
- .6 Expansion joints: 6000 mm o.c. maximum.
- .7 Tool edges of sidewalk with 50 mm wide steel trowel, radiusing edges six (6) mm.
- .8 Install sealant in expansion/isolation joints as shown and specified.

### 3.8 **CONSOLIDATING**

- .1 Consolidate concrete in accordance with CAN/CSA A23.1/A23.2-M
- .2 Work concrete into complete contact with forms and embedded items. Consolidate concrete adjacent to side forms and along entire length of forms to ensure a smooth surface finish after stripping of formwork.

### 3.9 **CURING AND PROTECTION**

- .1 Cure and protect concrete in accordance with CAN/CSA A23.1/A23.2-M.
- .2 Apply curing compound after finishing operations have been completed, at rate recommended by compound manufacturer. Ensure compound application is uniform and continuous over entire area being cured.

### 3.10 CONSTRUCTION JOINTS

- .1 Obtain Consultant's acceptance to install construction joints in locations other than those shown.
- .2 Construct construction joints to CAN/CSA A23.1-M and as shown. Supply and install dowels in construction joints unless otherwise detailed.
- .3 Joints at building face or other abutments: place 12 mm joint filler keeping top 12 mm below concrete surface; apply kraft paper or polyethylene bond over filler and fill with self-levelling sealant applied in accordance with manufacturer's printed instructions.
- .4 For sawn joints:
  - .1 Do sawn joints in accordance with drawing details. Prepare sample sawn joint for approval by Consultant.
  - .2 Ensure joints are straight. Mark alignment with chalk line or other suitable guide. Layout to be approved by Consultant.
  - .3 Saw joints using approved equipment and methods to produce joint dimensions indicated.
  - .4 Supply sufficient men and equipment including standby equipment, to maintain a satisfactory sawing schedule.
  - .5 Schedule sawing operations on 24 hour basis and consistent with concrete placing.
  - .6 Make initial saw cuts in a progressive manner and as soon as possible without excessive ravelling.
  - .7 If a crack occurs ahead of saw cut, stop immediately. Move ahead several joints and cut one or more joints before returning to saw intermediate joints. Where cracking persists, make 1060 mm saw cut from one edge and complete sawing from opposite edge. Adjust sawing schedule accordingly.
  - .8 If uncontrolled cracking or other surface damage results from inadequate or improper sawing techniques suspend further concrete operations until situation is corrected and immediately remove and replace damaged slabs.
  - .9 Immediately on completion of sawing, flush joints with water to remove laitance.

### 3.11 FINISHING

- .1 When striking off concrete surface, maintain a uniform roll of concrete ahead of first screed for it's full length when finishing machine is on first pass.
- .2 Where joints are formed rather than sawn, form longitudinal and transverse joints after final pass of finishing machine.
- .3 Hand finish areas inaccessible to finishing machine to same quality and surface characteristics as machine finished surfaces.
- .4 Finish concrete surface with an approved float at proper time. Operate from edge to edge with a wiping motion while advancing , with each succeeding pass overlapping previous one.

- .5 Check surface with approved straightedge 4500 mm long. Correct irregularities exceeding five (5) mm before concrete takes initial set.
- .6 Finish edges of slabs with edging tool to form a smooth squared surface. Do not patch with cement paste.

### 3.12 IDENTIFICATION STAMP

- .1 For sidewalks in the public right-of-way, mark concrete at each end of the work and at least every 18000 mm or such other places as the Consultant may select.
- .2 The stamp shall be located on the centre of the bay of walk, next to and parallel to a transverse joint.
- .3 The size and shape of the stamp shall be as shown on City of Barrie Drawings.
- .4 The imprint shall be clear and legible and satisfactory to the Consultant.

### 3.13 BROOM FINISH

- .1 Commence texturing immediately after float finishing.
- .2 Use soft bristled broom to produce an approved light, non-slip concrete surface finish with fine granular or sandy texture free from disfigurations. Finishes to be approved by Consultant.
- .3 Apply broom finish at right angles to curb and parallel to joints. All trowel and tool marks to be removed with broom. Do not contaminate joints by over-brooming.

### 3.14 REMOVAL OF FORMS

- .1 Do not disturb forms until concrete has hardened and developed sufficient strength to safely support its own weight and load on it.
- .2 Strip formwork in accordance with CAN/CSA A23.1-M.

### 3.15 DEFECTIVE CONCRETE

- .1 Concrete is defective when:
  - .1 Containing excessive honeycombing or embedded debris.
  - .2 Concrete damaged by freezing or which is unsatisfactory due to placement at too high a temperature.
  - .3 Average 28 day strength of any three consecutive strength tests is less than specified minimum 28 day strength.
  - .4 Any 28 day strength test result is less than 80% of specified minimum 28 day strength.
  - .5 Surface texturing, joint type and placement and tolerances are unacceptable in the opinion of the Consultant.

- .2 Repair of defective concrete work:
  - .1 Repair defective areas while concrete is still plastic, otherwise wait until curing is completed. Use repair methods approved by Consultant.
  - .2 Grind off high surface variations where directed.
- .3 Remove and replace defective concrete where directed.
  - .1 Remove minimum 3000 mm of pavement by sawing through concrete across full lane width.
  - .2 Replace with new concrete to this specification.
  - .3 Construct dummy contraction joint between sawn face of existing concrete and face of new concrete.

3.16 **PROTECTION**

- .1 Do not open concrete pavement to traffic or construction equipment until concrete reaches 70% of specified strength or until approved by Consultant.

END OF SECTION



1 General

1.1 **SECTION INCLUDES**

- .1 Labour, Products, equipment and services necessary for foundation drainage Work in accordance with the Contract Documents.

1.2 **REFERENCES**

- .1 ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
- .2 ASTM F449, Standard Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.
- .3 ASTM F667, Standard Specification for three (3) through 24 in. Corrugated Polyethylene Pipe and Fittings.

1.3 **SUBMITTALS**

- .1 Product data:
  - .1 Submit manufacturer's Product data in accordance with Section 01 30 00 indicating:
    - .1 Performance criteria, compliance with appropriate reference standard(s), characteristics, and limitations.
    - .2 Product transportation, storage, handling and installation requirements.
- .2 Samples:
  - .1 Submit following samples in accordance with Section 01 30 00:
    - .1 Two 300 x 300 mm samples of drainage board.
    - .2 Two 300 mm long samples of perimeter drainage and/or pipe.

2 Products

2.1 **MATERIALS**

- .1 Perimeter drainage:
  - .1 ASTM D3350 and ASTM F667, 100 mm diameter HDPE, perforated with fittings prewrapped with filter cloth by Ideal Pipe or 'TREMDrain Total Drain' by Tremco Inc or approved equivalent
  - .2 Perimeter drainage system to be complete with accessories as required for complete installation including but not limited to corner guard pieces and outlet pipe connections.

- .2 Drainage board: Three-dimensional dimpled core and geotextile fabric complete with adhesive or fasteners as required for installation. 'Miradrain 6000' by Carlisle Coatings and Waterproofing, 'Delta-Drain 6000' by Dorken Systems Inc., 'TREMDrain' by Tremco Inc. or 'Mel-Drain 5035' by W. R. Meadows or approved equivalent.
- .3 Drainage pipe: ASTM D3350 and ASTM F667, 100 mm diameter HDPE by Ideal Pipe or approved equivalent, unperforated with fittings, and perforated with fittings prewrapped with filter cloth in locations as indicated on drawings or as specified herein.
- .4 Clean outs: 100 mm HDPE outlets , tees, extension pipes, reducers, flush plugs, etc. suitable for use with drainage pipe as manufactured by Canon Inc, Ideal Pipe, or approved equivalent.
- .5 Foundation drainage Pipe Fill: 19 mm clear stone in accordance with OPSS 1004.
- .6 Granular fill: Free draining, sharp, hard, durable, granular material conforming to OPSS 1010, Type A.
- .7 Filter cloth: Terrafix 270R as manufactured by Terrafix Geosynthetics Inc. or approved equivalent.

### 3 Execution

#### 3.1 **EXAMINATION**

- .1 Verify condition and dimensions of previously installed Work upon which this Section depends. Report defects to Consultant. Commencement of Work means acceptance of existing conditions.

#### 3.2 **PREPARATION**

- .1 Verify substrate surfaces are solid, free from surface water, frozen matter, dust, oil, grease, scaling or laitance, projections and any other foreign matter detrimental to installation.

#### 3.3 **INSTALLATION**

- .1 Install perimeter drainage around perimeter of basement and where indicated on Drawings.
- .2 Install drainage board in accordance with ASTM F449 and manufacturer's recommendations. Drainage board shall extend full height of foundation wall to top of footing where indicated on Drawings. Install drainage board after installation of waterproofing membrane is complete. Position panel with flat side against wall and filter fabric toward soil/drainage side and attach to foundation wall using manufacturer approved fastening system.

- .3 Provide unperforated drainage pipe between perforated drainage pipe and drain connection installed by Division 22 and 23.
- .4 Install drainage pipe on a bed of foundation drainage fill, minimum 100 mm deep where pipe is not placed over footing, and surround with same fill 150 mm thick at sides and over top of pipe and for under floor drainage extend fill to under side of slab.
- .5 Provide cleanouts on non-perforated pipe at all changes of direction and in pipe runs greater than 15 metres. Provide flush cleanouts where indicated.
- .6 Cover foundation drainage fill with filter cloth. Cover filter cloth with sand 300 mm thick at top and sides.

END OF SECTION

**BARRIE FIRE STATION 6**

**845 Maplevue Drive East, Barrie, Ontario**

**salter pilon architecture inc.**

## Appendix

- Colour and Material Schedule

**NOTES:**

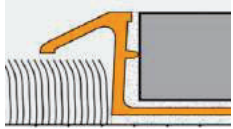
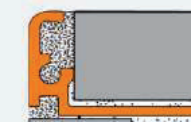
1. Read Colour Schedule in conjunction with full specifications, drawings and Room Finish Schedule.
2. It is the sub trades' responsibility to review Colour Schedule and bring to the attention of the Consultant any discrepancies, errors or inconsistencies. Those proceeding with work are responsible to correct mistakes.
3. Where specified products have more than one approved manufacturer, color selections are indicated for each manufacturer. Where products are single sourced, alternates will be allowed that match visually and of equal or superior quality. Alternates proposed during bidding will be subject to the process outlined in the City of Barrie Procurement documents. Substitutes during construction will be subject to the approval of the Consultant.
4. Where flooring has a direction/ pattern the subtrade must confirm Consultants intent prior to installing. Those proceeding without written confirmation will be responsible to correct mistakes.
5. Grout on projects will be Kiesel Servoperl Royal. No other grout will be accepted.
6. Sub trades must confirm colour choices with designer prior to ordering materials. Those proceeding without approval will be responsible to correct mistakes.
7. Proposed alternates will be considered as per City of Barrie procurement policies. All alternates to be submitted to consultant for review. Proposed alternates to meet the same quality as original proposed materials.


ABBREVIATIONS:							
*	Refer to Remarks	CG	Corner Guard	C.T.C	Centre to Centre	EQ	Equal
AFF	Above Finished Floor	CH	Coat Hook	C/W	Complete With	EXP	Exposed
ALUM	Aluminum	C/L	Centre Line	DIA	Diameter	EXIST.	Existing
ARCH	Architectural	CLG.	Ceiling	DIM	Dimensions	EXT	Exterior
A/V	Audio Visual	COL.	Column	DM	Decorative Metals	FD	Floor Drain
BF	Barrier Free	CONC	Concrete	DN	Down	FE	Fire Extinguisher
BLK	Block	CONST	Construction	DTL	Detail	O.C	On Centre
BLKG	Blocking	CFAW	Cold Fluid Applied	DWGS	Drawings	O.H	Overhead
BLKHD	Bulkhead	CONT.	Continuous	E.J	Expansion Joint	OWSJ	Open Web Steel Joist
BN	Bullnose	CPT	Carpet	ELECT	Electrical	P.WD	Plywood
B.O.H	Back of House	CRS	Course	ELEV	Elevator	PL	Plastic Laminate



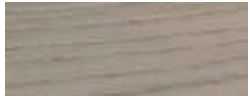
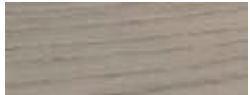
CBD	Cement Board	CT	Countertop	EP	Epoxy Paint	PREFIN	Prefinished
PREMNUF	Premanufactured	S.S	Stainless Steel	MTL	Metal	F.O.H	Front of House
PT	Paint	ST	Stain	N.I.C	Not In Contract	GLAV	Galvanized
PU	Polyurethane	STRUCT	Structural	N.T.S	Not to Scale	GB	Grab Bar
R	Radius	SUSP	Suspended	TRANSP.	Transparent	GL	Glazing
RB	Resilient Base	SW	Sculptural Screen	TYP	Typical	GWB	Gypsum Wall Board
RBB	Rubber Base	WALL		U.N.O	Unless Otherwise Noted	H	Hardware
REQ'D	Required	T	Tile	FEC	Fire Cabinet	HD	Hand Dryer
RH	Robe Hook	MECH	Mechanical	FF	Factory Finish	HDR	Hand Rail
RF	Resilient Floor	MG	Mirror	FIN	Finish	HDWD	Hardwood
SEAL	Sealer	MIN	Minimum	FLR	Floor	HM	Hollow Metal



SP	Solid Lumber Panel	MM	Millimeters	FR	Fire Retardant	HORIZ	Horizontal
SPECD	Specified	MS	Metal Stud	FRP		HR	Hour
HT	Height	V.B	Vapour Barrier	WV	Wood Veneer	WR	Washroom
INSUL.	Insulation	VERT	Vertical	U/S	Underside	WT	Wood Trim
JT	Joint	VEST	Vestibule	URETH	Urethane		
L	Lighting	VP	Wood Venner Panel				
LVT	Luxury Vinyl Tile	W/	With				
M	Mirror	WB	Wood Base				
MAT	Material	WC	Wallcovering				
MAX	Maximum	WD	Wood				
UR	Urinal	WDSLT	Wood Slat				

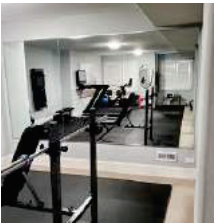


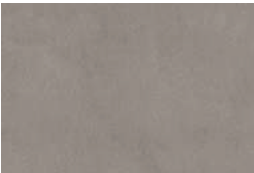

05 50 00 - Metal Fabrications							
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image
DM-1	Transition from Tile to LINO	Schluter Systems	Reno TK	Aluminum	Satin Anodized	1. Contractor to confirm specification	
							OR
							Approved Equal
DM-2	Tile Cap	Schluter Systems	Jolly	Aluminum	Satin Anodized	-	
							OR
							Approved Equal
MTL-1	Millwork Toe Kick, Typical	Custom	Custom 18ga stainless steel kick	match PT-3	powder coated	1. Refer to elevations for height	-


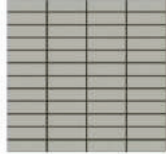
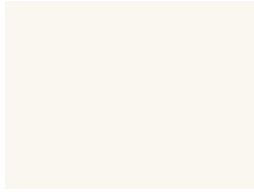
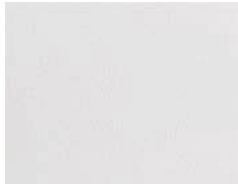
06 20 00 Finish Carpentry							
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image
H-1	Kitchen, Day Room	Richelieu	Modern Metal Pull #BP9256160195	Nickel	Brushed	1. Refer to elevations for installation orientation	
							OR
							Approved Equal

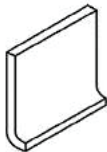
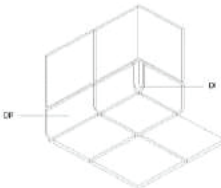


H-2	Crew Rooms Storage Millwork	Richelieu	Electronic Lock with Keypad #4001490	Grey	-	1. Refer to manufacturer for installation instructions	
	OR						
	Approved Equal						
H-3	Crew Rooms Storage Millwork	Richelieu	Modern Aluminum Edge Pull - 9494 #BP9494192170	Stainless Steel	-	-	
	OR						
	Approved Equal						
WD-1	Millwork	-	Solid Wood Hardwood Maple	-	STN-1	Contractor to provide control sample for approval	
WD-2	Millwork	-	Wood Veneer Hardwood Maple	-	STN-1	Contractor to provide control sample for approval	

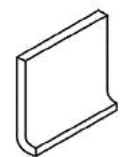
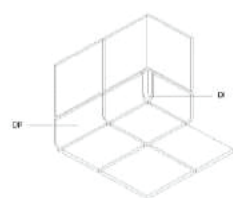
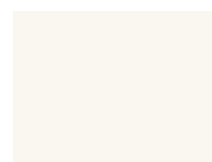

06 61 00 - Solid Surfacing							
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image
SS-1	Countertop	Wilsonart	Solid Surface 1/2" Thick 30"x144"	Powder White #9230SS	-	1. Bullnose edge profile	
	OR						
	Countertop	Corian	Solid Surface 1/2" Thick 30"x144"	Stonique	-	1. Bullnose edge profile	
	OR						
	Approved Equal						

08 83 00 - Mirror							
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image
MG-1	Training	-	Clear Mirror Panels 1800mm H x 900w	Clear	-	1. Affixed to partitions 2. Square edge profile, tightly abutted to adjacent mirror	

09 30 00 - Tiling						
Code	Location	Manufacturer	Product	Colour	Remarks	Image
CT-1	Vestibule Floor, WRM Floors	Daltile	Portfolio Ash Grey Rectangle 12x24 5/16 Thick	PF05 Ash Grey Matte Finish	1. Horizontal Stack Installlation 2. To be used with DM-1 As req 3. Grout	
	<u>OR</u>					
	Vestibule Floor, WRM Floors	Olympia Tile	Lea Stone Series Grey 12x24	HV.LS.GRY.122 4.MT	1. Horizontal Stack Installlation 2. To be used with DM-1 As req 3. Grout	
	<u>OR</u>					
	Approved Equal					




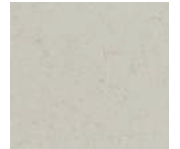
CT-2	Shower Floor	Daltile	Portfolio Ash GreyStraight Joint Mosaic 2x2 1/4 Thick	PF05 Ash Grey Matte Finish	1. Grout:	
	<u>OR</u>					
	Shower Floor	Olympia Tile	Unicolour Series Mosaic 2.3x7.3cm	Light Grey Matte Finish	1. Grout:	
	<u>OR</u>					
	Approved Equal					
CT-3	Shower Walls	Daltile	Color Wheel Arctic White 6x18 3/8" Thick	0190 Arctic White Glossy Finish	1. Horizontal Stack Installation 2. Grout:	
	<u>OR</u>					
	Shower Walls	Mosa (Holten Impex)	Global Collection Plain Cool White 6x12 0.28" Thick	16840 Plain Cool White Glossy Finish	1. Horizontal Stack Installation 2. Grout:	
	<u>OR</u>					
	Approved Equal					




CT-4	Shower Walls Tile Base (T-3 Walls)	Daltile	Color Wheel Arctic White 6x6 Cove Base #A3601 3/8" Thick	0190 Arctic White Glossy Finish	1. Grout: 2. Shower floor to be inline with edge of cove 3. Complete with corner pieces as required	
	OR					
	Shower Walls Tile Base (T-3 Walls)	Mosa (Holten Impex)	Global Collection Global Grip Plain Cool White 6x12 0.28" Thick	16840 Plain Cool White Glossy Finish	1. Grout: 2. Shower floor to be inline with edge of cove 3. Complete with corner pieces as required	
	OR					
Approved Equal						
CT-5	Shower Walls- Shower Control Wall	Daltile	Color Wheel Matte Chalkboard 6x18 3/8" Thick	0780 Matte Chalkboard Matte Finish	1. Horizontal Stack Installation 2. Grout:	
	OR					
	Shower Walls- Shower Control Wall	Mosa (Holten Impex)	Global Collection Plain Ivory Black 6x12 0.28" Thick	16850 Plain Ivory Black Glossy Finish	1. Horizontal Stack Installation 2. Grout:	
	OR					
Approved Equal						

CT-6	Shower Walls Tile Base (T-5 Walls)	Daltile	Color Wheel Matte Chalkboard 6x6 Cove Base #A3601 3/8" Thick	0780 Matte Chalkboard Finish	1. Grout: 2. Shower floor to be inline with edge of cove 3. Complete with corner pieces as required	
	OR					
	Shower Walls Tile Base (T-5 Walls)	Mosa (Holten Impex)	Global Collection Global Grip Plain Ivory Black 6x12 0.28" Thick	16850 Plain Ivory Black Glossy Finish	1. Grout: 2. Shower floor to be inline with edge of cove 3. Complete with corner pieces as required	
	OR					
	Approved Equal					
CT-7	Kitchen Backsplash	Daltile	Color Wheel Arctic White 3x6 3/8" Thick	0190 Arctic White Glossy Finish	1. Horizontal Stack Installation 2. To be used with DM-2 as Req. 3. Grout:	
	OR:					
	Kitchen Backsplash	Olympia Tile	Colour & Dimension Series Arctic White 3x6	QT.CD.ARW.03 06.BR Arctic White Finish: Bright	1. Horizontal Stack Installation 2. To be used with DM-2 as Req. 3. Grout:	
	OR					
	Approved Equal					

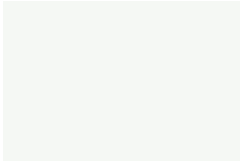


09 51 23 Acoustic Ceilings						
Code	Location	Manufacturer	Product	Colour	Remarks	Image
ACT-1	ACT Ceilings	Armstrong Ceilings	#1773 Dune Lay-In Tile with HumiGuard Plus and BioBlock 610mm x 1220mm x 16mm thick Suspension Grid System:Prelude XL - 23mm Wide Exposed T-Grid, White	White	1. Refer to ceiling plan for ceiling tile locations	
	OR:					
	ACT Ceilings	CGC Inc.	Olympia Micro ClimaPlus 4913 Lay in Tile 610mm x 1220mm x 16mm Suspension Grid System: Donn DX-23mm wide Exposed T-Grid, White	White	1. Refer to ceiling plan for ceiling tile locations	
	OR:					
	Approved Equal					

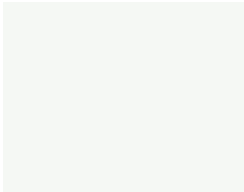
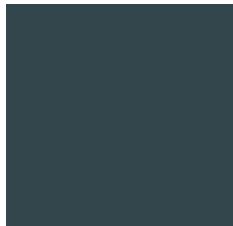
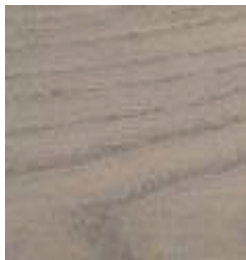



09 65 00 Resilient Flooring							
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image
LINO-1	Flooring	Gerflor	Linoleum Design: Lino Art Flow Format: Roll #R896-0050	0050 Grey Line	-	1. NCS: 5000-N 2. LRV: 26,0 3. Welding Rod: R8975150 4. C/W matching cove base wherever used	
	OR:						
	Flooring	Forbo	Marmoleum Striato Format: Roll	5248 Urban Silver	-	1. NCS: S 2005-Y10R 2. LRV:52 3. C/W matching cove base wherever used	
	OR:						
	Approved Equal						
SDT-1	IT, AV, FSA Service Space	Gerflor	Mipolam EL7 Format: Roll (2mx20m)	4111 Raffia	Permanent Dissipative Flooring	1. NCS: 2002-Y50R 2. LRV: 48.5 3. Welding Rod: 05852788 C/W RB-1 Base	
	OR:						
	IT, AV, FSA Service Space	Polyflor	Palettone SD Formatt: Roll 2mx20m	8606SD Frosted Glass	Permanent Dissipative Flooring	1. NCS: S 2002-G50Y 2. LRV: 53 3: Weld Rod: 8606	
	OR:						
	Approved Equal						

<b>RB-1</b> (Colours for tender only. TBD Once Floor Manufacturers are selected)	Resilient Base (Used with SDT-1 & RSF-1)	Johnsonite	Traditional Wall Base with Toe	40 Black	-	-	
	<b>OR:</b>						
	Resilient Base (Used with SDT-1 & RSF-1)	Roppe	Toeless Wall Base 4"Hx 0.125" Thick	100 Black	-	-	
	<b>OR:</b>						
	Approved Equal						
<b>RSF-1</b>	Rubber Sports Floor	Faber Surfaces	Canadian Sport Rubber Fit Tile	Black Field, White Accent	-	1. Roll installation 2. To be used with RB-1 Rubber Base	
	<b>OR:</b>						
	<b>APPROVED EQUAL</b>						

09 91 00 - Painting							
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image
CFAW1	Sealed Concrete	SikaFloor	Alkali - Silicate, water soluble concrete hardner and dust proofer	Sikafloor 3D	-	Sealed Concrete floors to have a metal trowel finish	-
	OR:						
	APPROVED EQUAL						

09 91 00 - Painting							
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image
PT-1	Wall Colour	Benjamin Moore	Scuff-X (F485)	Chantilly Lace OC-65	Eggshell	1. Moisture and Mildew resistant in W/R	
	OR						
	Approved Equal						
PT-2	Accent Wall Colour	Benjamin Moore	Scuff-X (F485)	Quiet Moments 1563	Eggshell	-	
	OR:						
	Approved Equal						
PT-3	Accent Wall Colour	Benjamin Moore	Scuff-X (F485)	Narragansett Green HC-157	Eggshell	-	
	OR:						
	Approved Equal						

PT-4	Ceiling Paint	Benjamin Moore	Waterborne Ceiling Paint	Chantilly Lace OC-65	Ultra Flat	1. Typical for all painted ceilings	
	OR:						
	Approved Equal						
PT-5	Hollow Metal Doors and Casing	Benjamin Moore	-	Narragansett Green HC-157	Eggshell	-	
	OR:						
	Approved Equal						
ST-1	WD-1	Sansin Stains	Purity Glacier	Morning Haze 3459	Low Lustre	1. Contractor to provide control sample for approval	
	OR						
	Approved Equal						

12 24 13 Rollar Window Shades															
Code	Location	Manufacturer	Product	Colour	Finish	Remarks	Image								
RS	All Exterior Windows	Altex	Altex Deko S-70 Chainless Single Cassette Roller Shade System with Vision Shade	Broome II Opaque - Monument 14BR33423	Pitch Black TM Blockout Coating	1. Typical for all exterior windows 2. Coverings to be complete blackout covering. 3. Ceiling Mount. Clear Anodized Aluminum Fascia and Weight Bar to be included									
								OR:							
								Approved Equal							