

**Part 1            General**

**1.1                DEFINITIONS**

- .1        **“Blackout Review Period”** means the period between December 24 and January 2 in each calendar year that will not be considered Business Days with respect to the timeframes noted for review and / or response as set out in this section.
- .2        **“RFI Procedure”** means the review procedure for RFIs in accordance with 1.6 of this section.
- .3        **“Submittals”** has the meaning as set out in D5 of the Tender.
- .4        **“Submittal Procedure”** means the procedure for Submittals in accordance with 1.3 of this section.
- .5        **“Submittal Schedule”** has the meaning as set out in D5 of the Tender.

**1.2                ADMINISTRATIVE**

- .1        Submit to the Contract Administrator, Submittals listed for review in the Contract Documents. Submit in accordance with 1.3.11 and in orderly sequence to not cause delay in Work. Failure to provide adequate review time in accordance with 1.3.12 is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2        Do not proceed with Work affected by the Submittal until review is complete and returned by the Contract Administrator.
- .3        Present Submittals including but not limited to Shop Drawings, product data, samples, and mock-ups in SI Metric units.
- .4        Where items or information is not produced in SI Metric units, converted values are acceptable.
- .5        Review Submittals prior to submission to the Contract Administrator. This review represents that necessary requirements have been determined and verified, or will be, and that each Submittal has been checked and co-ordinated with the requirements of the Work and the Contract Documents. Submittals not stamped, signed, dated, and identified as to the Work will be returned without being examined and considered rejected.
- .6        Notify the Contract Administrator, in writing at time of submission, of any deviations from the requirements of the Contract Documents stating reasons for deviations.
- .7        Verify field measurements and affected adjacent Work are co-ordinated.
- .8        If, upon review by the Contract Administrator, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If Submittals are rejected, noted copy will be returned and resubmission of corrected Submittals, through

same procedure indicated above, must be performed before the Work affected by the Submittal may proceed.

- .9 The Contractor shall make any corrections required by the Contract Administrator and shall resubmit the required number of corrected copies of Submittals. The Contractor shall direct specific attention in writing or on resubmittals to revisions other than the corrections requested by the Contract Administrator on previous submission.
- .10 Where Work is to be designed by the Contractor, comply with applicable codes and ensure Submittals are signed and sealed by a professional engineer licensed in the Province of Manitoba, as required by Specifications. If requested, calculations shall be submitted for review. Calculations shall also be signed and sealed by a professional engineer licensed in the Province of Manitoba.
- .11 The Contract Administrator will review Submittals for general conformance with the design concept and intent, and general compliance with the Contract.
- .12 The Contract Administrator's review does not relieve the Contractor from compliance with requirements of the Contract nor from errors in Submittals or the Contractor's design.
  - .1 For clarity, the Contractor's responsibility for errors and omissions in submission is not relieved by the Contract Administrator's review of Submittals.
- .13 After the Contract Administrator's review and return of copies, distribute copies to Subcontractors as appropriate.
- .14 Keep one reviewed copy of each submission on Site.

### **1.3 SUBMITTAL PROCEDURES**

- .1 Direct Submittals to the Contract Administrator:
  - .1 The Contract Administrator will not review Submittals received directly from a Subcontractor and the Submittals will be returned without being examined and considered rejected.
- .2 Procedures:
  - .1 Detailed procedures for handling electronic Submittals will be discussed at the pre-construction meeting.
  - .2 The Contractor shall submit Submittals in accordance with reasonable instructions provided by the Contract Administrator throughout the execution of the Work.
  - .3 At the Contract Administrator's discretion, the Contract Administrator's review comments and review stamp will be placed either directly on submitted copies of Submittals or on separate Submittal review comment form, or both.

- .3 Transmission of Submittals:
  - .1 The Contractor shall submit one electronic copy of Submittals for each requirement included in the Contract Documents and as the Contract Administrator may reasonably request.
  - .2 Hardcopies will only be submitted where specifically required under the Contract Documents or where requested by the Contract Administrator in accordance with 1.3.4.
- .4 Hardcopy Submittals:
  - .1 The Contractor shall submit hardcopies only where specifically required under the Contract Documents or requested by the Contract Administrator.
  - .2 All hardcopy Submittals require an electronic Submittal, with the exception of physical samples or similar.
- .5 Electronic Submittals:
  - .1 Submittals made in electronic format shall be as follows:
    - .1 Each Submittal shall be submitted in electronic form as Adobe Acrobat PDF, and native files (e.g. Word, Excel, AutoCAD, etc.), if requested by the Contract Administrator. For Microsoft Office files, use the version available at time of execution of Contract.
    - .2 Electronic files that contain more than 10 pages in PDF format shall contain internal book marking from index page to major sections of the document.
    - .3 PDF files shall be set to open "Bookmarks and Page" view.
    - .4 Add general information to each PDF file, including title, subject, author, and keywords.
    - .5 PDF files shall be searchable and not be scanned files, unless signed authorization is required.
    - .6 PDF files shall be accepted at the following printing sizes: 8.5 inches by 11 inches, 11 inches by 17 inches, or 22 inches by 34 inches. No other paper sizes will be accepted.
    - .7 The printing size for PDF files shall be set to print legibly.
  - .2 The Contract Administrator will not review Submittals that are not accompanied by an electronic copy and the Submittals will be returned without being examined and considered rejected.
  - .3 The City may, in reviewing any matter or Submittal in accordance with this section, refer such matter or Submittal to other City departments, or any of the City's servants, agents, advisers, consultants, contractors, or subcontractors.
- .6 Numbering and Tracking System:
  - .1 Number Submittals consecutively in one sequence in the order submitted, in a numbering system established by the Contract Administrator.
  - .2 Resubmission of Submittals shall have the original Submittal number with a sequential numeric suffix for the revision number (e.g., R1, R2, etc.).

- .7 Submittal Schedule:
  - .1 The Contractor shall prepare and submit the Submittal Schedule to the Contract Administrator prior to commencement of Work and in accordance with D16 of the Tender.
  - .2 Submittal Schedule shall:
    - .1 Include a table listing of all anticipated Submittals required to complete the Work.
    - .2 Take into account that more than one submission will likely be required for Submittals.
    - .3 Illustrate that Submittals are reasonably spread over the entire period required for the Work and meets minimum review period in accordance with 1.3.12, is reasonable to achieve, and the Blackout Review Period is adhered to.
    - .4 For each Specification show, at a minimum, the following within the Submittal Schedule:
      - .1 Specification reference.
      - .2 Total number of Submittals for each Specification reference.
      - .3 Identify each Submittal by its name or title.
      - .4 Identify the estimated date of submission to the Contract Administrator.
      - .5 State the revision number and status for each Submittal.
  - .3 The Contract Administrator reserves the right to review and comment on the Submittal Schedule. The Contractor shall update the Submittal Schedule with reasonable instructions provided by the Contract Administrator.
  - .4 Submit an updated Submittal Schedule to the Contract Administrator in accordance with D16 of the Tender. The updated Submittal Schedule shall also show the actual submission dates.
- .8 Transmittal Form:
  - .1 The Contractor shall accompany each submission with a transmittal form containing:
    - .1 Date.
    - .2 Project title and Tender number.
    - .3 The Contractor's name and address.
    - .4 Identification and quantity of each Submittal (Shop Drawing, product data, sample, etc.).
    - .5 Signature of authorized representative.
    - .6 Other pertinent data.
  - .2 The Contractor shall include a copy of the transmittal form for each Submittal and resubmittal.

- .3 Include the Contractor's written response to each of the Contract Administrator's review comments with resubmittals stamped "REVISE AND RESUBMIT".
- .9 Submissions to include:
  - .1 Date and revision dates.
  - .2 Project title and Tender number.
  - .3 Name of:
    - .1 Contractor.
    - .2 Subcontractor.
    - .3 Supplier.
    - .4 Manufacturer.
  - .4 The Contractor's stamp, signed by the Contractor's authorized representative certifying approval of submissions, verification of field measurements, and compliance with Contract Documents.
    - .1 Stamp to include project name, Submittal number, Specification section(s), the Contractor's reviewer name, date of the Contractor's approval, and statement certifying that Submittal has been reviewed, checked, and approved by the Contractor for compliance with the Contract.
  - .5 Identify and describe each deviation or variation from the Contract.
- .10 Format:
  - .1 Do not base Submittals on reproductions of Contract documents.
  - .2 Package Submittal information by individual Specification section. Do not combine different Specification sections together in Submittal package, unless otherwise directed in the Specification or by the Contract Administrator.
  - .3 Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, function of components, materials and devices, and compliance with the Contract.
- .11 Timeliness:
  - .1 Schedule and submit in accordance with 1.3.7, and the requirements of the Contract Documents.
  - .2 The Contractor shall submit Submittals well in advance of scheduled delivery date for associated equipment or material and in orderly sequence so as to cause no delay in the Work.
- .12 Review Time:
  - .1 Allow 14 Calendar Days for review of Submittals by the Contract Administrator unless otherwise noted in the Contract Documents.
  - .2 Time for review shall commence on the Contract Administrator's receipt of the Submittal. When the Submittal is received by the Contract Administrator before noon, the review period commences on that Calendar Day. When the Submittal is received by the Contract

- Administrator after noon, the review period commences on the subsequent Calendar Day.
- .3 Submittals will not be reviewed between the Blackout Review Period. These dates will not be included within the review timelines outlined in this section.
  - .4 The Contract Administrator will act upon the Contractor's Submittal and transmit response to the Contractor no later than 14 Calendar Days after receipt, unless otherwise specified.
  - .5 Resubmittals will be subject to same review time with the response to the Contractor no later than 14 Calendar Days after receipt, unless otherwise specified.
  - .6 The review time required for Submittals and resubmittals does not alleviate the Contractor of the Contractor's responsibilities to deliver the completed Work within the required time frame and schedule. Planning for Submittal reviews and the risk to the construction schedule remains the Contractor's sole responsibility.
- .13 Submittal Response:
- .1 Submittals will be returned to the Contractor with one of the following notations:
    - .1 "REVIEWED, NO COMMENT"
      - .1 When stamped "REVIEWED, NO COMMENT", distribute additional copies as required for execution of the Work.
    - .2 "REVIEWED, SEE COMMENTS"
      - .1 When stamped "REVIEWED, SEE COMMENTS" ensure that all copies for use are modified and distributed additional copies as required for execution of the Work.
    - .3 "REVISE AND RESUBMIT"
      - .1 When stamped "REVISE AND RESUBMIT", make the necessary revisions, as indicated, consistent with the Contract and submit again for review as specified in 1.3.14.
    - .4 "REJECTED"
      - .1 When stamped "REJECTED", resubmit Submittal in accordance with Submittal Procedures or as indicated in the Contract Documents.
    - .5 "FOR INFORMATION"
      - .1 When stamped "FOR INFORMATION", the submittal is not required as a submission for the Contract and has not been reviewed in detail and is intended for reference only.
    - .6 Only Submittals bearing "REVIEWED, NO COMMENT" and "REVIEWED, SEE COMMENTS", shall be used on the Work unless otherwise authorized by the Contract Administrator.
- .14 Resubmittals:
- .1 Submit new electronic files for each resubmittal.

- .2 Clearly identify each correction or change made and include revision date.
  - .3 Notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.
  - .4 Review time for resubmittals are outlined in 1.3.12.
  - .5 No adjustment of the schedule outlined in the Supplemental Conditions or Contract Price will be allowed due to delays in progress of Work caused by rejection and subsequent resubmittals.
  - .6 The City may deduct cost of additional reviews exceeding two submissions from the Contract Price at their sole discretion. Contractor will be charged for the Contract Administrator subsequent reviews of Submittal packages exceeding two submissions. Each additional review will be charged to the Contractor at the Contract Administrator's scheduled rates. The Contract Administrator's charges for additional reviews for Work will be deducted from the payment to the Contractor.
- .15 Incomplete Submittals:
- .1 The Contract Administrator will return the entire Submittal package for the Contractor's revision, if preliminary review deems it incomplete.
  - .2 When any of the following are missing, the Submittal will be deemed incomplete:
    - .1 The Contractor's review stamp, completed and signed.
    - .2 The Contractor's transmittal form, completed and signed.
    - .3 Insufficient number of copies.
    - .4 Electronic copies or hard copies required by the Contract or requested by the Contract Administrator.
    - .5 All requested information.
    - .6 Professional engineer's seal and signature, where it is required.
- .16 Submittals not required by the Contract:
- .1 Will not be reviewed in detail and will be returned stamped "FOR INFORMATION".

#### **1.4 SHOP DRAWINGS AND PRODUCT DATA**

- .1 The Contractor shall prepare the Shop Drawings in accordance with the Contract Documents or as the Contract Administrator may reasonably request. Shop Drawings are to clearly indicate Materials, weights, dimensions, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes, and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been co-ordinated, regardless of section under which adjacent items will be supplied and installed. Indicate cross references to design Drawings and Specifications. Notify the Contract Administrator in writing of any deviations in Shop Drawings from the requirements of the Contract Documents.

- .1 For clarity, in general all equipment / Material to be installed at the Site will require Shop Drawings.
- .2 Adjustments made on Shop Drawings by the Contract Administrator are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to the Contract Administrator prior to proceeding with Work.
- .3 The Contractor shall examine all Shop Drawings prior to submission to the Contract Administrator to ensure that all necessary requirements have been determined and verified and that each Shop Drawing has been checked and coordinated with the requirements of the Work and the Contract Documents. Examination of each Shop Drawings shall be indicated by stamp, date, and signature of a responsible person of the Subcontractor for supplied items and of the Contractor for fabricated items. Shop Drawings not stamped, signed, and dated will be returned without being examined and considered rejected. Ensure that the following are verified:
  - .1 Field measurements.
  - .2 Field construction criteria.
  - .3 Catalogue numbers and similar data.
- .4 The Contractor shall submit Shop Drawings stamped and signed by a professional engineer registered or licensed in the province of Manitoba as required in the Specifications.
- .5 Product Data shall include, at a minimum, the following:
  - .1 Make.
  - .2 Model.
  - .3 Size.
  - .4 Other pertinent information.
- .6 Details of appropriate portions of Work as applicable:
  - .1 Fabrication.
  - .2 Layout, showing dimensions, relation to adjacent structure or materials, including identified field dimensions, and clearances.
  - .3 Setting or erection details.
  - .4 Capacities.
  - .5 Performance characteristics.
  - .6 Standards.
  - .7 Operating weight.
  - .8 Wiring diagrams.
  - .9 Single line and schematic diagrams.
  - .10 Relationship to adjacent work.
- .7 Only submit information related to the Work.
- .8 Supplement standard information to provide details applicable to the Work.



## **1.5 DESCRIPTION OF CONSTRUCTION METHODS**

- .1 The Contractor shall, if required by the Contract Administrator or as indicated in the Specifications, submit for the review of the Contract Administrator method statements which describe in detail, supplement with Drawings where necessary, the methods to be adopted for executing any portion of the Work.
- .2 These statements shall also include details of constructional plant and labour to be employed. Acceptance by the Contract Administrator shall not relieve the Contractor of any responsibilities, nor shall reasonable refusal to approve entitle the Contractor to extra payment or an extension of time.

## **1.6 RFI PROCEDURE**

- .1 The Contractor shall submit an RFI in writing to the Contract Administrator in the event that the Contractor or any Subcontractor involved in the Work determines that some portion of the Drawings, Specifications, or other Contract Documents requires clarification or interpretation by the Contract Administrator.
- .2 Procedures:
  - .1 Submit RFIs to the Contract Administrator on the "Request for Information" form appended to this section. The Contract Administrator will return RFIs submitted without the RFI form without being examined and considered rejected. Resubmission of the RFI using the RFI form will be required for review and response by the Contract Administrator.
  - .2 Number RFIs consecutively in one sequence in the order submitted, in a numbering system established by the Contract Administrator.
  - .3 Submit one distinct subject per RFI request. Do not combine multiple requests or unrelated items on one form.
  - .4 Where the RFI form does not have sufficient space, attach additional sheets as required.
  - .5 Submit the RFI form with all necessary supporting documentation.
- .3 In the RFI, the Contractor shall clearly and concisely set forth:
  - .1 The issues for which clarification or interpretation is sought and why a response is needed from the Contract Administrator.
  - .2 An interpretation or understanding of the requirement along with reasons why an understanding was reached.
- .4 The Contract Administrator will review all RFIs to determine whether they are valid RFIs. If it is determined that the document is not a valid RFI, it will be returned to the Contractor not having been reviewed with an explanation why it was deemed not valid.
- .5 For clarity, RFIs are considered a Submittal and will follow the same review timelines as set out in 1.3.12.
- .6 If, at any time, the Contractor submits a large number of RFIs or the Contract Administrator considers the RFI to be of such complexity that the Contract Administrator cannot process the RFIs within 14 Calendar Days, the Contractor Administrator shall confer with the Contractor within Seven Calendar Days of receipt of such RFIs, and the Contract Administrator and the Contractor will

jointly prepare an estimate of the time necessary for processing as well as an order of priority among the RFIs submitted. The Contractor shall accommodate such necessary time at no impact to the schedule and at no additional cost to the Contract.

- .7 If the Contractor submits an RFI on an activity with 14 Calendar Days or less of available time to the impacted activity on the current project schedule, the Contractor shall not be entitled to any time extension due to the time it takes the Contract Administrator to respond to the request provided that the Contract Administrator responds within the 14 Calendar Days set forth above.
- .8 An RFI response from the Contract Administrator will not change any requirement of the Contract. In the event the Contractor believes that the RFI response from the Contract Administration will cause a change to the requirements of the Contract, the Contractor shall within 14 Calendar Days give written notice to the Contract Administrator stating that the Contractor believes the RFI response will result in a change in the Contract and the Contractor intends to submit a change request. Failure to give such written notice of 14 Calendar Days shall waive the Contractor's right to seek additional time or cost under the requirements of the Contract.
- .9 The City may, in reviewing any matter or RFI in accordance with this Submittal procedure, refer such matter or RFI to other City departments, or any of the City's servants, agents, advisers, consultants, contractors, or subcontractors.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                SUBMITTALS**

- .1    Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Provide the following submittals where requested in individual Specification sections:
  - .1    Qualification of Contractor's Representative
  - .2    Form 100: Certificate of Equipment Delivery
  - .3    Form 102: Certificate of Satisfactory Installation
  - .4    Functional test results (equipment test reports)
  - .5    Form 103: Certificate of Equipment Satisfactory Performance
  - .6    Performance test reports
  - .7    Form 104: Certificate of Satisfactory System Performance.

**1.2                QUALIFICATION OF CONTRACTOR'S REPRESENTATIVE**

- .1    Authorized representative of the Contractor and experienced in the installation and maintenance of respective equipment, subsystem, or system.
- .2    Representative subject to acceptance by the Contract Administrator. No substitute representatives will be allowed unless prior written approval by such has been given.

**Part 2            Products**

**2.1                NOT USED**

- .1    Not Used.

**Part 3            Execution**

**3.1                EQUIPMENT DELIVERY**

- .1    The Contractor shall be responsible for receiving, off-loading, and placing into storage all equipment at the Site. Certificate of Equipment Delivery (Form 100), a copy of which is attached to this section, shall be completed.

**3.2                FULFILLMENT OF SPECIFIED MINIMUM SERVICES**

- .1    Furnish Contractor's services when required by an individual Specification section, to meet the requirements of this section.
- .2    Where time is necessary in excess of that stated in the Specifications for Contractor's services, or when a minimum time is not specified, the time required to perform the specified services shall be considered incidental.

- .3 Schedule Contractor's services to avoid conflict with other onsite testing or other Contractor's onsite services.
- .4 Determine, before scheduling services, that all conditions necessary to allow successful testing have been met.
- .5 Only those days of service approved by the Contract Administrator will be credited to fulfill the specified minimum services.
- .6 When specified in individual Specification sections, Contractor's onsite services shall include:
  - .1 Inspection, checking, and adjustment as required for product (system, subsystem, or component) to function as warranted by manufacturer;
  - .2 Revisiting the Site as required to correct problems and until installation and operation are acceptable to the Contract Administrator;
  - .3 Resolution of assembly or installation problems attributable to, or associated with, respective installed products and systems;
  - .4 Assistance during functional and performance testing, and facility start-up and evaluation; and
  - .5 Additional requirements may be specified elsewhere.

### **3.3 EQUIPMENT INSTALLATION**

- .1 After installation is complete, the Contractor's representative shall verify successful installation.
- .2 The Contractor's representative shall conduct a detailed inspection of the installation including alignment, mechanical connections, piping, lubrication, workmanship, and all other items as required to ensure successful operation of the equipment.
- .3 The Contractor's representative shall identify any outstanding deficiencies in the installation.
- .4 The deficiencies shall be rectified by the installation Contractor and the Contractor's representative shall re-inspect the installation.
- .5 When the Contractor's representative accepts the installation, Certificate of Satisfactory Installation (Form 102), attached to this Specification, shall be signed by the Contractor's representative, the Contract Administrator, and the City.
- .6 Deliver the completed Form 102 to the Contract Administrator prior to departure of the tradespersons from the Site.
- .7 Tag the equipment with a 100 mm x 200 mm card stating "EQUIPMENT CHECKED. DO NOT RUN." stenciled in large black letters. Sign and date each card.
- .8 Separate copies of Form 102 shall be furnished for each individual unit process item of equipment. In addition, furnish a copy of Form 102 for the entire system supplied under this Contract.

### **3.4 EQUIPMENT PERFORMANCE TESTING (FUNCTIONAL TESTING)**

- .1 After the installation has been verified and any identified deficiencies have been remedied, the equipment shall be subjected to functional testing. Ready-to-test determination will be by the Contract Administrator based at least on the following:
  - .1 Adequate completion of Work adjacent to, or interfacing with, equipment to be tested, including items to be furnished by others;
  - .2 Equipment and electrical tagging complete;
  - .3 Availability and acceptability of Contractor's representative to assist in testing of respective equipment;
  - .4 Receipt of Certificate of Equipment Delivery (Form 100) and Certificate of Satisfactory Installation (Form 102);
  - .5 Final operation and maintenance manuals; and
  - .6 Notification by Contractor's representative of equipment readiness for testing.
- .2 The Contractor's representative shall conduct all necessary checks to equipment and, if necessary, conduct further flushing, cleaning, or other remedial measures required to ensure satisfactory operation prior to confirming the equipment is ready to run.
- .3 The Contractor's representative shall then notify the Contract Administrator of their readiness to demonstrate the functional operation of the equipment. The Contract Administrator shall attend, as expeditiously as possible.
- .4 The Contractor's representative shall demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, rotations checked, etc., shall be checked and if appropriate, code certifications provided.
- .5 On satisfactory completion of the one (1) hour functional demonstration, the equipment shall be stopped and critical parameters and equipment systems shall be rechecked.
- .6 The equipment shall then be run continuously for at least one (1) day. During this period, as practicable, conditions shall be simulated which represent the full range of operating conditions. These conditions shall be mutually agreed by the Contractor and the Contract Administrator on the basis of the information contained in the Specifications, as well as the methods utilized to create the simulated conditions and the time periods allotted to each.
- .7 Should the functional testing reveal any defects, then those defects shall be promptly rectified and the functional tests shall be repeated to the satisfaction of the Contract Administrator. If the defects are attributed to the Contractor, additional costs to repeat functional tests shall be the responsibility of the Contractor. The City shall deduct such costs from the Contract, amount of which will be determined by the Contract Administrator.
- .8 Equipment Test Reports: Provide written test reports for each item of equipment tested, to include the minimum information:
  - .1 City/Project Name/Tender number;

- .2 Equipment or item tested;
  - .3 Date and time of test;
  - .4 Type of test performed (Functional);
  - .5 Test conditions;
  - .6 Test results; and
  - .7 Signature space for Contractor and Contract Administrator representatives.
- .9 On successful completion of the functional test, Certificate of Equipment Satisfactory Performance (Form 103) attached to this Specification shall be signed by the Contract's representative, the Contract Administrator, and the City.
- .10 When, in Contract Administrator's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase.

### **3.5 SYSTEM PERFORMANCE TESTING**

- .1 Equipment shall be subjected to a performance test in accordance with the Specifications. Performance testing shall not commence until equipment has been accepted by the Contract Administrator as having satisfied the functional test requirements.
- .2 The Contractor shall submit the results of the performance tests to the Contract Administrator, documented and summarized in a format acceptable to the Contract Administrator. The Contract Administrator reserves the right to request additional testing. No equipment shall be accepted and handed over to the City prior to the satisfactory completion of the performance test(s) and receipt of the test reports.
- .3 Should the performance tests reveal any defects, then those defects shall be promptly rectified and the performance tests shall be repeated to the satisfaction of the Contract Administrator. If the defects are attributed to the Contractor, additional costs incurred due to repeat functional tests, and/or performance tests shall be the responsibility of the Contractor.
- .4 On successful completion of the performance tests, Certificate of Satisfactory System Performance (Form 104) attached to this Specification shall be signed by the Contractor's Representative, the Contract Administrator, and the City.
- .5 Total Performance shall only be issued after issuance of every required Form 104 and all other requirements of Total Performance have been met.

### **3.6 SUPPLEMENTS**

- .1 The supplemental forms listed below, following "End of Section", are part of this Specification.
  - .1 Form 100: Certificate of Equipment Delivery
  - .2 Form 102: Certificate of Satisfactory Installation
  - .3 Form 103: Certificate of Equipment Satisfactory Performance
  - .4 Form 104: Certificate of Satisfactory System Performance

**END OF SECTION**



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**Form 100**  
**CERTIFICATE OF EQUIPMENT DELIVERY**

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1. We certify that the equipment listed below has been delivered into the care and custody of the Installation Contractor. The equipment has been found to be in satisfactory condition. There is no visible evidence of exterior damage or defects.

**Project:** MacLean Pumping Station Valve House Electrical Upgrade  
**Equipment Description:**  
**Tender No.:** 195-2024  
**Equipment Tag No.:**  
**Specification Reference:**

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Print Name Signature  
(Authorized Representative of City)

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Date

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Print Name Signature  
(Authorized Representative of Contractor)

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Date

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Print Name Signature  
(Authorized Representative of Contract Administrator)

---

Date





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**Form 102**  
**CERTIFICATE OF SATISFACTORY INSTALLATION**

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We have completed our checks and inspection of the installation of our equipment as listed below and confirm that it is satisfactory and that any defects have been remedied except any as noted below.

**Project:** MacLean Pumping Station Valve House Electrical Upgrade  
**Equipment Description:**  
**Tender No.:** 195-2024  
**Equipment Tag No.:**  
**Specification Reference:**  
**Outstanding Defects:**

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Print Name  
(Authorized Representative of City)

Signature

---

Date

---

Print Name  
(Authorized Representative of Contractor)

Signature

---

Date



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**Form 103**  
**CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE**

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We certify that the equipment listed below has been continuously operated for a minimum of one (1) day and that the equipment operates satisfactorily and meets its specified operating criteria. No defects in the equipment were found and as such are classified as "conforming".

**Project:** MacLean Pumping Station Valve House Electrical Upgrade  
**Equipment Description:**  
**Tender No.:** 195-2024  
**Equipment Tag No.:**  
**Specification Reference:**

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Print Name \_\_\_\_\_ Signature \_\_\_\_\_  
(Authorized Representative of City)

---

Date \_\_\_\_\_

---

Print Name \_\_\_\_\_ Signature \_\_\_\_\_  
(Authorized Representative of Contractor)

---

Date \_\_\_\_\_

---

Print Name \_\_\_\_\_ Signature \_\_\_\_\_  
(Authorized Representative of Contract Administrator)

---

Date \_\_\_\_\_



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**Form 104**  
**CERTIFICATE OF SATISFACTORY PROCESS PERFORMANCE**

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We certify that the process/utility system listed below has been continuously operated and tested as per the Specifications and that the equipment meets its Performance Testing and Operating Criteria. No defects in the process system were found and as such are classified as "conforming".

**Project:** MacLean Pumping Station Valve House Electrical Upgrade  
**System Description:**  
**Tender. No.:** 195-2024  
**Equipment Tag Nos.:**  
**Specification Reference:**

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Print Name \_\_\_\_\_ Signature \_\_\_\_\_  
(Authorized Representative of City)

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Date \_\_\_\_\_

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Print Name \_\_\_\_\_ Signature \_\_\_\_\_  
(Authorized Representative of Contractor)

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Date \_\_\_\_\_

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Print Name \_\_\_\_\_ Signature \_\_\_\_\_  
(Authorized Representative of Contract Administrator)

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Date \_\_\_\_\_

**Part 1      General**

**1.1          REFERENCE STANDARDS**

- .1 Conform to reference standards, in whole or in part as specifically requested in the Contract Documents.
- .2 If there is a question as to whether products or systems are in conformance with applicable standards, the Contract Administrator reserves the right to have such products or systems tested to prove or disprove conformance.
- .3 Cost for such testing will be borne by the City in event of conformance with the Contract Documents or by the Contractor in event of non-conformance.

**1.2          QUALITY**

- .1 Products, materials, equipment, and articles incorporated in Work shall be new, not damaged or defective, and of best quality for purpose intended. If requested, furnish evidence as to type, source, and quality of products provided.
- .2 Defective products, whenever identified prior to 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 the Contractor's own expense and be responsible for delays and expenses caused by rejection.
- .3 Should disputes arise as to quality or fitness of products, the decision rests strictly with the Contract Administrator based upon the requirements of the Contract Documents.
- .4 Unless otherwise indicated in Specifications, maintain uniformity of manufacture for any particular or like item throughout the Work.

**1.3          AVAILABILITY**

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

**1.4          DELIVER, STORAGE, HANDLING, AND PROTECTION**

- .1 Delivery and Acceptance Requirements: deliver materials to Site in original factory packaging, labelled with manufacturer's name and address.

- .2 Deliver, handle, and store products in manner to prevent damage, adulteration, deterioration, and soiling, and in accordance with manufacturer's instructions when applicable.
- .3 Deliver and store packaged or bundled products in original and undamaged condition with manufacturer's seal and labels intact. Do not remove from packaging or bundling until required in Work.
- .4 Deliver and store products subject to damage from weather in weatherproof enclosures.
- .5 Storage and Protection:
  - .1 Store materials indoors, in dry location, and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
  - .2 Replace defective or damaged materials with new.
- .6 Store paints and freezable materials in a heated and ventilated room.
- .7 Remove and replace damaged products at own expense and to the satisfaction of the Contract Administrator.
- .8 Touch-up damaged factory finished surfaces to the Contract Administrator's satisfaction. Use touch-up materials to match original. Do not paint over name plates.

## **1.5 TRANSPORTATION**

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

## **1.6 MANUFACTURER'S INSTRUCTIONS**

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

## **1.7 QUALITY OF WORK**

- .1 Ensure quality of Work is of the highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify the Contract Administrator if required Work is such as to make it impractical to produce required results.
- .2 Do not employ anyone unskilled in their required duties. The Contract Administrator reserves the right to require the dismissal from Site, workers deemed incompetent or careless.

- .3 Decisions as to standard or fitness of quality of Work in cases of dispute rest solely with the Contract Administrator, whose decision is final.

## **1.8 REMEDIAL WORK**

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

## **1.9 LOCATION OF FIXTURES**

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

## **1.10 FASTENINGS**

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

## **1.11 PROTECTION OF WORK IN PROGRESS**

- .1 Prevent overloading of parts of building. Do not cut, drill, or sleeve load bearing structural members, unless specifically indicated, without written approval of the Contract Administrator.

## **Part 2 Products**

### **2.1 NOT USED**

- .1 Not Used.

**Part 3          Execution**

**3.1              NOT USED**

.1          Not Used.

**END OF SECTION**

**Part 1        General**

**1.1        ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit written request of demolition, cutting, or alteration at least two weeks prior to the scheduled demolition, cutting, or alteration in accordance with this section.

**1.2        PREPARATION**

- .1 Submit written request in advance of demolition, cutting, or alteration which affects:
  - .1 Structural integrity of elements of Work.
  - .2 Integrity of weather-exposed or moisture-resistant elements.
  - .3 Efficiency, maintenance, or safety of operational elements.
  - .4 Visual qualities of sight-exposed elements.
  - .5 Work of the City or separate contractor.
  - .6 Any interruption of equipment control, or equipment downtime.
- .2 Include in request:
  - .1 Identification of project.
  - .2 Location and description of affected Work.
  - .3 Statement on necessity for cutting or alteration.
  - .4 Description of proposed Work and products to be used.
  - .5 Alternatives to cutting and patching.
  - .6 Effect on Work of the City or separate contractor.
  - .7 Written permission of affected separate contractor.
  - .8 Date and time Work will be executed.
  - .9 Estimate Equipment downtime, and date equipment will be operational again.
- .3 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .4 After uncovering, inspect conditions affecting performance of Work.
- .5 Beginning of cutting or patching means acceptance of existing conditions.
- .6 Provide supports to assure structural integrity of surroundings are maintained; provide devices and methods to protect other portions of Work from damage.
- .7 Provide protection from elements for areas which are to be exposed by uncovering Work; maintain excavations free of water.
- .8 Exercise care where cutting holes in existing concrete elements so as not to damage existing reinforcing or conduit.



- .1 For reinforced concrete floors and walls, locate existing reinforcing and conduit by x-ray or ground penetrating radar scanning and mark out on the surface of the concrete prior to cutting.
  - .1 Mark the location of the proposed hole and all adjacent rebar and conduits.
  - .2 Obtain approval from the Contract Administrator prior to cutting.
- .2 Concrete scanning device shall to be capable of detecting rebar and conduit in the full depth of the floor.
- .9 The Contractor shall exercise care where installing anchors into existing concrete elements so as not to damage existing reinforcing. All anchors shall be installed utilizing carbide tip drill bits. The existing reinforcing shall be located utilizing a reinforcing bar locator and marked out on the surface of the concrete. The drill holes shall be advanced to the required depth for installation of the anchors. Should reinforcement be encountered while drilling, terminate the hole and reposition to clear the reinforcement. Do not use core bits that can easily intercept and damage/cut the reinforcing during drilling. Patch and repair damages.

### **1.3 EXECUTION**

- .1 Execute cutting, fitting, and patching including excavation and fill, to complete Work.
- .2 Fit several parts together, to integrate with other Work.
- .3 Uncover Work to install ill-timed Work.
- .4 Remove and replace defective and non-conforming Work.
- .5 Remove samples of installed Work for testing.
- .6 Provide openings in non-structural elements of Work for penetrations of electrical Work.
- .7 Execute Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.
- .8 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools not allowed on masonry work without prior approval from the Contract Administrator. Where significant removals are required, the Contractor to engage a Professional Engineer and provide sealed Shop Drawings for modifications.
- .9 Restore Work with new products in accordance with requirements of Contract Documents.
- .10 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .11 Penetrations though a floor above another space shall have a pipe sleeve extending above the floor to prevent water running to the floor below.
- .12 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with fire stopping with a rated fire stopping assembly to full thickness of the construction element.

- .13 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                PROJECT CLEANLINESS**

- .1        Maintain Work in tidy condition, free from accumulation of waste products and debris.
- .2        Remove waste materials from the Site at daily regularly scheduled times or dispose of as directed by the Contract Administrator. Do not burn waste materials on Site.
- .3        Make arrangements with and obtain permits from Authorities Having Jurisdiction for disposal of waste and debris.
- .4        Provide on-site containers for collection of waste materials and debris.
- .5        Dispose of waste materials and debris off Site.
- .6        For clarity, handling, and disposal of asbestos waste in accordance with Section 02 82 00.01 Asbestos Abatement – Minimum Precautions and Section 02 82 00.02 - Asbestos Abatement – Intermediate Precautions.
- .7        Clean interior areas prior to the start of finishing Work and maintain areas free of dust and other contaminants during finishing operations.
- .8        Store volatile waste in covered metal containers and remove from the premises at the end of each day.
- .9        Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .10       Use only cleaning materials recommended by the manufacturer of the surface to be cleaned and as recommended by the cleaning material manufacturer.
- .11       Schedule cleaning operations so that resulting dust, debris, and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.
- .12       Clean and maintain bathroom facilities utilized by construction staff daily.

**1.2                FINAL CLEANING**

- .1        When Work is substantially performed, remove surplus products, tools, construction machinery, and equipment not required for performance of remaining Work.
- .2        Remove waste products and debris other than that caused by others and leave Work clean and suitable for occupancy.
- .3        Prior to Total Performance, remove remaining surplus products, tools, construction machinery, and equipment.
- .4        Vacuum clean and dust building interiors.

**Part 2          Products**

**2.1              NOT USED**

.1          Not Used.

**Part 3          Execution**

**3.1              NOT USED**

.1          Not Used.

**END OF SECTION**

**Part 1      General**

**1.1      SECTION INCLUDES**

- .1      Closeout Submittals include O&M Manuals, As-Built Drawings, and Maintenance Materials.

**1.2      ACTION AND INFORMATIONAL SUBMITTALS**

- .1      Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2      O&M Manuals
  - .1      Prepare in accordance with this section and the Contract Documents.
- .3      As-Built Drawings
  - .1      Prepare in accordance to this section and the Contract Documents.
- .4      Maintenance Material
  - .1      Provide spare parts, extra stock material, and special tools of same quality and manufacture as products provided in the Work in accordance with this section and Contract Documents.
  - .2      Provide evidence, if requested, for type, source, and quality of products supplied.

**1.3      OPERATION AND MAINTENANCE MANUALS**

- .1      Develop the O&M Manuals throughout the course of the Work.
- .2      Operation and maintenance instructions and technical data to be sufficiently detailed with respect to design elements, construction features, component function, correct installation procedure, and maintenance requirements to permit effective start-up, operation, maintenance, repair, modification, extension, and expansion of any portion or feature of installation. Technical data to be in the form of approved Shop Drawings, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and maintenance material lists.
- .3      For the guidance of the City's operation and maintenance personnel, the Contractor shall prepare O&M Manuals for the Work, describing in detail the construction of each part of the Work and the recommended procedure for operation, servicing, and maintenance.
- .4      All instructions in these O&M Manuals shall be in simple language to guide the City in the proper operation and maintenance of this installation.
- .5      Submit one advance copy of the draft O&M Manual for the respective facility two weeks prior to facility closeout for review and comments.
  - .1      Modify and supplement the O&M Manuals as required by the Contract Administrator.
  - .2      After review and acceptance, continue compilation of the O&M Manuals for the final submission.

- .3 After review and acceptance, submit two hard copies and one searchable PDF copy in accordance with Section 01 33 00 – Submittal Procedures, on a flash memory drive, of the advanced draft O&M Manuals within two weeks of facility closeout. Mark the O&M Manual cover page “ADVANCED DRAFT”.
- .6 Submit completed final O&M Manuals, including all facilities, four weeks prior to Substantial Performance of the Work.
  - .1 Copy will be returned after final inspection of Substantial Performance with the Contract Administrator’s comments.
  - .2 Revise content of documents as required and provide final Submittal.
  - .3 After review and acceptance of the final Submittal, submit four hard copies and one searchable PDF copy in accordance with Section 01 33 00 – Submittal Procedures, on a flash memory drive, of the final O&M Manuals prior to Substantial Performance. Mark the O&M Manual cover page “FINAL”.
- .7 Further to the requirements set out in the Contract Documents, the O&M Manuals shall contain the following:
  - .1 Product data:
    - .1 Mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
    - .2 Typewritten Text: as required to supplement product data.
      - .1 Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
  - .2 Equipment and systems – provide the following:
    - .1 All equipment and systems documentation shall have project specific equipment tags clearly indicating the systems.
    - .2 Survey record of underground systems (cables, conduit, piping, etc.).
      - .1 Provide precise location of all buried systems.
    - .3 Brochures and catalogue excerpts for all components of the Work.
    - .4 Installation, start-up, and individual equipment operation and maintenance manuals.
    - .5 Calibration procedures for equipment.
    - .6 Final functional requirement specification outlining the programming of the PLC systems for individual processes or systems.
    - .7 Final instrumentation set points including but not limited to:
      - .1 Units
      - .2 Scale
      - .3 Alarm points (low-low, low, high, high-high)
      - .4 4-20 mA settings

- .8 List names, addresses, and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- .9 For each item of equipment and each system include description of unit or system, and component parts.
  - .1 Give function, normal operation characteristics, and limiting conditions.
  - .2 Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .10 Panelboard circuit directories: provide electrical service characteristics, controls, and communications.
- .11 Installed colour coded wiring diagrams.
- .12 Operating procedures: include start-up, break-in, and routine normal operating instructions and sequences.
  - .1 Include regulation, control, stopping, shut-down, and emergency instructions.
  - .2 Include summer, winter, and any special operating instructions.
- .13 Maintenance requirements: include routine procedures and guide for trouble-shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- .14 Include manufacturer's printed operation and maintenance instructions.
- .15 Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .16 Installed control diagrams by controls manufacturer.
- .17 List of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .18 Additional requirements: as specified in the Contract Documents.
- .3 Materials and finishes – provide the following:
  - .1 Building products, applied materials, and finishes: include product data with catalogue number, size, composition, and colour and texture designations.
  - .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 the Contract Documents.
- .4 Other documents – provide the following:

- .1 Maintain manufacturer's certifications, field test records, in accordance with Section 26 05 00 – Common Work Results for Electrical and required by individual Specifications sections to be included on the O&M Manuals.
- .2 Certificates and Permits:
  - .1 Include certificate of inspection from the AHJ, manufacturer's certifications, electrical permits, and warranty certificate, signed and dated in accordance with Section 26 05 00 – Common Work Results for Electrical and required in the Contract Documents.
- .3 Tests:
  - .1 Include testing, field test records, start-up tests, commissioning, and all test results documentation in Section 26 05 00 – Common Work Results for Electrical and as required in the Contract Documents.
- .5 Digital photographs – provide the following:
  - .1 In accordance with the Contract Documents or as requested.
- .6 Drawings – provide the following:
  - .1 Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams.
  - .2 Shop Drawings and cutsheets of all equipment and materials.
    - .1 Do not utilize the cutsheet and Shop Drawing submittals that were sent to the Contract Administrator for review as these may contain inaccurate information and markups. Only provide cutsheets and Shop Drawings representing the final materials and equipment supplied, without any markups from the Contract Administrator.
    - .2 For generic cutsheets and Shop Drawings that list multiple model numbers or configurations, place a rectangle around the specific model that was supplied and cross out other models.
  - .3 Sections for the record drawings and As-Built Drawings of all installations. Drafted record drawings and As-Built Drawings of size 432x279mm (11 x 17") will be inserted by the Contract Administrator, based on the As-Built Drawings marked up by the Contractor.
- .7 Training Documents:
  - .1 Submit complete training plan for review prior to site commissioning. Training plan to include:
    - .1 PLC Hardware configuration, programming and testing.
    - .2 Power Meter Configuration, programming and testing.
      - .1 In field training only.
    - .3 SCADA hardware and virtualization.
    - .4 SCADA System configuration, programming and testing.
    - .5 HMI System configuration, programming and testing.



- .6 Network configuration, programming and testing.
- .2 Training to be two (2), eight (8) hour sessions of in classroom training, as well as one (1), four (4) hour session in field training on new equipment.
- .8 The O&M Manuals shall be provided in the following Format:
  - .1 Organize data as an instructional manual.
  - .2 Main Cover page:
    - .1 Labelled "Operation and Maintenance Instructions".
    - .2 Facility name included in the volume.
    - .3 Project name and Tender number.
    - .4 Date of submission.
  - .3 List of Contents
    - .1 Indicate facilities updated by the Work.
    - .2 Name, addresses, and telephone numbers of the City, Contract Administrator, Contractor, and Subcontractors with name of responsible parties.
    - .3 Schedule of products and systems, indexed to content of volume.
    - .4 List subject matter of contents for each volume.
  - .4 Binders: vinyl, hard covered, 3 'D' ring, with spine and face pockets.
    - .1 When multiple binders are used correlate data into related consistent groupings.
    - .2 Identify contents of each binder on spine.
  - .5 Arrange content by systems under section numbers and sequence of table of contents.
  - .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
  - .7 Text: manufacturer's printed data, or typewritten data.
  - .8 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

#### **1.4 AS-BUILT DRAWINGS AND RECORD INFORMATION**

- .1 Print a complete full-sized set of Contract Drawings for the purpose of maintaining As-Built Drawings.
- .2 Submit draft As-Built Drawings for the facility two weeks after the facility closeout.
- .3 Submit final As-Built Drawings prior to Total Performance.
- .4 Accurately record information on Contract Drawings. All Work deviations from the original Contract to be provided as As-Built Drawings.
  - .1 Recorded information shall be updated on a daily basis with a red marker.
  - .2 Recorded information shall be concurrent with construction progress.
    - .1 Do not conceal Work until required information is recorded.
  - .3 Recorded information on the drawings shall include but not limited to:

- .1 Locations of devices.
  - .2 Location of all equipment.
  - .3 Electrical circuiting and networking of all devices.
  - .4 Conduit and feeder runs (complete with conductor size and number).
  - .5 Measured heights of installed equipment in relation to finished floor.
  - .6 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  - .7 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
  - .8 Field changes of dimension and detail.
  - .9 Changes made by Change in Work.
  - .10 Details not on original Contract Drawings.
- .5 Keep one complete set of the following to maintain at Site for the Contract Administrator, identify this set as "PROJECT RECORD COPY":
- .1 Contract Drawings.
  - .2 Specifications.
  - .3 Addenda.
  - .4 Change in Work and other modifications to the Contract.
  - .5 Reviewed Shop Drawings, product data, and samples.
  - .6 Field test records.
  - .7 Inspection certificates.
  - .8 Manufacturer's certificates.
  - .9 Site Instructions.
  - .10 Clarifications.
- .6 Store project record copy in field office apart from documents used for construction.
- .7 Maintain project record copy in good condition.
- .8 Keep project record copy assessable for inspection by Contract Administrator.

## **1.5 MAINTENANCE MATERIALS**

- .1 Provide spare parts, extra stock materials, and special tools, in quantities specified in individual Specification sections.
  - .1 Special tools: provide items with tags identifying their associated function and equipment.
- .2 Provide spare parts, extra stock materials, and special tools of same manufacture and quality as items in Work.
- .3 Deliver spare parts, extra stock materials, and special tools to Site; place and store in accordance with Section 01 61 00 – Common Product Requirements.

- .4 Receive and catalogue spare parts, extra stock materials, and special tools.
  - .1 Submit inventory listing to Contract Administrator.
  - .2 Include approved listings in O&M Manuals.
- .5 Obtain receipt from the City for delivered products and submit to Contract Administrator prior to final payment.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1        General**

**1.1            SUMMARY**

- .1 Both confirmed asbestos and presumed asbestos have been identified at the MacLean RPS, which will or may be affected by the Work. Refer to Appendix D of the tender documents for the following HMIS reports for further details:
  - .1 MacLean RPS\_2019 10 28\_HMIS Confirmed Asbestos and Presumed Asbestos Report
- .2 The presumed ACMs detailed in the Appendix D - Asbestos Reports shall be assumed to be ACM.
- .3 The Contractor is responsible for the removal and disposal of all confirmed ACMs and presumed ACMs affected by the Work.
- .4 Where penetrations through confirmed or presumed ACMs are required, the Contractor shall conduct the Work in accordance with this section.
- .5 The Contractor shall put in place a removal / disposal work plan and shall remove all confirmed and presumed ACMs to perform the Work as indicated in the Contract Documents which impact the Contractors activities, in a safe manner, as part of the required Work.
- .6 Provide training for all workers, including but not limited to:
  - .1 Asbestos Workers.
  - .2 Asbestos Visitors.
- .7 Comply with requirements of this section when performing following the Work:
  - .1 Removing ceiling tiles that are ACM, if the tiles cover an area less than 7.5 square metres and are removed without being broken, cut, drilled, abraded, ground, sanded, or vibrated.
  - .2 Removing Non-Friable ACMs, other than ceiling tiles, if the material is installed or removed without being broken, cut, drilled, abraded, ground, sanded, or vibrated.
  - .3 Break, cut, grind, sand, drill, scrape, vibrate, or abrade Non-Friable ACMs using non-powered hand-held tools, and wet the material to control the spread of dust or fibres.
  - .4 Removing less than one square metre of drywall in which joint-filling compounds that are ACMs have been used.
- .8 The Contractor shall ensure that Work does not impede the ongoing operations of the facility. The facility will continue to be operated by City staff.

**1.2            REFERENCE STANDARDS**

- .1 Department of Justice Canada (Jus)
  - .1 Canadian Environmental Protection Act, 1999 (CEPA).

- .2 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
- .2 Manitoba Workplace Safety and Health Regulation, Reg 217/2006
- .3 SAFE Work Manitoba
  - .1 Guide For Asbestos Management, May 2017.
- .4 The Workplace Safety & Health Act, Manitoba, Chapter W210 C.C.S.M.
- .5 Health Canada / WHMIS
  - .1 SDS.
- .6 Transport Canada (TC)
  - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).

### 1.3 DEFINITIONS

- .1 **“Amended Water”** means water with non-ionic surfactant wetting agent added to reduce water tension to allow thorough wetting of fibres.
- .2 **“Asbestos-Containing Materials”** or **“ACMs”** has the meaning as set out in D5 of the Tender;
- .3 **“Asbestos Abatement Monitoring & Inspection Agent”** means a person qualified to provide asbestos abatement monitoring and inspection services in the jurisdiction where the services are to be provided.
- .4 **“Asbestos Worker”** means a Competent Worker who is employed by an employer to perform a service that may include the disturbance or removal of ACMs.
- .5 **“Asbestos Work Area”** means area where Work takes place which will, or may, disturb ACMs.
- .6 **“Authorized Visitors”** means the Contract Administrator or designated representatives, the City, and representatives of regulatory agencies.
- .7 **“Competent Worker”** means in relation to specific work, means a worker who:
  - .1 Is qualified because of knowledge, training and experience to perform the Work.
  - .2 Is familiar with the provincial laws, federal laws, and the provisions of the regulations that apply to the Work.
  - .3 Has knowledge of all potential or actual danger to health or safety in the work.
- .8 **“Friable Materials”** means material that when dry can be crumbled, pulverized, or powdered by hand pressure and includes such material that is crumbled, pulverized, or powdered.
- .9 **“HEPA”** means high efficiency particulate air.

- .10 **“HEPA vacuum”** means HEPA filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any direction at 99.97 percent efficiency.
- .11 **“Non-Friable ACMs”** means material that when dry cannot be crumbled, pulverized, or powdered by hand pressure.
- .12 **“polyethylene”** means polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.
- .13 **“sprayer”** means garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for work.

#### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit removal / disposal work plan two weeks prior to the schedule removal / disposal work in accordance with this section and E2 of the Tender.
- .3 Submit proof of the Contractor's insurance in accordance with D13 of the Tender.
- .4 Submit daily air monitoring results and recommendations in accordance with this section.

#### **1.5 QUALITY ASSURANCE**

- .1 Regulatory Requirements: comply with Federal, Provincial/Territorial, and local requirements pertaining to asbestos, provided that in case of conflict among these requirements or with these Specifications, the more stringent requirement applies. Comply with regulations in effect at time Work is performed.
- .2 Health and Safety:
  - .1 Safety Requirements: Provide all requirements for Asbestos Worker protection.
    - .1 Protective equipment and clothing to be worn by Asbestos Workers and Authorized Visitor while in Asbestos Work Area include:
      - .1 Air purifying half-mask respirator with N-100, R-100, or P-100 particulate filter, personally issued to Asbestos Worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority Having Jurisdiction. The respirator to is be fitted so that there is an effective seal between the respirator and the Asbestos Worker's face, unless the respirator is equipped with a hood or helmet. The respirator is to be cleaned, disinfected, and inspected after use on each shift, or more often if necessary, when issued for the exclusive use of one Asbestos Worker, or after each use when used by more than one Asbestos Worker. If the respirator has damaged or deteriorated

parts, it is to be replaced prior to being used by an Asbestos Worker. The respirator, when not in use, is to be stored in a convenient, clean, and sanitary location. The Contractor is to establish written procedures regarding the selection, use, and care of respirators, and a copy of the procedures are to be provided to and reviewed with each Asbestos Worker who is required to wear a respirator. An Asbestos Worker is not to be assigned to an operation requiring the use of a respirator unless he or she is physically able to perform the operation while using the respirator.

- .2 Disposable-type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing to be provided by the Contractor and worn by every Asbestos Worker who enters the Asbestos Work Area. The protective clothing shall consist of a head and full body covering that fits snugly at the ankles, wrists, and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing. Suitable footwear must be worn with the protective clothing. Protective clothing to be repaired or replaced if torn.
- .2 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.
- .3 Before leaving the Asbestos Work Area, the Asbestos Worker can decontaminate his or her protective clothing by using a vacuum equipped with a HEPA filter, or by damp wiping, before removing the protective clothing, or, if the protective clothing will not be reused, place it in a container for dust and waste. The container to be dust tight, suitable for asbestos waste, impervious to asbestos, identified as asbestos waste, cleaned with a damp cloth or a vacuum equipped with a HEPA filter immediately before removal from the Asbestos Work Area, and removed from the Asbestos Work Area frequently and at regular intervals.
- .4 Facilities for washing hands and face shall be provided within or close to the Asbestos Work Area.
- .5 Ensure Asbestos Workers wash hands and face when leaving Asbestos Work Area.
- .6 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects the seal between the respirator and the face.
- .7 Authorized Visitor Protection:
  - .1 Provide protective clothing and approved respirators to Authorized Visitors to the Asbestos Work Areas.
  - .2 Instruct Authorized Visitors in the use of protective clothing, respirators, and procedures.

- .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from the Asbestos Work Areas.

## **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Disposal of asbestos waste generated by removal activities must comply with Federal, Provincial, Territorial, and Municipal regulations. Dispose of asbestos-containing waste in sealed double thickness 6 mils bags or leak proof drums. Label containers with appropriate warning labels.
- .2 Provide manifests describing and listing waste created. Transport containers by approved means to licensed landfill for burial.

## **1.7 REMOVAL / DISPOSAL WORK PLAN**

- .1 The following shall be included in the removal / disposal work plan:
  - .1 Anticipated duration for the asbestos abatement work.
  - .2 Submit proof satisfactory to the Contract Administrator that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of Authority Having Jurisdiction.
  - .3 Submit Provincial/Territorial and/or local requirements for notice of project form.
  - .4 Submit to the Contract Administrator necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed.
  - .5 Submit proof satisfactory to the Contract Administrator that all Asbestos Workers and/or supervisor have received appropriate training and education by a Competent Worker in the hazards of asbestos exposure, good personal hygiene and work practices while working in Asbestos Work Areas, and the use, cleaning, and disposal of respirators and protective clothing.
  - .6 Submit proof satisfactory to the Contract Administrator that Asbestos Workers have completed respirator fitting and testing. Asbestos Workers must be fit tested (irritant smoke test) with respirator that is personally issued.

## **1.8 EXISTING CONDITIONS**

- .1 Notify the Contract Administrator of any Friable Material discovered during Work and not apparent from Drawings, Specifications, or reports pertaining to the Work. Do not disturb such material until instructed by the Contract Administrator.

## **1.9 SCHEDULING**

- .1 All Work will be carried out so as not to affect normal operations of the facility taking place at the time of the abatement.



## **1.10 PERSONNEL QUALIFICATIONS**

- .1 Asbestos Worker:
  - .1 Maintenance and custodial staff, and workers of all trades who may work with, or near ACMs, should hold a record of attendance for asbestos awareness training.
  - .2 All workers who work with asbestos should hold a record of attendance for training on the procedures for working with asbestos (typically of two days' duration); best practice would yield a certificate of completion that the worker can carry on their person while working at asbestos sites.
  - .3 Workers must be able to demonstrate their knowledge in each type of asbestos work procedure they will be assigned to carry out (type 1, 2 and/or 3).
  - .4 Workers should be directly supervised on all new procedures for a minimum of three days.

## **1.11 PERSONNEL TRAINING**

- .1 Before beginning Work, provide the Contract Administrator with satisfactory proof that every Asbestos Worker has had instruction and training in hazards of asbestos exposure, in personal hygiene and work practices, and in use, cleaning, and disposal of respirators and protective clothing.
- .2 Instruction and training related to respirators includes, at minimum:
  - .1 Fitting of equipment.
  - .2 Inspection and maintenance of equipment.
  - .3 Disinfecting of equipment.
  - .4 Limitations of equipment.
- .3 Instruction and training must be provided by a Competent Worker.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Drop Sheets:
  - .1 Polyethylene: 0.15 mm thick.
  - .2 Fire retardant polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.
- .2 Wetting Agent: 50 percent polyoxyethylene ester and 50 percent polyoxyethylene ether mixed with water in a concentration to provide thorough wetting of ACM.
- .3 Waste Containers: contain waste in two separate containers.
  - .1 Inner container: 0.15 mm thick sealable polyethylene waste bag.
  - .2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise outer container may be

- sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.
- .3 Labelling requirements: affix pre-printed cautionary asbestos warning in both official languages that is visible when ready for removal to disposal site.
- .4 Tape: fibreglass - reinforced duct tape suitable for sealing polyethylene under both dry conditions and wet conditions using Amended Water.
- .5 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least eight hours and designed for purpose of trapping residual asbestos fibres.
  - .1 Sealer: flame spread and smoke developed rating less than 50 and be compatible with new fireproofing.

### **Part 3 Execution**

#### **3.1 PROCEDURES**

- .1 Before beginning Work, isolate the Asbestos Work Area using, minimum, preprinted cautionary asbestos warning signs in both official languages that are visible at access routes to the Asbestos Work Area.
  - .1 Remove visible dust from surfaces in the Asbestos Work Area where dust is likely to be disturbed during course of Work.
  - .2 Use HEPA vacuum or damp cloths where damp cleaning does not create a hazard and is otherwise appropriate.
  - .3 Do not use compressed air to clean-up or remove dust from any surface.
- .2 Prevent the spread of dust from the Asbestos Work Area using measures appropriate to Work to be done.
  - .1 Use fire retardant polyethylene drop sheets over flooring such as carpeting that absorbs dust and over flooring in Asbestos Work Area where dust and contamination cannot otherwise be safely contained. Drop sheets are not to be reused.
- .3 Wet ACM to be cut, ground, abraded, scraped, drilled, or otherwise disturbed unless wetting creates hazard or causes damage.
  - .1 Use garden reservoir type low-velocity fine-mist sprayer.
  - .2 Perform Work to reduce dust creation to lowest levels practicable.
- .4 Frequently and at regular intervals during Work and immediately on completion of Work:
  - .1 Dust and waste to be cleaned up and removed using a vacuum equipped with a HEPA filter, or by damp mopping or wet sweeping, and placed in a waste container.
  - .2 Drop sheets to be wetted and placed in a waste container as soon as practicable.

- .5 Clean-up:
  - .1 Place dust and asbestos-containing waste in sealed dust-tight waste bags. Treat drop sheets and disposable protective clothing as asbestos-containing waste; wet and fold these items to contain dust, and then place in plastic bags.
  - .2 Clean exterior of each waste-filled bag using damp cloths or HEPA vacuum and place in second clean waste bag immediately prior to removal from Asbestos Work Area.
  - .3 Seal waste bags and remove from Site. Dispose of in accordance with requirements of Provincial/Territorial and Federal Authority Having Jurisdiction. Supervise dumping and ensure that dump operator is fully aware of hazardous nature of material to be dumped and that the appropriate guidelines and regulations for asbestos disposal are followed.
  - .4 Perform a final thorough clean-up of Asbestos Work Areas and adjacent areas affected by Work using HEPA vacuum.

### **3.2 ASBESTOS ABATEMENT MONITORING & INSPECTION AGENT**

- .1 Asbestos abatement work shall be subject to visual inspection and air monitoring by the Asbestos Abatement Monitoring & Inspection Agent.
- .2 Visual inspection and air monitoring will be paid via cash allowance included in the Contract. To access the cash allowance, the Contractor shall submit invoices for the Asbestos Abatement Monitoring & Inspection Agent. The invoices shall conform to C0 of the General Conditions for Construction.
- .3 The Asbestos Abatement Monitoring & Inspection Agent shall maintain a certificate of accreditation for lab analysis through Canadian Association for Laboratory Accreditation Inc. (CALA) or National Voluntary Laboratory Accreditation Program (NVLAP) and a proficiency testing accreditation.

### **3.3 AIR MONITORING**

- .1 From the beginning of asbestos abatement work until completion of cleaning operations, the Contractor shall take air samples on daily basis outside of Asbestos Work Area in accordance with Provincial/Territorial Occupational Health and Safety Regulations.
  - .1 The Contractor shall retain an Asbestos Abatement Monitoring & Inspection Agent to preform air monitoring and provide air samples.
  - .2 Asbestos Abatement Monitoring & Inspection Agent shall be responsible for monitoring inside the enclosure in accordance with applicable Provincial/Territorial Occupational Health and Safety Regulations.
  - .3 Asbestos Abatement Monitoring & Inspection Agent to measure fibre content of air outside Asbestos Work Areas by means of air samples analyzed by Phase Contrast Microscopy (PCM).
    - .1 Stop Work when PCM measurements exceed 0.05 f/cc and correct procedures.

- .4 Asbestos Abatement Monitoring & Inspection Agent shall submit daily air monitoring results and recommendations to the Contract Administrator.
- .2 Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas. The costs of clean-up of affected surrounding areas due to contamination shall be borne by the Contractor and no adjustments to the Contract Price will be permitted.
- .3 If air monitoring shows that areas outside Asbestos Work Area are contaminated, enclose, maintain, and clean these areas in same manner as that applicable to Asbestos Work Area. The costs to enclose, maintain, and clean-up these areas shall be borne by the Contractor and no adjustments to the Contract Price will be permitted.
- .4 Ensure that respiratory safety factors are not exceeded.

**END OF SECTION**

**Part 1      General**

**1.1          SUMMARY**

- .1 Both confirmed asbestos and presumed asbestos have been identified at the MacLean RPS which will or may be affected by the Work. Refer to Appendix D – Asbestos Reports for the following HMIS reports for further details:
  - .1 MacLean RPS\_2019 10 28\_HMIS Confirmed Asbestos and Presumed Asbestos Report
- .2 The Contractor is responsible for the removal and disposal of all confirmed ACMs and presumed ACMs affected by the Work.
- .3 Where penetrations through confirmed or presumed ACMs are required, the Contractor shall conduct the Work in accordance with this section.
- .4 The Contractor shall put in place a removal / disposal work plan and shall remove all confirmed and presumed ACMs to perform the Work as indicated in the Contract Documents which impact the Contractors activities, in a safe manner, as part of the required Work.
- .5 Provide training for all workers, including but not limited to:
  - .1 Asbestos Supervisor.
  - .2 Asbestos Workers.
  - .3 Asbestos Visitors.
- .6 Comply with requirements of this section when performing the following Work:
  - .1 Removing all or part of a false ceiling to obtain access to a Work area, if ACM is likely lying on the surface of the false ceiling.
  - .2 Removing more than 7.5 square metres of asbestos-containing suspended ceiling tiles, as indicated.
  - .3 Removal or disturbance of one square metre or less of friable ACM during the repair, alteration, maintenance, or demolition of all or part of machinery or equipment, or of a building.
  - .4 Enclosure of friable ACM.
  - .5 Removing Non-Friable ACMs by breaking, cutting, drilling, abrading, grinding, sanding, or vibrating if:
    - .1 The material is not wetted to control the spread of dust or fibres; and,
    - .2 The Work is done only by means of non-powered hand-held tools.
  - .6 Removing Non-Friable ACMs by breaking, cutting, drilling, abrading, grinding, sanding, or vibrating if the Work is done by means of power tools that are attached to dust-collecting devices equipped with HEPA filters.
  - .7 Removing more than one square metre of drywall in which joint-filling compounds that are ACMs have been used.

- .8 Removing of ACM from a pipe, duct, or similar structure using a Glove Bag.
- .9 Removing filters used in an air handling unit in a building that has sprayed-on asbestos-containing fireproofing.
- .7 The Contractor shall ensure that Work does not impede the ongoing operations of the facility. The facility will continue to be operated by City staff.

## 1.2 REFERENCE STANDARDS

- .1 Department of Justice Canada (Jus)
  - .1 Canadian Environmental Protection Act, 1999 (CEPA).
  - .2 SOR/2018-196 Prohibition of Asbestos and Products Containing Asbestos Regulations.
- .2 Manitoba Workplace Safety and Health Regulation, Reg 217/2006
- .3 SAFE Work Manitoba
  - .1 Guide For Asbestos Management, May 2017.
- .4 The Workplace Safety & Health Act, Manitoba, Chapter W210 C.C.S.M.
- .5 Health Canada / WHMIS
  - .1 SDS.
- .6 Transport Canada (TC)
  - .1 Transportation of Dangerous Goods Act, 1992 (TDGA).

## 1.3 DEFINITIONS

- .1 **“Amended Water”** means water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.
- .2 **“Asbestos-Containing Materials”** or **“ACMs”** has the meaning as set out in D4 of the Tender;
- .3 **“Asbestos Abatement Monitoring & Inspection Agent”** means a person qualified to provide asbestos abatement monitoring and inspection services in the jurisdiction where the services are to be provided.
- .4 **“Asbestos Supervisor”** means a Competent Worker who has charge of an Asbestos Work Area or authority over an Asbestos Worker.
- .5 **“Asbestos Work Area”** means area where Work takes place which will, or may disturb ACMs.
- .6 **“Asbestos Worker”** means a Competent Worker who is employed by an employer to perform a service that may include the disturbance or removal of ACMs.
- .7 **“Authorized Visitors”** means the Contract Administrator or designated representatives, the City, and representatives of regulatory agencies.
- .8 **“Competent Worker”** means in relation to specific Work, means a worker who:

- .1 Is qualified because of knowledge, training, and experience to perform the Work.
- .2 Is familiar with the provincial and federal laws and with the provisions of the regulations that apply to the Work.
- .3 Has knowledge of all potential or actual danger to health or safety in the Work.
- .9 **“Friable Materials”** means material that when dry can be crumbled, pulverized, or powdered by hand pressure and includes such material that is crumbled, pulverized, or powdered.
- .10 **“Glove Bag”** means prefabricated Glove Bag as follows:
  - .1 Minimum thickness 0.25 mm (10 mil) polyvinyl-chloride bag.
  - .2 Integral 0.25 mm (10 mil) thick polyvinyl-chloride gloves and elastic ports.
  - .3 Equipped with reversible double pull double throw zipper on top and at approximately mid-section of the bag.
  - .4 Straps for sealing ends around pipe.
- .11 **“HEPA”** means high efficiency particulate air.
- .12 **“HEPA vacuum”** means HEPA filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any dimension at 99.97 percent efficiency.
- .13 **“Non-Friable ACMs”** means material that when dry cannot be crumbled, pulverized, or powdered by hand pressure.
- .14 **“polyethylene”** means polyethylene sheeting or rip-proof polyethylene sheeting with tape along edges, around penetrating objects, over cuts and tears, and elsewhere as required to provide protection and isolation.
- .15 **“sprayer”** means garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for the Work.

#### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Submit removal / disposal work plan two weeks prior to the schedule removal / disposal work in accordance with this section and E2 of the Tender.
- .3 Submit proof of the Contractor's insurance in accordance with D13 of the Tender.
- .4 Submit daily air monitoring results and recommendations in accordance with this Section.

#### **1.5 QUALITY ASSURANCE**

- .1 Regulatory Requirements: comply with Federal, Provincial/Territorial and local requirements pertaining to asbestos, provided that in case of conflict among these requirements or with these Specifications, the more stringent requirement applies. Comply with regulations in effect at the time Work is performed.

- .2 Health and Safety:
  - .1 Safety Requirements: Provide all requirements for Asbestos Worker and Authorized Visitor protection.
    - .1 Protective equipment and clothing to be worn by Asbestos Workers while in Asbestos Work Area include:
      - .1 Air purifying half-mask respirator with N-100, R-100, or P-100 particulate filter, personally issued to Asbestos Worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority Having Jurisdiction. The respirator is to be fitted so that there is an effective seal between the respirator and the Asbestos Worker's face, unless the respirator is equipped with a hood or helmet. The respirator is to be cleaned, disinfected, and inspected after use on each shift, or more often if necessary, when issued for the exclusive use of one Asbestos Worker, or after each use when used by more than one Asbestos Worker. If the respirator has damaged or deteriorated parts, it is to be replaced prior to being used by an Asbestos Worker. The respirator, when not in use, is to be stored in a convenient, clean, and sanitary location. The Contractor is to establish written procedures regarding the selection, use, and care of respirators, and a copy of the procedures to be provided to and reviewed with each Asbestos Worker who is required to wear a respirator. An Asbestos Worker is not to be assigned to an operation requiring the use of a respirator unless he or she is physically able to perform the operation while using the respirator.
      - .2 Disposable type protective clothing that does not readily retain or permit penetration of asbestos fibres. Protective clothing is to be provided by the Contractor and worn by every Asbestos Worker who enters the Work area, and the protective clothing is to consist of a head covering and full body covering that fits snugly at the ankles, wrists, and neck, in order to prevent asbestos fibres from reaching the garments and skin under the protective clothing. Suitable footwear must be worn with the protective clothing. Protective clothing to be repaired or replaced if torn.
    - .2 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.
    - .3 Before leaving the Asbestos Work Area, the Asbestos Worker can decontaminate his or her protective clothing by using a vacuum equipped with a HEPA filter, or by damp wiping, before removing the protective clothing, or, if the protective clothing will not be reused, place it in a container for dust and waste. The container is to be dust tight, suitable for asbestos waste, impervious to asbestos, identified as asbestos-containing waste, cleaned with a damp cloth or a vacuum equipped with a



HEPA filter immediately before removal from the Asbestos Work Area, and removed from the Asbestos Work Area frequently and at regular intervals.

- .4 Facilities for washing hands and face shall be provided within the Asbestos Work Area.
- .5 Ensure Asbestos Workers wash hands and face when leaving Asbestos Work Area.
- .6 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects seal between respirator and face.
- .7 Authorized Visitor Protection:
  - .1 Provide protective clothing and approved respirators to Authorized Visitors to the Asbestos Work Areas.
  - .2 Instruct Authorized Visitors in the use of protective clothing, respirators, and procedures.
  - .3 Instruct Authorized Visitors in proper procedures to be followed in entering into and exiting from the Asbestos Work Areas.

## **1.6 WASTE MANAGEMENT AND DISPOSAL**

- .1 Disposal of asbestos-containing waste generated by removal activities must comply with Federal, Provincial/Territorial and Municipal regulations. Dispose of asbestos-containing waste in sealed double thickness 6 mils bags or leak proof drums. Label containers with appropriate warning labels.
- .2 Provide manifests describing and listing waste created. Transport containers by approved means to licenced landfill for burial.

## **1.7 REMOVAL / DISPOSAL WORK PLAN**

- .1 The following shall be included in the removal / disposal work plan:
  - .1 Anticipated duration for the asbestos abatement work.
  - .2 Submit proof satisfactory to the Contract Administrator that suitable arrangements have been made to dispose of asbestos-containing waste in accordance with requirements of Authority Having Jurisdiction.
  - .3 Submit Provincial/Territorial and/or local requirements for notice of project form.
  - .4 Submit to the Contract Administrator necessary permits for transportation and disposal of asbestos-containing waste and proof that asbestos-containing waste has been received and properly disposed.
  - .5 Submit proof satisfactory to the Contract Administrator that all Asbestos Workers and Asbestos Supervisor have received appropriate training and education by a Competent Worker in the hazards of asbestos exposure, good personal hygiene, entry, and exit from Asbestos Work Area, aspects of Work procedures and protective measures while working in Asbestos Work Areas, and the use, cleaning, and, disposal of respirators and protective clothing.

- .6 Submit proof to the Contract Administrator that Asbestos Supervisor have attended asbestos abatement course, of not less than two days duration. Minimum of one Asbestos Supervisor for every 10 Asbestos Workers.
- .7 Submit documentation to the Contract Administrator including test results, fire and flammability data, and SDS for chemicals or materials including:
  - .1 Encapsulants.
  - .2 Amended Water.
  - .3 Slow drying sealer.
- .8 Submit proof satisfactory to the Contract Administrator that Asbestos Workers have completed respirator fitting and testing. Asbestos Workers must be fit tested (irritant smoke test) with respirator that is personally issued.

### **1.8 EXISTING CONDITIONS**

- .1 Notify the Contract Administrator of any Friable Material discovered during Work and not apparent from Drawings, Specifications, or report pertaining to the Work. Do not disturb such material until instructed by the Contract Administrator.

### **1.9 SCHEDULING**

- .1 All Work will be carried out so as not to affect normal operations of the facility taking place at the time of the abatement.

### **1.10 PERSONNEL QUALIFICATIONS**

- .1 Asbestos Supervisor:
  - .1 Should hold a record of attendance certificate for training on asbestos work procedures.
  - .2 Must have demonstrated knowledge of the procedures for working with ACMs, at minimum, for the type of work they are supervising – types 1, 2, and/or 3.
  - .3 Must be able to evaluate worker competency.
- .2 Asbestos Worker:
  - .1 Maintenance and custodial staff, and workers of all trades who may work with, or near ACMs, should hold a record of attendance for asbestos awareness training.
  - .2 All workers who work with asbestos should hold a record of attendance for training on the procedures for working with asbestos (typically of two days' duration); best practice would yield a certificate of completion that the worker can carry on their person while working at asbestos sites.
  - .3 Workers must be able to demonstrate their knowledge in each type of asbestos work procedure they will be assigned to carry out (type 1, 2, and/or 3).
  - .4 Workers should be directly supervised on all new procedures for a minimum of three days.

## **1.11 PERSONNEL TRAINING**

- .1 Before beginning Work, provide the Contract Administrator with satisfactory proof of personnel qualifications for the Asbestos Supervisor.
- .2 Before beginning Work, provide the Contract Administrator with satisfactory proof that every Asbestos Worker has had instruction and training in hazards of asbestos exposure, in personal hygiene and work practices, in use of Glove Bag procedures, and in use, cleaning, and disposal of respirators and protective clothing.
- .3 Instruction and training related to respirators includes, at minimum:
  - .1 Fitting of equipment.
  - .2 Inspection and maintenance of equipment.
  - .3 Disinfecting of equipment.
  - .4 Limitations of equipment.
- .4 Instruction and training must be provided by a Competent Worker.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Drop and Enclosure Sheets:
  - .1 Polyethylene: 0.15 mm thick.
  - .2 Fire retardant polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.
- .2 Wetting Agent: 50 percent polyoxyethylene ester and 50 percent polyoxyethylene ether mixed with water in concentration to provide thorough wetting of ACM.
- .3 Waste containers: contain waste in two separate containers.
  - .1 Inner container: 0.15 mm thick sealable polyethylene bag or where Glove Bag method is used, Glove Bag itself.
  - .2 Outer container: sealable metal or fibre type where there are sharp objects included in waste material; otherwise outer container may be sealable metal or fibre type or second 0.15 mm thick sealable polyethylene bag.
  - .3 Labelling requirements: affix preprinted cautionary asbestos warning, in both official languages, that is visible when ready for removal to disposal site.
- .4 Glove Bag:
  - .1 Acceptable materials: safe-T-Strip products in configuration suitable for Work or approved equal in accordance with B7 of the Tender.
  - .2 The Glove Bag to be equipped with:
    - .1 Sleeves and gloves that are permanently sealed to the body of the bag to allow the Asbestos Worker to access and deal with the

- insulation and maintain a sealed enclosure throughout the Work period.
- .2 Valves or openings to allow insertion of a vacuum hose and the nozzle of a water sprayer while maintaining the seal to the pipe, duct, or similar structure.
- .3 A tool pouch with a drain.
- .4 A seamless bottom and a means of sealing off the lower portion of the Glove Bag.
- .5 A high strength double throw zipper and removable straps, if the Glove Bag is to be moved during the removal operation.
- .5 Tape: tape suitable for sealing polyethylene to surfaces under both dry and wet conditions using Amended Water.
- .6 Slow - drying sealer: non-staining, clear, water - dispersible type that remains tacky on surface for at least eight hours and designed for purpose of trapping residual asbestos fibres.
  - .1 Sealer: flame spread and smoke developed rating less than 50 and be compatible with new fireproofing.
- .7 Encapsulants: penetrating, surface film forming type conforming to CAN/CGSB-1.205.

### **Part 3 Execution**

#### **3.1 SUPERVISION**

- .1 Minimum of one Asbestos Supervisor for every 10 Asbestos Workers is required.
- .2 Approved supervisor must remain within Asbestos Work Area during disturbance, removal, or other handling of ACM.

#### **3.2 PROCEDURES**

- .1 Before beginning Work, at each access to the Asbestos Work Area, install warning signs in both official languages reading as follows, where number in parentheses indicates font size to be used: 'CAUTION ASBESTOS HAZARD AREA (25 mm) / NO UNAUTHORIZED ENTRY (19 mm) / WEAR ASSIGNED PROTECTIVE EQUIPMENT (19 mm) / BREATHING ASBESTOS DUST MAY CAUSE SERIOUS BODILY HARM (7 mm)'.
  - .2 Before beginning Work remove visible dust from surfaces in the Asbestos Work Area where dust is likely to be disturbed during course of Work.
    - .1 Use HEPA vacuum or damp cloths where damp cleaning does not create hazard and is otherwise appropriate.
    - .2 Do not use compressed air to clean up or remove dust from any surface.
- .3 Prevent spread of dust from the Asbestos Work Area using measures appropriate to the Work to be done.

- .1 Use fire retardant polyethylene drop sheets over flooring such as carpeting that absorbs dust and over flooring in Work areas where dust or contamination cannot otherwise be safely contained.
- .2 When removing ACM from piping or equipment and "Glove Bag" method is not used, removing suspended ceilings and walls themselves do not enclose Asbestos Work Area, erect enclosure of polyethylene sheeting around Asbestos Work Area Work Area, shut off mechanical ventilation system serving Work area and seal ventilation ducts to and from Asbestos Work Area.
- .4 Before removing suspended ceilings, remove Friable Material on upper surfaces using HEPA vacuum equipment.
  - .1 Remove and clean surfaces of ceiling panels using HEPA vacuum, wrap clean panels in 0.10 mm thick polyethylene, and store in building as directed by the Contract Administrator.
  - .2 Clean "T" grid suspension system, disconnect, wrap in 0.10 mm thick polyethylene, and store in building as directed by the Contract Administrator.
- .5 Remove loose material by HEPA vacuum; thoroughly wet Friable Material containing asbestos to be removed or disturbed before and during Work unless wetting creates hazard or causes damage.
  - .1 Use garden reservoir type low - velocity sprayer or airless spray equipment capable of producing mist or fine spray.
  - .2 Perform Work in a manner to reduce dust creation to lowest levels practicable.
- .6 Pipe insulation removal using Glove Bag:
  - .1 A Glove Bag is not to be used to remove insulation from a pipe, duct, or similar structure if:
    - .1 It may not be possible to maintain a proper seal for any reason including, without limitation:
      - .1 The condition of the insulation.
      - .2 The temperature of the pipe, duct, or similar structure.
    - .2 The bag could become damaged for any reason including, without limitation.
      - .1 The type of jacketing.
      - .2 The temperature of the pipe, duct, or similar structure.
  - .2 Upon installation of the Glove Bag, inspect bag for any damage or defects. If any damage or defects are found, the Glove Bag is to be repaired or replaced. The Glove Bag to be inspected at regular intervals for damage and defects, and repair or replaced, as appropriately. The asbestos-containing contents of the damaged or defective Glove Bag found during removal are to be wetted and the Glove Bag and its contents are to be removed and disposed of in an appropriate waste disposal container. Any damaged or defective Glove Bags are not to be reused.

- .3 Place tools necessary to remove insulation in tool pouch. Wrap bag around pipe and close zippers. Seal bag to pipe with cloth straps.
  - .4 Place hands in gloves and use necessary tools to remove insulation. Arrange insulation in bag to obtain full capacity of bag.
  - .5 Insert nozzle of garden reservoir type sprayer into bag through valve and wash down pipe and interior of bag thoroughly. Wet surface of insulation in lower section of bag.
  - .6 To remove bag after completion of stripping, wash top section and tools thoroughly. Remove air from top section through elasticized valve using a HEPA vacuum. Pull polyethylene waste container over Glove Bag before removing from pipe. Release one strap and remove freshly washed tools. Place tools in water. Remove second strap and zipper. Fold over into waste container and seal.
  - .7 After removal of bag ensure that pipe is free of residue. Remove residue using HEPA vacuum or wet cloths. Ensure that surfaces are free of sludge which after drying could release asbestos dust into atmosphere. Seal exposed surfaces of pipe and ends of insulation with slow drying sealer to seal in any residual fibres.
  - .8 Upon completion of Work shift, cover exposed ends of remaining pipe insulation with polyethylene taped in place.
- .7 Clean-up:
- .1 Frequently during Work and immediately after completion of Work, clean up dust and asbestos-containing waste using HEPA vacuum or by damp mopping.
  - .2 Place dust and asbestos-containing waste in sealed dust tight waste bags. Treat drop sheets and disposable protective clothing as asbestos waste and wet and fold to contain dust and then place in waste bags.
  - .3 Immediately before their removal from Asbestos Work Area and disposal, clean each filled waste bag using damp cloths or HEPA vacuum and place in second clean waste bag.
  - .4 Seal and remove double bagged waste from Site. Dispose of in accordance with requirements of Provincial/Territorial and Federal Authority Having Jurisdiction. Supervise dumping and ensure that dump operator is fully aware of hazardous nature of material to be dumped and that guidelines and regulations for asbestos disposal are followed.
  - .5 Perform a final thorough clean-up of Asbestos Work Areas and adjacent areas affected by Work using HEPA vacuum.

### **3.3 ASBESTOS ABATEMENT MONITORING & INSPECTION AGENT**

- .1 Asbestos abatement work shall be subject to visual inspection and air monitoring by the Asbestos Abatement Monitoring & Inspection Agent.
- .2 Visual inspection and air monitoring will be paid via cash allowance included in the Contract. To access the cash allowance, the Contractor shall submit invoices

for the Asbestos Abatement Monitoring & Inspection Agent. The invoices shall conform to C0 of the General Conditions for Construction.

- .3 The Asbestos Abatement Monitoring & Inspection Agent shall maintain a certificate of accreditation for lab analysis through Canadian Association for Laboratory Accreditation Inc. (CALA) or National Voluntary Laboratory Accreditation Program (NVLAP) and a proficiency testing accreditation.

### **3.4 AIR MONITORING**

- .1 From the beginning of asbestos abatement work until completion of cleaning operations, the Contractor shall take air samples on daily basis outside of Asbestos Work Area in accordance with Provincial/Territorial Occupational Health and Safety Regulations.
  - .1 The Contractor shall retain an Asbestos Abatement Monitoring & Inspection Agent to preform air monitoring and provide air samples.
  - .2 Asbestos Abatement Monitoring & Inspection Agent shall be responsible for monitoring inside the enclosure in accordance with applicable Provincial/Territorial Occupational Health and Safety Regulations.
  - .3 Asbestos Abatement Monitoring & Inspection Agent to measure fibre content of air outside Asbestos Work Areas by means of air samples analyzed by Phase Contrast Microscopy (PCM).
    - .1 Stop Work when PCM measurements exceed 0.05 f/cc and correct procedures.
  - .4 Asbestos Abatement Monitoring & Inspection Agent shall submit daily air monitoring results and recommendations to the Contract Administrator.
- .2 Work is subject to visual inspection and air monitoring. Contamination of surrounding areas indicated by visual inspection or air monitoring will require complete enclosure and clean-up of affected areas. The costs of clean-up of affected surrounding areas due to contamination shall be borne by the Contractor and no adjustments to the Contract Price will be permitted.
- .3 If air monitoring shows that areas outside Asbestos Work Area are contaminated, enclose, maintain, and clean these areas in same manner as that applicable to Asbestos Work Area. The costs to enclose, maintain, and clean-up these areas shall be borne by the Contractor and no adjustments to the Contract Price will be permitted.
- .4 Ensure that respiratory safety factors are not exceeded.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 National Research Council Canada (NRC)
  - .1 National Building Code of Canada [2015] (NBC).
- .2 Standards Council of Canada
  - .1 CAN/ULC-S115-2015 Standard Method of Fire Tests of Firestop Systems.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's printed product literature, specifications, and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3 Shop Drawings:
  - .1 Submit Shop Drawings to show location, proposed material, reinforcement, anchorage, fastenings, and method of installation.
  - .2 Construction details should accurately reflect actual job conditions.

**1.3 DELIVER, STORAGE, HANDLING, AND PROTECTION**

- .1 Packing, shipping, handling, and unloading:
  - .1 Deliver, store, and handle materials in accordance with Section 01 61 00 – Common Product Requirements.

**Part 2 Products**

**2.1 MATERIALS**

- .1 Fire stopping and smoke seal systems: in accordance with CAN-ULC-S115.
  - .1 Asbestos-free materials and systems capable of maintaining effective barrier against flame, smoke, and gases in compliance with requirements of CAN-ULC-S115 and not to exceed opening sizes for which they are intended.
- .2 Service penetration assemblies: systems tested to CAN-ULC-S115.
- .3 Service penetration fire stop components: certified by test laboratory to CAN-ULC-S115.
- .4 Fire-resistance rating of installed fire stopping assembly in accordance with NBC.
- .5 Fire stopping and smoke seals at openings intended for ease of re-entry such as cables: elastomeric seal.



- .6 Fire stopping and smoke seals at openings around penetrations for pipes, ductwork, and other mechanical items requiring sound and vibration control: elastomeric seal.
- .7 Primers: to manufacturer's recommendation for specific material, substrate, and end use.
- .8 Water (if applicable): potable, clean, and free from injurious amounts of deleterious substances.
- .9 Damming and backup materials, supports, and anchoring devices: to manufacturer's recommendations and in accordance with tested assembly being installed as acceptable to Authorities Having Jurisdiction.
- .10 Sealants for vertical joints: non-sagging.

### **Part 3 Execution**

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

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

#### **3.2 PREPARATION**

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

#### **3.3 INSTALLATION**

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

### **3.4 FIELD QUALITY CONTROL**

- .1 Inspections: notify the Contract Administrator when ready for inspection and prior to concealing or enclosing Fire Stopping Materials and service penetration assemblies.

### **3.5 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.
- .3 Remove temporary dams after initial set of fire stopping and smoke seal materials.

### **3.6 SCHEDULE**

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

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 Health Canada/ WHMIS
  - .1 SDS.
- .2 The Master Painters Institute (MPI)
  - .1 Maintenance repainting manual.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature, and data sheets for paint and coating products and include product characteristics, performance criteria, physical size, finish, and limitations.
  - .2 Submit WHMIS SDS.
- .3 Samples:
  - .1 Submit for review and acceptance of each unit.
  - .2 Samples will be returned for inclusion into Work.
  - .3 Submit sample panels for specified paint or coating in colours, gloss/sheen, and textures required to MPI painting specification manual standards.

**1.3 DELIVERY, STORAGE, HANDLING, AND PROTECTION**

- .1 Deliver, store, and handle materials in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Storage and Handling Requirements:
  - .1 Provide and maintain dry, temperature controlled, secure storage.
  - .2 Store painting materials and supplies away from heat generating devices.
  - .3 Store materials and equipment in well ventilated area within temperature as recommended by manufacturer.
- .3 Fire Safety Requirements:
  - .1 Supply one 9 kg dry chemical Type ABC fire extinguisher adjacent to storage area.
  - .2 Store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC approved, sealed containers, and remove from Site on a daily basis.
  - .3 Handle, store, use, and dispose of flammable and combustible materials in accordance with National Fire Code of Canada requirements.

## **1.4 SITE CONDITIONS**

- .1 Heating, Ventilation, and Lighting:
  - .1 Ventilate enclosed spaces.
  - .2 Co-ordinate use of existing ventilation system and ensure its operation during and after application of paint as required.
  - .3 Provide minimum lighting level of 323 Lux on surfaces to be painted.
- .2 Temperature, Humidity, and Substrate Moisture Content Levels:
  - .1 Apply paint finishes when ambient air and substrate temperatures at location of installation can be satisfactorily maintained during application and drying process, within MPI and paint manufacturer's prescribed limits.
  - .2 Test concrete, masonry, and plaster surfaces for alkalinity as required.
  - .3 Apply paint to adequately prepared surfaces, when moisture content is below paint manufacturer's prescribed limits.
- .3 Additional application requirements:
  - .1 Apply paint finish in areas where dust is no longer being generated by related construction operations or when wind or ventilation conditions are such that airborne particles will not affect quality of finished surface.
  - .2 Apply paint in occupied facilities during time of application subject to the Contract Administrator approval. Schedule operations to approval of the Contract Administrator such that painted surfaces will have dried and cured sufficiently before occupants are affected.

## **Part 2 Products**

### **2.1 MATERIALS**

- .1 Supply paint materials for paint systems from single manufacturer.
- .2 Conform to latest MPI requirements for painting work including preparation and priming.
- .3 Materials in accordance with MPI "Approved Product" listing.
- .4 Colours:
  - .1 Submit proposed colour schedule to the Contract Administrator for review.
- .5 Mixing and tinting:
  - .1 Perform colour tinting operations prior to delivery of paint to Site, in accordance with manufacturer's written recommendations.
  - .2 Use and add thinner in accordance with paint manufacturer's recommendations.
    - .1 Do not use kerosene or similar organic solvents to thin water-based paints.
  - .3 Thin paint for spraying in accordance with paint manufacturer's written recommendations.

- .4 Re-mix paint in containers prior to and during application to ensure break-up of lumps, complete dispersion of settled pigment, and colour and gloss uniformity.
- .6 Gloss/sheen ratings:
  - .1 Paint gloss is defined as sheen rating of applied paint, in accordance with following values:

Gloss Level-Category	Gloss @ 60 degrees	Sheen @ 85 degrees
Gloss Level 1 - Matte Finish	Max. 5	Max. 10
Gloss Level 2 - Velvet	Max.10	10 to 35
Gloss Level 3 - Eggshell	10 to 25	10 to 35
Gloss Level 4 - Satin	20 to 35	min. 35
Gloss Level 5 - Semi-Gloss	35 to 70	
Gloss Level 6 - Gloss	70 to 85	
Gloss Level 7 - High Gloss	More than 85	

- .2 Gloss level ratings of painted surfaces as noted on finish schedule.
- .7 Interior painting:
  - .1 Structural Steel and Metal Fabrications: columns, beams, joists, and miscellaneous metal.
    - .1 INT 5.1E Alkyd, finish to match existing.
  - .2 Galvanized Metal: high contact/high traffic areas (doors, frames, railings and handrails, etc.).
    - .1 INT 5.3C – Alkyd, finish to match existing (over cementitious primer).
- .8 Interior re-painting:
  - .1 Structural Steel and Metal Fabrications: columns, beams, joists, and miscellaneous metal.
    - .1 RIN 5.1E – Alkyd, finish to match existing.
  - .2 Galvanized Metal: high contact/high traffic areas (doors, frames, railings and handrails, etc.).
    - .1 RIN 5.3C – Alkyd, finish to match existing.

**Part 3 Execution**

**3.1 GENERAL**

- .1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and data sheets.
- .2 Perform preparation and operations for interior painting in accordance with MPI except where specified otherwise.
- .3 Paint all surfaces which are affected by the Work. Paint to match existing finishes.

### **3.2 EXAMINATION**

- .1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to the Contract Administrator any damages, defects, unsatisfactory, or unfavourable conditions before proceeding with Work.

### **3.3 PREPARATION**

- .1 Protection of in-place conditions:
  - .1 Protect existing building surfaces and adjacent structures from paint spatters, markings, and other damage by suitable non-staining covers or masking. If damaged, clean and restore surfaces as directed by the Contract Administrator.
  - .2 Protect items that are permanently attached such as fire labels on doors and frames and name plates on equipment.
  - .3 Protect factory finished products and equipment.
- .2 Surface Preparation:
  - .1 Remove electrical cover plates, light fixtures, surface hardware on doors, bath accessories, and other surface mounted equipment, fittings, and fastenings prior to undertaking painting operations. Identify and store items in secure location and re-install after painting is completed.
  - .2 Move and cover furniture and portable equipment as necessary to carry out painting operations. Replace as painting operations progress.
  - .3 Place "WET PAINT" signs in occupied areas as painting operations progress.
  - .4 Clean and prepare surfaces in accordance with MPI specific requirements and coating manufacturer's recommendations.
  - .5 Prevent contamination of cleaned surfaces by salts, acids, alkalis, other corrosive chemicals, grease, oil, and solvents before prime coat is applied and between applications of remaining coats. Apply primer, paint, or pre-treatment as soon as possible after cleaning and before deterioration occurs.
  - .6 Where possible, prime non-exposed surfaces of new wood surfaces before installation. Use same primers as specified for exposed surfaces.
    - .1 Apply vinyl sealer to MPI #36 over knots, pitch, sap, and resinous areas.
    - .2 Apply wood filler to nail holes and cracks.
    - .3 Tint filler to match stains for stained woodwork.
  - .7 Sand and dust between coats as required to provide adequate adhesion for next coat and to remove defects visible from a distance up to 1,000 mm.
  - .8 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt, oil, grease, and other foreign substances in accordance with MPI requirements.
  - .9 Touch up of shop primers with primer as specified.

### **3.4 APPLICATION**

- .1 Paint only after prepared surfaces have been accepted by the Contract Administrator.
- .2 Use method of application approved by the Contract Administrator.
  - .1 Conform to manufacturer's application recommendations.
- .3 Apply coats of paint in continuous film of uniform thickness.
  - .1 Repaint thin spots or bare areas before next coat of paint is applied.
- .4 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.
- .5 Sand and dust between coats to remove visible defects.
- .6 Finish surfaces both above and below sight lines as specified for surrounding surfaces.
- .7 Finish top, bottom, edges, and cutouts of doors after fitting as specified for door surfaces.
- .8 Mechanical / Electrical Equipment:
  - .1 Paint piping, hangers, ductwork, and other mechanical and electrical equipment exposed in finished areas, to match adjacent surfaces, except as indicated.
  - .2 Do not paint over nameplates.
  - .3 Keep sprinkler heads free of paint.
  - .4 Paint both sides and edges of backboards for telephone and electrical equipment before installation.
    - .1 Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories, and other unfinished items.

### **3.5 CLEANING**

- .1 Progress Cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.
- .3 Remove over-spray, paint splatter, and spills from exposed surfaces that were not intended for painting. Remove smears and splatter immediately as operations progress, using appropriate methods as per manufacturer's instructions.
- .4 Place paint, stains, primer defined as hazardous or toxic waste, including tubes and containers, in containers or areas designated for hazardous waste.

**END OF SECTION**

**Part 1        General**

**1.1            SECTION INCLUDES**

- .1        Materials and installation for electric valve actuators, and gearboxes.

**1.2            REFERENCE STANDARDS**

- .1        Canadian Standards Association (CSA International):
  - .1        CSA C22.2 "General Requirements Canadian Electrical Code Part II"
  - .2        AWWA Standard C540, "Power-Actuating Devices for Valves and Sluice Gates"

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Data to indicate system components, system control, mounting method, source of power, and special attachments.

**1.4            Description**

- .1        This specification shall cover the design and manufacture of electric actuators for existing butterfly valves that located in MacLean Reservoir Valve House or associated with the MacLean Reservoir. This specification is supplementary to and shall be read together with the latest revision of AWWA Standard C540, "Power-Actuating Devices for Valves and Sluice Gates".
- .2        All electric actuators to be supplied under this Contract shall be designed and manufactured by a company having at least five (5) years prior experience in manufacturing these types of products in the size and to the operating ratings as those specified in the Tender.
- .3        All technologies and devices used in the actuator shall have a minimum of five (5) years of commercial operating experience for that specific manufacturer. This is to include torque and position sensing, lubrication, and electrical compartment design.

**Part 2        Products**

**2.1            Acceptable Products**

- .1        Electric Valve Actuators shall be:
  - .1        Solid State Type - Rotork IQ Range or approved equal in accordance with B7 of the Tender.
- .2        Quarter Turn Gearbox shall be:



- .1 Rotork IW Range, or approved equal in accordance with B7 of the Tender.

## 2.2 Design Requirements

### .1 Design Parameters

- .1 Opening: Quarter Turn, Counter clockwise to open.
- .2 Service Condition: On/Off Service.
- .3 Service Temperature: -40°C to +70°C (-22°F to +158°F) Signal lights: solid state, for 'Fault'.
- .4 Opening/ Closing Time: 5 minutes
- .5 Power Supply: 600 V/3 ph/60 Hz
- .6 Actuator Mounting: Remote floor stand

### .2 Actuator Sizing

- .1 The electric actuators shall be sized to provide the torque required to close or open the valve for full bi-directional flow at a differential pressure equal to the AWWA numerical class designation of the valve. The maximum thrust output of the actuator shall not exceed the valve shaft torque capability as indicated in the latest revision of AWWA Standard C504. Refer to drawings for valve size. Contractor responsible for confirming actual valve size with drawings.

### .3 Mounting

- .1 Electric actuator shall be designed and constructed for remote mounting on a floor stand, coupled to quarter turn gear actuator with a connection shaft. Connection shafts shall be type 304 stainless steel. Floor stands shall be designed and constructed such that the centre of the handwheel is 900 millimetres above the operating floor. The length of the extension shafts shall be confirmed by field measurement prior to manufacture. Approximate length of shaft shall be based on distance of 3.3 metres from center line ¼ turn gear box to operating floor.
- .2 Connection shaft shall be designed to accommodate actuator torque for the length of connection shaft required.
  - .1 Accommodate any intermediate support bearing with any additional supports required for full stable working system.

### .4 Motor

- .1 Motors shall be CSA approved, of the totally-enclosed, reversing, squirrel cage induction type with Class 'F' insulated windings and suitable for operation at 10% above and below normal specified power supply. Motor duty rating shall be sufficient for one complete operating cycle (open-close-open) without exceeding its temperature rating. Motor bearings shall be amply proportioned of the anti-friction type and permanently lubricated.
- .2 The motor shall be of a design that allows for electrical and mechanical disconnection without disturbing the gear case or valve position. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gear case. Plugs and

- sockets shall not be acceptable as a means of electrical connection for the motor.
- .3 The actuator shall include circuitry to ensure the motor runs with the correct rotation for the required direction of operation with either phase sequence of the 3-phase power supply.
- .5 Motor Protection
- .1 Protection shall be provided for the motor as follows:
- .1 The motor shall be de-energized in the event of a stall, when attempting to unseat a jammed valve.
- .2 Motor temperature shall be sensed by a thermostat to protect against overheating.
- .3 Single phasing protection for 3 phase motors only.
- .4 Instantaneous reversal protection whereby an automatic time delay circuit limits the current surges when the actuator is signalled to instantaneously reverse direction – for solid state type actuators only.
- .6 Integral Starter and Transformer
- .1 The reversing starter, control transformer, and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation built-up. For ON/Off service, the starter shall be a solid-state type suitable for sixty (60) starts per hour, and of rating appropriate to motor size. The controls supply transformer shall be fed from two (2) of the incoming three (3) phases. It shall have the necessary tapings and be adequately rated to provide power for the following functions:
- .1 120V AC energization of the contactor coils;
- .2 24V DC output where required for remote controls; and
- .3 Supply for all the internal electrical circuits.
- .2 The primary and secondary windings shall be protected by easily replaceable fuses.
- .3 The reversing motor controller shall consist of separate contactors for controlling valve movement in either the opening or closing direction. Each contactor shall be either magnetic or solid state, full voltage across-the-line type, sized to suit the motor power rating. The contactors shall be of robust construction with double break contacts, requiring a minimum of maintenance and being easily replaceable. Mechanical and electrical interlocks shall be provided.
- .7 Gearing
- .1 The actuator gearing shall be totally encased in an oil filled or sealed gear case complete with fill and drain taps, suitable for operation at any angle. All gearing shall be of hardened steel alloy and alloy bronze construction with machine cut teeth. Thrust bearings of the ball or roller type shall be provided at the base of the operator. The gear case shall be designed to be opened for inspection or repair without releasing the stem thrust or taking the valve out of service.
- .8 Manual Operation

- .1 Motorized actuators shall be provided with a handwheel, which shall not rotate during motor operation. The handwheel shall be made of cast iron or aluminum with the word "OPEN" and a directional arrow cast in relief on the rim. Spinners shall be provided on the handwheels. The handwheel operation shall be accomplished by a declutch lever, capable of lockout by padlock. The handwheel shall disengage automatically from the operating mechanism once the motor is capable of operation. The handwheel shall be located sufficiently away from the valve flanges, housings, etc. such that personnel will not hit their knuckles on any of these obstructions when using the handwheel.
  - .2 The handwheel shall be positioned on the operating floor as indicated 2.2.8.1.
  - .3 The handwheel shall be sized to allow one-man operation with a maximum rim pull of 356 Newtons (80pounds) at maximum torque conditions.
  - .4 Clockwise operation of the handwheel shall give closing movement of the valve unless otherwise stated in this specification.
- .9 Drive Bushing
- .1 The actuator shall be furnished with an easily detachable drive bushing for machining to suit the valve stem or gearbox input shaft. The drive bushing shall be positioned in the base of the actuator to facilitate the valve stem extensions.
  - .2 Thrust bearings, when housed in a separate thrust base, should be of the sealed-for-life type.
- .10 Turns Limit and Torque Limit Switches for Solid State Type
- .1 Torque and turns limitation to be adjustable as follows:
    - .1 Position setting range: 2.5 to 100,000 turns, with resolution to 15° of actuator output.
    - .2 Torque setting: 40% to 100% rated torque.
    - .3 Torque sensing shall be by purely electrically or electronically methods. Extrapolation of torque from mechanically measured motor speed will not be acceptable due to response time.
    - .4 "Latching" shall be provided for the torque sensing system to inhibit torque off during unseating or during starting in mid-travel against high inertia loads.
- .11 Remote Valve Position Indication
- .1 Four contacts shall be provided to indicate open position, close position, remote selected, and thermostat tripped.
  - .2 Contacts to be rated at 5A, 250 VAC, 30V DC.
- .12 Local Position Indication
- .1 The actuator shall incorporate an illuminated, mechanical dial indicator or digital readout to show continuous movement from fully open to fully closed in 1% increments. The digital display shall be maintained even when the power to the actuator is isolated.

- .2 The local display shall be large enough to be viewed from a distance of 1.83 metres (6 feet) when the actuator is powered up.
- .13 Push Button and Selector Switch
  - .1 Each actuator shall be complete with a local Open-Stop-Close push-button station with external Red-Open, Green-Closed indicating lights and a Local-Off-Remote selector switch padlockable in any one of the following three positions:
    - .1 Local Control Only
    - .2 Off (No Electrical Operation)
    - .3 Remote Control
  - .2 It shall be possible to select maintained or non-maintained local control.
  - .3 The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.
- .14 Controls
  - .1 The internal control and monitoring circuits shall operate at nominal 24 VDC or 120 VAC. Customer control interface shall operate at 120 VAC. All necessary transformers shall be provided.
  - .2 The necessary wiring and terminals shall be provided in the actuator for the following control functions:
  - .3 Removable links for substitution by external interlocks to inhibit valve opening and/or closing.
  - .4 Control Method:
    - .1 Open and Close maintained contact closure.
  - .5 Selection of maintained or push-to-run control for modes 2.2.14.1 and 2.2.14.2 above shall be provided by links.
  - .6 The internal circuits associated with the control and monitoring functions shall be designed to withstand simulated lightning impulses of up to 1 kilovolt.
- .15 Monitoring Facilities
  - .1 Facilities shall be provided for monitoring actuator operation and availability as follows:
    - .1 Motor (availability) relay, having one normally open contact, the relay being energized from the control transformer only when the Local/Off/Remote selector switch is in the remote position to indicate that the actuator is available for remote (control room) operation.
    - .2 Where required, it shall be possible to provide indication of thermostat trip and "Remote" selected as discrete signals.
  - .2 Solid State type only:
    - .1 Provision shall be made for the addition of diagnostic module which will store and enable download of historical actuator data to permit analysis of changes in actuator or valve performance.
    - .2 Diagnostic status screens shall be provided to show multiple functions simultaneously so troubleshooting can be affected rapidly and efficiently. All diagnostic information shall be

contained on no more than seven or eight (7 or 8) screens so multiple functions can be checked simultaneously.

- .3 One (1) copy of the actuator diagnostic/programming software, in a Microsoft Windows base portable computer format, shall be included with The actuator diagnostic/programming software shall be supplied with one data communications cable for connection between the portable computer and the electric actuator.

#### .16 Wiring and Terminals

- .1 Internal wiring shall be of CSA approved insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end. Permanent heat shrunk labelling shall be used.
- .2 The terminals shall be embedded in terminal block of high tracking-resistance compound.
- .3 The terminal compartment shall be separated from the inner electrical components of the actuator by means of a watertight 'O' ring seal.
- .4 The terminal compartment of the actuator shall be provided with a minimum of two (2) threaded cable entries.
- .5 All wiring supplied as part of the actuator shall be contained within the main enclosure for physical and environmental protection. External conduit connections between components will not be acceptable.
- .6 Control logic circuit boards and relay boards shall be mounted on plastic mounts to comply with double insulated standards. No more than a single primary size fuse shall be provided to minimize the need to remove single covers for replacement.
- .7 A durable terminal identification card showing plan of terminals shall be attached to the inside of the terminal box cover indicating:
  - .1 Serial number
  - .2 External voltage values
  - .3 Wiring diagram number
  - .4 Terminal layout
- .8 The identification card shall be suitable to inscribe cable core identification alongside terminal numbers.

#### .17 Enclosure

- .1 Actuators shall be O-ring sealed, watertight to NEMA 6/IP68 as well as have an inner watertight and dustproof O-ring seal between the terminal compartment and the internal electrical elements of the actuator, fully protecting the switch mechanism, motor and all other internal electrical elements of the actuator from ingress of moisture and dust when the terminal cover is removed on site for cabling.
- .2 Actuators shall be provided with an internal motor and compartment heater.
- .3 All external fasteners shall be of stainless steel.

### **2.3 Quarter Turn Gearbox**

- .1 Quarter turn, geared actuators shall be of worm gear drive type.

- .2 Gearing and Enclosure
  - .1 Actuators shall be geared with a ball bearing mounted worm gear drive, machine cut gear teeth, and be totally enclosed in a sealed housing sufficient to permit normal operation even when totally submerged in water. Travelling nut type of mechanisms will not be accepted. Gear lubricant shall be of the bulk grease type; synthetic lubricants will not be accepted.
  - .2 Number of actuator turns to open or close the valve shall be kept to as few as possible to avoid over torqueing and damage to the actuator.
  - .3 Submersible rating shall be adequate for 7.5 metres water submergence for forty-eight hours.
  - .4 Accessible parts of the actuator requiring lubrication shall be provided with button-head alemite grease fittings.
- .3 Input Limit Stops
  - .1 Adjustable, external stop-limiting devices shall be provided on the actuators to prevent over-travel of the valve disc in the open and closed position.
  - .2 Under circumstances where spur gear attachments are installed on the input side of the actuator to facilitate the maximum input operating torque of 110 Newtons meters (80 ft. pounds), input limit stops shall be installed on the input side of the spur gear attachment.
  - .3 A shear pin or other torque regulating device shall be provided on the actuator or handwheel/operating nut as an extra precaution against actuators being over-torqued.
- .4 Valve Position Indicator
  - .1 A mechanical, valve position indicator shall be provided and mounted on the outside of each valve actuator. The dial or scale plate shall be 316 stainless steel and shall be clearly graduated and marked. A 316 stainless steel pointer shall be aligned to show the exact position of the valve disc in the valve body. The fastener for the indicator dial shall be made of 316SS stainless steel.
  - .2 There shall also be a visible indication on the valve shaft end showing the position of the valve disc in relation to the shaft to ensure proper relation of the disc and indicating mechanism in the event an actuator has to be removed and replaced on a valve.
- .5 Protective Coatings
  - .1 In accordance with AWWA C540.

### **Part 3 Execution**

#### **3.1 General**

- .1 Coordinate the orientation of each actuator and handwheel with the Contract Administrator and the City prior to ordering.

### **3.2 Demolition and Pre-Installation**

- .1 Coordinate the timing of the Work with the Contract Administrator and the City as directed in Part E.
- .2 Prior to demolition of the existing actuators confirm the following:
  - .1 full movement of the valve in both directions from fully open to fully closed; and
  - .2 move the valve to the closed position and confirm the valve's ability to seal against flow with the Contract Administrator and the City.

### **3.3 Installation**

- .1 The installation and successful operation of each actuator and valve assembly shall be completed as directed in Part E.
- .2 Installation of actuators shall be in accordance with the manufacturer's installation instructions and under the supervision and direction of the manufacturer's representative.
- .3 The actuator and each element of the valve must be accurately aligned so that after fastening in place there shall be no binding or excessive pressure or wear in any moving part and no distortion of any member.
- .4 Field terminate all electrical and control wiring in accordance with the loop drawings and manufacturer's requirements.
- .5 Test all electrical and control wiring prior in accordance with Division 26 and Division 29 requirements prior to operation and field testing of the valve and actuator assembly.

### **3.4 Start Up Kit**

- .1 Each actuator shall be supplied with a start-up kit comprising installation instruction, electrical wiring diagram, and sufficient spare cover screws and seals to make good any Site losses during the commissioning period.

### **3.5 Protective Coatings**

- .1 All external ferrous components including floor stands, adaptors and mounting plates, shall be painted with two coats of polyamide epoxy paint, Amerlock 400 or approved equal in accordance to B7 of the Tender.
- .2 Any touch-up paintwork required during installation shall be undertaken by the Installation Contractor. The touch-up paint shall be of the same colour and specifications used in the above clauses and shall be supplied by the Contractor. The Contractor shall provide a minimum of one (1) additional litre of paint product after the completion of the Work.

### **3.6 Factory Testing**

- .1 Each electric motorized actuator shall be performance tested by the manufacturer at their facilities prior to shipping. The test shall simulate a typical

valve torque load from full-open to full-close and full-close to full-open. The following information shall be recorded:

- .1 Torque at Maximum Torque Setting;
  - .2 Current at Maximum Torque Setting;
  - .3 Test Voltage and Frequency;
  - .4 Flash Test Voltage;
  - .5 Actuator Output Speed and Operating Time for Full-Open to Full-Close; and
  - .6 Amperage draw on motors at breakaway and normal operation.
- .2 Copies of the test reports for the above performance tests signed by the official who is responsible for the actuator assembly and testing.
  - .3 Test reports shall be forwarded to the Contract Administrator as soon as completed.
  - .4 In addition, the test reports shall include details of specification such as gear ratios for both manual and automatic drive, closing direction, wiring diagram code number, etc.
  - .5 Electric actuators shall be tested in accordance with the latest revision of AWWA Standard C540.
  - .6 In addition to factory inspections and tests, the Contractor shall provide copies of the following test reports prior to delivery of the actuators:
    - .1 proof-of-design test as per AWWA C540, and
    - .2 performance tests.

### **3.7 Field Testing**

- .1 Quality Control Tests
  - .1 The valve and actuator assembly shall be operated and tested by the Contractor with representatives of the manufacturer, the Contract Administrator, and the City present to verify the systems have been properly installed and meet the requirements of the specification.
  - .2 After all position and torque limit switches have been set, actuate the valve not less than three times from fully open to fully closed using the electric actuator. Measure and record the operating current each time the valve actuators open and closed.
  - .3 Also actuate the valve 15 degrees in both directions using the manual handwheel.
  - .4 After completion of the above tests the valve shall be fully closed and verified with the Contract Administrator and the City the sealing of the valve is acceptable relative to the preinstallation condition.
  - .5 The Contractor shall prepare a quality control field test report indicating the test date, personnel present, number of times the assembly was operated, measured operating current and written verification from the actuator manufacturer's representative the actuator has been properly installed and adjusted and successfully installed.



- .2 Quality Assurance Tests
  - .1 Coordinate the timing of the Quality Assurance Tests with the Contract Administrator and the City.
  - .2 The valve and actuator assembly must be operated and tested by the Contractor with representatives of the manufacturer, the Contract Administrator, and the City present to verify the system after the system has been in operation a minimum of 14 Calendar Days after receipt of the Quality Control Field Test Report.
  - .3 Repeat the tests performed during the Quality Control Tests.
  - .4 Any deficiencies disclosed as a result of the installation shall be remediated by the Contractor at no additional cost to the City, and tests reconducted.

### **3.8 Maintenance**

- .1 After completion of the installation, the Contractor must maintain the assembly and keep them ready for operation at any time until the Work achieves Substantial Performance.
- .2 Contractor responsible for providing Inspection, Operation and Maintenance plan (IOM) including all commissioned actuator parameters (e.g. number of turns from fully closed to fully open and the direction of rotation to open, etc.).

### **3.9 Identification**

- .1 Provide the following information on the actuator assemblies lamacoid:
  - .1 actuator and valve tags;
  - .2 valve size;
  - .3 power information;
  - .4 direction of rotation to open; and
  - .5 number of turns to move from fully closed to fully open.
- .2 Locate lamacoid as to be visible when manually operating the handwheel.

**END OF SECTION**

**Part 1        General**

**1.1            SECTION INCLUDES**

- .1        General requirements that are common to Specification sections found in Division 26 - Electrical. This section supplements requirements of Division 1 - General Requirement, and Specifications of the Tender.

**1.2            RELATED SECTIONS**

- .1        Division 1 - General Requirements.
- .2        Division 26 - Electrical.

**1.3            REFERENCE STANDARDS**

- .1        CSA Group
  - .1        CSA C22.1, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.
  - .2        CSA C22.2.
  - .3        CAN/CSA-C22.3 No.1, Overhead Systems.
  - .4        CAN3-C235, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .1        Institute of Electrical and Electronics (IEEE)/National Electrical Safety Code Product Line (NESC).
  - .1        IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms, 7th Edition.
- .2        Electrical and Electronic Manufacturer's Association of Canada (EEMAC)
  - .1        EEMAC 2Y-1, Light Gray Colour for Indoor Switch Gear.
- .3        Health Canada / WHMIS
  - .1        SDS.
- .4        City of Winnipeg Water and Waste Department Drawing Standard.  
<https://winnipeg.ca/waterandwaste/pdfs/dept/CAD-GIS-Specifications.pdf>
- .5        City of Winnipeg Water and Waste Department Electrical Identification Standard.  
<https://winnipeg.ca/waterandwaste/pdfs/dept/IdentificationStandard.pdf>
- .6        City of Winnipeg Water and Waste Department Electrical Design Guide.  
<https://winnipeg.ca/waterandwaste/pdfs/dept/ElectricalDesignGuide.pdf>
- .7        Comply with all laws, ordinances, rules, regulations, codes, and orders of all Authorities Having Jurisdiction relating to this Work.

#### **1.4 DRAWINGS AND SPECIFICATIONS**

- .1 The intent of the Drawings and Specifications is to include all labour, products, and services necessary for the completion and testing of the Work, and to render the system ready for operation.
- .2 All materials, equipment, labour, and work denoted on the Drawings is to be considered as new work, to be provided by the Contractor unless specifically noted otherwise. Some of the electrical and automation Drawings show existing systems (with modifications to these systems). These Drawings specifically indicated that there are existing systems shown. Where Drawings do not specifically indicate that existing systems are depicted, the Contractor shall assume that the materials, equipment, labour, and work indicated will form part of their scope, and the Contractor shall include all costs (including materials, labour, etc.) to perform the Work.
- .3 Prior to installing power and control cabling for equipment, review the equipment Shop Drawings and ensure that cabling requirements are understood. There may be variations in wiring requirements with equipment that may require alternate wiring requirements from that shown on the Drawings. This shall result in no additional cost to the Contract.
- .4 The intent of the Drawings and Specifications is to indicate labour, products, and services necessary for a complete, installed, tested, commissioned, and functional installation.
- .5 The Drawings, in some cases indicate the size of cables, breakers, conduits, etc. These sizes are based on the supply of specific sizes of equipment. For cases where the Contractor supplies equipment that varies from these assumptions it is the responsibility of the Contractor to provide the correct size of breaker, cable, etc. to suit the installation, at no additional cost to the Contract.
- .6 The Drawings in some cases, may indicate approximate route to be followed by conduits, cable tray, and cables and general location of electrical equipment. They do not show all structural, architectural, and mechanical details. In some cases conduit, cable tray, or wiring is only shown diagrammatically on the Drawings. The details on exact cable, cable tray, or conduit routing and exact equipment installation location is to be determined on Site and coordinated with all other Subcontractors.
- .7 Where circuit numbers are shown adjacent to equipment, provide all wiring, conduit, supports, and any other requirements to provide power to that piece of equipment from the circuit indicated. Where circuit numbers are not shown refer to the single line Drawings for connections details. Provide all wiring, conduit, cable tray, supports, and any other requirements to provide power to that piece of equipment.
- .8 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Work.
- .9 To provide sufficient detail and maximum degree of clarity on the Drawings, symbols used for various electrical devices, particularly wall mounted devices, take up more space on the Drawings than devices physically do. Locate devices

with primary regard for convenience of operation, accessibility and space utilization, rather than locating devices to comply with the exact scaled locations of the electrical symbols.

- .10 Where systems are shown as being removed or demolished, this means all associated systems back to the source power supply. For example – removal of light fixtures means complete removal of all wiring, conduit, and controls back to source power supply. Rewire and reconnect any systems to remain that are adversely affected by the demolition work. Site trace and site confirm wiring and circuits prior to removals.
- .11 All new systems shall have new wiring and new conduit. Do not re-use existing conduit unless specifically indicated as acceptable. Provide new wiring and new conduit systems for all new devices.
- .12 All equipment shall be installed and oriented in a manner such that maintenance can be performed on the equipment. Do not block components that are meant to be replaced or maintained.

## **1.5 DEFINITIONS**

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these Specifications and on Drawings are those defined by IEEE SP1122.

## **1.6 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
  - .1 Submit manufacturer's instructions, printed product literature, and data sheets.
  - .2 Certificates:
    - .1 Provide CSA certified equipment and Material.
    - .2 Submit test results of installed electrical systems and instrumentation.
    - .3 Submit certificate of acceptance from Authority Having Jurisdiction upon completion of Work to Contract Administrator.
- .3 Shop Drawings:
  - .1 Submit installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure co-ordinated installation.
  - .2 Indicate on Drawings clearances for operation, maintenance, and replacement of operating equipment devices.
- .4 Manufacturer's field reports:
  - .1 Submit manufacturer's written report.
- .5 Nameplates and Labels:

- .1 The Contract Administrator will provide an overall lamacoid list indicating equipment that requires labels as well as a draft loop tag number. This list is for reference only and the Contractor shall submit lamacoid labels to the Contract Administrator for review.

## **1.7 QUALITY ASSURANCE**

- .1 Qualifications: electrical Work to be carried out by qualified, licensed electricians who hold valid Master Electrical Contractor license or apprentices in accordance with Authorities Having Jurisdiction as per the conditions of Provincial Act respecting manpower vocational training and qualification.
  - .1 Employees registered in provincial apprentices' program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.
  - .2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

## **1.8 CLOSEOUT SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures and Section and 01 78 00 – Closeout Submittals.
- .2 O&M Manuals:
  - .1 Provide for each system and principal item of equipment as specified in technical sections for use by operation and maintenance personnel.
  - .2 Operating instructions to include the following:
    - .1 Control sequence for each principal system and item of equipment.
    - .2 Start up, proper adjustment, operating, lubrication, and shutdown procedures.
    - .3 Safety precautions.
    - .4 Procedures to be followed in event of equipment failure.
    - .5 Other items of instruction as recommended by manufacturer of each system or item of equipment.
  - .3 Post instructions where directed.

## **1.9 SYSTEM START-UP**

- .1 System start-up to be performed in accordance with E14 of the Tender.

## **1.10 PERMITS, FEES, AND INSPECTION**

- .1 Submit to the Electrical Inspection Department and Supply Authority the necessary number of Drawings and Specifications for examination and approval prior to commencement of Work.
- .2 Acquire permits and pay associated fees in accordance with Part C - General Conditions of the Tender.

- .1 The Contractor to obtain all permits for each Site.
- .3 Provide Drawings and Specifications required by the Electrical Inspection Department and Supply Authority at no cost.
- .4 Notify the Contract Administrator of changes required by the Electrical Inspection Department prior to making changes.
- .5 Furnish certificates of acceptance from Authorities Having Jurisdiction on completion of Work to the Contract Administrator.

## **1.11 SITE AREA CLASSIFICATIONS**

- .1 Classification of Pumping Station Areas:
  - .1 Valve House: Category 2 (NEMA 4X equipment rating required) corrosive environment containing various chlorine compounds (e.g. chlorides, chloramines, etc.).
  - .2 Below Grade Exterior Valve Chambers: IP68 equipment required.
  - .3 Control Room: Ordinary (NEMA 1 equipment rating required).
  - .4 Electrical Room: Ordinary (NEMA 1 equipment rating required).
  - .5 Pump Floor: Ordinary (NEMA 12 equipment rating required).
  - .6 Basement or Crawl Space: Ordinary (NEMA 12 equipment rating required).
  - .7 Chlorine Room: Category 2 (NEMA 4X equipment rating required).

## **Part 2 Products**

### **2.1 DESIGN REQUIREMENTS**

- .1 Operating voltages: to CAN3-C235.
- .2 Motors, electric heating, control, and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
  - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .3 Language operating requirements: provide identification nameplates for control items in English only.

### **2.2 MATERIALS AND EQUIPMENT**

- .1 Provide Material and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Material and equipment to be CSA certified. Where CSA certified Material and equipment are not available, obtain special approval from Authority Having Jurisdiction before delivery to Site and submit for special approval before delivery to Site.
- .3 Material and equipment shall be new and free from all defects.

- .4 Factory assemble control panels and component assemblies.
  - .1 Verify spacing requirements onsite prior to purchasing equipment.

**2.3 ELECTRIC MOTORS, EQUIPMENT, AND CONTROLS**

- .1 Verify installation and coordination responsibilities related to motors, equipment and controls, as indicated.
- .2 Control wiring and conduit: in accordance with Division 29 – Instrumentation and Control.

**2.4 WARNING SIGNS**

- .1 Warning signs: in accordance with requirements of inspection authorities.
- .2 Lamacoid labels: minimum size 175 x 250 mm.

**2.5 WIRING TERMINATIONS**

- .1 Ensure lugs, terminals, and screws used for termination of wiring are suitable for either copper or aluminum conductors.

**2.6 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates in accordance with City of Winnipeg Water and Waste Department Electrical Identification Standard and as follows:
  - .1 Nameplates: lamacoid 3 mm thick plastic engraving sheet, white face with black core, lettering accurately aligned and engraved into core mechanically attached with self-tapping stainless steel screws.
  - .2 Lamacoids as follows:

Application	Text Size	Text
Electrical Equipment - General	5 mm	Line 1: Identifier
Circuit Breaker - Separate	5 mm	Line 1: Identifier Line 2: Load Identifier Line 3: Load Description
Disconnect Switch - Separate	5 mm	Line 1: Identifier Line 2: Load Identifier Line 3: Load Description
Fire Alarm Devices	8 mm	Line 1: Identifier
Light Switches	3 mm	Source Panel and Circuit Number
MCC	8 mm	Line 1: Identifier Line 2: Description Line 3: System Voltage Line 4: Fed By
Motor Starter or MCC Bucket	5 mm	Line 1: Load Identifier Line 2: Load Description
Panelboards	8mm	Line 1: Identifier Line 2: Description Line 3: System Voltage Line 4: Fed By

<b>Application</b>	<b>Text Size</b>	<b>Text</b>
Receptacles	3 mm	Source Panel and Circuit Number
Switchgear	8 mm	Line 1: Identifier Line 2: Description Line 3: System Voltage Line 4: Fed By
Switchgear Breaker	8 mm	Line 1: Identifier Line 2: Description Line 3: System Voltage Line 4: Fed By
Transformer - Indoor	8 mm	Line 1: Identifier Line 2: Rating, System Voltage Line 3: Fed By
Transformer – Outdoor	10 mm	Line 1: Identifier Line 2: Rating, System Voltage Line 3: Fed By

## 2.7 WIRING IDENTIFICATION

- .1 Identify writing in accordance with City of Winnipeg Water and Waste Department Electrical Identification Standard.
- .2 Identify wiring with permanent indelible identifying markings, coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .3 Maintain phase sequence and colour coding throughout.
- .4 Colour coding: to CSA C22.1 and City of Winnipeg Water and Waste Department Electrical Design Guide.
- .5 Use colour coded wires in communication cables, matched throughout system.

## 2.8 CONDUIT AND CABLE IDENTIFICATION

- .1 Identify conduit and cable in accordance with City of Winnipeg Water and Waste Department Electrical Design Guide.
- .2 Colour code conduits, boxes, and metallic sheathed cables.
- .3 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals.
- .4 Colours: 38 mm wide prime colour and 19 mm wide auxiliary colour.
- .5 Colour Codes

	<b>Prime</b>	<b>Auxiliary</b>
Power, 120/208/240 VAC	Black	
UPS Power, 120/208/240 VAC	Black	Green
Control Wiring, 120VAC	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control Wiring, <50 V	Blue	Orange



	<b>Prime</b>	<b>Auxiliary</b>
Intrinsically Safe	Blue	White
Up to 250 V	Yellow	
Up to 600 V	Yellow	Green
Other Communication Systems	Green	Blue

**2.9 FINISHES**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint outdoor electrical equipment "equipment green" finish.
  - .2 Paint indoor switchgear and distribution enclosures light gray EEMAC 2Y.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.
- .2 Do overhead and underground systems in accordance with CAN/CSA-C22.3 No.1 except where specified otherwise.

**3.2 NAMEPLATES AND LABELS**

- .1 Ensure manufacturer's nameplates, CSA labels, and identification nameplates are visible and legible after equipment is installed.
- .2 Submit lamacoid wording to the Contract Administrator prior to manufacture.
  - .1 If changes are required, notify the Contract Administrator of these changes prior to manufacturing of labels.

**3.3 MOUNTING HEIGHTS**

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .3 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Local switches: 1400 mm.
  - .2 Wall receptacles:
    - .1 General: 300 mm.
    - .2 Above top of continuous baseboard heater: 200 mm.
    - .3 In mechanical rooms: 1400 mm.
  - .3 Panelboards: as required by Code or as indicated.
  - .4 LAN outlets: 300 mm.

### **3.4 COORDINATION OF PROTECTIVE DEVICES**

- .1 Ensure circuit protective devices such as overcurrent trips, relays, and fuses are installed to required values and settings as per the short circuit coordination study which will be provided by the Contract Administrator.
  - .1 The Contractor shall request the short circuit coordination study after award of the Contract.

### **3.5 FIELD QUALITY CONTROL**

- .1 Conduct the following tests:
  - .1 Continuity tests on circuits originating from branch distribution panels.
  - .2 Continuity tests on control circuits originating from the PLC and terminating at the appropriate field device.
  - .3 Communication systems: in accordance with Section 29 15 01 - Instrumentation Cable.
  - .4 Insulation resistance testing:
    - .1 Megger circuits, feeders, and equipment up to 350 V with a 500 V instrument.
    - .2 Megger 350-600 V circuits, feeders, and equipment with a 1000 V instrument.
    - .3 Check resistance to ground before energizing.
- .2 Carry out tests in presence of the Contract Administrator.
- .3 Provide instruments, meters, equipment, and personnel required to conduct tests during and at conclusion of Work.
- .4 Manufacturer's Field Services:
  - .1 Obtain written report from manufacturer verifying compliance of Work, in handling, installing, applying, protecting, and cleaning of product and submit manufacturer's field reports within three days of manufacturer's review, verifying compliance of Work and electrical system and instrumentation testing.
  - .2 Provide manufacturer's field services consisting of product use recommendations and periodic Site visits for inspection of product installation in accordance with manufacturer's instructions.
- .5 Perform tests using qualified personnel. Provide necessary instruments and equipment.
- .6 Check phase rotation and identify each phase conductor of each feeder.
- .7 Site Acceptance Tests
  - .1 Ensure that terminations and accessory equipment are disconnected.
  - .2 Ground shields, ground wires, metallic armour, and conductors not under test.

- .8 Provide Contract Administrator with list of test results showing location at which each test was made, circuit tested, and result of each test.
- .9 Remove and replace entire length of cable if cable fails to meet any of test criteria.

**3.6 TRAINING**

- .1 Provide training to the City personnel in the operation, care, and maintenance of systems, system equipment, and components in accordance with E15 of the Tender.

**3.7 CLEANING**

- .1 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.
- .2 Clean and prime exposed non-galvanized hangers, racks, and fastenings to prevent rusting.
- .3 Progress cleaning: clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Leave Work area clean at the end of each day.
- .4 Final cleaning: upon completion remove surplus Materials, rubbish, tools, and equipment in accordance with Section 01 74 00 - Cleaning.

**END OF SECTION**

**Part 1      General**

**1.1      SECTION INCLUDES**

- .1      Requirements for selective demolition and removal of electrical and communications components including removal of conduit, junction boxes, and panels to source (home run removal) and incidentals required to complete Work.

**1.2      RELATED SECTIONS**

- .1      Section 01 33 00 - Submittal Procedures.

**1.3      REFERENCE STANDARDS**

- .1      CSA
  - .1      CSA S350 M1980 (R2003), Code of Practice for Safety in Demolition of Structures.

**1.4      ACTION AND INFORMATIONAL SUBMITTALS**

- .1      Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Submit written request of demolition, cutting, or alteration at least two weeks prior to the scheduled demolition, cutting, or alteration in accordance with this section and Section 01 73 00 - Execution.

**1.5      ADMINISTRATIVE REQUIREMENTS**

- .1      Coordination: coordinate Work of this section to avoid interference with Work by other sections.
- .2      Scheduling: account for the City's continued occupancy requirements during selective demolition and schedule staged occupancy and Site activities.

**1.6      SITE CONDITIONS**

- .1      Existing conditions: condition of Materials identified as being salvaged or Demolished are based on their observed condition at time of Site examination before tendering.
- .2      Existing Hazardous Substances: The City has performed a Hazardous Substances assessment and identified materials requiring asbestos abatement as follows:
  - .1      Hazardous Substances are as defined in Hazardous Products Act.
  - .2      Hazardous Substances will be Removed by Contractor as a part of Contract before starting Work.
  - .3      Any asbestos abatement work shall follow the requirements set out in Section 02 82 00.01 – Asbestos Abatement – Minimum Precautions and Section 02 82 00.02 – Asbestos Abatement – Intermediate Precautions.

- .1 HMIS Asbestos reports for all Sites containing confirmed and presumed asbestos are provided as Appendix D – Asbestos Reports.

## **Part 2 Products**

### **2.1 SALVAGE AND DEBRIS MATERIALS**

- .1 Material ownership: Demolished materials become the Contractor's property and will be removed from Site; except for items indicated as being reused, salvaged, reinstalled, or otherwise indicated to remain the City's property.
  - .1 For clarity, automation equipment (PLCs, MPRs, HMIs, actuators) are to be returned to the City as indicated on the Drawings. Wire, cable, conduit, MCC, electrical panels, lights that is salvaged is Contractor's responsibility.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of existing conditions: visit all Work facilities, thoroughly examine and become familiar with conditions that may affect Work.

### **3.2 PREPARATION**

- .1 Submit written request in advance of demolition in accordance with Section 01 73 00 – Execution.
- .2 Protection of existing systems to remain: protect systems and components indicated to remain in place during selective demolition operations and as follows:
  - .1 Prevent movement and install bracing to prevent settlement or damage of adjacent services and parts of existing buildings scheduled to remain.
  - .2 Notify the Contract Administrator and cease operations where safety of buildings being Demolished, adjacent structures or services appears to be endangered and await additional instructions before resuming demolition Work specified in this section.
  - .3 Prevent debris from blocking drainage inlets.
  - .4 Protect mechanical systems that will remain in operation.
  - .5 Protect electrical systems that will remain in operation.
- .3 Protection of building occupants: sequence demolition Work so that interference with use of the building by the City and users is minimized.
  - .1 Prevent debris from endangering safe access to and egress from all buildings.

- .2 Notify the Contract Administrator and cease operations where the safety of occupants appears to be endangered and await additional instructions before resuming demolition Work specified in this section.

### **3.3 EXECUTION**

- .1 Removal and Demolition:
  - .1 Disconnect electrical circuits and panel feeders; maintain electrical service and main distribution panel as is, ready for subsequent Work.
  - .2 Remove existing electrical devices and equipment including associated conduits, boxes, wiring, and similar items.
  - .3 Disconnect and Remove communication systems including associated conduits, boxes, cabling, and similar items unless specifically noted otherwise.
  - .4 Perform demolition Work in a neat and workmanlike manner:
    - .1 Remove tools or equipment after completion of Work and leave Site clean and ready for subsequent renovation Work.
    - .2 Repair and restore damages caused as a result of Work of this section to match existing materials and finishes.
  - .5 Disconnect panel feeders back to main distribution panel and re-label respective circuit breaker as "SPARE".
  - .6 Remove existing conduits, boxes, cabling, and wiring associated with Removed electrical devices and equipment.
  - .7 Seal open ends of conduit with silicone sealant and leave in place where they are inaccessible or cannot be removed without damaging adjacent construction.
  - .8 Provide sequencing plan for removal of existing MCC in the Valve House for City of Winnipeg review. Sequencing plan to include temporary power plans, equipment outage timelines, and full plan to transfer control to new MCC. Refer to drawings for suggested phasing.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCE STANDARDS**

- .1 CSA Group
  - .1 CAN/CSA-C22.2 No.18), Outlet Boxes, Conduit Boxes and Fittings.
  - .2 CAN/CSA-C22.2 No.65), Wire Connectors (Tri-National Standard with UL 486A-486B and NMX-J-543-ANCE-03).
- .2 Electrical and Electronic Manufacturers' Association of Canada (EEMAC)
  - .1 EEMAC 1Y-2-, Bushing Stud Connectors and Aluminum Adapters (1200 Ampere Maximum Rating).
- .3 NEMA® standard

**Part 2 Products**

**2.1 MATERIALS**

- .1 Pressure type wire connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors as required.
- .2 Fixture type splicing connectors to: CAN/CSA-C22.2 No.65, with current carrying parts of copper sized to fit copper conductors ten AWG or less.
- .3 Bushing stud connectors: to EEMAC 1Y-2 or NEMA to consist of:
  - .1 Connector body and stud clamp for copper conductors.
  - .2 Clamp for round stranded copper conductors.
  - .3 Stud clamp bolts.
  - .4 Bolts for copper bar.
- .4 Clamps or connectors for flexible conduit, armoured cable, non-metallic sheathed cable as required to: CAN/CSA-C22.2 No.18.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Remove insulation carefully from ends of conductors and:
  - .1 Install mechanical pressure type connectors and tighten screws. Installation shall meet secureness tests in accordance with CAN/CSA-C22.2 No.65.
  - .2 Install fixture type connectors and tighten to CAN/CSA-C22.2 No.65. Replace insulating cap.
  - .3 Install bushing stud connectors in accordance with EEMAC 1Y-2 or NEMA.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1      Section 26 05 00 - Common Work Results for Electrical.
- .2      Section 26 05 20 - Wire and Box Connectors (0-1000 V).
- .3      Section 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings.
- .4      Section 26 05 36 - Cable Trays for Electrical Systems.
- .5      Section 29 05 00 - Common Works - Instrumentation and Control.

**1.2                REFERENCE STANDARDS**

- .1      CSA Group
  - .1      CSA C22.2 No.0.3, Test Methods for Electrical Wires and Cables.
  - .2      CAN/CSA-C22.2 No.131, Type TECK 90 Cable.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1      Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Shop Drawings:
  - .1      Provide numbered wire collars for control wiring. Numbers to correspond to the control legend. Obtain wiring diagram for control wiring.

**Part 2            Products**

**2.1                BUILDING WIRES**

- .1      Conductors: stranded for 10 AWG and larger.
- .2      Minimum size: 12 AWG.
- .3      Copper conductors: size as indicated, with 1000 V insulation of cross-linked thermosetting polyethylene rated RWU90 XLPE or RW90 XLPE.

**2.2                TECK 90 CABLE**

- .1      Cable: to CAN/CSA-C22.2 No.131.
- .2      Conductors:
  - .1      Grounding conductor: copper.
  - .2      Circuit conductors: copper, size as indicated.
- .3      Insulation:
  - .1      Cross-linked polyethylene XLPE.
  - .2      Rating: 1000 V.
- .4      Inner jacket: PVC.



- .5 Armour: interlocking, aluminum.
- .6 Overall covering: thermoplastic PVC.
- .7 Fastenings:
  - .1 One-hole stainless steel straps to secure surface cables 50 mm and smaller.
  - .2 Two-hole stainless steel straps for cables larger than 50 mm.
  - .3 Channel type supports for two or more cables at 900 mm centers.
  - .4 Stainless steel threaded rods: 8 mm diameter to support suspended channels.
- .8 Connectors:
  - .1 Watertight, approved for TECK cable.

### **2.3 CONTROL CABLES**

- .1 Type:
  - .1 Low voltage thermostat: soft annealed copper conductors, sized as indicated.
  - .2 Insulation: thermoplastic.
  - .3 Sheath: thermoplastic jacket and armour of closely wound aluminum wire.
- .2 Type:
  - .1 Low energy 300 V control cable: solid annealed copper conductors sized as indicated.
  - .2 Low voltage thermostat: soft annealed copper conductors, sized as indicated.
  - .3 Insulation: PVC.
  - .4 Shielding: braid over each conductor group.
  - .5 Overall covering: polyethylene jackets.
- .3 Type:
  - .1 600 V conductors, sizes as indicated, annealed copper.
  - .2 Insulation: PVC or cross-linked polyethylene type RW90.
  - .3 Shielding: metallized tapes over each pair of conductors.
  - .4 Overall covering: thermoplastic jacket interlocked armour and jacket over sheath of PVC.
- .4 Fastenings:
  - .1 One-hole stainless steel straps to secure surface cables 50 mm and smaller.
  - .2 Two-hole stainless steel straps for cables larger than 50 mm.
  - .3 Channel type supports for two or more cables at 900 mm centers.
  - .4 Stainless steel threaded rods: 8 mm diameter to support suspended channels.

- .5 Stainless steel straps, hardware, channels, supports for NEMA 4, NEMA 4x, CSA enclosure type 4, CSA enclosure type 4X areas, all wet areas.
- .5 Connectors:
  - .1 Watertight, approved for TECK cable.
    - .1 An elastomeric bevelled bushing.
    - .2 A funnel entry, splined gland nut.
    - .3 A taper threaded hub.
    - .4 A hexagonal body and gland nut

### **Part 3 Execution**

#### **3.1 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform tests before energizing electrical system.

#### **3.2 GENERAL CABLE INSTALLATION**

- .1 Do not splice cables. A continuous length is required for all feeds.
- .2 Exercise care in stripping insulation from wire.
  - .1 Make certain conductors are not nicked.
- .3 Lay cable in cable trays in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .4 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors (0-1000 V).
- .5 Cable colour coding in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .6 Conductor length for parallel feeders to be identical.
- .7 Lace or clip groups of feeder cables at distribution centres, pull boxes, and termination points.
- .8 Provide numbered wire collars for control wiring. Numbers to correspond to control Shop Drawing legend. Obtain wiring diagram for control wiring.
- .9 Provide scanning, coring, and drilling for installation of all wire and cables in accordance with Section 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings.

#### **3.3 INSTALLATION OF BUILDING WIRES**

- .1 Install wiring as follows:
  - .1 In conduit systems in accordance with Section 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings.

**3.4 INSTALLATION OF TECK90 CABLE (0 -1000 V)**

- .1 Group cables wherever possible on channels.
- .2 Lay cable in cable troughs/cable tray in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.
- .3 Terminate cables in accordance with Section 26 05 20 - Wire and Box Connectors (0-1000 V).

**3.5 INSTALLATION OF CONTROL CABLES**

- .1 Install control cables in conduit or cable troughs as indicated on Drawings.
  - .1 Separate cables in conduit and cable troughs as required by the CEC and Section 29 05 00 - Common Works - Instrumentation and Control.
- .2 Ground control cable shield at one end only. Where possible, ground shields at the end where power is supplied to the cable. Utilize shield grounding bar in panels, where present, to ground overall shields. Individual pair shields to be grounded on appropriate terminals.
- .3 Shield drain wires, at the ungrounded end, are to be taped back to the cable. Fully insulate the shield. Do not cut the shield drain wire off.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1            Section 01 33 00 - Submittal Procedures.
- .2            Section 26 05 00 - Common Work Results for Electrical.
- .3            Section 26 05 36 - Cable Trays for Electrical Systems

**1.2                REFERENCE STANDARDS**

- .1            American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE).
  - .1            ANSI/IEEE 837-02, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1            Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2            Shop Drawings:
  - .1            Submit Shop Drawings indicating ground connection details.

**Part 2            Products**

**2.1                EQUIPMENT**

- .1            Grounding conductors: bare stranded copper, soft annealed, size as required.
- .2            Insulated grounding conductors: green, copper conductors, size as required, type RW90.
- .3            Ground bus: copper, size as required complete with insulated supports, fastenings, connectors.
- .4            Non-corroding accessories necessary for grounding system, type, size, Material as indicated, including but not necessarily limited to:
  - .1            Grounding and bonding bushings.
  - .2            Protective type clamps.
  - .3            Bolted type conductor connectors.
  - .4            Thermit welded type conductor connectors.
  - .5            Bonding jumpers, straps.
  - .6            Pressure wire connectors.

**Part 3 Execution**

**3.1 INSTALLATION GENERAL**

- .1 Install complete permanent, continuous grounding system including conductors, connectors, and accessories.
- .2 Install connectors in accordance with manufacturer's instructions.
- .3 Protect exposed grounding conductors from mechanical injury.
- .4 Use mechanical connectors for grounding connections to equipment provided with lugs.
- .5 Soldered joints not permitted.
- .6 Install bonding wire for flexible conduit, connected at one end to grounding bushing, solderless lug, clamp or cup washer and screw. Neatly cleat bonding wire to exterior of the flexible conduit.
- .7 Make grounding connections in radial configuration only, with connections terminating at single grounding point. Avoid loop connections.

**3.2 SYSTEM AND CIRCUIT GROUNDING**

- .1 Install system and circuit grounding connections to neutral of primary 600 V system, secondary 208 V system.

**3.3 EQUIPMENT GROUNDING**

- .1 Install grounding connections to typical equipment included in, but not necessarily limited to, following list: service equipment, transformers, switchgear, duct systems, frames of motors, motor control centres, starters, control panels, building steel work, generators, elevators and escalators, distribution panels, outdoor lighting, and cable trays.
- .2 All new or modified metallic components installed as a part of this Work shall be bonded to ground.
- .3 Ground cable tray in accordance with Section 26 05 36 - Cable Trays for Electrical Systems.

**3.4 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Perform ground continuity and resistance tests using method appropriate to Site conditions and approval of Contract Administrator and local Authority Having Jurisdiction over installation.
- .3 Perform tests before energizing electrical system.
- .4 Disconnect ground fault indicator during tests.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 61 00 - Common Product Requirements.
- .3        Section 26 05 00 - Common Work Results for Electrical.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for hangers and supports and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3        Shop Drawings:
  - .1        Submit Shop Drawings indicating connection details.

**Part 2            Products**

**2.1                FRAMING AND SUPPORT SYSTEM**

- .1        Materials:
  - .1        Indoors, dry locations: Conduit support structures shall employ aluminium strut framing system together with the manufacturer's connecting components and fasteners for a complete system.
  - .2        Exterior and wet locations, including areas that may contain chlorine compounds in the atmosphere: stainless steel.
- .2        Accessories:
  - .1        Exterior and wet locations, including areas that may contain chlorine compounds in the atmosphere: stainless steel.
  - .2        Nuts, bolts, washers, machine screws, fittings, accessories: stainless steel.

**2.2                CONCRETE AND MASONRY ANCHORS**

- .1        Materials: hardened steel inserts, zinc plated for corrosion resistance.
- .2        Components: non-drilling anchors for use in predrilled holes, sized to safely support the applied load with a minimum safety factor of four.
- .3        Manufacturer: Hilti (Canada) Limited or approved equal in accordance B7 of the Tender.
- .4        Contractor to test all concrete before installation for asbestos. If asbestos is found, refer to Spec section 02 82 00.01 & 02 82 00.02.

## **2.3 SPACERS**

- .1 PVC coated malleable metal spacers, CSA approved for the purpose.
- .2 Aluminium or stainless steel (wet and chlorine locations) channel may be utilized where conduits are grouped; however, a non-metallic spacer must be provided between the metallic channel and concrete.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Refer to Appendix D – Asbestos Reports prior to drilling or coring in existing materials.
- .2 Secure equipment to hollow or solid masonry, tile, and plaster surfaces with lead anchors.
- .3 Secure equipment to poured concrete with expandable inserts.
- .4 Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .5 Support equipment, conduit, or cables using clips, spring loaded bolts, and cable clamps designed as accessories to basic channel members.
- .6 Maximum spacing between conduit supports:
  - .1 16 mm conduit: 1.0 m
  - .2 21 mm conduit: 1.5 m
  - .3 27 mm conduit: 1.5 m
  - .4 35 mm conduit: 2.0 m
  - .5 41 mm conduit and larger: 2.5 m
- .7 Fasten exposed conduit or cables to building construction or support system using straps.
  - .1 One-hole stainless steel straps to secure surface conduits and cables 50 mm and smaller.
  - .2 Two-hole stainless steel straps for conduits and cables larger than 50 mm.
  - .3 Beam clamps to secure conduit to exposed steel work.
- .8 Suspended support systems.
  - .1 Support individual cable or conduit runs with 8 mm diameter stainless steel threaded rods and spring clips.
  - .2 Support two or more cables or conduits on channels supported by 8 mm diameter stainless steel threaded rod hangers where direct fastening to building construction is impractical.
- .9 For surface mounting of two or more conduits use channels at 1 m on center spacing.

- .10 Provide metal brackets, frames, hangers, clamps, and related types of support structures where indicated or as required to support conduit and cable runs.
- .11 Do not install conduit directly onto concrete, provide offset supports.
- .12 Ensure adequate support for raceways and cables dropped vertically to equipment where there is no wall support.
- .13 Do not use wire lashing or perforated strap to support or secure raceways or cables.
- .14 Do not use supports or equipment installed for other trades for conduit or cable support except with permission of other trade and approval of the Contract Administrator.
- .15 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .16 Bond all metallic components to ground, utilizing 2/0 AWG copper conductor for all systems that are part of a facility in accordance with CEC.

**END OF SECTION**



**Part 1        General**

**1.1            RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 26 05 00 - Common Work Results for Electrical.

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

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

**Part 2        Products**

**2.1            SPLITTERS**

- .1        Construction: sheet metal enclosure, welded corners, and formed hinged cover suitable for locking in closed position.
- .2        Terminations: main and branch lugs, connection blocks to match required size and number of incoming and outgoing conductors as indicated.
- .3        Spare terminals: minimum three spare terminals or lugs on each connection or lug block sized less than 400 A.

**2.2            JUNCTION AND PULL BOXES**

- .1        Junction and pull boxes installed in dry, non-hazardous, non-corrosive locations:
  - .1        Construction: welded steel enclosure CSA enclosure type 2 or greater for normal dry area. Use sealed, gasketed, CSA enclosure type 12 for sprinklered areas.
  - .2        Covers Flush Mounted: 25 mm minimum extension all around.
  - .3        Covers surface mounted: screw-on flat covers.
- .2        Junction and pull boxes installed in wet or wet and corrosive locations:
  - .1        Construction: CSA enclosure type 4X, gasketed.

**2.3            CABINETS**

- .1        Cabinets installed in dry, non-hazardous, non-corrosive locations:
  - .1        Construction: welded sheet steel, or as indicated, hinged door, handle. CSA enclosure type 12 or greater, gasketed.
  - .2        Type E empty: flush overlapping sides mounting as indicated.
  - .3        Type T terminal: flush overlapping sides mounting as indicated containing sheet steel 19 mm backplane.
- .2        Cabinets installed in wet or wet and corrosive locations:

- .1 Construction: stainless steel, CSA enclosure type 4X, gasketed, hinged door, handle.
- .2 Back-plate with offsets for installation of devices.

**Part 3 Execution**

**3.1 SPLITTER INSTALLATION**

- .1 Mount plumb, true, and square to building lines.
- .2 Extend splitters full length of equipment arrangement except where indicated otherwise.

**3.2 JUNCTION, PULL BOXES, AND CABINETS INSTALLATION**

- .1 Install pull boxes in inconspicuous but accessible locations.
- .2 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.
- .3 Install terminal blocks as indicated in Type T cabinets.
- .4 Only main junction and pull boxes are indicated. Install additional pull boxes as required by CSA C22.1.
- .5 Install junction and pull boxes to not exceed 30 m of conduit runs between devices. Add additional boxes to meet all code requirements.

**3.3 IDENTIFICATION**

- .1 Equipment identification: to Section 26 05 00 - Common Work Results for Electrical.

**END OF SECTION**

**Part 1        General**

**1.1            RELATED SECTIONS**

- .1        Section 26 05 00 - Common Work Results for Electrical.

**1.2            REFERENCE STANDARDS**

- .1        CSA Group
  - .1        CSA C22.1-18, Canadian Electrical Code, Part 1, 20th Edition.

**Part 2        Products**

**2.1            OUTLET AND CONDUIT BOXES GENERAL**

- .1        Size boxes in accordance with CSA C22.1.
- .2        102 mm square or larger outlet boxes as required.
- .3        Gang boxes where wiring devices are grouped.
- .4        Blank cover plates for boxes without wiring devices.
- .5        Combination boxes with barriers where outlets for more than one system are grouped.
- .6        Knock-out covers for sealing penetration holes.

**2.2            GALVANIZED STEEL OUTLET BOXES**

- .1        One-piece electro-galvanized construction.
- .2        Single and multi-gang flush device boxes for flush installation, minimum size 76 x 50 x 38 mm or as indicated. 102 mm square outlet boxes when more than one conduit enters one side with extension and plaster rings as required.
- .3        Utility boxes for outlets connected to surface-mounted SS conduit, minimum size 102 x 54 x 48 mm.
- .4        102 mm square or octagonal outlet boxes for lighting fixture outlets.
- .5        Extension and plaster rings for flush mounting devices in finished plaster or tile walls.

**2.3            MASONRY BOXES**

- .1        Electro-galvanized steel masonry and multi single gang boxes for devices flush mounted in exposed block walls.

**2.4            CONCRETE BOXES**

- .1        Electro-galvanized sheet steel concrete type boxes for flush mount in concrete with matching extension and plaster rings as required.

**2.5 CONDUIT BOXES**

- .1 Cast FS or FD aluminium boxes with factory-threaded hubs and mounting feet for surface wiring of devices in non-hazardous areas.
- .2 PVC boxes with non-threaded hubs for surface wiring of devices in wet or wet and corrosive areas.

**2.6 FITTINGS - GENERAL**

- .1 Bushing and connectors with nylon insulated throats.
- .2 Knock-out fillers to prevent entry of debris.
- .3 Conduit outlet bodies for conduit up to 35 mm and pull boxes for larger conduits.
- .4 Double locknuts and insulated bushings on sheet metal boxes.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Support boxes independently of connecting conduits.
- .2 Fill boxes with paper, sponges, foam, or similar approved material to prevent entry of debris during construction. Remove upon completion of Work.
- .3 For flush installations, mount outlets flush with finished wall using plaster rings to permit wall finish to come within 6 mm of opening.
- .4 Provide correct size of openings in boxes for conduit. Do not install reducing washers.
- .5 Extension rings shall not be utilized to accommodate conductor fill requirements.
- .6 Vacuum clean interior of outlet boxes before installation of wiring devices.
- .7 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 74 00 - Cleaning.
- .3        Section 26 05 00 - Common Work Results for Electrical.

**1.2                REFERENCE STANDARDS**

- .1        CSA Group
  - .1        CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, Fittings and Associated Hardware, A National Standard of Canada.
  - .2        CSA C22.2 No. 45, Rigid Metal Conduit.
  - .3        CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
  - .4        CSA C22.2 No. 83, Electrical Metallic Tubing.
  - .5        CSA C22.2 No. 211.2, Rigid PVC (Unplasticized) Conduit.
  - .6        CAN/CSA C22.2 No. 227.3, Nonmetallic Mechanical Protection Tubing (NMPT).

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Shop Drawings and Product Data:
  - .1        Provide manufacturer's printed product literature and data sheets.

**Part 2            Products**

**2.1                CONDUITS**

- .1        Rigid aluminum conduit: to CSA C22.2 No. 45, aluminum threaded.
- .2        Rigid PVC conduit: to CSA C22.2 No. 211.2 FT4 rated.
- .3        Flexible metal conduit: to CSA C22.2 No. 56, liquid-tight flexible metal.

**2.2                CONDUIT FASTENINGS**

- .1        One-hole stainless steel straps to secure surface conduits 50 mm and smaller.
- .2        Two-hole stainless steel straps for conduits larger than 50 mm.
- .3        Beam clamps to secure conduits to exposed steel Work.
- .4        Channel type supports for two or more conduits at 1 m spacing on centre.
- .5        Stainless steel threaded rods, 8 mm diameter, to support suspended channels.

## **2.3 CONDUIT FITTINGS**

- .1 Fittings: to CAN/CSA C22.2 No. 18, manufactured for use with conduit specified.
- .2 Coating: same as conduit.
- .3 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .4 Watertight connectors and couplings for EMT.
  - .1 Set-screws are not acceptable.

## **2.4 EXPANSION FITTINGS FOR RIGID CONDUIT**

- .1 Weatherproof expansion fittings with internal bonding assembly suitable for 100 mm linear expansion.
- .2 Watertight expansion fittings with integral bonding jumper suitable for linear expansion and 19 mm deflection.
- .3 Weatherproof expansion fittings for linear expansion at entry to panel.

## **2.5 CONDUIT SPACERS**

- .1 PVC coated malleable iron spacers, CSA approved for the purpose.
- .2 Aluminium channel may be utilized in non-hazardous areas where conduits are grouped; however, a non-metallic spacer must be provided between the aluminum channel and concrete.

## **2.6 FISH CORD**

- .1 Polypropylene.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.
- .2 X-ray cast walls and floors before coring to confirm location of embedded items.
- .3 Use rigid aluminum threaded conduit in ordinary locations.
- .4 Use PVC conduit in cast in place concrete and Category 1 and 2 locations.
- .5 Use PVC conduit underground.
- .6 Use flexible metal conduit for connection to motors in dry areas.
- .7 Use liquid tight flexible metal conduit for connection to motors or vibrating equipment in damp, wet, or corrosive locations.
- .8 Minimum conduit size for lighting and power circuits: 19 mm.
- .9 Bend Conduit Cold.
  - .1 Replace conduit if kinked or flattened more than 1/10<sup>th</sup> of its original diameter.

- .10 Mechanically bend steel conduit over 19 mm diameter.
- .11 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .12 Install fish cord in empty conduits.
- .13 Remove and replace blocked conduit sections.
  - .1 Do not use liquids to clean out conduits.
- .14 Dry conduits out before installing wire.
- .15 Where conduit leaves a warm room and enters a cooler atmosphere, seal the conduit and arrange the conduit in a manner to avoid condensation accumulation at the seal.

**3.2 SURFACE CONDUITS**

- .1 Run parallel or perpendicular to building lines.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Run conduits in flanged portion of structural steel.
- .4 Group conduits wherever possible on surface or suspended aluminum channels.
- .5 Do not pass conduits through structural members except as indicated.
- .6 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

**3.3 CONDUITS UNDERGROUND**

- .1 Slope conduits to provide drainage.
- .2 Waterproof joints (PVC excepted) with heavy coat of bituminous paint.

**3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 On completion and verification of performance of installation, remove excess Materials, rubbish, tools, and equipment.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1            Section 01 33 00 - Submittal Procedures.
- .2            Section 26 05 00 - Common Work Results for Electrical.

**1.2                SUMMARY**

- .1            Provide a complete system of cable trays required to fully support all new cables and conduit throughout the facility. System shall provide separate trays or barriers for 600 VAC systems, 120 VAC systems, and 24 VDC systems. System shall be complete with all supports and hangers and seismic bracing necessary for the installation.
- .2            Existing cable trays to be utilized where possible.
- .3            Coordinate the location of the support channels so as not to interfere with other services or maintenance activities.
- .4            Utilize common supports with process and mechanical piping where practical.
- .5            Existing cable trays are not shown on the Drawings. Provide additional cable tray as required to extend existing cable trays to fully support all new cable and conduit throughout the facility.

**1.3                REFERENCE STANDARDS**

- .1            CSA Group
  - .1            CAN/CSA C22.1 No.126, Cable Tray Systems.

**1.4                ACTION AND INFORMATIONAL SUBMITTALS**

- .1            Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2            Product Data:
  - .1            Submit manufacturer's product data sheets for cable tray indicating dimensions, Materials, and finishes, including classifications and certifications.
- .3            Shop Drawings:
  - .1            Include:
    - .1            Show Materials, finish, dimensions, accessories, layout, and installation details.
    - .2            Identify types of cable troughs used.
    - .3            Show actual cable trough installation details and suspension system.



**Part 2 Products**

**2.1 CABLE TRAY**

- .1 All power trays shall be rigid aluminum ladder type, Class E to CSA C22.2 No. 126 with 300 mm rung spacing, 150 mm side rails and width as indicated.
  - .1 All power cable tray in chlorine areas to be galvanized steel.
- .2 All instrumentation and control trays to be rigid aluminum ventilated, Class E to CSA C22.2 No. 126, 150 mm side rails and width as indicated.
  - .1 All instrumentation and control cable tray in chlorine areas to be galvanized steel.
- .3 Horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers, and other fittings where required. Field fabricate only those fittings not available from manufacturer.
- .4 Provide stainless steel rod hanger clamps, rod hangers, floor mounted support frames, and all necessary accessories for complete installation.
- .5 Provide barriers where different voltage systems or electrical systems are in the same cable trough, or as indicated.
- .6 Approved Manufacturers:
  - .1 Pilgrim, Unitray.
  - .2 B-Line, Comtray.
  - .3 Canstrut.
  - .4 ElectroTray.
  - .5 Or approved equal in accordance with B7 in the Tender.
- .7 Unless otherwise approved by the Contract Administrator, provide cable trays of the same manufacturer throughout the Work.
- .8 Ground cable trays to ground bar in electrical room with #2 AWG insulated copper conductor attached to each tray section in accordance with CEC requirements.
  - .1 Fasten with electrically conducting metal clamps at 6 m centres and at each end of terminated cable troughs.
- .9 Provide fire stop material at firewall penetrations.
- .10 De-rate power cables according to the electrical code.

**2.2 SUPPORTS**

- .1 Provide stainless steel rod hangers, rod hanger clamps, and accessories as required.
- .2 Floor mounted support brackets: provide aluminum channel strut supports mounted vertically and supported on floor complete with mounting brackets sized to suit cable tray width and loading.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Support cable trays as required by loading classification rating and not more than 3000 mm on centers. Fasten channels securely mounted to the structure.
- .2 Install trays and raceways generally as indicated on Drawings. Coordinate this Work with existing systems to ensure adequate horizontal and vertical clearances.
- .3 Provide the minimum vertical clearance above the trays as indicated on the Drawings.
- .4 Provide a minimum 600 mm horizontal clearance on one side of cable tray throughout.
- .5 All trays are shown diagrammatically on the Drawings. Determine the exact location in the field. Install tray runs to prevent interference with process or service piping and ducting and to maintain clearance for tray access. Coordinate the exact location of tray supports and runs with the Work of other NMS divisions.
- .6 Do not install tray routes and tray supports until the location of same has been reviewed by the Contract Administrator.
- .7 Install tray systems in such a manner as to conserve head-room and minimize the use of free space through which they pass. Maintain a minimum 2100 mm clear head-room wherever possible.
- .8 Run trays parallel to building lines unless otherwise shown on the Drawings. A tray in tunnel areas to run parallel with the ceiling lines as the floor is graded for drainage. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.
- .9 When the ends on u-channel type shelf brackets are below 2100 mm above finished floor in a walking area, cut flush with tray. Permanently cap the end of u-channel, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.
- .10 Use beam clamps to fasten support systems to structural steel. Do not weld, drill, or cut structural steel without approval by the Contract Administrator.
- .11 Extend a stranded #2 tin plated bare, or green insulated, copper ground conductor the length of each new tray route, and solidly connect sections of new tray runs to the ground bus of the electrical room. Connect ground conductor to the new tray every 15 m with approved grounding clamps suitable for connecting aluminum tray with copper conductor.
- .12 Generally, run cables of different voltage classes in separate trays. Where a common tray is shown on Drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray manufacturer.
- .13 Check all trays for surface smoothness prior to installation and remove all burrs, ridges, etc. on tray surfaces facing cables.

- .14 Size cable trays as indicated on Drawings. If any discrepancies are found or changes in tray size are required, advise the Contract Administrator before installing the tray.

### **3.2 CABLES IN CABLE TROUGH**

- .1 Install cables individually.
- .2 Do not exceed cable tray weight capacity.
- .3 Lay cables into cable trough. Use rollers when necessary to pull cables.
- .4 Secure cables in cable trough at 3 m centres, with:
  - .1 Nylon ties in horizontal applications.
  - .2 Cable clips in vertical applications.
- .5 Identify cables every 30 m with size two nameplates.

**END OF SECTION**

**Part 1        General**

**1.1            RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 26 05 00 - Common Work Results - Electrical.

**1.2            REFERENCE STANDARDS**

- .1        CSA International.
- .2        Insulated Cable Engineers Association, Inc. (ICEA).

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Quality Tests:
  - .1        Submit Site acceptance tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

**Part 2        Products**

**2.1            CABLE PROTECTION**

- .1        100mm wide detectable marking tape.

**Part 3        Execution**

**3.1            CABLE INSTALLATION IN DUCTS**

- .1        Install cables as indicated in ducts.
- .2        Install multiple cables in duct simultaneously.
- .3        Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.
- .4        To facilitate matching of colour coded multi-conductor control cables reel off in same direction during installation.
- .5        Before pulling cable into ducts and until cables are properly terminated, seal ends of lead covered cables with wiping solder; seal ends of non-leaded cables with moisture seal tape.
- .6        After installation of cables, seal duct ends with duct sealing compound.

**3.2            FIELD QUALITY CONTROL**

- .1        Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 74 00 - Cleaning.
- .3        Section 01 78 00 - Closeout Submittals.
- .4        Section 26 05 00 - Common Work Results for Electrical.

**1.2                REFERENCE STANDARDS**

- .1        CSA Group
  - .1        CAN3-C17, Alternating - Current Electricity Metering.
- .2        American National Standards Institute (ANSI)
  - .1        ANSI/IEEE C37.90A, Surge Withstand Capability Test.
- .3        Federal Communications Commission (FCC)
  - .1        FCC Title 47, Telecommunication.
- .4        International Electrotechnical Commission (IEC)
  - .1        IEC 61000-4, Electromagnetic Compatibility (EMC) Testing and Measurement Techniques.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for metering and switchboard instruments and include product characteristics, performance criteria, physical size, finish, and limitations.
  - .2        Include meter, instrument, outline dimensions, panel drilling dimensions, and installation cut-out template.

**1.4                CLOSEOUT SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 78 00 - Closeout Submittals.
- .2        O&M Manuals:
  - .1        Power meter product data manufacturer's instructions.

**Part 2      Products**

**2.1      DIGITAL METERING INSTRUMENT**

- .1      Microprocessor-based data collection and storage meter to monitor power conditions on main service as shown on the Drawings.
- .2      Meter to display true RMS value of:
  - .1      Amps    3-phase current.
  - .2      Volts    Line-to-line or line-to-neutral 3-phase voltage.
  - .3      kW      kilowatts.
  - .4      kVA     kilovoltamperes.
  - .5      Pf      power factor.
  - .6      F      frequency.
  - .7      kWd    kilowatt demand.
  - .8      Ad     amperes demand.
  - .9      kWh    kilowatt hours.
  - .10     Total kWh as an accumulating total, providing bi-directional (import/export) indication.
  - .11     Total kVARH (kilo-VAR-hours) as an accumulating total, providing bi-directional (import/export) indication.
  - .12     kW demand, user-programmable length of each demand period and the number of periods averaged to match local utility billing method.
  - .13     Amps demand.
  - .14     kVA demand, user-programmable length of each demand period, and the number of periods averaged to match local utility billing method.
  - .15     Total harmonic current and voltage.
  - .16     Individual harmonic true RMS current and voltage to the 63rd harmonic.
- .3      Each power meter to have:
  - .1      True RMS measurement.
  - .2      Fourth current input for measurement of ground or neutral current.
  - .3      Eight digital inputs for status/counter inputs, self-excited dry contact sensing, to remotely monitor breaker status, ground fault relay status, or any other dry contact input.
  - .4      Storage in non-volatile memory for the following:
    - .1      A time-stamped alarm and event log of up to 800 events, which records event date, time (to 0.001 sec), event type, and value for all over/under limit conditions, all status input activity, and all relay operations.
    - .2      A time-stamped minimum/maximum log, which records the value of any parameter exceeding the previous highest or lowest value recorded. Log to be read from the front panel display or via the communications port.

- .3 All setup data.
- .5 Waveform capture capability allowing any of the eight voltage and current input channels to be digitally sampled at 256 samples/60 Hz cycle. Waveform capture to be initiated using commands made via the communications port or event triggered. Waveform capture data is to be made accessible via the communications port.
- .6 LCD, 320 x 240 pixels resolution, backlight.
- .7 Serial communications ports:
  - .1 One RS-232C/RS-485, and one RS-485.
  - .2 Protocols: Modbus RTU.
  - .3 Baud rate: RS-232, 300 bps to 115,200 bps.
  - .4 Baud rate: RS-485, 300 bps to 57,600 bps.
- .8 Ethernet port:
  - .1 Protocols: Modbus TCP.
  - .2 10BaseT, 100BaseT, and/or 1000BaseT.
- .9 Field programmability as follows:
  - .1 Volts scale, volts mode (wye, delta, single phase), amps scale, Vaux scale, baud rate, TCP/IP address, and the relay operation are programmable from the front panel.
  - .2 All parameters in 10.1 above, plus additional alarm/event parameters may be programmed via the communications port using a portable terminal or a computer.
  - .3 Ensure programming is password protected and shared with the City.
- .10 Compliance with the following standards:
  - .1 ULC certified.
  - .2 CSA approved.
  - .3 Voltage, current, status, relay, and power inputs pass the ANSI/IEEE C37.90A surge withstand and fast transient tests.
  - .4 Certified to comply with FCC Part 15 Subpart B for Class A computing devices.
  - .5 Immunity to electrostatic discharge, radiated fields, fast transients, surges, conducted disturbances, power frequency magnetic fields, voltage dips and interruptions, and ring waves to IEC 61000-4 standards.
- .11 300 amps for one second surge protection on all four current inputs.
- .12 The following accuracy, resolution, range, and power supply ratings specifications:

Parameter	Accuracy	Resolution	Range
Volts (V1, V2, V3)	0.1%	0.1%	0 - 1,000,000 <sup>1</sup>
Amps (I1, I2, I3)	0.1%	0.1%	0 - 30,000
Neutral Current (I4)	0.4%	0.1%	0 - 9,999
kW	class 0.2	0.1%	0 - 1,000,000 <sup>2</sup>

Parameter	Accuracy	Resolution	Range
kVAR	class 0.2	0.1%	0 - 1,000,000 <sup>2</sup>
kVA	class 0.2	0.1%	0 - 1,000,000 <sup>2</sup>
Power Factor	0.2%	1.0%	1.0 to ±0.6
Frequency	0.005 Hz	0.1 Hz <sup>3</sup>	40 to 450 Hz
kW Demand	class 0.2	0.1%	0 - 1,000,000
Amps Demand	class 0.2	0.1%	0 - 30,000
kWH (-F, -R)	class 0.2	1 kWH	0 - 1,000,000,000
kVARH (-F, -R)	class 0.2	1 kVARH	0 - 1,000,000,000

- .1 Reads in kV for voltages over 9,999.
- .2 Reads in MVA, MW, MVAR for readings over 9,999 K.
- .3 One Hz resolution at 400 Hz range.
- .4 Power Supply
  - .1 85 to 250 VAC.
  - .2 Burden: 15 VA typical, 35 VA maximum.
  - .3 Record and store the following information in meter memory. Recall and reset stored data via meter controls and meter indicator.
    - .1 Volts max/min at 1 second interval.
    - .2 Amps max/min at 1 second interval.
    - .3 F max/min at 1 second interval.
    - .4 kW max/min at 1 second interval.
    - .5 Pf max/min (or kVA max/min) at one second interval.
    - .6 kWd at field programmable intervals of one minute to 30 minutes; set at one minute.
    - .7 Ad per kWd.
- .5 10BaseT, 100BaseT, and/or 1000BaseT communications port for connection to Ethernet network.
- .6 Field programmable for set-up and system variables.
- .7 Test terminal blocks as required.
- .8 Relay output signalling loss of phase. Relay to open on phase loss.
- .9 CSA approved.
- .10 Approved Product:
  - .1 Schneider Electric PowerLogic ION9000.
  - .2 Or approved equal in accordance with B7 of the Tender.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install instruments in existing equipment and ensure accessibility.



- .1 Installation to occur during facility shutdown in accordance with E5.
- .2 Ensure adequate spacing between current transformers installed on each phase.
- .3 Provide equipment identification as per Section 26 05 00 - Common Work Results for Electrical.

### **3.2 METERING INSTALLATION**

- .1 Install instruments and meters in locations as indicated.
- .2 Make connections in accordance with diagrams.
- .3 Connect meter and instrument transformer cabinets to ground.

### **3.3 FIELD QUALITY CONTROL**

- .1 Conduct tests in accordance with Section 26 05 00 - Common Work Results for Electrical and in accordance with manufacturer's recommendations.
- .2 Perform simulated operation tests with metering, instruments disconnected from permanent signal and other electrical sources.
- .3 Verify correctness of connections, polarities of meters, instruments, potential and current transformers, transducers, signal sources, and electrical supplies.
- .4 Perform tests to obtain correct calibration.
- .5 Do not dismantle meters and instruments.

### **3.4 CLEANING**

- .1 Proceed in accordance with Section 01 74 00 - Cleaning.
- .2 Progress Cleaning
  - .1 Leave Work area clean at end of each day.
- .3 Final Cleaning
  - .1 Upon completion remove surplus Materials, rubbish, tools, and equipment.

### **3.5 PROTECTION**

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

**END OF SECTION**

**Part 1        General**

**1.1            RELATED SECTIONS**

- .1        Section 01 33 00   Submittal Procedures.
- .2        Section 26 05 00 - Common Work Results for Electrical.

**1.2            SECTION INCLUDES**

- .1        Materials and components for dry type transformers up to 600 V primary, equipment identification and transformer installation.

**1.3            REFERENCES**

- .1        Canadian Standards Association (CSA International):
  - .1        CAN/CSA-C22.2 No.47, Air-Cooled Transformers (Dry Type).
  - .2        CSA C9, Dry-Type Transformers.
- .2        National Electrical Manufacturers Association (NEMA)

**1.4            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufactures product data sheets in accordance with Section 01 33 00 - Submittal Procedures.

**Part 2        Products**

**2.1            TRANSFORMERS**

- .1        Use transformers of one manufacturer throughout project and in accordance with CAN/CSA-C22.2 No.47.
- .2        600V Primary Transformers:
  - .1        Type: ANN.
  - .2        Phase and kVA as indicated on the drawings, 600V input, output as per drawings, 60 Hz.
  - .3        Voltage taps: 2.5 percent and 5 percent full capacity above and below normal.
  - .4        Windings: copper.
  - .5        Insulation: Class H, 220 degrees C
  - .6        Temperature rise: 115 degrees C at continuous full load.
  - .7        Basic Impulse Level (BIL): 10 kV.
  - .8        Hipot: 4kV.

- .9 Average sound level: To meet the local municipal and building codes and meet at minimum the following criteria:
  - .1 45 dB max. up to 45 kVA
  - .2 50 dB max. up to 150 kVA
- .10 Impedance at 170 degrees C: standard
- .11 Overload capability: Short-term overload per IEEE C57.96.
- .12 K-Factor power transformer in accordance with IEEE C57.110.
- .13 Enclosure:
  - .1 CSA enclosure type 12, or other as indicated on the Drawings.
  - .2 Exterior finish: ANSI 61 gray.
- .14 Refer to the Drawings for the preferred transformer mounting method.
  - .1 Where wall mounting is specified, provide the required manufacturer approved wall mount kit. Ensure that wall mounts are connected to the building structure, and that the facility is designed to handle the loads.
  - .2 Where floor mounting is specified via note or placement, provide 3.5 inch thick concrete housekeeping pad below transformer, extend the pad under the footprint of the transformer, plus a minimum of 2 inch beyond the transformer enclosure in all direction.
  - .3 Other mounting methods, such as steel transformer supports to be as detailed on the Drawings or as approved by the Contract Administrator.
- .15 Nameplate to include actual transformer impedance (%Z).
- .16 Finish and Environmental Rating: in accordance with Section 26 05 00 - Common Work Results - Electrical and E4 – Electrical System Hazards and Conditions.

## 2.2 EQUIPMENT IDENTIFICATION

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results - Electrical.
- .2 Label size: 7.
- .3 Nameplate for each transformer, example as follows:

XFMR-R741 30 kVA, 600 – 120/208V, 3Ø, 4W FED FROM MCC-R740
--

## Part 3 Execution

### 3.1 INSTALLATION

- .1 Mount dry type transformers as indicated on the Drawings. Provide brackets and bolts for wall mounted transformers. Ensure all transformers have good ventilation.

- .2 Ensure adequate clearance around transformer for ventilation.
- .3 Install transformers in level upright position.
- .4 Remove shipping supports only after transformer is installed and just before putting into service.
- .5 Loosen isolation pad bolts until no compression is visible.
- .6 Make primary and secondary connections in accordance with wiring diagram.
- .7 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers.
- .8 Make connections to transformers in flexible conduit, entering the enclosure below the coils.
- .9 Provide suitable ground and bond cables / connections to the transformer (even though this may not be explicitly shown on the Drawings) in accordance with code requirements. For three-phase, star grounded secondary transformers:
  1. Provide a separate green insulated ground conductor to the transformer star connection. Minimum size is #6 AWG in accordance with the CEC. Run ground conductor in a separate conduit, back to the main ground. Ensure conduit is bonded to ground at both ends, and electrically continuous.
  2. Provide a separate green insulated bond conductor connected to the enclosure frame, sized in accordance with CEC.
- .10 Energize transformers after installation is complete.
- .11 Adjust tap connections to give a continuous rated secondary voltage, under load.

### **3.2 TESTING**

- .1 Measure and record the voltage on the primary and secondary of the transformer. Adjust the tap position as required. Record final tap position and voltage.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 78 00 - Closeout Submittals.
- .3        Section 26 05 00 - Common Work Results for Electrical.

**1.2                REFERENCE STANDARDS**

- .1        CSA Group
  - .1        CSA C13-M83, Instrument Transformers.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

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

**1.4                CLOSEOUT SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 78 00 - Closeout Submittals.
- .2        O&M Manuals:
  - .1        Include control and signal transformers for incorporation into manual.

**1.5                MAINTENANCE MATERIALS**

- .1        Provide spare parts in accordance with Section 01 78 00 – Closeout Submittals and Part 2 of this section.
- .2        Provide one spare set of fuses of each type and rating used per facility.
- .3        Provide PT spare parts as per the manufacturer's recommendation.

**Part 2            Products**

**2.1                MOUNTING BRACKETS**

- .1        PT with channel type mounting brackets.
- .2        Fabricate brackets and channels from stainless steel.

**Part 3          Execution**

**3.1              INSTALLATION**

- .1      Install instruments in existing equipment and ensure accessibility.
- .2      Ensure adequate spacing between PT installed on each phase.
- .3      Provide equipment identification as per Section 26 05 00 - Common Work Results for Electrical.

**END OF SECTION**

**Part 1        General**

**1.1            SECTION INCLUDES**

- .1        Materials and installation for standard and custom breaker type panelboards.

**1.2            RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 78 00 - Closeout Submittals.
- .3        Section 26 05 00 - Common Work Results for Electrical.
- .4        Section 26 28 21 - Moulded Case Circuit Breakers.

**1.3            REFERENCE STANDARDS**

- .1        CSA International
  - .1        CSA C22.2 No.29, Panelboards and enclosed Panelboards.

**1.4            DEFINITIONS**

- .1        "kA" means kiloamps

**1.5            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Shop Drawings:
  - .1        Include electrical detail of panel, branch breaker type, quantity, ampacity, and enclosure dimension.

**1.6            CLOSEOUT SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 78 00 - Closeout Submittals.
- .2        O&M Manuals:
  - .1        Panelboard product data.

**Part 2        Products**

**2.1            PANELBOARDS**

- .1        Panelboards: to CSA C22.2 No.29 and product of one manufacturer.
  - .1        Install circuit breakers in panelboards before shipment.
  - .2        In addition to CSA requirements manufacturer's nameplate must show fault current that panel including breakers has been built to withstand and related arc flash rating.
- .2        600 V panelboards: bus and breakers rated for 18 kA (symmetrical) interrupting capacity or as indicated.

- .3 250 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity or as indicated.
- .4 Panelboard width to be less than 230 mm.
- .5 Integral SPD.
- .6 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase.
- .7 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated on Drawings.
- .8 Two keys for each panelboard and key panelboards alike.
- .9 Copper bus with neutral of same ampere rating as mains.
- .10 Mains: suitable for bolt-on breakers.
- .11 Trim with concealed front bolts and hinges.
- .12 Trim and door finish: baked grey enamel.
- .13 Approved model: Square D MVP NQ series or approved equal in accordance with B7 of the Tender.

## **2.2 BREAKERS**

- .1 Breakers: to Section 26 28 21 - Moulded Case Circuit Breakers.
- .2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.
- .3 Lock-on devices for fire alarm clock outlet, emergency, door supervisory, intercom, stairway, exit, and night light circuits.
- .4 Provide and install a minimum of two extra single pole 15 A breakers per panelboard.

## **2.3 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Complete circuit directory with typewritten legend showing location and load of each circuit.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Surface mount panelboards to match existing panelboard installations as required by Code or as indicated.
- .2 Connect loads to circuits.
- .3 Connect neutral conductors to common neutral bus with respective neutral identified.



- .4 Measure load current on each phase and adjust phase loading for a balanced system.

**END OF SECTION**

**Part 1      General**

**1.1          RELATED SECTIONS**

- .1      Section 01 33 00   Submittal Procedures.
- .2      Section 01 78 00   Closeout Submittals.
- .3      Section 26 05 00 - Common Work Results for Electrical.

**1.2          ACTION AND INFORMATIONAL SUBMITTALS**

- .1      Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2      Product Data:
  - .1      Submit product data sheets for sills, busbars, and compartments. Include product characteristics, physical size, and finish.
  - .2      Manufacturer's instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.
- .3      Shop Drawings:
  - .1      Outline dimensions.
  - .2      Configuration of identified compartments.
  - .3      Floor anchoring method and dimensioned foundation template.
  - .4      Cable entry and exit locations.
  - .5      Dimensioned position and size of busbars and details of provision for future extension.
  - .6      Schematic and wiring diagrams.
  - .7      Layout of all customer starter assemblies.
- .4      Installation Instructions: Clear guidelines for installation.

**1.3          CLOSEOUT SUBMITTALS**

- .1      Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures and Section and 01 78 00 – Closeout Submittals.
- .2      O&M Manuals:
  - .1      Provide As-Built Drawings and supplemental information.
  - .2      Include data for each type and style of starter.
- .3      Spare Parts:
  - .1      Submit spare parts as described in 2.16.3 of this section.
- .4      Wall Mounted Single Line Diagram:
  - .1      Provide a wall mounted as-built final copy of the Work's Single Line Diagram (Size A1: 594mm x 841mm) block mounted with a durable backing and UV-resistant sealed face.

**Part 2 Products**

**2.1 SUPPLY CHARACTERISTICS**

- .1 600 V, 600A, 60Hz, wye connected, 3 phase, 3 wire.

**2.2 GENERAL DESCRIPTION**

- .1 The MCC shall be provided with a factory wired and tested intelligent communication system. Provide network switches to accommodate internal connections between all starters, as well as field connections to facility PLC / automation system.
- .2 Compartmentalized vertical sections with common power busbars.
- .3 Floor mounting, free standing, enclosed dead front.
- .4 Gasketed NEMA enclosure rated for environment, front mounting.
- .5 Class IIS (custom, smart MCC), Type B-T as indicated on the Drawings.
- .6 Nameplates: white with black letters.
- .7 SCCR: 25 kA minimum.
- .8 Acceptable manufacturer:
  - .1 Schneider Electric Model 6 or approved equal in accordance with B7.

**2.3 VERTICAL SECTION CONSTRUCTION**

- .1 Independent vertical sections fabricated from rolled flat steel sheets bolted together to form rigid, completely enclosed assembly.
- .2 Dimensions: 2324 mm (91.5") high, 381 mm (15") deep and 508 mm (20") wide, except as noted on the Drawings.
- .3 Assemble sections into a group having a common power bus and forming an enclosure to which additional sections may be readily added.
- .4 Design for all power and control connections to be made from the front. All bus and feeder bolted connections shall be accessible from the front.
- .5 Sections with horizontal wiring spaces at the top and bottom and with 102 mm full height vertical wiring spaces complete with cable tie supports. Insulate wireways from horizontal and vertical bus.
- .6 Each vertical section divided into compartment units, minimum 152 mm high, as indicated.
- .7 Each unit to have complete top and bottom steel plate for isolation between units.
- .8 Horizontal wireways, equipped with cable supports, across top and bottom, extending full width of MCC, isolated from busbars by steel barriers.

- .9 Vertical wireways c/w doors for load and control conductors extending full height of vertical sections and equipped with cable tie supports. Installation wiring to units accessible with doors open and units in place.
- .10 Stab opening protection: Removable protective caps.
- .11 Isolation barriers between units and wireways.
- .12 Openings, with removable cover plates, in the side of the vertical sections for horizontal wiring between MCC sections.
- .13 Incoming cables to enter at bottom.
- .14 Provision for outgoing cables to exit via top and/or bottom.
- .15 Removable lifting means that can be removed after the equipment is in place.
- .16 Provision for future extension of both ends of MCC including busbars without need for further drilling, cutting, or preparation in field.
- .17 Divide assembly for shipment to Site, complete with hardware and instructions for re-assembly.
- .18 Provide all spaces complete with bussing hardware and other accessories required so that additional combination starter units can be readily installed. Provide barriers to isolate the space from all buswork.
- .19 Provide barriers to isolate all buswork to prevent accidental contact when starter units are removed or when prepared spaces are provided. Barriers shall also provide phase-to-phase isolation of the vertical bus.
- .20 Master nameplate lamacoid: text as shown on the Drawings.

## **2.4 SILLS**

- .1 Continuous channel iron floor sills for mounting bases with 19 mm diameter holes for bolts.

## **2.5 BUSBARS**

- .1 Main horizontal and branch vertical, three phase high conductivity, tin plated copper busbars in separate compartment bare self-cooled, extending entire width and height of MCC, supported on insulators and rated:
  - .1 Main horizontal busbars: 400 A.
  - .2 Branch vertical busbars: 200 A.
- .2 Branch vertical busbars for distribution of power to units in vertical sections.
- .3 No other cables, wires, equipment in main and branch busbar compartments.
- .4 Brace buswork to withstand effects of short-circuit current of 42 kA rms symmetrical.

- .5 Bus supports: with high dielectric strength, low moisture absorption, high impact material and long creepage surface designed to discourage collection of dust.
- .6 Location: Top.

## **2.6 GROUND BUS**

- .1 Copper ground bus extending entire width of MCC.
  - .1 Size: Full size.
  - .2 Plating: Tin plated.
  - .3 Location: Bottom.
- .2 Vertical ground bus, full height of section, tied to horizontal ground bus, engaged by plug-in unit ground stab.
  - .1 Material: tin plated copper.

## **2.7 TRANSIENT VOLTAGE SURGE SUPPRESSOR**

- .1 Supply and install a Transient Voltage Surge Suppressor (TVSS) where shown on the Drawings.
- .2 Requirements:
  - .1 TVSS units and all components shall be designed, manufactured, and tested in accordance with the latest applicable UL standard (ANSI/UL 1449 3rd Edition).
  - .2 Voltage: Refer to Drawings.
  - .3 Maximum Continuous Operating Voltage (MCOV): The MCOV shall not be less than 115 percent of the nominal system operating voltage. In cases where a neutral grounding resistor is part of the distribution, utilize minimum MCOV levels of 700V L-G and L-L. TVSS units shall be specifically designed for operation with an NGR.
  - .4 The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.
  - .5 Protection Modes – The TVSS must protect all modes of the electrical system being utilized. The required protection modes are:
    - .1 3Ø, 3W System:L-L, and L-G
    - .2 3Ø, 4W Wye System:L-L, L-N, L-G, and N-G
    - .3 1Ø, 3W Wye System:L-L, L-N, L-G, and N-G
  - .6 Nominal Discharge Current ( $I_n$ ) – All TVSSs applied to the distribution system shall have a 20kA  $I_n$  rating regardless of their TVSS Type (includes Types 1 and 2) or operating voltage. TVSSs having an  $I_n$  less than 20kA shall be rejected.

- .7 ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:
  - .1 L-N, L-G, N-G:
    - .1 120/208 V: 700V
    - .2 347/600 V: 1500V
  - .2 L-L:
    - .1 120/208 V: 1200V
    - .2 347/600 V: 3000V
- .3 TVSS Design:
  - .1 Maintenance Free Design – The TVSS shall be maintenance free and shall not require any user intervention throughout its life. TVSSs containing items such as replaceable modules, replaceable fuses, or replaceable batteries shall not be accepted. TVSSs requiring any maintenance of any sort such as periodic tightening of connections shall not be accepted. TVSSs requiring user intervention to test the unit via a diagnostic test kit or similar device shall not be accepted.
  - .2 Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable TVSS modules shall not be accepted.
  - .3 Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
  - .4 Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall utilize low impedance conductors.
  - .5 Monitoring Diagnostics – Each TVSS shall provide the following integral monitoring options:
    - .1 Protection Status Indicators - Each unit shall have a green / red solid-state indicator light that reports the status of each protection mode on each phase.
  - .6 The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
- .4 Overcurrent Protection
  - .1 The unit shall contain thermally protected MOVs. These thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from

the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

- .5 Surge Current Capacity – Refer to the Drawings for required capacity. The minimum surge current capacity the device is capable of withstanding shall be as shown:
  - .1 600V MCCs – Service entrance: 240 kA.
  - .2 600V MCCs – Not Service Entrance: 120 kA or greater.
- .6 Installation Requirements:
  - .1 The TVSS shall be installed immediately following the load side of the main breaker or main switch.
  - .2 The MCC shall be capable of re-energizing upon removal of the TVSS.
  - .3 Utilize a breaker, appropriately rated as directed by the TVSS manufacturer, to connect the TVSS to the MCC. The TVSS shall be located directly adjacent to the circuit breaker.
  - .4 The TVSS shall be included and mounted within the MCC by the manufacturer of the MCC where shown on the Drawings.
    - .1 The complete MCC including the TVSS shall be CSA/cUL listed.

## **2.8 COMMUNICATION CABLING**

- .1 The MCC shall employ a network communication cabling system to interconnect units within the MCC.
- .2 Network cabling shall be routed through the lower horizontal wireway to isolate the network from the horizontal bussing routed through the top.
- .3 A communication barrier in the full-depth vertical wireway shall serve to separate communications from power cabling and to prevent noise interference on the network cable.
- .4 Provisions for appropriate terminators and grounding shall be provided.
- .5 Addition, removal, or rearrangement of units shall not interrupt the trunk line and shall not affect the cabling of other units attached to the trunk line.
- .6 Cable coupler design shall include a vibration-resistant ratchet to prevent loosening.
- .7 The cabling is to be configured in a star configuration.
- .8 Cabling shall be Category 6 shielded twisted pair Ethernet cable with RJ45 connector.
- .9 Ethernet cable insulation rating shall be 600V minimum.

## **2.9 NETWORK SWITCHES**

- .1 Type: managed switch.
- .2 Speed: 100 Mbit or gigabit as required.

- .3 Port quantity: as indicated on the Drawings.
- .4 Power supply: 24 VDC.
  - .1 Provide redundant power supplies for each network switch. Two 24 VDC supplies, fed from separate transformers and separate fused disconnects. One will be fed from a control power transformer within the MCC and one fed from the UPS. Each supply shall be brought into the network switches. The UPS feed shall be used to normally power the network switches. Provide dual power input network switches.
- .5 Include: network switch power supplies - one shall be fed from a control power transformer within the MCC and one fed from the UPS.

## **2.10 MOTOR STARTERS AND DEVICES**

- .1 Equip the MCC with intelligent motor starters as specified and shown on the Drawings.
- .2 Refer to Section 26 29 10 – Motor Starters to 600 V.

## **2.11 STARTER UNIT COMPARTMENTS**

- .1 Units EEMAC size 5 and smaller, circuit breaker units 225A and smaller, plug-in type with self-disconnect. Guide rail supports for units to ensure that stabs make positive contact with vertical bus. Provision for units to be installed or removed, off load, while buses energized.
- .2 Unit mounting:
  - .1 Engaged position - unit stabbed into vertical bus.
  - .2 Withdrawn position - unit isolated from vertical bus but supported by structure.
  - .3 Provision for positive latching in either engaged or withdrawn position and padlocking in withdrawn position.
  - .4 Stab-on connectors free-floating tin-plated clips, self-aligning, backed up with steel springs.
- .3 External operating handle of circuit switch interlocked with door to prevent door opening with switch in "on" position. Provision for padlock to lock operating handle in "off" position and lock door closed.
- .4 Hinge unit doors on same side.
- .5 Overload relays manually reset from front with door closed.
- .6 Pushbuttons and indicating lights mounted on door front.
- .7 Devices and components by one manufacturer to facilitate maintenance.
- .8 Pull-apart terminal blocks for power and control to allow removal of starter units without removal of field wiring.



- .9 Control wiring shall be extended from each starter module to the control terminal section, including all auxiliary contacts. A multi unit style terminal block having screw type terminal connections shall be installed on standoff supports on back plate.
- .10 All terminals shall be number coded or otherwise suitably identified to indicate which section or module of the MCC they are associated with and their function.
- .11 Complete control wiring diagrams for each starter with conductor identification clearly shown shall be affixed to the interior cover of the starter section or provide a book of wiring diagrams for all starters in each MCC. Submit as part of Shop-Drawing submittal.
- .12 Primary and secondary high rupturing capacity (HRC) fusing shall be installed on the control transformer.
- .13 Equip door of each individual unit with a removable plate replaceable with similar plate complete with pushbuttons, pilot lights, or selector switches as required. Use pilot lights of push-to-test type and push button of heavy-duty oil tight construction.

## **2.12 WIRING IDENTIFICATION**

- .1 Provide wiring and cable identification in accordance with Section 26 05 00 - Common Work Results for Electrical and in accordance with the Drawings.

## **2.13 EQUIPMENT IDENTIFICATION**

- .1 Identify MCC with nameplates as follows:
  - .1 Nameplates:
    - .1 Lamacoid 3 mm thick plastic lamacoid nameplates, white face, black lettering, mechanically attached with self tapping screws.
  - .2 Nameplate Sizes:
    - .1 MCC main nameplate:  
70 x 120 mm 1 line 40 mm high letters.
    - .2 Individual compartment nameplate:  
70 x 120 mm 1 line 40 mm high letters.
  - .3 Wording on nameplates to be approved by the Contract Administrator prior to manufacture.
  - .4 Allow for average of 25 letters per nameplate.
  - .5 Identification to be English.

## **2.14 FINISHES**

- .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
  - .1 Paint indoor switchgear and distribution enclosures light grey to ANSI 61 grey enamel, unless otherwise specified.

- .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during construction.
- .3 Clean and prime exposed non-galvanized hangers, racks, and fastenings to prevent rusting.
- .4 Paint motor control centre exterior light gray and interiors white.

## **2.15 SPACE FOR MOUNTING PLC'S**

- .1 Provide space for mounting of PLC's as indicated on the drawings.

## **2.16 SOURCE QUALITY CONTROL**

- .1 **Submit, within a minimum of fourteen (14) Calendar Days prior to the proposed date of tests, four (4) copies of manufacturer's routine factory test procedures and production line tests for all motor control centers.**
- .2 Each item of equipment supplied under this Contract is given the manufacturer's routine factory tests and tests as specified below, to insure successful operation of all parts of the assemblies. All tests required herein is witnessed by the Contract Administrator unless waived in writing, and no equipment shipped until it has been approved for shipment by the Contract Administrator. Notify the Contract Administrator a minimum of fourteen (14) Calendar Days prior to the proposed date of the tests so that arrangements can be made for the Contract Administrator to be present at the tests. The factory test equipment and the test methods used conforms to the applicable NEMA Standards and is subject to the approval of the Contract Administrator. Reports of all witnessed tests are signed by witnessing representatives of the Contractor and Contract Administrator. Bear the cost of performing all tests.
- .3 Motor Control Centers Tests
  - .1 Dielectric Tests: Completely assemble the motor control center and perform dielectric tests in accordance with NEMA ICS 1.
  - .2 Operational Tests: Check the correctness of operation of each air circuit breaker, motor circuit protector, and magnetic contactor and of all control devices, accessories and indicating lamps. These checks are made at rated voltage with power supplies to the main buses. Check all magnetic contactors for proper operation with power at 90 percent of rated voltage.
  - .3 Short Circuit Tests: Unit to be ULC labeled.
  - .4 Test Results: Submit four (4) complete reproducible copies of the factory inspection results and the factory test results, including all plotted data curves, all test conditions, a listing of test equipment complete with calibration certifications, and all measurements taken. Contractor's and Contract Administrator to sign and date report. Provide Motor Control Center certification signed by official authorized to certify on behalf of the manufacturer, attesting that the motor control center meets the specified requirements. Ensure the statement is dated after the award of this Contract, stating the Contractors name and address, name of the project and location, and list the specific requirements which are being certified.

**2.17 SPARE PARTS**

- .1 One set of fuses of each type and size.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Set and secure MCC in place on channel bases, rigid, plumb, and square to building floor and wall.
- .2 Make field power and control connections as indicated.
- .3 Ensure correct overload settings are applied.

**3.2 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical and as follows:
- .2 Perform all applicable inspections and electrical tests, including optional tests, in accordance with NETA ATS. Engage a factory-authorized service representative to perform start-up services. Verify complete system operation including all hardware, software and communication devices. Start units to confirm proper motor rotation and unit operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment. Perform final equipment adjustments:
  - .1 Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload relay pickup and trip ranges.
  - .2 Adjust overload relay, heaters, and settings for power factor correction capacitors connected to the load side of the overload relays.
  - .3 Adjust the trip settings of motor circuit protectors and thermal-magnetic circuit breakers with adjustable.
  - .4 Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage, solid state controllers.
- .3 Final acceptance depends upon the satisfactory performance of the motor-control centers under test. Do not energize the motor-control center until recorded test data have been approved by the Contract Administrator. Provide full test reports.
- .4 Ensure moving and working parts are lubricated where required.
- .5 Operate starters in sequence to prove satisfactory performance of MCC during eight-hour period.
- .6 Securely mount the final as-built Single Line Diagram to an internal wall of the facility. Coordinate location with the Contract Administrator.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 26 05 00 - Common Work Results for Electrical.

**1.2 REFERENCE STANDARDS**

- .1 CSA Group
  - .1 CSA C22.2 No.42, General Use Receptacles, Attachment Plugs and Similar Devices.
  - .2 CAN/CSA C22.2 No.42.1, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).
  - .3 CSA C22.2 No.55, Special Use Switches.
  - .4 CSA C22.2 No.111, General-Use Snap Switches (Bi-national standard, with UL 20).

**Part 2 Products**

**2.1 GENERAL**

- .1 Switches, receptacles, and cover plates from one manufacturer throughout Work.

**2.2 SWITCHES**

- .1 20 A, 120 V, single pole, double pole, three-way, four-way switches to: CSA C22.2 No.55 and CSA C22.2 No.111.
- .2 Manually-operated specification grade AC switches with following features:
  - .1 Terminal holes approved for No. 10 AWG wire.
  - .2 Silver alloy contacts.
  - .3 Urea or melamine moulding for parts subject to carbon tracking.
  - .4 Suitable for back and side wiring.
  - .5 Ivory toggle.
- .3 Toggle operated locking fully rated for tungsten filament and fluorescent lamps, and up to 80 percent of rated capacity of motor loads.
- .4 Acceptable manufacturer:
  - .1 Hubbell or approved equal in accordance with B7 of the Tender.

**2.3 RECEPTACLES**

- .1 Duplex receptacles, CSA type 5-15 R, 125 V, 15 A, U ground, to: CSA C22.2 No.42 with following features:
  - .1 Specification grade.

- .2 Heavy duty nylon face with steel reinforcing plate in centre.
  - .3 Suitable for No. 10 AWG for back and side wiring.
  - .4 Break-off links for use as split receptacles.
  - .5 Eight back wired entrances, four side wiring screws.
  - .6 Triple wipe contacts and riveted grounding contacts.
- .2 Single receptacles CSA type 5-15 R, 125 V, 15 A, U ground with following features:
- .1 Heavy duty nylon face with steel reinforcing place in centre.
  - .2 Suitable for No. 10 AWG for back and side wiring.
  - .3 Four back wired entrances, two side wiring screws.
- .3 Other receptacles with ampacity and voltage as indicated.
- .4 Acceptable manufacturer:
- .1 Hubbell 8200, 8210, or approved equal in accordance with B7 of the Tender.

## **2.4 COVER PLATES**

- .1 Cover plates for wiring devices to: CSA C22.2 No.42.1.
- .2 Weatherproof steel utility box cover for wiring devices installed in surface-mounted utility boxes.
- .3 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.
- .4 Weatherproof spring-loaded cast aluminum cover plates complete with gaskets for single receptacles or switches.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Switches:
  - .1 Install single throw switches with handle in "UP" position when switch closed.
  - .2 Install switches in gang type outlet box when more than one switch is required in one location.
  - .3 Mount toggle switches at height in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Receptacles:
  - .1 Install receptacles in gang type outlet box when more than one receptacle is required in one location.
  - .2 Mount receptacles at height in accordance with Section 26 05 00 - Common Work Results for Electrical.

- .3 Where split receptacle has one portion switched, mount vertically and switch upper portion.
- .3 Cover plates:
  - .1 Install weatherproof suitable common cover plates where wiring devices are grouped.
  - .2 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

**END OF SECTION**

**Part 1        General**

**1.1            SECTION INCLUDES**

- .1        Materials for moulded-case circuit breakers.

**1.2            RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 78 00 - Closeout Submittals.
- .3        Section 26 05 00 - Common Work Results for Electrical.

**1.3            REFERENCE STANDARDS**

- .1        CSA International
  - .1        CSA-C22.2 No. 5, Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures (Tri-national standard with UL 489, tenth edition, and the second edition of NMX-J-266-ANCE).

**1.4            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Include time-current characteristic curves for breakers with ampacity of 90A and over or with interrupting capacity of 22,000 A symmetrical RMS and over at system voltage.

**1.5            MAINTENANCE MATERIALS**

- .1        Provide spare parts in accordance with Section 01 78 00 – Closeout Submittals and Part 2 of this section.
- .2        Provide minimum two (2) spare 15A circuit breakers per provided panel.

**Part 2        Products**

**2.1            BREAKERS GENERAL**

- .1        Moulded-case circuit breakers and circuit breakers to CSA C22.2 No. 5.
- .2        Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- .3        Circuit breakers shall have an over center, trip free, toggle operating mechanism which shall provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.
- .4        Moulded case circuit breakers shall be bolt-on, quick-make, quick-break type, for manual and automatic operation with temperature compensation for 40 degrees Celsius ambient.

- .5 Breakers to be mounted using manufacturer approved breaker mounting accessories.
- .6 Common-trip breakers: with single common handle for multi-pole applications.
- .7 Branch circuit breakers shall have a minimum interrupting capacity as indicated on the Drawings. Breakers shall have the same interrupting rating as that indicated for the panelboard, on the panelboard schedules. Series rated breakers will not be accepted.
- .8 Moulded case circuit breakers shall operate automatically by means of trip element devices to provide inverse time current tripping.
- .9 The circuit breaker handle shall reside in a tripped position between on and off to provide local trip indication. Circuit breaker escutcheon shall be clearly marked on and off.
- .10 Protective devices shall be suitable for use with 75°C or greater wire insulation systems and Canadian Electrical Code 75°C conductor ampacity.
- .11 The maximum ampere rating, CSA standards with applicable voltage systems and corresponding interrupting ratings, shall be clearly marked on the face of the circuit breaker.
- .12 Circuit breakers shall be factory sealed, with an installed hologram quality mark and shall have a date code on the face of the circuit breaker.
- .13 All equipment and components must be supplied through a manufacturer approved distribution channel. Equipment shall be supported, guaranteed, and traceable through the equipment manufacturer channels. Equipment procured from an unauthorized third party will be rejected.
- .14 Breakers shall be manufacturer approved, tested, and CSA approved for use within the panelboard or distribution equipment that it is installed within.
- .15 Magnetic instantaneous trip elements in circuit breakers to operate only when value of current reaches setting.
  - .1 Trip settings on breakers with adjustable trips to range from three to eight times current rating.
- .16 Circuit breakers to have minimum symmetrical RMS interrupting capacity rating matching the panelboard or switchboard containing breaker as required per the short circuit coordination study which will be provided by the Contract Administrator.
  - .1 The Contractor shall request the short circuit coordination study after award of the Contract.

## **2.2 THERMAL MAGNETIC BREAKERS [DESIGN A]**

- .1 Moulded case circuit breaker to operate automatically by means of thermal and magnetic tripping devices to provide inverse time current tripping and instantaneous tripping for short circuit protection.

## **2.3 MAGNETIC BREAKERS [DESIGN B]**

- .1 Moulded case circuit breaker to operate automatically by means of magnetic tripping devices to provide instantaneous tripping for short circuit protection.



**2.4 SOLID STATE TRIP BREAKERS [DESIGN D]**

- .1 Moulded case circuit breaker to operate by means of solid-state trip unit with associated current monitors and self-powered shunt trip to provide inverse time current trip under overload condition, and long time, short time, instantaneous tripping for phase and ground fault short circuit protection.

**Part 3 Execution**

**3.1 INSTALLATION**

- .1 Install circuit breakers as indicated.
- .2 Circuit breakers to match existing panels.
- .3 Set adjustable trip settings according to the short circuit coordination study provided by Contract Administrator.
  - .1 The Contractor shall request the short circuit coordination study after award of the Contract.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 33 00 - Submittal Procedures.
- .2        Section 01 78 00 - Closeout Submittals.
- .3        Section 26 05 00 - Common Work Results for Electrical.

**1.2                REFERENCE STANDARDS**

- .1        CSA Group
  - .1        CSA C22.2 No.14-, Industrial Control Equipment.
- .2        NEMA® standard
  - .1        NEMA ICS 1, Industrial Control and Systems: General Requirements.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Submit manufacturer's instructions, printed product literature and data sheets for control devices and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3        Shop Drawings:
  - .1        Include schematic, wiring, and interconnection diagrams.

**1.4                CLOSEOUT SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 01 78 00 - Closeout Submittals.
- .2        O&M Manuals:
  - .1        Submit operation and maintenance data for control devices for incorporation into manual.

**1.5                MAINTENANCE MATERIALS**

- .1        Provide one spare plug-in type relay for each panel in which new relays are installed.

**Part 2            Products**

**2.1                AC CONTROL RELAYS**

- .1        Control relays: to CSA C22.2 No.14.
- .2        Fixed contact plug-in type: general purpose heavy duty with two poles.

- .3 Coil rating: 120 V or 24 VDC as specified.
- .4 Contact rating: 240 V, 2 A.

## **2.2 RELAY ACCESSORIES**

- .1 Standard contact cartridges: normally-open - convertible to normally-closed in field.

## **2.3 OILTIGHT LIMIT SWITCHES**

- .1 Snap action type: fork, roller, rod, lever, wobble stick, top, side, push actuator, CSA type 4 enclosure.
- .2 Contact rating: 240 V, 2 A.

## **2.4 SOLID STATE TIMING RELAYS**

- .1 Construction: AC and DC operated electronic timing relay with solid-state timing circuit to operate output contact.
- .2 Operation: on-delay or off-delay.
- .3 Potentiometer: self-contained to provide time interval adjustment.
- .4 Supply voltage: 24 VDC or 120 VAC 60 Hz.
- .5 Temperature range: minus 20 degrees Celsius to plus 60 degrees Celsius.
- .6 Output contact rating: maximum voltage 300 V AC or DC.
- .7 Current: [NEMA ICS 1] A.
- .8 Timing ranges: minimum 0.1 seconds, maximum five minutes.

## **2.5 CONTROL AND RELAY PANELS**

- .1 CSA Type 12 sheet steel enclosure with hinged padlockable access door, accommodating control equipment, labels, as indicated, factory installed, and wired to identified terminals.

## **Part 3 Execution**

### **3.1 EXAMINATION**

- .1 Verification of conditions: verify that conditions of substrate previously installed under other sections or contracts are acceptable for control devices installation in accordance with manufacturer's written instructions.
  - .1 Visually inspect substrate.
  - .2 Inform the Contract Administrator of unacceptable conditions immediately upon discovery.
  - .3 Proceed with installation only after unacceptable conditions have been remedied.

**3.2           INSTALLATION**

- .1       Install pushbutton stations, control and relay panels, control devices, and interconnect.

**3.3           FIELD QUALITY CONTROL**

- .1       Perform tests in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2       Depending upon magnitude and complexity, divide control system into convenient sections, energize one section at time, and check out operation of section.
- .3       Upon completion of sectional test, undertake group testing.
- .4       Check out complete system for operational sequencing.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1        Section 01 33 00    Submittal Procedures.
- .2        Section 01 78 00    Closeout Submittals.
- .3        Section 26 05 00 - Common Work Results for Electrical.

**1.2                ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Provide manufacturer's printed product literature, specifications, and datasheet and include product characteristics, performance criteria, physical size, finish, and limitations.
- .3        Shop Drawings:
  - .1        Provide Shop Drawings for each type of starter to indicate:
    - .1        Mounting method and dimensions.
    - .2        Starter size and type.
    - .3        Layout and components.
    - .4        Enclosure type.
    - .5        Wiring diagrams.
    - .6        Terminal block layout and connections.

**1.3                CLOSEOUT SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures and Section and 01 78 00 – Closeout Submittals.
- .2        Submit spare parts as indicated in part 2.8 of this section and in accordance with Section 01 78 00 – Closeout Submittals.

**Part 2            Products**

**2.1                GENERAL**

- .1        Starters: to NEMA ICS 2-2000.
- .2        Equipment Identification:
  - .1        Refer to Section 26 05 00 – Common Work Results for Electrical
  - .2        Colour: White nameplate, black letters.
  - .3        Text Size: 8mm high letters.
  - .4        Text as shown on the Drawings.

- .3 Control Wiring:
  - .1 Tin Plated Copper, 16 AWG, TEW unless otherwise indicated.
- .4 Wire Identification:
  - .1 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram. Markings are to be computer generated.
- .5 Device Identification:
  - .1 Door-mounted indicating lights, push buttons, selector switches, as indicated on the Drawings. Identification to be lamacoids.
  - .2 On the door interior, install identification labels adjacent to each pilot device containing the identifier of the pilot device (e.g. HS-EF-G1). The identification is to be provided by a lamacoid.
  - .3 Internal components such as contactors and relays must be identified by a lamacoid. Relays composed of a base and removable relay are to be identified on the base or enclosure back-panel rather than on the removable relay component.
- .6 Finishes:
  - .1 Shop finish metal enclosure surfaces by application of rust resistant primer inside and outside, and at least two coats of finish enamel.
    - .1 Paint indoor switchgear and distribution enclosures light grey to ANSI 61 grey enamel, unless otherwise specified.
  - .2 Clean and touch up surfaces of shop-painted equipment scratched or marred during construction.
    - .1 Clean and prime exposed non-galvanized hangers, racks, and fastenings to prevent rusting.

## **2.2 MANUAL MOTOR STARTERS**

- .1 Single or Three-phase manual motor starters of size, type, rating, and enclosure type as indicated, with components as follows:
  - .1 Switching mechanism, quick make and break.
  - .2 One or Three overload heaters as required, manual reset, trip indicating handle.
- .2 Accessories:
  - .1 Toggle switch: heavy duty labelled as indicated.
  - .2 Indicating light: heavy duty type and red in colour.
  - .3 Locking tab to permit padlocking in "ON" or "OFF" position.

## **2.3 FULL VOLTAGE MAGNETIC STARTERS**

- .1 UL/CSA listed, NEMA size as shown on the Drawings.
  - .1 Smallest size of starter: NEMA size 1, unless otherwise indicated.
  - .2 IEC rated starters are not acceptable.

- .2 Magnetic of size, type, rating, and enclosure type as indicated with components as follows:
  - .1 The Short Circuit Current Rating (SSCR) of the assembly must equal or exceed 25 kA.
  - .2 Combination style motor starter, with instantaneous overcurrent protection, starter contactor, overload protection.
  - .3 All coils to be epoxy coated.
  - .4 Transient suppressors shall be supplied for all coils in each individual starter unit.
  - .5 Contactor solenoid operated, rapid action type.
  - .6 Smart motor starter contactor / overload protective device:
    - .1 Electronic overloads, manually reset from outside enclosure.
    - .2 Modbus TCP over Ethernet communications.
  - .7 Wiring and schematic diagram inside starter enclosure in visible location.
  - .8 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
  - .9 Transient suppressors shall be supplied for all coils in each individual starter unit.
  - .10 Motor overload protective device in each phase, manually reset from outside enclosure.
  - .11 Wiring and schematic diagram inside starter enclosure in visible location.
  - .12 Identify each wire and terminal for external connections, within starter, with permanent number marking identical to diagram.
- .3 Accessories:
  - .1 Selector switches: heavy-duty oil tight labelled as indicated.
  - .2 Indicating lights: heavy-duty oil tight type and color as indicated.
  - .3 1-N/O spare auxiliary contact.
- .4 Approved manufacturers:
  - .1 Schneider TeSys T or approved equal in accordance with B7.

## **2.4 CONTROL TRANSFORMER**

- .1 Single phase, dry type, control transformer with primary voltage as indicated and 120 V secondary, complete with primary and secondary fuses, installed in with starter as indicated.
- .2 Size control transformer as indicated and as necessary to support the system controls.

## **2.5 ACCESSORIES**

- .1 Pushbutton: heavy duty, oil tight as required.
- .2 Selector switches: heavy duty, oil tight as required.
- .3 Indicating lights: heavy duty, oil tight, type and colour as indicated.

## **2.6 FINISHES**

- .1 Apply finishes to enclosure in accordance with Section 26 05 00 - Common Work Results for Electrical.

## **2.7 EQUIPMENT IDENTIFICATION**

- .1 Provide equipment identification in accordance with Section 26 05 00 - Common Work Results for Electrical.
- .2 Starter designation label, white plate, black letters, size 5 or larger as needed to accommodate 8mm text, engraved to indicate the equipment tag, as well as the equipment description.
- .3 Manual starter designation label, white plate, black letters, size 1.

## **2.8 SPARE PARTS**

- .1 Fuses: two of each rating.
- .2 Two indicating lamp bulbs of each type.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install starters and control devices in accordance with manufacturer's instructions.
- .2 Install and wire starters and controls as indicated.
- .3 Ensure correct fuses are installed.
- .4 Confirm motor nameplate and adjust / replace overload device to suit.

### **3.2 MOTOR STARTER TESTING**

- .1 Perform complete testing of motor starter operation, including but not limited to simulating a module fault to ensure the starter can be reset and put back into operation.
- .2 Submit test results to the Contract Administrator.
- .3 Confirm each motor rotates in the same direction as it did before construction. Capture all motor running directions before beginning construction.

### **3.3 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with manufacturer's instructions.
- .2 Operate switches and contactors to verify correct functioning.
- .3 Perform starting and stopping sequences of contactors and relays.



- .4 Check that sequence controls, interlocking with other separate related starters, equipment, control devices, operate as indicated.

**END OF SECTION**

**Part 1        General**

**1.1            REFERENCES**

- .1 (ANSI/IEEE)
  - .1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in LowVoltage AC Power Circuits.
  - .2 ASTM International Inc.
    - .1 ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.
  - .3 Canadian Standards Association (CSA International).
  - .4 ICES-005-07, Radio Frequency Lighting Devices.
  - .5 Underwriters' Laboratories of Canada (ULC).
  - .6 IESNA LM-79 and LM-80

**1.2            ACTION AND INFORMATIONAL SUBMITTALS**

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

**Part 2        Products**

**2.1            LAMPS**

- .1 All lamps to be LED and integral to luminaires.

**2.2            DRIVERS**

- .1 All drivers shall be supplied with rated voltage matching the supply voltage indicated on the drawings and output current and voltage ratings of the LED's they are designed to operate.
- .2 Long life, 60,000 hours minimum.

**2.3            LUMINAIRES**

- .1 Refer to luminaire schedule on the Drawings for acceptable products.
- .2 Luminaires and all related controls equipment must be CSA approved.
- .3 Minimum complete, replacement – five-year warranty on all components.

- .4 Compliance with IESNA LM-79 and LM-80.
- .5 Acceptable manufacturers and models:
  - .1 As indicated in luminaire schedule on the Drawings.

## **2.4 FINISHES**

- .1 Light fixture finish and construction to meet ULC listings and CSA certifications related to intended installation.

## **2.5 OPTICAL CONTROL DEVICES**

- .1 As indicated in luminaire schedule.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Locate and install luminaires as indicated on the Drawings.
- .2 Provide adequate supports to suit ceiling and wall mounted luminaires. Provide fixture mounting kits in accordance with manufacturer recommendations.
- .3 Replace any fixtures damaged throughout the construction.
- .4 Install a permanent label or lamacoid for all luminaires indicating the circuits contained within.
  - .1 Example R741-01 (Panelboard PNL-R741, circuit 01).

### **3.2 WIRING**

- .1 Connect luminaires to lighting circuits:
  - .1 Provide wiring to luminaires run in conduit system, refer to section 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings.
  - .2 Provide separate bonding conductor.
  - .3 Provide separate neutral for all lighting circuits.

### **3.3 LUMINAIRE SUPPORTS**

- .1 Support luminaires in accordance with manufacturer recommendations and in accordance with the Drawings.

### **3.4 LUMINAIRE ALIGNMENT**

- .1 Align luminaires mounted in continuous rows to form straight uninterrupted line.
- .2 Align luminaires mounted individually parallel or perpendicular to building grid lines.

**3.5 CLEANING**

- .1 Clean in accordance with Section 01 74 00 - Cleaning.
  - .1 Remove surplus materials, excess materials, rubbish, tools, and equipment.
- .2 Remove surplus materials, excess materials, rubbish, tools, and equipment.
- .3 Clean lenses and remove dust / debris from the luminaires.

**END OF SECTION**

**Part 1        General**

**1.1            SECTION INCLUDES**

- .1        Materials and installation for emergency lighting systems.

**1.2            REFERENCE STANDARDS**

- .1        Canadian Standards Association (CSA International):
  - .1        CSA C22.2 No.141 (2015), Unit Equipment for Emergency Lighting.

**1.3            ACTION AND INFORMATIONAL SUBMITTALS**

- .1        Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Product Data:
  - .1        Data to indicate system components, mounting method, source of power, and special attachments.

**Part 2        Products**

**2.1            EQUIPMENT**

- .1        Emergency lighting equipment: to CSA C22.2 No.141.
- .2        Supply voltage: 120 VAC.
- .3        Output voltage: 12 VDC.
- .4        Operating time: as shown in schedule on Drawings.
- .5        Provide "autotest" feature for all battery banks.
- .6        Battery: sealed, maintenance free.
- .7        Charger: solid state, multi-rate, voltage/current regulated, inverse temperature compensated, short circuit protected with regulated output of plus or minus 0.01V for plus or minus 10 percent input variations.
- .8        Solid state transfer circuit.
- .9        Low voltage disconnect: solid state, modular, operates at 80% battery output voltage.
- .10      Signal lights: solid state, for 'Fault'.
- .11      Lamp heads: integral on unit and remote, 345 degrees horizontal and 180 degrees vertical adjustment. Lamp type: LED.
- .12      Cabinet: suitable for direct or shelf mounting to wall and c/w knockouts for conduit. Removable or hinged front panel for easy access to batteries.

- .13 Finish: white.
- .14 Auxiliary equipment:
  - .1 Test switch.
  - .2 Battery disconnect device.
- .15 Acceptable manufacturers and models:
  - .1 As indicated on the Emergency Lighting Schedule, located on the Drawings.

## **2.2 WIRING OF REMOTE HEADS**

- .1 Conductors: RW90 type in accordance with Section 26 05 21 - Wires and Cables (0-1000 V), sized to accommodate voltage drop.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install unit equipment and remote mounted fixtures in locations indicated on the Drawings.
- .2 Demonstrate emergency lighting operation and coverage for the full duration run time, in the presence of the Contract Administrator.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1        Supply, install, and commissioning a complete PLC upgrade for panel as shown on the Drawings and as specified herein.
- .2        Component subsystems of the SCADA system and PLC upgrade will include, but are not limited to, the following:
  - .1        Station fibre optic network.
  - .2        PLC and RIO modules.
  - .3        Primary elements and transmitters.
  - .4        Final control elements.
  - .5        Instrumentation cabling.
  - .6        Instrumentation power supplies.
  - .7        Conduit and cable tray.
  - .8        All other items shown or implied on the Drawings and described herein.
- .3        Where packaged, stand-alone control systems are supplied by others provide cabling to connect to the required remote monitoring and/or control functions. Provide end-to-end commissioning of all required remote monitoring and/or control functions. Assist in ensuring the correct functionality of any equipment supplied by others.

**1.2                RELATED SECTIONS**

- .1        Part E – Specifications
- .2        Division 1 – General Requirements
- .3        Section 01 33 00 - Submittal Procedures.
- .4        Section 01 61 00 - Common Product Requirements
- .5        Division 26 - Electrical.

**1.3                REFERENCE STANDARDS**

- .1        This division contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section, and those of the listed documents, the requirements of this section prevail.
  - .1        IEEE 100, Dictionary of Electrical and Electronic Terms
  - .2        ISA S5.4, Instrument Loop Diagrams
  - .3        ISA S18.1, Annunciator Sequences and Specifications
  - .4        ISA S51.1, Process Instrumentation Terminology
  - .5        NEMA 250, Enclosures for Industrial Controls and Systems
  - .6        NEMA ICS 1, General Standards for Industrial Control and Systems
  - .7        NEMA ICS 2, Industrial Control Devices, Controllers, and Assemblies
  - .8        NFPA 70, National Electrical Code (NEC)

- .9 SAMA PMC 17-10, Bushings and Wells for Temperature Sensing Elements
- .10 UL 1012, Power Supplies

#### **1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings
- .3 Location Drawings
  - .1 Indicate in plan and/or elevation views where the instrument elements are physically located. These Drawings are provided to assist the Contractor in estimating the amount of cable and ducting required.
- .4 Standard Details
  - .1 Provide a reference for installation, operation, and other instructions pertinent to a particular device.
- .5 Detailed Specification
  - .1 Provide lists qualifications, quality of Materials and workmanship, and supplementary information.

#### **1.5 DEFINITIONS**

- .1 Interpret specialized terms not explicitly defined herein in accordance with ISA-S51.1, NEMA-ICS-1, ANSI/IEEE-Std-100, and The Communications Standard Dictionary, by Martin H. Weik.

#### **1.6 QUALIFICATIONS**

- .1 The instrumentation Subcontractor shall be a firm normally engaged and fully competent in the type of Work described in Division 29 - Instrumentation and Control. The firm shall have been continuously and successfully engaged in this business for at least five years.
- .2 Qualified journeyman instrument mechanics that are familiar with the devices being installed shall perform all instrument hook-ups, calibrations, and checkouts.
- .3 Qualified journeyman electricians shall perform all control wiring installation and connections.

#### **1.7 CODES, RULES, PERMITS, AND FEES**

- .1 Comply with all laws, ordinances, rules, regulations, codes, and orders of all Authorities Having Jurisdiction relating to this Work.
- .2 Comply with all rules of the Electrical Safety Act of the Province, CSA Standards, and the applicable building codes, whether specifically shown on Drawings or not.
- .3 Give all required notices, submit Drawings, obtain all permits, licenses and certificates, and pay all fees required for this Work.
- .4 Furnish a certificate of final inspection and approvals from an inspection authority to the Contract Administrator.



## **1.8 STANDARDS OF WORKMANSHIP**

- .1 Employ a competent supervisor and all necessary licensed tradesmen to complete the Work in the required time.
- .2 Arrange and install products to fit properly into designated building spaces.
- .3 Install products in accordance with the recommendations and ratings of the product manufacturers.
- .4 Drawings and Specifications
  - .1 Refer to Division 1 – General Requirements and Part E – Specifications.
  - .2 Perform all operations as designated by the NMS according to the methods prescribed, complete with all necessary labour and incidentals.
  - .3 Treat any item or subject omitted from Division 29 - Instrumentation and Control or Drawings, but which is mentioned or reasonably specified in other NMS divisions' or Drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.
  - .4 Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.
  - .5 If discrepancies or omissions in the Drawings or Specifications are found, or if intent or meaning is not clear, consult the Contract Administrator for clarification before submitting Bid.

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

- .1 Deliver, store and handle Materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Examine each component upon delivery to Site. Report all damage noted to the Contract Administrator prior to accepting or rejecting delivery.
- .3 All instrumentation primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building.
- .4 Maintain the space temperature above 10 degrees Celsius and the space relative humidity below 50 percent.
- .5 Perform a preliminary examination upon delivery to ensure that:
  - .1 All instrumentation and control components supplied for Work under this section comply with the requirements stated in the instrument specification sheets.
  - .2 All instrumentation and control components supplied by others, to be connected to instrumentation and control components comply with the requirements stated in the Contract Documents.
  - .3 Itemize all non-conformities noted above and forward them to the Contract Administrator.
  - .4 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Contract Administrator prior to installing any equipment of this type.

- .5 Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.
- .6 Return all damaged equipment to the supplier for total corrective repairs. If deemed necessary by the Contract Administrator, the damaged equipment shall be replaced with new product.

## **1.10 SITE AREA CLASSIFICATIONS**

- .1 Classification of Pumping Station Areas
  - .1 Valve House: Category 2 (NEMA 4X equipment rating required) corrosive environment containing various chlorine compounds (e.g. chlorides, chloramines, etc.)
  - .2 Below Grade Exterior Valve Chambers: IP68 equipment required.
  - .3 Control Room: Ordinary (NEMA 1 equipment rating required)
  - .4 Electrical Room: Ordinary (NEMA 1 equipment rating required)
  - .5 Pump Floor: Ordinary (NEMA 12 equipment rating required)
  - .6 Basement or Crawl Space: Ordinary (NEMA 12 equipment rating required)
  - .7 Chlorine Room: Category 2 (NEMA 4X equipment rating required)

## **Part 2 Products**

### **2.1 GENERAL**

- .1 Refer to the requirements of Division 1 – General Requirements.
- .2 Selected Products
  - .1 Provide products and Materials that are new and free from all defects.
  - .2 The design has been based on the use of the first named product where multiple products have been listed.
- .3 Quality of Products
  - .1 All products provided to be CSA and/or ULC approved where applicable.
  - .2 If products specified are not CSA approved, obtain approval of the relevant provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.
  - .3 Refer to Division 1 – General Requirements for further information.
- .4 Uniformity of Manufacture
  - .1 Unless otherwise specifically called for in the NMS, uniformity of manufacture to be maintained for similar products throughout the Work.
- .5 Use of Products during Construction
  - .1 Any equipment used for temporary or construction purposes is to be approved by the Contract Administrator. Clean and restore to "as new" condition all equipment prior to the time of Substantial Performance.

### **2.2 INSTRUMENTATION**

- .1 General

- .1 Instruments and installation methods to be suitable for the environmental conditions in which they are to be installed.
- .2 Determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation.

### **2.3 IDENTIFICATION**

- .1 Provide 3 mm thick lamacoid nameplates with 6 mm black lettering on white background. Identify the loop tag number (where applicable) and the device name, function, and instrument range or setpoint value on the nameplate.
- .2 Where it is not possible to attach a lamacoid nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.
- .3 Identify all wires where they terminate at the marshalling panels, junction boxes and field devices with a heat shrink sleeve with machine printed labelling.
- .4 Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.
- .5 Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.
- .6 Identify all exposed control conduits at all pull box locations, where the conduits enter or leave a room, and 13 m on center throughout the room. This shall apply to conduits above removable ceilings. Use Thomas & Betts TY-RAP 5532-M labels conduit identification.
- .7 For direct current wiring use black for positive and white for negative.
- .8 For thermistor wiring to motors use red and blue coloured, insulated wire.

## **Part 3 Execution**

### **3.1 SITE EXAMINATION**

- .1 Refer to the requirements of Division 1 – General Requirements.

### **3.2 COORDINATION WITH OTHER DIVISIONS**

- .1 Examine the Drawings and Specifications and become fully familiar the Work. Before commencing Work, obtain a ruling from the Contract Administrator on any conflicting issues between NMS divisions. No compensation will be made for any costs arising from conflict not identified before Work has commenced.
- .2 Coordinate the Work to be performed under this section with Division 26 - Electrical installing equipment to ensure that there are no conflicts.
- .3 Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to other installation Work.
- .4 Lay out the Work and equipment with due regard to architectural, structural and mechanical features. Architectural and structural Drawings take precedence over electrical Drawings regarding locations of walls, doors, and equipment.
- .5 Structural members shall not be cut without prior approval of the Contract Administrator.

- .6 Examine previously constructed Work and notify the Contract Administrator of any conditions, which prejudice the proper completion of this Work.

**3.3 PRODUCT HANDLING**

- .1 Use all means necessary to protect the products included in this division before, during and after installation, and to protect products and installed Work of all other trades.
- .2 Any damage to the products and/or installed Work shall be repaired or replaced by the Contractor at no additional cost to the City and to the approval of the Contract Administrator.
- .3 Remove advertising labels from all products installed that have such labels attached. Identification or CSA labels are not to be removed.
- .4 Remove dirt, rubbish, grease, etc. resulting from Work performed under this division from all surfaces.

**3.4 SEPARATION OF SERVICES**

- .1 Maintain separation between the electrical wiring system, piping, ductwork, and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.
- .2 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings are not to be used for the support of wiring.
- .3 Classifications of Circuits

- .1 The circuit categorization shall of first priority follow CEC with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility:

Very Noisy	High voltage circuits and their associated grounding
	High current (>200 A) LV circuits.
	Harmonic-rich LV circuits
	DC circuits: un-suppressed or above 50 V
Noisy	Low current class two (2) circuits
	Medium power pulsed or radio frequency circuits
Indifferent	ELV digital status circuits
	Intrinsically safe circuits
	Telecommunications circuits
	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits).
	Any other emergency, shutdown, or high integrity circuit (e.g. toxic gas alarm).
Sensitive	Analogue signal circuits
	Data communication circuits
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors).

- .2 This section relates to the running of cables carrying differing types of circuit in close proximity to one another and to other services. Sensitive circuits shall normally be run in overall shielded cable. Very sensitive circuits shall normally be run in individually twisted pair shielded cable.

- .3 For cables sharing the same support/containment system, the following shall provide guidance to minimize extraneous interference:

<b>Segregation between Circuits</b>	<b>Very Noisy</b>	<b>Noisy</b>	<b>Indifferent</b>	<b>Sensitive</b>	<b>Very Sensitive</b>
Very Noisy	Thermal grouping as per CE Code	150 mm	300 mm	300 mm	300 mm
Noisy	150 mm	Thermal grouping as per CE Code	150 mm	150 mm	150 mm
Indifferent	300 mm	150 mm	Separation of Circuit types	100 mm	100 mm
Sensitive	300 mm	150 mm	100 mm	Touching	50 mm
Very Sensitive	300 mm	150 mm	100 mm	50 mm	Touching

### 3.5 WIRE AND CABLE

- .1 Refer Division 26 – Electrical.

### 3.6 CONTROL WIRING COLOUR IDENTIFICATION

- .1 Colour Codes

<b>Conductor Purpose</b>	<b>Colour</b>
Power, 120/208/240 VAC Supply	Black
Power, 120/208/240 VAC Neutral	White
Power, 24 VDC Supply (+)	Blue
Power, 24 VDC Common (-, or 0VDC)	Brown
Discrete Control AC	Red
Discrete Control DC	Blue
Intrinsically Safe	IS (light) Blue
Protective Earth (PE)	Green
Signal Ground/Instrumentation Earth (IE)	Green/Yellow

### 3.7 NETWORK CABLE – JACKET COLOUR

- .1 Colour Codes

<b>Cable Purpose</b>	<b>Colour</b>
Fibre Optic	Blue
Ethernet, CAT5E or CAT6	Blue
Profibus DP	Purple
Profibus PA, Non-Intrinsically Safe	Black
Profibus PA, Intrinsically Safe	Light Blue
Modbus/RTU (serial)	Grey

### 3.8 EQUIPMENT CONNECTIONS

- .1 Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the

corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Contract Administrator.

- .2 All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different manufacturer's equipment. Verify all control circuits with the manufacturers of the equipment and make any corrections to the control wiring diagrams that may be required.

### **3.9 WIRING TO EQUIPMENT SUPPLIED BY OTHER DIVISIONS**

- .1 Equipment supplied by the City or by other divisions, that have external or field mounted control devices, are to be installed, wired and commissioned by this division.

### **3.10 INSTRUMENT MOUNTING STANDS**

- .1 Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminum.
- .2 Supply and install protective drip shields for any exterior stand-mounted instrumentation equipment. Drip shields are to extend 50 mm past the front and side faces of the equipment. Drip shields are to be fabricated from aluminum.

### **3.11 SEALING OF WALL AND FLOOR OPENINGS**

- .1 Seal all conduit and cable entries passing through walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.
- .2 Seal openings after all wiring entries have been completed.
- .3 Sealing Material shall be fire resistant and shall not contain any compounds that could chemically affect the wiring jacket or insulating Material.
- .4 Cable penetrations through fire separations, if required, are to be sealed.
- .5 Submit Shop Drawing for rated assembly prior to installation of fire stop.

### **3.12 TAGGING STANDARDS FOR DEVICES AND WIRING**

- .1 Tag all devices, wires, and I/O using the assigned loop, equipment, or device tag name. Where tag naming and numbering is not specified, the Contract Administrator will provide naming and numbering that is consistent with the plant naming conventions.

### **3.13 TESTING OF INSTRUMENTATION LOOPS**

- .1 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide written notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed at the Contract Administrator's discretion.
- .2 Check the operation of final control elements such as solenoid valves, actuators, etc. by manual control before checking with automatic control.
- .3 Check and simulate all alarms and shutdown functions.

- .4 Test all tubing for leaks in compliance with ISA RP7.1. Isolate all instruments when tubing is being tested to protect against over pressure.
- .5 Perform tests and record results on the test data forms that are included in this section. Develop additional and/or more detailed test forms as necessary to suit more complex instrumentation.
- .6 Sign and date all test reports. Submit the test reports to the Contract Administrator within five Business Days of testing.
- .7 Coordinate and cooperate with City's staff while they verify the instrument loop I/O in the PLC and on the SCADA system.

### **3.14 CALIBRATION**

- .1 Instruments are to be factory pre-calibrated. Verify calibration after installation for all instruments installed under these Specifications. Provide a printed record of the factory calibration parameters for "smart" devices.
- .2 Prior to calibration, completely program all "smart" transmitters including entries of the appropriate range and tag number. Provide a printed record of smart device serial numbers against their assigned tag number with all programmed parameters.
- .3 Calibrate all instruments to an accuracy of 0.5 percent of full range, or to the manufacturer's stated accuracy of the instrument whenever an accuracy of 0.5 percent is not achievable.
- .4 Prior to instrument installation perform the following applicable calibration for each instrument and its associated signal conditioning equipment:
  - .1 Calibrate online analyzers with known samples.

### **3.15 COMMISSIONING**

- .1 Refer to the requirements of Division 1 – General Requirements for additional requirements.
- .2 Inspections
  - .1 Provide two weeks' written notice to the Contract Administrator prior to energizing any system to allow for inspection by the Contract Administrator of the following:
    - .1 Proper mounting.
    - .2 Proper connections.
  - .2 During commissioning, demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges
  - .3 Commissioning of the instrumentation and control system to include but not be limited to the following.
    - .1 Verify installation of components, wiring connections and piping connections.
    - .2 Supervise wiring continuity and pipe leak tests.
    - .3 Verify instrument calibration and provide written report.
    - .4 Function check and adjust the instruments and control equipment under operational conditions.

- .5 Coordinate manufacturer's service personnel as required for complete system testing.
- .6 Instruct plant personnel in correct method of instruments equipment operation.
- .7 Direct plant personnel at hand-over as to final adjustment of the system for correct plant operation.
- .8 Ensure that the manufacturer's representatives cooperate to complete the Work of this section.
- .9 Verify signal levels and wiring connections to all instrumentation and control equipment.
- .10 Work with control system programmer to verify all field devices, wiring, calibration and operation.

**3.16 TEST FORMS**

<b>Form No.</b>	<b>Title</b>
.1 ITR	Instrument Test Report
.2 LCR	Loop Check Report



# LOOP CHECK REPORT

- CHECKED OUT OK
- NOT APPLICABLE
- FURTHER ACTION REQUIRED

	INSTRUMENT TAG NO.								
LOOP NO.									
SHEET NO.									
P & I DWG. NO.									
<b>INSTALLATION COMPLETE</b>									
Primary Element									
Impulse Lines									
Block and Drain Valves									
Air Supply/Filter/Reg.									
Wiring									
Tracing/Insulation/Housing									
Mounting and Location									
PLC/SCADA I/O & Status									
<b>CALIBRATED</b>									
Impulse Lines Press. Tested									
<b>LOOP CHECKED</b>									
Element To Receiver									
X Mtr. to Receiver									
X Mtr./Trans. to Receiver									
X Mtr./Trans. to Switches									
Switches to Annunciator									
Interlocking Circuit									
Controller to Valve									
Controller Action D or R									

REMARKS:

**READY FOR START-UP**

DATE: \_\_\_\_\_

Installed by: \_\_\_\_\_

Checked by: \_\_\_\_\_

# INSTRUMENT TEST REPORT

SYSTEM: \_\_\_\_\_  
 SERVICE: \_\_\_\_\_ TAG NO. \_\_\_\_\_  
 LOCATION: \_\_\_\_\_  
 MAKE: \_\_\_\_\_ MODEL: \_\_\_\_\_  
 SERIAL NO.: \_\_\_\_\_ CSA: \_\_\_\_\_  
 ELEMENT: \_\_\_\_\_ RANGE: \_\_\_\_\_  
 DESIGN SETTING/RANGE: \_\_\_\_\_ CONTACT TO: \_\_\_\_\_ ON: \_\_\_\_\_  
 SIGNAL IN: \_\_\_\_\_ OUT: \_\_\_\_\_ ASSOCIATED INSTRUMENT: \_\_\_\_\_  
 INSTRUMENT CONDITION: \_\_\_\_\_ CONFORM TO SPEC: \_\_\_\_\_  
 PROJECT NO.: \_\_\_\_\_ DATA SHEET: \_\_\_\_\_

TEST METHOD	TEST 1				TEST 2			
	INPUT		OUTPUT		INPUT		OUTPUT	
	INC.	DEC.	INC.	DEC.	INC.	DEC.	INC.	DEC.
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

TESTED BY: \_\_\_\_\_ CHECKED BY: \_\_\_\_\_  
 DATE: \_\_\_\_\_ DATE: \_\_\_\_\_

**END OF SECTION**

**Part 1        General**

**1.1            GENERAL**

- .1 Suppliers, equipment, products, and execution must meet all requirements detailed in Section 29 05 00 - Common Work - Instrumentation and Control.
- .2 Local control stations shall be supplied to house local control switches, push buttons, and indicator lights associated with field devices (valves, drives, etc.). The control stations shall be located in close proximity to their associated devices. Where a group of devices are located within close proximity to each other, the local controls may be combined into a single common local control panel. Line of sight must be maintained between all devices and the respective local controls.

**1.2            RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 29 05 00 - Common Work - Instrumentation and Control.
- .3 Division 26 - Electrical.

**1.3            REFERENCE STANDARDS**

- .1 NEMA® Standard
- .2 ANSI

**1.4            ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Shop Drawings:
  - .1 Provide Shop Drawings for all new enclosures to be used.

**Part 2        Products**

**2.1            GENERAL**

- .1 Unless otherwise specified, provide outside finishes on all enclosures in ANSI 61 Grey.
- .2 The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any warpage.

**2.2            ENCLOSURES**

- .1 Provide Electrical NEMA Type 12 enclosures for ordinary locations.
- .2 Provide Electrical NEMA Type 4X enclosures for Category 1 and 2 locations in accordance with Section 26 05 00.

**2.3            WIRING AND ACCESSORIES**

- .1 Provide wiring inside the enclosures according to the following specifications:
  - .1 Control wiring to be a minimum of #16 AWG tinned stranded copper; insulation rated at 600 V.

- .2 Wiring for power distribution shall be a minimum of #12 AWG tinned stranded copper; insulation rated at 600 V.
- .3 Install cables in accordance with the requirements of Division 26 - Electrical.
- .2 Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to relevant electrical codes.
- .3 Run all wiring in enclosed plastic wireways such as Panduit or approved equal in accordance with B7 of the Tender. Size all wireways so that the total cross-sectional area of the insulated wire and cable does not exceed 40 percent of the cross sectional area of the wire way.
- .4 Provide a minimum clearance of 50 mm between wireways and any point of wire termination.
- .5 Terminate all wiring, incoming and outgoing, at terminal strips mounted inside the enclosure. Identify each terminal strip with a terminal strip number, defined as follows:
  - .1 Wire identification to use the connected field device tag name with the wire's corresponding end device terminal number appended to it.
  - .2 Identify every joint and/or terminal of the above wire run with the same identifier until the wire meets another tagged device, at which point the wire identifier will change to use the new device name and terminal number.
    - .1 For example, spill switch LAH-R1212-1 located in the field has a 1 PR-TPSH cable connected to it. The wire identifiers for the pair of wires would be M1500-1 from the terminal blocks in the control panel.
  - .3 Identify spare wires by using the cable tag, wire number, and an "-SP" suffix.
  - .4 Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal blocks and all external wiring terminates on the outboard side.
- .6 Provide sufficient terminals in order to avoid not more than two wires are connected under the same terminal. Provide 20 percent spare terminal capacity at each terminal block assembly for each type of terminal block (fused, non-fused, etc.).

## **2.4 PANEL GROUNDING**

- .1 Provide a ground system for the instrumentation circuits.
- .2 Provide grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor.
- .3 Firmly bond all panel-mounted devices on or within the panels to ground. Provide supplementary bonding conductors for backpanels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

**Part 3       Execution**

**3.1           MOUNTING HEIGHTS**

- .1       Unless otherwise specified or a conflict exists, mount all panels, starters, and disconnects 2000 mm to top of cover.

**END OF SECTION**

**Part 1            General**

**1.1                RELATED SECTIONS**

- .1    Section 01 33 00 - Submittal Procedures.;
- .2    Division 26 - Electrical.

**1.2                REFERENCES STANDARDS**

- .1    CSA International
  - .1    CSA-C22.2 No. 214, Communications Cables (Bi-National standard with UL 444).
  - .2    CSA-C22.2 No. 232, Optical-Fibre Cables.
- .2    TIA
  - .1    TIA-455, General requirements for standard test procedures for optical fibers, cables, transducers, sensors, connecting and terminating devices, and other fiber optic components.
  - .2    TIA-526, Standard Test Procedures for Fiber Optic Systems.
  - .3    TIA-568.0, Generic Telecommunications Cabling for Customer Premises
  - .4    TIA-569, Telecommunications Pathways and Spaces.
  - .5    TIA-606, Administration Standard for Telecommunications Infrastructure.
  - .6    TIA-607, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
  - .7    TIA-758, Customer-Owned Outside Plant Telecommunications Infrastructure Standard.
  - .8    TIA-862, Building Automation Systems Cabling Standard.
  - .9    TIA-1005, Telecommunications Infrastructure Standard for Industrial Premises.
  - .10   TIA-1152, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling.
  - .11   TIA TSB-140, Telecommunications Systems Bulletin – Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems.
  - .12   TIA-598, Optical Fiber Cable Color Coding.

**1.3                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Product Data:
  - .1    Provide product data sheets for cable testing:
    - .1    Provide sample test data sheets and information with respect to test instrumentation to be used as described in 3.6.6 and 3.8.10.
    - .2    Provide fibre-optic cable test results.
    - .3    Provide Category 6 cable test results.

#### **1.4 INSPECTION**

- .1 Provide adequate notice to the Contract Administrator in order that all cable installations can be inspected prior to energizing equipment.

#### **1.5 STANDARDS**

- .1 All wire and cable shall be CSA approved.

### **Part 2 Products**

#### **2.1 TPSH**

- .1 TPSH shall be constructed as follows:
  - .1 Two copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 50 mm.
  - .2 Insulated for 600 V, 90 degrees Celsius.
  - .3 100 percent coverage aluminum foil or tape shield.
  - .4 Separate bare stranded copper drain wire, minimum #18 AWG.
  - .5 Overall flame-retardant PVC jacket to CSA-C22.2.
  - .6 The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.
  - .7 Interlocked aluminum armour and outer PVC jacket.
  - .8 Shaw Type 1751-CSA or Belden equivalent or approved equal in accordance with B7 of the Tender.
- .2 Where multi-conductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame-retardant PVC jacket.

#### **2.2 RTD AND MULTI CONDUCTOR SHIELDED CABLE**

- .1 RTD cables shall be CSA approved and shall be constructed as follows:
  - .1 Three or more copper conductors, stranded, minimum # 18 AWG.
  - .2 PVC insulated for 600 V.
  - .3 100 percent coverage aluminum foil or tape shield.
  - .4 Separate bare stranded copper drain wire.
  - .5 Interlocked aluminum armour and outer PVC jacket.
  - .6 Overall flame-retardant PVC jacket to CSA-C22.2.

#### **2.3 TECK CABLES**

- .1 As per Division 26 - Electrical.

#### **2.4 WIRE**

- .1 As per Division 26 - Electrical.

#### **2.5 CATEGORY 6 COMMUNICATION CABLE**

- .1 Category 6 cable shall be CSA approved and constructed as follows:
  - .1 Four bonded pairs, solid stranded, #24 AWG.

- .2 Interlocked aluminum armour.
- .3 Rip cord.
- .4 PVC inner and outer jackets.
- .5 ULC verified to Category 6.
- .6 Insulated for 300 V.
- .7 Shielded.
- .8 FT4 Fire rating.

## **2.6 FIBRE OPTIC CABLE**

- .1 Fibre optic cable shall be CSA approved and constructed as follows:
  - .1 12-strand multimode 50/125µ 10 Gig fibre cable.
- .2 Interlocked aluminum armour.
- .3 FT4 Fire rating.
- .4 Terminate all strands using duplex LC's.

## **Part 3 Execution**

### **3.1 ANALOG SIGNALS**

- .1 Use TPSH cable for all low level analog signals such as 4-20 mA, pulse type circuits 24 VDC and under, and other signals of a similar nature.
- .2 Use RTD cable for connections between RTDs and transmitters or control system RTD inputs.

### **3.2 DIGITAL SIGNALS**

- .1 Use TPSH cable for all low level input (24 V and below) and output signals to the control system.

### **3.3 INSTRUMENT POWER**

- .1 Use wire and conduit for power to instruments, for 120 V signals, other than those mentioned above and as otherwise indicated on the Drawings. Use stranded wire and cable to supply power to instruments.

### **3.4 INSTALLATION**

- .1 Install instrumentation cables in conduits or cable trays. Use a minimum of 300 mm and a maximum of 1000 mm length of liquid tight flexible conduit to connect the field sensors to the conduit.
- .2 At each end of the run, leave sufficient cable length for termination.
- .3 Do not make splices in any of the instrumentation cable runs.
- .4 Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.
- .5 Ground cable shields at one end only. Unless otherwise specified, ground the shields at the PLC control panel.
- .6 Protect all conductors against moisture during and after installation.



### **3.5 CATEGORY 6 INSTALLATION**

- .1 Follow the manufacturer's guidelines for minimum bend radius and tension.
- .2 Provide 1 m coil of slack to enable the possibility of future changes for balanced twisted-pair cabling.
- .3 All installations and terminations shall be performed by personnel certified by cable manufacturer or experienced in Category 6 cable installation.

### **3.6 CATEGORY 6 TESTING**

- .1 Perform all Category 6 cable testing to TIA-568 standards.
- .2 Testing must be performed by trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof. These certificates may have been issued by any of the following organizations or an equivalent organization:
  - .1 Manufacturer of the connectors or cable.
  - .2 Manufacturer of the test equipment used for the field certification.
  - .3 Training organizations.
- .3 Category 6 cable testing instrument:
  - .1 Level III accuracy in accordance with TIA-1152.
  - .2 Independent verification of accuracy.
- .4 Each cabling link shall be in tested for:
  - .1 Wire Map.
  - .2 Length.
  - .3 Propagation Delay.
  - .4 Delay Skew.
  - .5 DC Loop Resistance – recorded for information only.
  - .6 DC Resistance Unbalance – recorded for information only.
  - .7 Insertion Loss.
  - .8 NEXT.
  - .9 PS NEXT.
  - .10 ACR-N – recorded for information only.
  - .11 PS ACR-N – recorded for information only.
  - .12 ACR-F.
  - .13 PS ACR-F.
  - .14 Return Loss.
  - .15 TCL – recorded for information only.
  - .16 ELTCTL – recorded for information only.
- .5 Reconnect or re-install and retest as necessary to correct excessive variations.
- .6 Before commencing testing, submit sample test data sheets and information with respect to test instrumentation to be used.

### **3.7 FIBRE OPTIC CABLE INSTALLATION**

- .1 Install all fibre optic cabling to manufacturer's instructions.

- .2 Follow the manufacturer's guidelines for minimum bend radius and tension.
- .3 Provide 1 m coil of slack to enable the possibility of future changes for fibre optic cabling.
- .4 All installations and terminations shall be performed by personnel certified by cable manufacturer or experienced in fibre optic cable installation.
- .5 Install cabling in a neat and professional manner using best industry practice.
- .6 Equipment shall not be connected directly to backbone fibre optic cables.
- .7 Tie wraps shall not be used for cable suspension.
- .8 Fibre strands must be routed at the patch panel in such a manner to ensure signal transmission will not be adversely affected.
- .9 The Contractor shall not exceed the maximum pull-tension rating of the fibre cables during installation.
- .10 The minimum bend radius of the fibre cables shall not be exceeded during installation.
- .11 Protect all cables from mechanical damage during installation.
- .12 Fibre optic cables to be installed in a star topology where indicated on the Drawings.
- .13 Contractor to terminate and test all strands of fibre cable installed. To further clarify all strands including the spare strands in a fibre optic cable shall be terminated and tested.

### **3.8 FIBRE OPTIC CABLE TESTING**

- .1 Fibre optic cable testing to be in accordance with TIA-455, TIA-526, and TIA-568.
  - .1 Fibre optic cable test includes testing the attenuation and polarity of the installed cable with an OLTS and the installed condition of the cabling system and its components with an OTDR. The condition of the fibre end faces shall also be verified.
  - .2 Testing shall be performed on each cabling link (connector to connector).
  - .3 Testing shall be performed on each cabling channel (equipment to equipment).
- .2 All tests shall be documented including OLTS dual wavelength attenuation measurements and OTDR traces with event tables as well as OTDR maps.
- .3 Testing must be performed by trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. These certificates may have been issued by any of the following organizations or an equivalent organization:
  - .1 Manufacturer of the fiber optic cable and/or the fiber optic connectors.
  - .2 Manufacturer of the test equipment used for the field certification or representative.
  - .3 Equivalent training organization.
- .4 Fibre optic cable testing instrument:

- .1 The field-test instrument shall be within the calibration period recommended by the manufacturer.
- .2 OLTS
  - .1 Multimode optical fiber light source:
    - .1 Provide dual LED light sources with central wavelengths of 850 nm (+/-30 nm) and 1300 nm (+/-20 nm). VCSEL sources are not permitted per TIA-526-14.
    - .2 Output power of -20 dBm minimum.
    - .3 The launch shall meet the Encircled Flux launch requirements of TIA 526-14.
    - .4 The test reference cords must demonstrate an insertion loss  $\leq 0.15$  dB when mated against each other.
  - .2 Power meter:
    - .1 Provide 850 nm, 1300 nm, 1310 nm, and 1550 nm wavelength test capability.
    - .2 Power measurement uncertainty of +/- 0.25 dB.
- .3 OTDR
  - .1 Multimode OTDR:
    - .1 Wavelengths of 850 nm (+/- 10 nm) and 1300 nm (+ 35 nm / - 15 nm).
    - .2 Event dead zones not to exceed 0.7 m at 850 nm and 1300 nm.
    - .3 Attenuation dead zones not to exceed 2.5 m at 850 nm and 4.5 m at 1300 nm.
    - .4 Distance range not less than 9,000 m.
    - .5 Dynamic range at least 28 dB for 850 nm and 30 dB at 1300 nm.
    - .6 Allow bi-directional testing without moving the OTDR to the far end.
  - .4 Fiber Microscope
    - .1 Field of view 420  $\mu$ m x 320  $\mu$ m
      - .1 Video camera systems are preferred.
      - .2 Camera probe tips that permit inspection through adapters are required.
  - .5 Integrated OLTS, OTDR, and fiber microscope
    - .1 Test equipment that combines into one instrument an OLTS, an OTDR and a fiber microscope may be used.
- .5 OLTS testing:
  - .1 Multimode links shall be tested in one direction at 850 nm and 1300 nm in accordance with TIA-526-14, with an Encircled Flux compliant launch.
  - .2 Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
  - .3 The link attenuation shall be calculated as specified in TIA-568.
  - .4 Maximum allowable connector loss = 0.75 dB.
  - .5 Maximum allowable splice loss = 0.3 dB.

- .6 OTDR testing:
  - .1 Fiber links shall be tested at these wavelengths for anomalies and to ensure uniformity of cable attenuation, connector insertion loss, and reflectance.
    - .1 Multimode: 850 nm and 1300 nm.
  - .2 Reflective events (connections) shall not exceed:
    - .1 0.75 dB in optical loss when bi-directionally averaged.
    - .2 -35 dB Reflectance for multimode connections.
  - .3 Non-reflective events (splices) shall not exceed 0.3 dB.
- .7 Magnified end face inspection:
  - .1 Fibre connections shall be visually inspected for end face quality.
  - .2 Scratched, pitted, or dirty connectors shall be diagnosed and corrected.
- .8 Length measurement:
  - .1 The length of each fiber shall be measured using an OLTS or OTDR and be recorded.
- .9 Polarity testing:
  - .1 Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with TIA 568.0. The polarity of the paired duplex fibers shall be verified using an OLTS.
- .10 Before commencing testing, submit sample test data sheets, and information with respect to test instrumentation to be used.

### **3.9 CONDUCTOR TERMINATIONS**

- .1 All equipment supplied shall be equipped with terminal blocks to accept conductor connections.
- .2 Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with Burndy-YAE-2 or STA-KON or approved equal in accordance with B7 of the Tender, self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.

### **3.10 CABLE TESTING**

- .1 Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable manufacturer.

### **3.11 IDENTIFICATION**

- .1 Identify all instrumentation cables.
- .2 Identify each conductor with wire numbers using a machine printed Raychem TMS heat shrink wire marker or approved equal in accordance with B7 of the Tender.

**END OF SECTION**

**Part 1 General**

**1.1 GENERAL**

- .1 Equipment, products, and execution must meet all requirements detailed in Section 29 05 00 - Common Work - Instrumentation and Control.

**1.2 RELATED SECTIONS**

- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 78 00 - Closeout Submittals.
- .3 Division 26 - Electrical.
- .4 Section 26 29 03 - Control Devices.
- .5 Section 29 05 00 - Common Work - Instrumentation and Control.

**1.3 DEFINITIONS**

- .1 The following acronyms are device names defined in the City of Winnipeg Identification Standard:
  - .1 “**NSW**” means network switch; and
  - .2 “**LCP**” means local control panel.

**1.4 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 – Submittal Procedures.
- .2 Product Data:
  - .1 Provide product data sheet for Ethernet switches and routers.

**1.5 CLOSEOUT SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 78 00 - Closeout Submittals.
- .2 O&M Manuals:
  - .1 Ethernet switch, Ethernet UTP converter and cellular modem product data and itemized part numbers.

**1.6 MAINTENANCE MATERIALS**

- .1 Provide spare parts in accordance with Section 01 78 00 – Closeout Submittals and Part 2 of this section.
- .2 Where fused terminal blocks are installed, provide 10 spare terminal block style fuses per control panel.
- .3 Provide one spare Ethernet UTP Converter.

**1.7 REFERENCE STANDARDS**

- .1 CSA Group
  - .1 CAN/CSA-C22.2 NO. 60950-1-07 Information Technology Equipment – Safety – Part 1: General Requirements
- .2 Institute of Electrical and Electronics Engineers (IEEE)

- .1 IEC 61000-6-2 Electromagnetic Compatibility (EMC) – Part 6-2: Generic Standards – Immunity for Industrial Environments

**Part 2 Products**

**2.1 MISCELLANEOUS PANEL DEVICES**

- .1 Managed Ethernet Switches and Routers
  - .1 To CAN/CSA-C22.2 NO. 60950-1-07 and IEC 61000-6-2 Standards.
  - .2 Siemens RUGGEDCOM RS900G or approved equal in accordance with B7 of the Tender.
    - .1 Mounting: DIN rail.
    - .2 Power Supply: 120 V.
    - .3 Fibre Optic Connector: LC
      - .1 1000 Mb/s FX Data Speed.
    - .4 Copper Connector: RJ45
      - .1 10/100 Mb/s TX Data Speed.
    - .5 Rapid Spanning Tree Protocol (RSTP) support for the station fibre optic loop and EIO fibre optic loop.
    - .6 Provide Ethernet Switches with the ports listed below for the locations listed below:

FACILITY	PANEL	NAME	1000 FX PORTS	100 FX PORTS	1000 TX PORTS	100 TX PORTS
Maclean VH	LCP-R800	NSW-R801	2			8
Maclean VH	MCC-R740	NSW-R740	2			8

- .2 Fibre Optic Termination Panel
  - .1 Wall mount termination panel.
    - .1 Single 12 fibre CCH Splice Cassette.
    - .2 Approved products: Corning SCH-01C or approved equal in accordance with B7 of the Tender.
  - .3 Network Media Convertor
    - .1 Fibre convertor module.
      - .1 Modicon X80 multimode convertor module. or approved equal in accordance with B7 of the Tender.
      - .2 24VDC power supply
      - .3 2 RJ45 100BASE TX Ports
  - .4 2 fibre optic 100BASE-FX ports Pilot Lights
    - .1 Provide LED transformer type pilot lights for extended lamp life, oil tight, push to test, complete with appropriate colour lenses.
    - .2 Normal colours used are:
      - .1 Run=red.
      - .2 Stop=green.
      - .3 Fault=amber.

- .3 Refer to Division 26 - Electrical for additional information.
- .5 Terminals
  - .1 Provide strap screw type terminal blocks rated for 600 V.
  - .2 Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks to be identified by the electrical ground symbol.
  - .3 Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors.
  - .4 Terminals to be Weidmuller or approved equal in accordance with B7 of the Tender. Where indicated on Drawings, install terminal blocks that match existing terminal block style.
  - .5 Provide a group of terminals for each of 120 VAC hot and neutral and 24 VDC positive and negative power. Distribution wiring to have a thermal magnetic circuit breaker upstream of all major blocks of loads, adequately sized to protect the connected load while not causing nuisance tripping.
  - .6 Provide Weidmuller or approved equal in accordance with B7 disconnect type terminal blocks for each load or loop powered from the marshalling panels.
  - .7 New terminal blocks shall be color coded as follows:
    - .1 Red = positive 24 VDC.
    - .2 Black = analog signal plus.
    - .3 White = analog signal common and VAC neutral.
    - .4 Grey = 120 VAC.
    - .5 Green = ground.
- .6 Control Relays
  - .1 Refer to Section 26 29 03 - Control Devices.
- .7 Nameplates
  - .1 Refer to Section 29 05 00 - Common Work - Instrumentation and Control.

### **Part 3 Execution**

#### **3.1 REFERENCES - GENERAL**

- .1 Refer to Section 29 05 00 - Common Work - Instrumentation and Control.

**END OF SECTION**

**Part 1 General**

**1.1 RELATED SECTIONS**

- .1 Section 29 05 00 - Common Work - Instrumentation and Controls.

**1.2 ACTION AND INFORMATIONAL SUBMITTALS**

- .1 Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.

**Part 2 Products**

**2.1 POWER SUPPLY AND CONDITIONING EQUIPMENT**

- .1 General
  - .1 Provide all DC power supplies as required for all instrument circuits. All circuits are to be powered from the PLC control panels. Power supplies to be Hammond, G.F.C., Weidmuller or approved equal in accordance with B7 of the Tender, complete with an over-voltage protection module.
  - .2 DC power supplies shall be fully redundant. Individual fault signals from each power supply shall be monitored by the PLC for alarming.
  - .3 Unless otherwise required, all DC power supplies to be rated 28 VDC, adjustable plus or minus five percent, and set to provide 26.4 V on the panel direct current bus. Size the power supply for two times the connected load, minimum size is 2 amps.

**2.2 NOISE SUPPRESSION**

- .1 Provide TVSS (Transient Voltage Surge Suppressor) units in each new control panel to power AC instrumentation and control loads. Power conditioners are to be Square D, Eaton, Leviton or approved equal in accordance with B7 of the Tender.

**Part 3 Execution**

**3.1 REFERENCES - GENERAL**

- .1 Refer to Section 29 05 00 - Common Work - Instrumentation and Controls, Part 3.

**END OF SECTION**



**Part 1        General**

**1.1            RELATED SECTIONS**

- .1        Section 29 05 00 – Common Work - Instrumentation and Control.

**1.2            INSTRUMENT INDEX**

- .1        The Instrumentation Index in this section's supplements gives an itemized list of the instrumentation included as part of this Work.

**1.3            PLC I/O INDEX**

- .1        The PLC I/O Index in this section gives an itemized list of the new PLC System inputs and outputs. It is intended to serve as an aid for determining the cabling requirements for the Work specified in this Division.

**Part 2        Products**

- .1        Not used

**Part 3        Execution**

- .1        Supplements
  - .1        Instrumentation Index
  - .2        PLC I/O Index

**END OF SECTION**

**SUPPLEMENT – INSTRUMENTATION INDEX**

Tag	Description	P&ID Drawing	Plan Drawing	Segment/Schem./ Loop Drawing	Datasheet	Mounting	Supplied By	Notes
LRV-1	Motorized Valve Actuator	1-0630R-P0001	1-0630A-E0018-001	1-0630P-A0088	TBD	Pipe - Inline	Contractor - I&C	
LRV-2	Motorized Valve Actuator	1-0630R-P0001	1-0630A-E0018-001	1-0630P-A0089	TBD	Pipe - Inline	Contractor - I&C	
LAV-1	Motorized Valve Actuator	1-0630R-P0001	1-0630A-E0018-001	1-0630P-A0090	TBD	Pipe - Inline	Contractor - I&C	
LAV-2	Motorized Valve Actuator	1-0630R-P0001	1-0630A-E0018-001	1-0630P-A0091	TBD	Pipe - Inline	Contractor - I&C	
LSV-1	Motorized Valve Actuator	1-0630R-P0002	1-0630R-E0003-001	1-0630P-A0092	TBD	Pipe - Inline	Contractor - I&C	
LSV-2	Motorized Valve Actuator	1-0630R-P0002	1-0630R-E0003-001	1-0630P-A0093	TBD	Pipe - Inline	Contractor - I&C	
LSV-3	Motorized Valve Actuator	1-0630R-P0002	1-0630R-E0003-001	1-0630P-A0094	TBD	Pipe - Inline	Contractor - I&C	

Notes:

1. This instrument list is provided for reference only and is not necessarily comprehensive.
2. The specific division (Mechanical, HVAC, Electrical, I&C) indicated in the "Supplied By" column is a suggestion only. The Contractor may divide the supply of the instruments between subtrades as required

**SUPPLEMENT – PLC I/O INDEX**

Module Address	Hardware Point	Wire Tag	DNP3 Register	Tag	Description	0 State	1 State	P&ID Dwg	PLC Tag Name
0	0	1054	0	ZSC-LRV-1	VALVE CLOSED STATUS	NOT CLOSED	CLOSED	1-06330-A0088-001	-
0	1	1056	1	ZSO-LRV-1	VALVE OPENED STATUS	NOT OPENED	OPENED	1-06330-A0088-001	-
0	2	1058	2	ZSC-LRV-2	VALVE CLOSED STATUS	NOT CLOSED	CLOSED	1-06330-A0089-001	-
0	3	1060	3	ZSO-LRV-2	VALVE OPENED STATUS	NOT OPENED	OPENED	1-06330-A0089-001	-
0	4	1062	4	ZSC-LAV-1	VALVE CLOSED STATUS	NOT CLOSED	CLOSED	1-06330-A0090-001	-
0	5	1064	5	ZSO-LAV-1	VALVE OPENED STATUS	NOT OPENED	OPENED	1-06330-A0090-001	-
0	6	1066	6	ZSC-LAV-2	VALVE CLOSED STATUS	NOT CLOSED	CLOSED	1-06330-A0091-001	-
0	7	1068	7	ZSO-LAV-2	VALVE OPENED STATUS	NOT OPENED	OPENED	1-06330-A0091-001	-
0	8	1070	8	ZSC-LSV-1	VALVE CLOSED STATUS	NOT CLOSED	CLOSED	1-06330-A0092-001	-
0	9	1072	9	ZSO-LSV-1	VALVE OPENED STATUS	NOT OPENED	OPENED	1-06330-A0092-001	-
0	10	1074	10	ZSC-LSV-2	VALVE CLOSED STATUS	NOT CLOSED	CLOSED	1-06330-A0093-001	-
0	11	1076	11	ZSO-LSV-2	VALVE OPENED STATUS	NOT OPENED	OPENED	1-06330-A0093-001	-
0	12	1078	12	ZSC-LSV-3	VALVE CLOSED STATUS	NOT CLOSED	CLOSED	1-06330-A0094-001	-
0	13	1080	13	ZSO-LSV-3	VALVE OPENED STATUS	NOT OPENED	OPENED	1-06330-A0094-001	-
0	14	1082	14	-	SPARE	-	-	-	-
0	15	1084	15	-	SPARE	-	-	-	-
0	16	1104	16	LCP-R800	LCP-R800 120V POWER	POWER FAIL	NORMAL	-	-
0	17	1106	17	LAH-R5950	VH COMMON FLOOD ALARM	ALARM	NORMAL	1-0630-A0095-001	-

0	18	1108	18	LAH-R1212	NORTH RESERVOIR SPILL SWITCH	ALARM	NORMAL	1-0630-A0096-001	-
0	19	1110	19	LAH-R1312	SOUTH RESERVOIR SPILL SWITCH	ALARM	NORMAL	1-0630-A0096-001	-
0	20	1112	20	YLR-P010	RESERVOIR DRAIN PUMP RUNNING	STOPPED	RUNNING	1-0630R-E0005-001	-
0	21	1114	21	YA-P010	RESERVOIR DRAIN PUMP OVERLOAD	NORMAL	OVERLOAD	1-0630R-E0005-001	-
0	22	1116	22	YLR-P020	RESERVOIR DRAIN PUMP RUNNING	STOPPED	RUNNING	1-0630R-E0006-001	-
0	23	1118	23	YA-P020	RESERVOIR DRAIN PUMP OVERLOAD	NORMAL	OVERLOAD	1-0630R-E0006-001	-
0	24	1120	24	XS-R740	MCC-R740 SURGE PROTECTION STATUS	ALARM	NORMAL	1-0630R-E0004-001	-
0	25	1122	25	ESL-R740	MCC-R740 600V POWER STATUS	ALARM	NORMAL	1-0630R-E0004-001	-
0	26	1124	26	-	SPARE	-	-	-	-
0	27	1126	27	-	SPARE	-	-	-	-
0	28	1128	28	-	SPARE	-	-	-	-
0	29	1130	29	-	SPARE	-	-	-	-
0	30	1132	30	-	SPARE	-	-	-	-
0	31	1134	31	-	SPARE	-	-	-	-

**Part 1            General**

**1.1                GENERAL REQUIREMENTS**

- .1    PLC controllers, I/O sub-systems, and HMIs shall be housed in control panels as indicated. General requirements for the control panels are defined in Section 29 10 01 - Enclosures.
- .2    Coordinate and cooperate with other contractors, suppliers, and the City's representatives during system programming, start-up, and commissioning of the complete control system and associated field devices and wiring.
- .3    Provide complete PLC programming, start-up, and commissioning.

**1.2                RELATED SECTIONS**

- .1    Section 01 33 00 - Submittal Procedures.
- .2    Section 01 78 00 - Closeout Submittals.
- .3    Section 29 05 00 - Common Work - Instrumentation and Control.
- .4    Section 29 10 01 - Enclosures.

**1.3                DEFINITIONS**

- .1    "MBTCP" means Modbus Transmission Control Protocol

**1.4                ACTION AND INFORMATIONAL SUBMITTALS**

- .1    Provide Submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2    Submit the following product data and Shop Drawings:
  - .1    PLC rack layouts.
  - .2    PLC racks.
  - .3    PLC rack expansion kit.
  - .4    PLC processors.
  - .5    PLC power supply.
  - .6    PLC fibre optic repeater.
  - .7    PLC quick wiring adapters.
  - .8    PLC I/O card data sheets.
  - .9    PLC network card data sheets.
  - .10    Quantum PLC RIO drop.
  - .11    Quantum PLC fibre optic repeater.
- .3    Test results:
  - .1    Submit loop test results for all I/O points. Sample test form can be found in Section 29 05 00 - Common Work - Instrumentation and Control.

**1.5                CLOSEOUT SUBMITTALS**

- .1    Provide Submittals in accordance with Section 01 78 00 - Closeout Submittals.

- .2 O&M Manuals:
  - .1 PLC product data and itemized part numbers.
  - .2 PLC rack layout Shop Drawings.
  - .3 Loop test results.

## **1.6 MAINTENANCE MATERIALS**

- .1 Provide spare parts in accordance with Section 01 78 00 – Closeout Submittals and Part 2 of this section.

## **Part 2 Products**

### **2.1 PROGRAMMABLE LOGIC CONTROLLER**

- .1 General
  - .1 New PLC equipment shall be based on the Schneider Modicon M580 hardware platform or approved equal in accordance with B7 of the Tender.
  - .2 Where new PLC cards are to be added to existing PLC racks, PLC cards must be compatible with the existing PLC rack.
  - .3 Provide all necessary racks, power supplies, cables, communication cards, and accessories to provide a complete and functioning system.
  - .4 Communication protocol for the PLC processor network to be Modbus TCP (MBTCP).
  - .5 I/O signal voltage and I/O channels to match existing PLC cards for use with wiring adapters as indicated.
- .2 New Schneider Modicon M580 PLC Equipment
  - .1 PLC Rack
    - .1 X-bus and dual Ethernet.
    - .2 4, 8, or 12 slot as indicated and as required.
      - .1 BME XBP 0400.
      - .2 BME XBP 0800.
      - .3 BME XBP 1200.
      - .4 Or approved equal in accordance with B7 of the Tender.
    - .3 Rack extender kits as indicated and as required.
      - .1 BMX XBE 2005 or approved equal in accordance with B7 of the Tender.
  - .2 PLC Power Supply
    - .1 Source: 120 VAC.
    - .2 Power output: 36 W.
    - .3 BMX CPS 3500 or approved equal in accordance with B7 of the Tender.
    - .4 Standard PLC Processor

- .1 BME P58 2010 or approved equal in accordance with B7 of the Tender.
- .3 24 VDC Sink Discrete Input Card
  - .1 24 VDC.
  - .2 16 channel.
  - .3 BMX DDI 1602 or approved equal in accordance with B7 of the Tender.
- .4 120 VAC Discrete Input Card
  - .1 120 VAC.
  - .2 16 channel.
  - .3 BMX DAI 1604 or approved equal in accordance with B7 of the Tender.
- .5 24 VDC Sink High Density Discrete Input Card
  - .1 24 VDC.
  - .2 32 channel.
  - .3 BMX DDI 3202K or approved equal in accordance with B7 of the Tender.
- .6 Relay Discrete Output Card
  - .1 24 VDC relay.
  - .2 8 channel.
  - .3 BMX DRA 0805 or approved equal in accordance with B7 of the Tender.
- .7 24 VDC Discrete Output Card
  - .1 24 VDC.
  - .2 16 channel.
  - .3 BMX DDO 1602 or approved equal in accordance with B7 of the Tender.
- .8 Analogue Input Card
  - .1 4-20 mA.
  - .2 8 channel.
  - .3 BMX AMI 0810 or approved equal in accordance with B7 of the Tender.
- .9 Analogue Output Card
  - .1 4-20 mA.
  - .2 2 channel.
  - .3 BMX AMO 0802 or approved equal in accordance with B7 of the Tender.
- .10 Ethernet Communication Card
  - .1 BME NOC 0301 or approved equal in accordance with B7 of the Tender.
- .11 Performance EIO Drop Card
  - .1 BME CRA 312 10 or approved equal in accordance with B7 of the Tender.
- .12 Fibre Optic Repeater

- .1 For use with multimode optical fibre.
- .2 BMX NRP 0200 or approved equal in accordance with B7 of the Tender.
- .3 New Quantum PLC cards
  - .1 Ethernet EIO Drop Card.
    - .1 140 CRA 312 00 or approved equal in accordance with B7 of the Tender.
    - .2 Fibre Optic Repeater.
      - .1 140 NRP 312 00 or approved equal in accordance with B7 of the Tender.

### **Part 3 Execution**

#### **3.1 INSTALLATION**

- .1 Install the hardware in accordance with the foregoing requirements to satisfy the performance requirements defined in 29 05 00.
- .2 Cooperate with other contractors, suppliers, the City, and the Contract Administrator to commission and start-up the system as defined herein.

#### **3.2 COMMISSIONING AND START-UP TESTING**

- .1 Commission and perform start-up testing for each facility in accordance with E14 of the Tender.

#### **3.3 TRAINING**

- .1 Provide training to the City personnel in the operation, care, and maintenance of system, system equipment, and components in accordance with E15.

**END OF SECTION**