

**Part 1            General**

**1.1                ADMINISTRATIVE**

- .1        Submit to Contract Administrator submittals listed for review in accordance with the Specifications, or as requested by the Contract Administrator.
- .2        Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
  - .1        Allow 10 Working Days for review of submittals by the Contract Administrator.
- .3        Do not proceed with Work affected by submittal until review is complete.
- .4        Present shop drawings, product data, samples and mock ups in SI Metric units.
- .5        Where items or information is not produced in SI Metric units converted values are acceptable.
- .6        Review submittals prior to submission to 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 requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.
- .7        Notify Contract Administrator, in writing at time of submission for review, identifying deviations from requirements of Contract Documents stating reasons for deviations.
- .8        Verify:
  - .1        Field measurements
  - .2        Field construction criteria
  - .3        Catalogue numbers and similar data
  - .4        Ensure affected adjacent Work is co-ordinated.
- .9        Contractor's responsibility for errors and omissions in submission is not relieved by Contract Administrator's review of submittals.
- .10       Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved by Contract Administrator review.
- .11       Acceptance of Shop Drawings for a component or a subassembly does not constitute acceptance of the complete assembly of which it is a part.
- .12       The Contractor shall make any corrections required by the Contract Administrator and shall resubmit the required number of corrected copies of Shop Drawings. The Contractor shall direct specific attention in writing or on resubmitted Shop Drawings to revisions other than the corrections requested by the Contract Administrator on previous submission.
- .13       After Contract Administrator's review and return of copies, distribute copies to sub-trades as appropriate.
- .14       Keep one reviewed copy of each submission on site.

## 1.2 SHOP DRAWINGS AND PRODUCT DATA

- .1 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.
- .2 The Contractor shall arrange for the preparation of clearly identified Shop Drawings as specified 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 the Work. Where articles or equipment attach or connect to other articles or equipment, clearly indicate that all such attachments and connections have been properly coordinated, regardless of the trade under which the adjacent articles or equipment will be supplied and installed. Shop Drawings are to indicate their relationship to design Drawings and Specifications. Notify the Contract Administrator in writing of any deviations in Shop Drawings from the requirements of the Contract Documents.
- .3 Have Shop Drawings stamped, signed and dated by a Professional Engineer licensed to practice in the Province of Manitoba where required in the Specifications or by the Contract Administrator.
- .4 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 Drawing shall be indicated by stamp, date and signature of a responsible person of the sub-contractor for supplied items and of the General Contractor for fabricated items. Shop Drawings not stamped, signed and dated will be returned without being reviewed and stamped "Re-submit". Ensure that the following are verified:
  - .1 Field measurements.
  - .2 Field construction criteria.
  - .3 Catalogue numbers and similar data.
- .5 Submittals shall be in one of the following formats:
  - .1 Submit three (3) copies of white prints and three (3) copies of all fixture cuts and brochures.
  - .2 Submit one electronic PDF copy.
- .6 Shop Drawing reviews by the Contract Administrator is solely to ascertain conformance with the general design concept. Responsibility for approval of detail design inherent in Shop Drawings rests with the Contractor and review by the Contract Administrator shall not imply such approval.
- .7 Shop Drawings will be returned to the Contractor with one of the following notations:
  - .1 When stamped "REVIEWED" or "NO EXCEPTIONS TAKEN", distribute additional copies as required for execution of the Work.
  - .2 When stamped "REVIEWED AS MODIFIED" or "MAKE NOTED CORRECTIONS", ensure that all copies for use are modified and distributed, same as specified for "REVIEWED".
  - .3 When stamped "REVISE AND RESUBMIT", make the necessary revisions, as indicated, consistent with the Contract Documents and submit again for review.

- .4 When stamped "NOT REVIEWED" or "REJECTED", submit other Drawings, brochures, etc., for review consistent with the Contract Documents.
- .5 Only Shop Drawings bearing "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS", or "REVIEWED AS MODIFIED" shall be used on the Work unless otherwise authorized by the Contract Administrator.
- .8 After submittals are stamped "REVIEWED", "NO EXCEPTIONS TAKEN", "MAKE NOTED CORRECTIONS" or "REVIEWED AS MODIFIED", no further revisions are permitted unless re-submitted to the Contract Administrator for further review.
- .9 Any adjustments made on Shop Drawings by the Contract Administrator are not intended to change the Contract Price. If it is deemed that such adjustments affect the Contract Price, clearly state as such in writing prior to proceeding with fabrication and installation of Work.
- .10 Make changes in Shop Drawings, which the Contract Administrator may require, consistent with Contract Documents. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.
- .11 Only two (2) reviews of Shop Drawings will be made by the Contract Administrator at no cost. Each additional review will be charged to the Contractor at the Contract Administrator's scheduled rates. The Contract Administrator's charges for the additional Work will be deducted from the Contractor's Progress Certificates.
- .12 Show the following information in lower right hand corner of shop drawings.
  - .1 Project Title.
  - .2 Tender number or other project number assigned by the Contract Administrator.
  - .3 Name of the depicted item in accordance with the Specifications and Drawings.
  - .4 Project series number and location where the item is used if applicable.
  - .5 Specification section number if applicable
  - .6 Proposed option if applicable.
  - .7 Name of Contractor.
- .13 Accompany submissions with transmittal letter, containing:
  - .1 Date.
  - .2 Project title and number.
  - .3 Contractor's name and address.
  - .4 Identification and quantity of each shop drawing, product data and sample.
  - .5 Specification Section, Title, Number, and Clause
  - .6 Other pertinent data.
  - .7 Date and revision dates.
  - .8 Project title and Bid Opportunity number.
  - .9 Name of:
    - .1 Contractor
    - .2 Subcontractor
    - .3 Supplier
    - .4 Manufacturer
    - .5 Separate detailer when pertinent
  - .10 Identification of product of material.

- .11 Relation to adjacent structure or materials.
- .12 Field dimensions, clearly identified as such.
- .13 Specification section name, number and clause number or drawing number and detail/section number.
- .14 Applicable standards, such as CSA or CGSB numbers.
- .15 Contractor's stamp, initialled or signed, certifying review of submission, verification of field measurements and compliance with Contract Documents.

**1.3 PROCEDURES**

- .1 The Contractor shall, if required by the Contract Administrator, 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 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 of his responsibilities, nor shall reasonable refusal to approve entitle the Contractor to extra payment or an extension of time.
- .3 Other Considerations
  - .1 Fabrication, erection, installation or commissioning may require modifications to equipment or systems to conform to the design intent. Revise pertinent shop drawings and resubmit.
  - .2 Material and equipment delivered to the site of the works will not be paid for at least until pertinent shop drawings have been submitted and reviewed.
  - .3 Incomplete shop drawing information will be considered as stipulated deductions for the purposes of progress payment certificates.
  - .4 No delay or cost claims will be allowed that arise because of delays in submissions, re-submissions and review of shop drawings.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 NOT USED**

- .1 Not Used.

**END OF SECTION**

**Part 1           General**

**1.1               REFERENCE STANDARDS**

- .1       Within the text of the specifications, reference may be made to the following standards:
  - .1       ANSI   American National Standards Institute
  - .2       CEC   Canadian Electrical Code (published by CSA)
  - .3       CEMA   Canadian Electrical Manufacturer's Association
  - .4       CSA   Canadian Standards Association
  - .5       IEEE   Institute of Electrical and Electronic Engineers
  - .6       NBC   National Building Code
  - .7       NEMA   National Electrical Manufacturers Association
  - .8       NFPA – National Fire Protection Association
  - .9       ULC   Underwriters' Laboratories of Canada

**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                INSPECTION**

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

**1.2                INDEPENDENT INSPECTION AGENCIES**

- .1        Independent Inspection/Testing Agencies may be engaged by the City for purpose of inspecting and/or testing portions of Work. Cost of such services will be borne by the City. Costs of additional tests required due to defective Work shall be paid by the Contractor.
- .2        All equipment required for executing inspection and testing will be provided by the respective agencies.
- .3        Employment of inspection/testing agencies does not relieve or relax responsibility to perform Work in accordance with Contract Documents.
- .4        If defects are revealed during inspection and/or testing, appointed agency will request additional inspection and/or testing to ascertain full degree of defect. Correct defect and irregularities as advised by the Contract Administrator at no cost to the City. Pay costs for retesting and reinspection.

**1.3                ACCESS TO WORK**

- .1        The City, the Contract Administrator, and other authorities having jurisdiction shall have access to the work.

**1.4                REJECTED WORK**

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

**1.5 REPORTS**

- .1 Submit draft inspection and test reports to Contract Administrator, prior to inclusion with the O&M manuals, in accordance with Section 01 33 00 - Submittal Procedures.

**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            REFERENCES**

- .1        Conform to reference standards, in whole or in part as specifically requested in specifications.
- .2        If there is 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 born by the City in event of conformance with 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 precaution against oversight or error. Remove and replace defective products at own expense and be responsible for delays and expenses caused by rejection. Should disputes arise as to quality or fitness of products, decision rests strictly with the Contract Administrator based upon requirements of Contract Documents.
- .3        Unless otherwise indicated in specifications, maintain uniformity of manufacture for any particular or like item throughout building.
- .4        Permanent labels, trademarks and nameplates on products are not acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.

**1.3            AVAILABILITY**

- .1        Immediately upon signing Contract, review product delivery requirements and anticipate foreseeable supply delays for items. If delays in supply of products are foreseeable, notify 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 Work.
- .2        In event of failure to notify the Contract Administrator at 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 Contract Price or Contract Time.

**1.4            METRIC PROJECT**

- .1        Unless otherwise noted, this project has been designed and is to be constructed in the International System (SI) of Units metric system of measurements.
- .2        During construction, when specified metric elements are unattainable at the time they are required to meet the construction schedule, the Contractor shall notify the Contract Administrator in writing and suggest alternative substitutions. Costs due to these substitutions shall be borne by the Contractor.



**1.5 STORAGE, HANDLING AND PROTECTION**

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

**1.6 TRANSPORTATION**

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

**1.7 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 that the Contract Administrator will establish the course of action.
- .3 Improper installation or erection of products, due to failure in complying with these requirements, authorizes the Contract Administrator to require removal and re-installation at no increase in Contract Price or Contract Time.

**1.8 CO-ORDINATION**

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

**1.9 CONCEALMENT**

- .1 In finished areas conceal pipes, ducts and wiring in floors, walls and ceilings, except where indicated otherwise.
- .2 Before installation inform the Contract Administrator if there is interference. Install as directed by the Contract Administrator.

**1.10 REMEDIAL WORK**

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

**1.11 LOCATION OF FIXTURES**

- .1 Consider location of existing and new mechanical and electrical items as approximate. Coordinate location with the Contract Administrator if not clear.
- .2 Inform the Contract Administrator of conflicting installation. Install as directed.

**1.12 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.

**1.13 PROTECTION OF WORK IN PROGRESS**

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

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used.

**Part 3 Execution**

**3.1 WORKMANSHIP**

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

**END OF SECTION**

**Part 1            General**

**1.1                PROJECT CLEANLINESS**

- .1      Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by City or other Contractors.
- .2      Remove waste materials from 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      Clean interior areas prior to start of finishing work, and maintain areas free of dust and other contaminants during finishing operations.
- .7      Store volatile waste in covered metal containers, and remove from premises at end of each working day.
- .8      Provide adequate ventilation during use of volatile or noxious substances. Use of building ventilation systems is not permitted for this purpose.
- .9      Use only cleaning materials recommended by manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.
- .10     Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

**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 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Copy will be returned after final inspection, with Contract Administrator's comments.
- .3 Revise content of documents as required prior to final submittal.
- .4 Furnish evidence, if requested, for type, source and quality of products provided.
- .5 Pay costs of transportation.

**1.2 OPERATING AND MAINTENANCE MANUALS**

- .1 Prepare using personnel experienced in maintenance and operation of described products.
- .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 form of approved shop drawings, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists.
- .3 Quantity and Format
  - .1 Submit for review and comments prior to Substantial Performance:
    - .1 One (1) paper manual copy.
    - .2 One (1) electronic CD copy.
  - .2 Final Copies:
    - .1 Five (5) paper binder copies.
    - .2 Two (2) electronic CD copies.
- .4 For the guidance of the City's operating 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.
- .5 All instructions in these manuals shall be in simple language to guide the City in the proper operating and maintenance of this installation.
- .6 In addition to information called for in the Specifications, include the following:
  - .1 Overall Title sheet, labelled "Operation and Maintenance Instructions", and containing project name and date, facility's covered in the manual, City's Contract number, the name and address of the Contractor, and the issue date.
  - .2 Overall list of contents, indicating the facilities upgraded by the project.
  - .3 Title sheet for each section, labelled "Operation and Maintenance Instructions", the applicable facility, and containing project name and date.
  - .4 List of contents for each section.
  - .5 Include:
    - .1 Brochures/catalogue excerpts of all components of the Work.
    - .2 Documentation of all test results.
    - .3 Complete set of equipment and assembly drawings

- .4 Installation, start-up, O&M Manuals
- .5 Any specific requirements from the Specifications
- .6 Reviewed Shop Drawings of all equipment.
- .7 Names, addresses, and telephone numbers of all major sub-contractors and suppliers.
- .7 Modify and supplement the manual as required by the Contract Administrator.
- .8 Paper Manual format to be as follows:
  - .1 Organize data as instructional manual.
  - .2 Binders: vinyl, hard covered, 3 'D' ring, with spine and face pockets.
  - .3 When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.
  - .4 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- .9 Electronic CD Manual format to be as follows:
  - .1 Contain at minimum the same information as the Paper Manual format. Additional information may be provided electronically.
  - .2 Organize into logical PDF files, arranged into a directory structure that is similar to the Paper Manual Format. Organize in a manner to make it easy to find documents from the Table of Contents.
  - .3 Where practical, provide PDF documents in native, searchable format rather than scanned documents. Do not simply scan in the paper copies.
    - .1 Where comments are required in the manuals to clarify the applicable equipment, utilize electronic editing of the PDF files rather than handwritten comments and scanning.
  - .4 Where documents are scanned, they shall be provided at a sufficient resolution to prevent distortion. Unsuitable scanned documents will be rejected.
- .10 Prototype for O&M Manual organization as follows. Utilize as the basis for developing the O&M manuals, but not that the below is not necessarily comprehensive.
  - .1 Table of Contents
  - .2 Supplier Index
  - .3 Permit and Inspection Certificate
  - .4 Shop Drawings, Product Data, Installation & User Manuals
  - .5 Commissioning Forms (typed)
  - .6 Other data as applicable

### **1.3 AS-BUILT DRAWINGS**

- .1 After award of Contract, the Contract Administrator will provide a complete set of Drawings for the purpose of maintaining Project As-Built Drawings. Accurately record significant deviations from Contract Documents caused by Site conditions and changes ordered by the Contract Administrator. Update daily.
- .2 Identify Drawings as "Project As-Built Copy". Maintain in good condition and make available for inspection on-site by Contract Administrator at all times.
- .3 On completion of the Work, submit As-Built Drawings to Contract Administrator for review.

**Part 2            Products**

**2.1                NOT USED**

.1            Not Used.

**Part 3            Execution**

**3.1                NOT USED**

.1            Not Used.

**END OF SECTION**

**Part 1            General**

**1.1                DESCRIPTION**

- .1     Demonstrate operation and maintenance of equipment and systems to City personnel as equipment is replaced and upgraded.
- .2     City will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed upon times.

**1.2                QUALITY CONTROL**

- .1     When specified in individual Sections, require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct City personnel, and provide written report that demonstration and instructions have been completed.

**1.3                SUBMITTALS**

- .1     Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2     Give time and date of each demonstration, with list of persons present.

**1.4                CONDITIONS FOR DEMONSTRATIONS**

- .1     Equipment has been inspected and put into operation in accordance with Section 01 45 00.
- .2     Testing, adjusting, and balancing has been performed and equipment and systems are fully operational.

**1.5                PREPARATION**

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

**1.6                DEMONSTRATION AND INSTRUCTIONS**

- .1     Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.
- .2     Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3     Review contents of manual in detail to explain aspects of operation and maintenance.
- .4     Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

**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                GENERAL**

- .1        This Section covers items common to Sections of Division 26. This section supplements requirements of Division 1.

**1.2                CODES AND STANDARDS**

- .1        Complete installation in accordance with CSA C22.1-2012 except where specified otherwise.
- .2        Comply with all laws, ordinances, rules, regulations, codes, and orders of all authorities having jurisdiction relating to this Work.

**1.3                DRAWINGS AND SPECIFICATIONS**

- .1        The intent of the Drawings and Specifications is to include all labour, products, and services necessary for complete Work, tested and ready for operation.
- .2        These Specifications and the Drawings and Specifications of all other divisions shall be considered as an integral part of the accompanying Drawings. Any item or subject omitted from either the Specifications or the Drawings but which is mentioned or reasonably specified in and by the others, shall be considered as properly and sufficiently specified and shall be provided.
- .3        Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.
- .4        If discrepancies or omissions in the Drawings or Specifications are found, or if the intent or meaning is not clear, advise the Contract Administrator for clarification before submitting Bid, in accordance with B4.

**1.4                CARE, OPERATION AND START-UP**

- .1        Instruct City maintenance and operating personnel in the operation, care and maintenance of systems, system equipment and components.
- .2        Where services of a manufacturer's factory service engineer is required, arrange and pay for services to supervise start-up of installation, check, adjust, balance and calibrate components and instruct operating personnel.
- .3        Provide these services for such period, and for as many visits as necessary to put equipment in operation, and ensure that operating personnel are conversant with all aspects of its care and operation.

**1.5                PERMITS, FEES AND INSPECTION**

- .1        Submit to Electrical Inspection Department and Supply Authority necessary number of drawings and specifications for examination and approval prior to commencement of work.
- .2        Pay associated fees.
- .3        Notify Contract Administrator of changes required by Electrical Inspection Department prior to making changes.

- .4 Furnish a Certificate of Final Inspection and approvals from inspection authority to the Contract Administrator.

## **1.6 MATERIALS AND EQUIPMENT**

- .1 Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Equipment and material to be CSA certified. Where there is no alternative to supplying equipment which is not CSA certified, obtain special approval from Electrical Inspection Department.
- .3 Factory assemble control panels and component assemblies.
- .4 Minimum enclosure type to be NEMA 12 unless otherwise specified.

## **1.7 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 shipment or installation, to match original paint.
- .3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

## **1.8 EQUIPMENT IDENTIFICATION**

- .1 Identify electrical equipment with nameplates as follows:
- .2 Nameplates:
  - .1 Lamicaid 3 mm thick plastic lamicaid nameplates, white face, black core, mechanically attached with self tapping screws.

### **NAMEPLATE SIZES**

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	5 mm high letters
Size 8	35 x 100 mm	3 lines	5 mm high letters

- .3 Wording on nameplates to be approved by Contract Administrator prior to manufacture.
- .4 Allow for average of twenty-five (25) letters per nameplate.
- .5 Identification to be English.

### 1.9 WIRING IDENTIFICATION

- .1 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders and branch circuit wiring.
- .2 Maintain phase sequence and colour coding throughout.
- .3 Colour code: to CSA C22.1.
- .4 Use colour coded wires in communication cables, matched throughout system.

### 1.10 CONDUIT AND CABLE IDENTIFICATION

- .1 Colour code conduits, boxes and cables.
- .2 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals.
- .3 Colours: 38 mm wide prime colour and 19 mm wide auxiliary colours.

<b>System</b>	<b>Prime Band</b>	<b>Aux. Band</b>
Medium Voltage (>750 V)	Orange	
347/600 V	Yellow	
120/208/240 V Power	Black	
UPS 120/208/240 V Power	Black	Green
Control Wiring (120 V)	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control Wiring (<50 V)	Blue	Orange
Intrinsically Safe	Blue	White

- .4 Cable Identification: Supply and install lamacoid type cable identification tags for all cables. Install identification tag at both ends.

### 1.11 MANUFACTURERS AND CSA LABELS

- .1 Visible and legible after equipment is installed.

### 1.12 WARNING SIGNS

- .1 As specified and to meet requirements of Electrical Inspection Department and the Contract Administrator.
- .2 Lamicaid 3 mm thick plastic engraving sheet, red face, white core, mechanically attached with self tapping screws, 20mm text.

### 1.13 MOUNTING HEIGHTS

- .1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.
- .2 Unless otherwise noted, mount equipment replacing existing equipment at the same height.
- .3 If mounting height of equipment is not specified or indicated, verify before proceeding with installation.
- .4 Install electrical equipment at following heights unless indicated otherwise.
  - .1 Panelboards: as required by Code or as indicated.

**1.14 CONDUIT AND CABLE INSTALLATION**

- .1 Fire stop openings through concrete with ULC approved assembly for the installation conditions.
- .2 Provide a detailed proposed conduit routing plan to the Contract Administrator prior to proceeding with the installation of conduit.
- .3 If possible, avoid routing conduits through hazardous area.
- .4 Separate cables of different voltage levels when cables are installed parallel to each other.

**1.15 CUTTING AND PATCHING**

- .1 Provide all cutting and patching as required.
- .2 Return exposed surfaces to an as-found condition.
- .3 Exercise care where cutting holes in existing concrete elements so as not to damage existing reinforcing.
  - .1 Locate existing reinforcing utilizing a reinforcing bar locator and mark out on the surface of the concrete.
  - .2 For all holes larger than 50mm passing through reinforced concrete, mark the location of the desired hole and all adjacent rebar. Obtain approval from the Contract Administrator prior to cutting.
  - .3 Firestop and seal all penetrations, regardless of whether the penetration requires a fire rating.

**1.16 FIELD QUALITY CONTROL**

- .1 All electrical work to be carried out by qualified, licensed electricians or apprentices as per the conditions of the Provincial Act respecting manpower vocational training and qualification. Employees registered in a provincial apprentices program shall be permitted, under the direct supervision of a qualified licensed electrician, to perform specific tasks - the activities permitted shall be determined based on the level of training attained and the demonstration of ability to perform specific duties.
- .2 The work of this division to be carried out by a contractor who holds a valid Master Electrical contractor license as issued by the Province of Manitoba.
- .3 Furnish manufacturer's certificate or letter confirming that entire installation as it pertains to each system has been installed to manufacturer's instructions.

**1.17 ANCHOR INSTALLATION**

- .1 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 the hole shall be terminated and repositioned to clear the reinforcement. Do not use core bits that can easily intercept and damage/cut the reinforcing during drilling.

**1.18 TESTING**

- .1 All test instruments utilized are to have been calibrated within one year of the date utilized.

- .2 Carry out tests in presence of the Contract Administrator or delegated representative.
- .3 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of project.
- .4 Submit test results for Contract Administrator's review.

#### **1.19 SUBMITTALS**

- .1 Within 15 days of award of Contract, the Contractor shall submit a completed equipment procurement schedule, which lists the Manufacturer and model of equipment, indicating the projected ordering, Shop Drawing submittal date and delivery dates of all Products to meet the required construction schedule.
- .2 Prior to delivery of any Products to job Site and sufficiently in advance of requirements to allow ample time for checking, submit Shop Drawings for review as specified in Division 01.
- .3 Submit Shop Drawings (including Product Data) for all equipment as required in each Section of this Specification.
- .4 Prior to submitting the Shop Drawings to the Contract Administrator, the Contractor shall review the Shop Drawings to determine that the equipment complies with the requirements of the Specifications and Drawings.
- .5 The term "Shop Drawing" means drawings, diagrams, illustrations, schedules, performance characteristics, brochures and other data, which are to be provided by the Contractor to illustrate details of a portion of the Work. Indicate materials, methods of construction and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes and other information necessary for completion of Work. Where equipment is connected to other equipment, indicate that such items have been coordinated, regardless of the section under which the adjacent items will be supplied and installed. Indicate cross-references to Design Drawings and Specifications. Adjustments made on Shop Drawings by the Contract Administrator are not intended to change the contract price. If adjustments affect the value of the Work state such in writing to the Contract Administrator prior to proceeding with the Work.
- .6 Manufacture of Products shall conform to revised Shop Drawings.
- .7 Keep one (1) complete set of Shop Drawings at job Site during construction.
- .8 Prior to shipping pre-fabricated panels, photos of completed panels shall be sent to the Contract Administrator of final review. The resolution of the photos should be such that individual wire tags can be read.

#### **1.20 AS-BUILT DRAWINGS**

- .1 The Contractor shall keep one (1) complete set of white prints at the Site during work, including all addenda, change orders, Site instructions, clarifications, and revisions for the purpose of As-Built Drawings. As the Work on-site proceeds, the Contractor shall clearly record in Red Pencil all as-built conditions, which deviate from the original Contract Documents. As-Built Drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment.
- .2 On completion of the Work, two (2) weeks prior to final inspection, submit As-Built Drawings to Contract Administrator for review. The Contractor shall certify, in writing,

that the As-Built Drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items

**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 REFERENCES**

- .1 CSA C22.2 No .0.3, Test Methods for Electrical Wires and Cables.
- .2 CAN/CSA-C22.2 No. 38, Thermoset-Insulated Wires and Cables.
- .3 CAN/CSA-C22.2 No. 131, Type TECK 90 Cable.

**1.2 SUBMITTALS**

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

**Part 2 Products**

**2.1 TECK 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: chemically cross-linked thermosetting polyethylene rated type RW90.
  - .1 Insulation Voltage Rating:
    - .1 Circuits 480 V and less: 600 V
    - .2 Circuits > 480 V: 1000 V
- .4 Inner jacket: polyvinyl chloride material.
- .5 Armour: interlocking aluminum.
- .6 Overall covering: polyvinyl chloride material.
- .7 Fastenings:
  - .1 One hole aluminum straps to secure surface cables 50 mm and smaller. Two hole aluminum straps for cables larger than 50 mm.
  - .2 Channel type supports for two (2) or more cables at 1000 mm centers.
  - .3 Threaded rods: 6 mm dia. to support suspended channels.
- .8 Cable Fittings:
  - .1 Minimum requirement: Watertight, approved for TECK cable.
  - .2 Hazardous Locations:
    - .1 CSA approved.
    - .2 Watertight type with:
      - .1 an elastomeric bevelled bushing.
      - .2 a funnel entry, splined gland nut.
      - .3 a non-magnetic, stainless steel grounding device with dual grounding action.
      - .4 a taper threaded hub.



- .5 a hexagonal body and gland nut
- .3 Integral seal type with metal-to-metal contact construction.
- .4 Sealing of multi-conductor cable shall be accomplished with a liquid type polyurethane compound.
- .5 The fitting must:
  - .1 Provide an environmental seal around the outer jacket of the cable and electrically bond the fitting to the cable armour prior to potting the explosion-proof seal.
  - .2 Allow the possibility of disconnection without disturbing the environmental seal, the electrical bonding or the explosionproof seal.
- .6 All metal-clad cable fittings, for jacketed and non-jacketed interlocked armour cable, shall incorporate an easily-removable armour stop (not requiring fitting disassembly) ensuring proper positioning of the cable armour during cable termination.
- .7 Approved products:
  - .1 T&B Startech XP series.

### **Part 3 Execution**

#### **3.1 GENERAL**

- .1 Do not splice cables. A continuous length is required for all feeds.
- .2 Install in accordance with manufacturer's recommendations, observing requirements for minimum bending radius and pulling tensions.
- .3 Exercise care in stripping insulation from wire. Do not nick conductors.

#### **3.2 INSTALLATION OF CONTROL CABLES**

- .1 Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.
- .2 Install control cables in conduit or cable tray as indicated. Do not locate in power cable trays without permission from the Contract Administrator.
- .3 Ground shields 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.
- .4 Shield drain wires, at the ungrounded end, are to be taped back to the cable. Do not cut the shield drain wire off.

#### **3.3 TERMINATIONS AND SPLICES**

- .1 Wire nuts are permitted only in the following circuits:
  - .1 Lighting circuits.
  - .2 Receptacle circuits.
- .2 Exercise care in stripping insulation from wire. Do not nick conductors.
- .3 Strictly follow manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

- .4 Where screw-type terminals are provided on equipment and instrumentation, terminate field wiring with insulated fork tongue terminals.
  - .1 Manufacturer: Thomas and Betts, Sta-Kon, or approved equal in accordance with B6.

### **3.4 RE-USE OF EXISTING WIRING**

- .1 Except where specifically identified or approved, reuse of existing wiring is not permitted.
- .2 Ensure all existing wiring is tagged prior to disconnection of equipment.
- .3 Tag spare wires as “Spare” and indicate the location of the other end of the wire.

### **3.5 CABLE IDENTIFICATION**

- .1 Install cable tags on both ends of each cable.
- .2 Cable tags to be located external to equipment and panels and within 203 mm of point of entry of cable.
- .3 Construction and installation: white plate and black text, four through holes to facilitate fastening to cable by means of cable ties (tie-wraps).

### **3.6 TESTING**

- .1 Test all power conductors 12 AWG and larger in accordance with 26 08 05.

**END OF SECTION**

**Part 1            General**

**1.1                SECTION INCLUDES**

- .1            Materials and installation for connectors and terminations.

**1.2                REFERENCES**

- .1            Canadian Standards Association (CSA International)
  - .1            CSA C22.2 No.65.

**1.3                PRODUCT DATA**

- .1            Submit product data in accordance with Section 01 33 00 - Submittal Procedures.

**Part 2            Products**

**2.1                CONNECTORS AND TERMINATIONS**

- .1            Copper long barrel compression connectors to CSA C22.2 No.65 as required sized for conductors.
- .2            Contact aid for aluminum cables where applicable.
- .3            Belleville washers to be utilized.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1            Install stress cones, terminations, and splices in accordance with manufacturer's instructions.
- .2            Bond and ground as required.

**END OF SECTION**

**Part 1            General**

**1.1                NONE**

- .1        None.

**Part 2            Products**

**2.1                FRAMING AND SUPPORT SYSTEM**

- .1        Materials:

- .1        Conduit support structures shall employ a galvanized steel strut framing system together with the manufacturer's connecting components and fasteners for a complete system.

- .2        Finishes:

- .1        Wet locations: Aluminum.
  - .2        Indoors, dry locations: Aluminum.
  - .3        Nuts, bolts, machine screws: 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 with B6.

**Part 3            Execution**

**3.1                INSTALLATION**

- .1        Secure equipment to solid masonry, tile and plaster surfaces with galvanized anchors.
- .2        Secure equipment to poured concrete with expandable inserts.
- .3        Secure equipment to hollow masonry walls or suspended ceilings with toggle bolts.
- .4        Support equipment, conduit or cables using clips, spring loaded bolts, cable clamps designed as accessories to basic channel members.
- .5        Multiple cables are not permitted under a single strap, unless the strap is specifically listed by the manufacturer as approved for multiple cables, and the cable is adequately derated for the installation.
- .6        For surface mounting of two or more conduits use channels, with maximum centre spacing as indicated above.
- .7        Provide metal brackets, frames, hangers, clamps and related types of support structures where indicated or as required to support conduit and cable runs.
- .8        Ensure adequate support for raceways and cables dropped vertically where there is no wall support.

- .9 Do not use wire lashing or perforated strap to support or secure cables.
- .10 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.
- .11 Install fastenings and supports as required for each type of equipment cables and conduits, and in accordance with manufacturer's installation recommendations.
- .12 Touch up abraded surfaces and cut ends of galvanized members with an approved galvanizing repair compound.

**END OF SECTION**

**Part 1            General**

**1.1                REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CAN/CSA C22.1 No.126.1-02, Metal Cable Tray Systems.
- .2 National Electrical Manufacturers Association (NEMA)
  - .1 NEMA VE 1-2002, Metal Cable Tray Systems.
  - .2 NEMA VE 2-2001, Cable Tray Installation Guidelines.

**1.2                SUBMITTALS**

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data: submit manufacturer's product data sheets for cable tray indicating dimensions, materials, and finishes, including classifications and certifications.
- .3 Shop Drawings: submit shop drawings showing materials, finish, dimensions, accessories, layout, and installation details.
- .4 Identify types of cable tray and cable channels used.
- .5 Show actual cable tray and cable channel installation details and suspension system.

**Part 2            Products**

**2.1                CABLE TRAY**

- .1 Cable tray and fittings: to NEMA VE 1 and CAN/CSA C22.1 No. 126.1.
- .2 Ladder type, Class C1 to CAN/CSA C22.2 No. 126.1.
- .3 Trays: aluminum, width as indicated on the drawings.
  - .1 Side rail height: 150mm unless otherwise indicated.
- .4 Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints and reducers where required, manufactured accessories for cable tray supplied.
  - .1 Radii on fittings: 300 mm minimum.
- .5 Barriers where different voltage systems are in same cable tray.
- .6 Ground cable trays with 2/0 AWG bare copper conductor attached to each tray section in accordance with CEC requirements.

**2.2                CABLE CHANNEL**

- .1 Cable channel and fittings: to NEMA VE 1 and CAN/CSA C22.1 No. 126.1.
- .2 Ventilated trough type.
- .3 Channels: aluminum, width and depth as required.
- .4 Fittings: horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints and reduces where required, manufactured accessories for cable channel supplied.

- .5 Ground cable channels with #6 AWG bare copper conductor attached to each channel section in accordance with CEC requirements.

### **2.3 SUPPORTS**

- .1 Provide splices, supports as required.
- .2 Supports to be located minimum one-quarter span from points of coupling, where practicable.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install complete cable tray and cable channel system in accordance with NEMA VE 2.
- .2 Support cable tray and cable channel on both sides at 2000 mm maximum spacing.
- .3 Remove sharp burrs or projections to prevent damage to cables or injury to personnel.
- .4 Provide fire stop material at firewall penetrations.

### **3.2 CABLES IN CABLE TRAY**

- .1 Install cables individually.
- .2 Lay cables into cable tray. Use rollers when necessary to pull cables.
- .3 Secure cables in cable tray at 6 m centres, with nylon ties.

### **3.3 CABLES IN CABLE CHANNEL**

- .1 Install cables individually.
- .2 Lay cables into cable channel.
- .3 Secure cables in cable channel at 2 m centres, with nylon ties.

**END OF SECTION**

**Part 1        General**

**1.1            REFERENCES**

- .1        NETA Acceptance Testing Specifications, 2003 (ATS-2003)

**1.2            SUBMITTALS**

- .1        Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2        Submit:
  - .1        Test equipment to be utilized with last calibration date.
  - .2        Qualifications of lead on site inspector.

**1.3            QUALIFICATION**

- .1        Provide competent lead electrical inspection technician thoroughly familiar with all aspects of electrical testing. It is expected that the technician will have a CET or equivalent designation. The designated technician is to be on-site and lead all electrical testing.
  - .1        The Contract Administrator reserves right to approve the lead electrical inspection technician, and request an alternate technician if deemed to be unqualified.

**1.4            TESTING EQUIPMENT**

- .1        All test equipment shall be in good mechanical and electrical condition.
- .2        Accuracy of metering in test equipment shall be appropriate for the test being performed.
- .3        Wave shape and frequency of test equipment output waveforms shall be appropriate for the test and the tested equipment.
- .4        The test equipment shall be calibrated as specified below:
  - .1        The testing organization shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.
  - .2        The firm providing calibration service shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.
  - .3        Instruments shall be calibrated in accordance with the following frequency schedule:
    - .1        Field instruments: Analog, 6 months maximum. Digital, 12 months maximum.
    - .2        Laboratory instruments: 12 months maximum.
    - .3        Leased specialty equipment: 12 months maximum.
    - .4        Dated calibration labels shall be visible on all test equipment.
    - .5        Records, which show date and results of instruments calibrated or tested, must be kept up-to-date.
    - .6        Calibrating standard shall be of higher accuracy than that of the instrument tested.
- .5        Specific requirements of insulation resistance meters.



- .1 Must be digital units. Crank-type analog insulation resistance meters will not be acceptable.
- .6 Specific requirements of low-resistance meters:
  - .1 Measure resistance range from 1  $\mu\Omega$  to 1000  $\Omega$ .
  - .2 Standard electrician multimeters will not be accepted.

## **1.5 TESTING REPORT**

- .1 Prepare an overall inspection and test report that details all investigations and tests.
- .2 The Contractor shall include the report in the O&M manuals.
- .3 The report shall be neat and organized. Any omissions, inconsistencies, or incomplete work identified by the Contract Administrator shall be corrected and incorporated into the report in the appropriate section, and completely resubmitted.
- .4 A draft of each report shall be completed and sent to the Contract Administrator for review a maximum of one month after the completion of the inspections at the Site.
- .5 The final report shall be submitted a maximum of two weeks after the Contractor receives the mark-up of the draft report from the Contract Administrator.
- .6 The report shall include the following:
  - .1 Summary of project.
  - .2 Testing Equipment.
  - .3 Detail the type, manufacturer, model, and last calibration date of all testing equipment.
  - .4 Description of equipment tested.
  - .5 Description of all tests.
  - .6 Typed inspection forms including:
    - .1 Identification of the testing organization.
    - .2 Equipment identification.
    - .3 Humidity, temperature, and other conditions that may affect the results of the tests/calibrations.
    - .4 Date of inspections, tests, maintenance, and/or calibrations.
    - .5 Identification of the testing technician.
    - .6 Indication of inspections, tests, maintenance, and/or calibrations performed and recorded, along with charts, and graphs as applicable. All measurements and readings taken shall be noted for inclusion in the report. Where repairs are made, measurements and readings before and after the repair shall be included.
    - .7 Indication of expected results, when calibrations are to be performed.
    - .8 Indication of “as-found” and “as-left” results, as applicable.
- .7 Itemized list of all repaired deficiencies which shall include:
  - .1 Detailed description of the deficiency.
  - .2 The cost associated with the deficiency repair.
- .8 Itemized list of all un-repaired deficiencies encountered which shall include:
  - .1 Detailed description of the deficiency.

**Part 2 Products**

**2.1 NOT USED**

- .1 Not Used

**Part 3 Execution**

**3.1 SCOPE OF TESTING**

- .1 PFC-U701
  - .1 Metering
  - .2 Capacitors
  - .3 Contactors
- .2 PFC-U702
  - .1 Metering
  - .2 Capacitors
  - .3 Contactors
- .3 600V bus duct feeding PFC units.

**3.2 INSPECTION, TESTING AND MAINTENANCE PROCEDURES**

- .1 General
  - .1 All tests are based on NETA (InterNational Electrical Testing Association) standard ATS-2003. Where manufacturer's specifications, tolerances, and/or published data are not available, refer to the appropriate tables in ATS-2003.
  - .2 Torque all accessible bolted electrical connections. Additional requirements apply as specified.
  - .3 Utilize the existing drawings for reference while performing the specified electrical inspection work. Where the existing installation deviates from that shown on the drawings, mark-up the drawings with red pen as required to reflect the installation. Include the marked-up drawings in the report.
  - .4 The scope of required drawing checks is limited to the equipment and components that are part of the electrical inspection work.
  - .5 Any repairs made that affect the accuracy of the drawings shall be marked up on the drawings.
  - .6 Drafting of drawings is not required.
  - .7 All inspection values, readings, corrections, and assessments shall be clearly recorded for inclusion within the report.
  - .8 Where corrections or repairs are made, record both as found/as left test readings on the inspection sheet. If space is not provided on the inspection form, record the readings in the Note fields or on a separate sheet.
- .2 Inspection Forms
  - .1 The inspection forms to be completed by the Contractor are provided for reference in PDF format.
  - .2 Microsoft Word form templates will be provided prior to the work being initiated.

- .3 Make appropriate print-outs of the inspection forms and utilize for entry of data and test results on site.
- .4 Utilizing the Microsoft Word form templates, enter the data recorded manually into the forms electronically.
- .5 Complete the inspection forms in the entirety and include them in the report.
- .6 Submit electronic PDF copies of the inspection forms.
- .7 The scope of work required in the specifications is in no way limited by the inspection forms, or spaces provided. Provide additional pages, documents, and forms as required to provide a complete report.
- .8 The inspection forms may be updated during the Work by the City or Contract Administrator. Utilize the latest forms provided.
- .9 Perform insulation resistance temperature correction calculations utilizing the following:
  - .1 To correct to 20°C, utilize Table 260805-1.
  - .2 To correct to 40°C, utilize Table 260805-2.

<b>Table 260805-1</b>		
<b>Insulation Resistance Correction Factors (20 °C)</b>		
<b>Measured Temperature (°C)</b>	<b>Oil Immersed Insulation</b>	<b>Solid Insulation</b>
-10	0.125	0.25
-5	0.18	0.32
0	0.25	0.40
5	0.36	0.50
10	0.50	0.63
15	0.75	0.81
16	0.80	0.85
17	0.85	0.89
18	0.90	0.92
19	0.95	0.96
20	1.00	1.00
21	1.08	1.05
22	1.16	1.10
23	1.24	1.15
24	1.32	1.20
25	1.40	1.25
30	1.98	1.58
35	2.80	2.00
40	3.95	2.50
45	5.60	3.15
50	7.85	3.98
55	11.20	5.00
60	15.85	6.30

<b>Table 260805-2</b>		
<b>Insulation Resistance Correction Factors (40 °C)</b>		
<b>Measured Temperature (°C)</b>	<b>Oil Immersed Insulation</b>	<b>Solid Insulation</b>
-10	0.03	0.10
-5	0.04	0.13
0	0.06	0.16
5	0.09	0.20
10	0.13	0.25
15	0.18	0.31
16	0.19	0.33
17	0.21	0.34
18	0.22	0.36
19	0.24	0.38
20	0.25	0.40
21	0.27	0.42
22	0.29	0.44
23	0.31	0.46
24	0.33	0.48
25	0.35	0.50
30	0.50	0.63
35	0.71	0.79
40	1.00	1.00
45	1.41	1.26
50	2.00	1.59
55	2.83	2.00
60	4.00	2.52

.3 Perform winding resistance temperature correction calculations utilizing the following:

.1 
$$R_C = R_M \frac{T_C + T_K}{T_M + T_K}$$

- .2 Where, RC = Resistance at corrected temperature.  
RM = Resistance at measured temperature.  
TC = Temperature to correct to in °C.  
TM = Measured temperature in °C.  
TK = Temperature Resistance Constant  
(234.5 °C for copper, 226.0 °C for aluminum)

### 3.3 **BUSWAY, <1000V**

- .1 Inspection and testing of low voltage busway shall be comprised of the following:
  - .1 Inspect end sections of busway and bends for any physical damage and evidence of overheating. Inspect bends for any thermo mechanical stresses and insulator stressing.
  - .2 Inspect anchorage, alignment, and grounding.
  - .3 Confirm physical orientation in accordance with manufacturer's labels to insure adequate cooling.
  - .4 Examine outdoor busway for removal of "weep-hole" plugs, if applicable, and for the correct installation of joint shield.
  - .5 Inspect and clean ventilating openings.
  - .6 Verify operation of busway heaters.
  - .7 Inspect end termination and tap bolted electrical connections for high resistance using one of the following methods:
    - .1 Use of a low resistance ohmmeter to measure resistance through bolted connections.
    - .2 Verify tightness of accessible bolted electrical connections and bus joints by calibrated torque-wrench method.
  - .8 Inspect busway grounding and support system.
  - .9 Perform an insulation-resistance test on each phase conductor. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 1000 megaohms. The voltage applied shall be 500 Vdc for busway rated 300 V or less, and 1000 Vdc for 600V busway.
  - .10 Measure the total resistance of the busway on each phase, and the total inductance of the bus on each phase.
  - .11 Measure the total length of busway centerline.

### 3.4 **CAPACITOR BANKS**

- .1 Inspection and testing shall be comprised of the following:
  - .1 Note the equipment nameplate data for inclusion in the report.
  - .2 Record all adjustable settings.
  - .3 Inspect physical and mechanical condition.
  - .4 Inspect anchorage, alignment, and grounding.
  - .5 Verify the unit is clean.
  - .6 Torque all accessible bolted power connections.
  - .7 Inspect unit for evidence of overheating or stress.
  - .8 Visually inspect and exercise transfer switch.

- .2 If power and/or control fuses are present, record fuse size and type. Measure the resistance of each fuse. Investigate inconsistent resistance values.
- .3 Perform an insulation resistance test.
  - .1 Units rated  $< 600\text{V}$ , test voltage is to be 500 VDC.
  - .2 Units rated  $\geq 600\text{V}$ , test voltage is to be 1000 VDC.
- .4 Perform a contact/pole-resistance test.
- .5 Measure and record capacitance of each capacitor.
- .6 Measure and record resistance of discharge resistors, if present.
- .7 Perform functional testing to verify operation of unit.

**END OF SECTION**

**Part 1 General**

**1.1 REFERENCES**

- .1 Canadian Standards Association (CSA International)
  - .1 CSA C22.2 No.190-M1985(R2004), Capacitors for Power Factor Correction.

**1.2 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, and limitations.
  - .2 List of all major components and weights.
- .3 Shop Drawings
  - .1 Outline dimensions, front, side and sectional views.
  - .2 Foundation and support details.
  - .3 Enclosure construction, lifting and supporting points.
  - .4 Conduit / cable entrance locations and requirements.
  - .5 Electrical single line diagram and equipment electrical ratings including voltage, frame size and trip ratings, withstand ratings, and time current curves of equipment and components.
  - .6 Compartment layout drawings showing device locations.
  - .7 Wiring diagram showing terminal blocks and terminal numbers.
- .4 Submit certified factory test results to Contract Administrator.
- .5 Closeout Submittals
  - .1 Complete set of shop drawings and submittals.
  - .2 Operation and maintenance manuals.
  - .3 Factory test reports.

**1.3 SERVICE CONDITIONS**

- .1 Temperature: 5 - 40 degrees C, maximum ambient.
- .2 Altitude: Less than 1000 feet.

**Part 2 Products**

**2.1 AUTOMATIC POWER FACTOR CORRECTION BANK - DETUNED**

- .1 General:
  - .1 The automatic power factor correction bank shall be a self-contained, automatically and manually-controlled self-protecting capacitor bank. The equipment shall allow automatic or manual switching of the capacitor bank kVAR's in minimum of 50 kVAR per step for a total of nine (9) steps. Bus duct



to the existing power factor correction banks shall be re-used /modified to connect to the new units.

- .2 Approvals:
  - .1 CSA Approved
  - .2 Capacitor assembly for power factor correction: to CSA C22.2 No.190.
- .3 Ratings:
  - .1 System Voltage: 600V, 3-phase, 3-wire, 60 Hz, solidly grounded (wye).
  - .2 Total nominal kVAR: 450 kVAR
    - .1 Actual capacitor kVAR will be higher due to reactors.
  - .3 Nominal Capacitance Stages:
    - .1 One (1) 50 kVAR
    - .2 Four (4) 100 kVAR
  - .4 Insulation Class: 1000 V
  - .5 Minimum system short circuit capacity: 85 kA
- .4 Capacitor bank characteristics:
  - .1 Fuse or breaker protected.
  - .2 Contactor controlled.
  - .3 Included transient suppressors.
  - .4 Included discharge resistors capable of bringing residual voltage across capacitor terminals below 50 V within one minute of de-energization.
  - .5 Detuned reactors, series connected with capacitors.
- .5 Capacitors:
  - .1 CSA and UL approved.
  - .2 Self-healing type utilizing a low-loss metalized polypropylene film dielectric system with a pressure sensitive interrupter in each capacitor cell. Metallized paper is not acceptable.
  - .3 Designed for 20 year life span.
  - .4 Electrical losses shall be less than 0.5 W/kVAR
  - .5 Capacitor casing: seamless aluminum.
  - .6 Capacitor fluid shall be completely biodegradable (no polychlorinated bi-phenyls).
  - .7 Voltage Rating: 690V to protect against current and voltage overload due to harmonic distortion.
  - .8 Capacitors shall be suitable for -40°C to +60°C ambient temperature.
- .6 Fuses
  - .1 Individually fused on the line side of the contactor
  - .2 Use current-limiting HRCI-J fuses having an interrupting capacity of 200,000 symmetrical amperes.
  - .3 Fuses shall be rated to protect the contactor, capacitor, and interconnecting wiring.
  - .4 Provide means to automatically detect a blown fuse.

- .1 Blown fuse indication shall be indicated on enclosure door via controller display or fuse light.
  - .2 Blown fuse shall actuate alarm contact.
- .7 Contactors:
  - .1 Contactors shall be three-pole, 600-volt type provided with silver-coated contacts and rated to withstand the in-rush currents imposed by dynamic capacitor switching.
  - .2 Minimum current rating: 135% of nominal current.
  - .3 Rated Operations: 10,000,000
  - .4 Coil rating: 120 VAC, 60hz
- .8 Harmonic De-Tuned Reactors
  - .1 Installed on every stage and matched with the capacitors to avoid tuning on whole harmonic frequencies.
  - .2 Filter tuning frequency shall be  $4.1 \times 60 \text{ Hz}$  (245 Hz), unless otherwise approved by the Contract Administrator.
  - .3 Insulation rating: 220°C.
  - .4 Maximum temperature rise: 115°C.
  - .5 Provide temperature sensitive device on each reactor to de-energize the contactor and alarm on overheating.
- .9 Control Transformer
  - .1 Provide an integrated control transformer with primary and secondary fuse or breaker protection.
  - .2 No external power shall be required for operation.
- .10 Controller
  - .1 The controller shall be microprocessor based with a menu driven user interface. The controller shall provide control of the contactors to select the appropriate number of stages of power factor correction.
  - .2 User selectable target power factor.
  - .3 The controller shall respond to a current signal from the current transformer on the main switchgear bus and the voltage signal from a potential transformer included in the equipment with a built-in adjustable time delay.
  - .4 Auto / Manual control. In manual, the user shall have the capability to turn each stage on and off manually.
  - .5 Provide a 120VAC, 5A rated Form C dry contact alarm output, indicating any internal alarm condition.
  - .6 Controller shall be capable of ignoring steps containing defective capacitors.
  - .7 The time delay between switching of capacitors shall be field adjustable and shall range from 10 to 900 seconds.
  - .8 A no-volt release feature shall be incorporated to remove instantaneously all energized capacitor banks from the bus, in the event of a power failure.
  - .9 Display target power factor, actual power factor, and indicate steps energized.
  - .10 Provide measurement and display of voltage, current, frequency, voltage harmonics, current harmonics, power, reactive power, apparent power, and missing reactive power to reach pre-set power factor.

- .11 Unit Enclosure:
  - .1 NEMA Type 1 dust-tight or Type 12. If Type 1, the enclosure must be positively pressurized with filtered fans.
  - .2 Provide required fans and louvers to maintain specified temperature in enclosure.
  - .3 All air intakes to be filtered.
  - .4 Access door: hinged latch handle and provision for locking.
  - .5 Provide appropriate warning labels indicating dangerous voltages in enclosure.
  - .6 Provide lifting lugs to allow for transport.
  - .7 Size:
    - .1 Maximum depth including rear clearance (in order to fit on existing housekeeping pad): 584 mm (23")
    - .2 Maximum height: 2298 mm (90.5")
    - .3 Maximum width: 1730 mm (68")
  - .8 Each unit shall be factory assembled and pre-wired, consisting of capacitors, capacitor fuses on all three phases, contactors, reactors, controller, and bus bar with termination points for customer connections. All modifications to the new PFC unit shall be performed at the factory.

## **2.2 CURRENT TRANSFORMER**

- .1 Current transformers for installation within switchgear.
  - .1 The current transformer for the existing power factor correction equipment may be re-utilized, provided it is verified to be adequate.
  - .2 Determine ratio of existing CT by metering and mark ratio on As-Built drawings.

## **2.3 FINISH**

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

## **2.4 SPARE PARTS**

- .1 Power Fuses, 3 phase:
  - .1 Supply three (3) spare fuses of each type and size.
- .2 Control Fuses, single phase:
  - .1 Supply one (1) spare fuse of each type and size.

## **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 TESTS**

- .1 The Contractor shall carry out in his premises all the production tests in accordance with the standards specified and any other tests normally performed by the Contractor to assure quality and conformance to these specifications.
- .2 The following tests on capacitors shall be performed by the Contractor or obtained from the capacitor manufacturer:
  - .1 Production tests shall be performed on each capacitor and shall include the following:
    - .1 Short time overvoltage test
    - .2 Capacitance test
    - .3 Leak test
    - .4 Discharge resistor test
    - .5 Loss determination test
  - .2 Design tests shall be performed on one unit of a group of capacitors with same ratings, and shall include the following:
    - .1 Impulse withstand test
    - .2 Bushing test
    - .3 Thermal stability test
    - .4 Radio influence test
    - .5 Voltage decay test
- .3 Field verify alarm contact connection to the facility control system.

### **3.3 INSTALLATION**

- .1 Install and connect capacitors.

### **3.4 FIELD QUALITY CONTROL**

- .1 Perform tests in accordance with Section 26 08 05 – Acceptance Testing.

### **3.5 START-UP ASSISTANCE**

- .1 Provide factory-trained representative to verify the installation and start-up the equipment.
- .2 Set-up and verify all parameters and settings. Verify correct operation with loads in operation.
- .3 Provide formatted, typed form indicating all settings as programmed.
- .4 Allow a minimum of four hours on site, or as required to complete the required work.

### **3.6 TRAINING**

- .1 Furnish the services of a competent, factory-trained engineer or technician for one 2-hour period to instruct City personnel in the operation and maintenance of the equipment, on a date requested by the Contract Administrator.

**END OF SECTION**