Part 1 General

1.1 GENERAL

.1 Submit to Contract Administrator submittals required by individual Specification sections for review. 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 and no claim for extension by reason of such default will be allowed.

.2 In general all equipment to be installed at the Site will require Shop Drawings, which shall be submitted to the Contract Administrator.

.3 Do not proceed with Work affected by submittal until reviewed by the Contract Administrator.

.4 The review by the Contract Administrator is for the sole purpose of ascertaining conformance with general concept. It does not provide 'approval' of the detail design inherent in shop drawings (which remains with the contractor), nor does it relieve the contractor of responsibility for errors or omissions in shop drawings or for meeting all requirements of the construction and contract documents

.5 Present submittals in SI Metric units.

.6 Where items or information is not produced in SI Metric units converted values are acceptable.

.7 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.

.8 Notify Contract Administrator, in writing at time of submission for review, identifying deviations from requirements of Contract stating reasons for deviations.

.9 Verify field measurements and affected adjacent Work are co-ordinated.

.10 Contractor's responsibility for errors and omissions in submission is not relieved by Contract Administrator’s review of submittals.

.11 Contractor's responsibility for deviations in submission from requirements of Contract is not relieved by Contract Administrator review.

.12 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 resubmitted submittals 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 SUBMITTAL PROCEDURES

.1 Direct submittals to the Contract Administrator.

.2 Hardcopy Submittals: Submit hardcopies only where specifically required under individual Specifications sections.

.3 Electronic Submittals: Submittals made in electronic format shall be as follows:

.1 Each submittal shall be electronic file in Adobe Acrobat Portable Document Format (PDF), and native files (e.g. Word, Excel, AutoCAD, etc.). Use 2010 version available at time of execution of Agreement.

.2 Electronic files that contain more than 10 pages in PDF format shall contain internal book marking from index page to major sections of 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 set up to print legibly at 8.5 inches by 11 inches, or 11 inches by 17 inches, or 22 inches by 34 inches. No other paper sizes will be accepted.

.6 Submit new electronic files for each resubmittal.

.7 Include copy of Transmittal of Contractor's Submittal. .

.8 Contract Administrator will reject submittals that are not accompanied by an electronic copy.

.9 Provide authorization for Contract Administrator to reproduce and distribute each file as many times as necessary for Project documentation.

.10 Detailed procedures for handling electronic submittals will be discussed at pre-construction meeting.

.4 Schedule of Submittals

.1 Prepare a table listing all anticipated submittals required to complete the Work.

.2 For each Specification section show, at a minimum, the following:

.1 Specification section.

.2 Total number of submittals for each specification section.

.3 Identify each submittal by its submittal number in accordance with a numbering and tracking system.

.4 Identify each submittal by its name or title.

.5 Identify the estimated date of submission to the Contract Administrator.

.6 State the revision number and status for each submittal.

.3 On a monthly basis, submit an updated schedule of submittals to the Contract Administrator if changes have occurred.

.5 Transmittal of Submittal:

.1 Stamp each submittal with uniform approval stamp before submitting to Contract Administrator.

.1 Stamp to include project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement

certifying that submittal has been reviewed, checked, and approved for compliance with Contract.

.2 Contract Administrator will not review submittals that do not bear Contractor's approval stamp and will return them without action.

.3 Contract Administrator will not review submittals received directly from a Subcontractor and will return them without action.

.4 Complete, sign, and transmit with each submittal package, one transmittal of Contractor's submittal form.

.2 Identify each submittal with the following:

.1 Numbering and tracking system:

.1 Sequentially number each submittal.

.2 Resubmission of submittal shall have original number with sequential alphabetic suffix.

.2 Specification section and paragraph to which submittal applies.

.3 Project title and City Tender number.

.4 Date of transmittal.

.5 Name of Contractor.

.3 Identify and describe each deviation or variation from Contract.

.4 Include Contractor's written response to each of Contract Administrator's review comments with resubmission of submittals stamped "Exceptions Noted, Resubmit".

.6 Format:

.1 Do not base Shop Drawings 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 Specification.

.3 Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract.

.4 Index with labeled tab dividers in orderly manner.

.7 Timeliness:

.1 Schedule and submit in accordance with schedule of submittals, and requirements of individual Specification sections.

.2 Submit Shop Drawings and samples well in advance of scheduled delivery date for associated equipment or material and in an orderly sequence so as to cause no delay in the Work.

.8 Processing Time:

.1 Time for review shall commence on Contract Administrator's receipt of submittal.

.2 Contract Administrator will act upon Contractor's submittal and transmit response to Contractor not later than 14 Calendar Days after receipt, unless otherwise specified.

.3 Resubmittals will be subject to same review time.

.4 The review time required will not alleviate the Contractor of his responsibility 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.

.9 Resubmittals:

.1 Clearly identify each correction or change made and include revision date.

.2 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.

.3 The City may deduct cost of additional reviews from the Contract Price.

.10 Incomplete Submittals:

.1 The Contract Administrator will return the entire submittal for the Contractor's revision if preliminary review deems it incomplete.

.2 Incomplete Shop Drawing information will be considered as stipulated deductions for the purposes of progress payment certificates.

.3 When any of the following are missing, the submittal will be deemed incomplete:

.1 Contractor's review stamp, completed and signed.

.2 Transmittal of Contractor's Submittal form, completed and signed.

.3 Insufficient number of copies.

.4 All requested information is not provided.

.5 Submittals missing professional engineer's seal and signature, where it is required.

.11 Submittals not required by Contract:

.1 Will not be reviewed and will be returned stamped "RECEIVED FOR INFORMATION".

.2 Contract Administrator will keep one copy and return all remaining copies to Contractor.

1.3 SHOP DRAWINGS AND PRODUCT DATA

.1 The term "Shop Drawing" as defined in the City's General Conditions for Construction (Revision 2019-09-01) means all drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are prepared by the Contractor, Subcontractor, manufacturer, supplier or distributor and which illustrate some portion of the work.

.2 Shop Drawings are to 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 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.

.3 Notify the Contract Administrator in writing of any deviations in Shop Drawings from the requirements of the Contract.

.4 Submit Shop Drawings stamped and signed by professional engineer registered or licensed in the province of Manitoba as required in the Specifications. The following components require sealed Shop Drawings:

.1 Reinforcing Steel
.2 Metal Fabrications
.3 Stem Extensions
.4 Automation PLC and control panels

.5 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. Examination of each Shop Drawing 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 reviewed and stamped " REVISE AND RESUBMIT ". Ensure that the following are verified:

.1 Field measurements.
.2 Field construction criteria.
.3 Catalogue numbers and similar data.

.6 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.

.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 and submit again for review.
.4 When stamped "NOT REVIEWED" or "REJECTED", submit other Shop Drawings, brochures, etc., for review consistent with the Contract.
.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 Make changes in Shop Drawings, which the Contract Administrator may require, consistent with Contract. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.

.10 Only two 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 payment to the Contractor.

1.4 DESCRIPTION OF CONSTRUCTION METHODS

.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.

1.5 REQUESTS FOR INFORMATION

.1 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, the Contractor shall submit a Request for Information (RFI) in writing to the Contract Administrator.

.2 Submission Procedure

.1 Submit RFI's to the Contract Administrator on the "Request for Information" form appended to this section. The Contract Administrator shall not respond to a RFI except as submitted on this form.

.2 Number RFI's consecutively in one sequence in order submitted, in a numbering system established by the Contract Administrator.

.3 Submit one distinct subject per RFI request. Do not combine unrelated items on one form.

.4 Where RFI form does not have sufficient space, attach additional sheets as required.

.5 Submit with RFI form all necessary supporting documentation.

.3 In the RFI, the Contractor shall clearly and concisely set forth:

.1 the issue for which clarification or interpretation is sought and why a response is needed from the Contract Administrator; and

.2 an interpretation or understanding of the requirement along with reasons why such 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 An RFI response shall be issued within 14 Calendar Days of receipt of the request from the Contractor unless the Contract Administrator determines that a longer time is necessary to provide an adequate response. When the RFI submission is received by the Contract Administrator before noon, the review period commences on that Calendar Day. When the RFI submission is received by the Contract Administrator after noon, the review period commences on the subsequent Calendar Day.

.6 If, at any time, the Contractor submits a large number of RFI's or the Contract Administrator considers the RFI to be of such complexity that the Contract Administrator cannot process the RFI's within 14 Calendar Days, the Contract Administrator, shall confer with the Contractor within five Calendar Days of receipt of such RFI's, and the Contract Administrator and the Contractor will jointly prepare an estimate of the time necessary for processing same as well as an order of priority among the RFI's 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 a 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 Contractor 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 Administrator 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 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.

1.6 CLOSEOUT SUBMITTALS

.1 Refer to Section 1 78 00 - Closeout Submittals for closeout submittal requirements.

1.7 MISCELLANEOUS SUBMITTALS

.1 Prepare and submit submittals required Contract Documents.

.2 Copies: Submit one electronic copy to Contract Administrator. Method of electronic submission to be coordinated with Contract Administrator after execution of the Contract. Submit hard copies only where specifically required under individual Specification sections.

.3 Contract Administrator will review submittals for general conformance with design concept and intent, and general compliance with Contract.

.4 Contract Administrator's review does not relieve Contractor from compliance with requirements of Contract nor from errors in submittals or Contractor's design.

.5 Contractor is responsible for confirmation of dimensions at jobsite; fabrication processes; means, methods, techniques, sequences and procedures of construction; coordination of work of all trades; and performance of Work in safe and satisfactory manner.

.6 At Contract Administrator's option, 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.

.7 Where work is to be designed by Contractor, comply with applicable codes and furnish submittals signed and sealed by professional engineer licensed in 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 registered in the Province of Manitoba.

Part 2 Products

2.1 NOT USED

.1 Not Used.

Part 3 Execution

3.1 NOT USED

.1 Not Used.

END OF SECTION

Request for Information (RFI)

RFI No. 0

For details and instructions on how to complete this document, click the [¶] icon under the Home tab to display the hidden text.

RFI Title: _____ **RFI No.:** 0

Date RFI initiated: _____ **Date Response Requested by:** _____

Date Response Issued: _____

Project Name: _____

Submitted To:			
Contract Administrator (CA):		Consultant Ref. No.	
Company/Dept.:		Tender No.	

Requested By:		***For CA Use***	
Name:		City File No.:	
Title:		Project ID:	
Company:		Project Record Index No.:	
Email::		Purchase Order No.:	

Request/Question: (to be completed by Contractor)

Answer/Response: (to be completed by Contract Administrator)

Attachment(s):

Distribution (to be completed by Contract Administrator)

- Contract Administrator
- Contractor
- City Project Manager
- Other:

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. Qualifications 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 report
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

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 startup and evaluation.
    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:
        a. Certificate of Equipment Delivery (Form 100)
        b. Certificate of Satisfactory Installation (Form 102)
    5. Final operation and maintenance manuals.
    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.
    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 supplements listed below, following "End of Section", are part of this Specification.
    1. Forms:
        a. Form 100: Certificate of Equipment Delivery

b. Form 102: Certificate of Satisfactory Installation
c. Form 103: Certificate of Equipment Satisfactory Performance
d. Form 104: Certificate of Satisfactory System Performance

END OF SECTION

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Form 100
CERTIFICATE OF EQUIPMENT DELIVERY

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:
Equipment Description:
Equipment Supply Bid Opp. No.: -2019
Equipment Install Bid Opp. No.: -2019
Equipment Tag No.:
Specification Reference:

Print Name	Signature	Date
(Authorized Representative of City)		

Print Name	Signature	Date
(Authorized Representative of Contractor)		

Print Name	Signature	Date
(Authorized Representative of Contract Administrator)		

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Form 102
CERTIFICATE OF SATISFACTORY INSTALLATION

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:
Equipment Description:
Equipment Supply Bid Opp. No.: -2019
Equipment Install Bid Opp. No.: -2019
Equipment Tag No.:
Specification Reference:
Outstanding Defects:

Print Name	Signature	Date
(Authorized Representative of City)		

Print Name	Signature	Date
(Authorized Representative of Contractor)		

Print Name	Signature	Date
(Authorized Representative of Contract Administrator)		

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Form 103
CERTIFICATE OF EQUIPMENT SATISFACTORY PERFORMANCE

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 it's specified operating criteria. No defects in the equipment were found and as such are classified as "conforming".

Project:
Equipment Description:
Equipment Supply Bid Opp. No.: -2019
Equipment Install Bid Opp. No.: -2019
Equipment Tag No.:
Specification Reference:

Print Name	Signature	Date
(Authorized Representative of City)		
Print Name	Signature	Date
(Authorized Representative of Contractor)		
Print Name	Signature	Date
(Authorized Representative of Contract Administrator)		

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Form 104
CERTIFICATE OF SATISFACTORY SYSTEM PERFORMANCE

We certify that the 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:
Equipment Description:
Equipment Supply Bid Opp. No.: -2019
Equipment Install Bid Opp. No.: -2019
Equipment Tag No.:
Specification Reference:

Print Name	Signature	Date
(Authorized Representative of City)		

Print Name	Signature	Date
(Authorized Representative of Contractor)		

Print Name	Signature	Date
(Authorized Representative of Contract Administrator)		

Part 1 General

1.1 INSPECTION

.1 Allow Contract Administrator access to the Work. If part of the Work is in preparation at locations other than the Site, allow access to such Work wherever it is in progress.

.2 Give timely notice of a minimum of 5 working days, requesting inspection if the Work is designated for special tests, inspections or approvals by Contract Administrator.

.3 If the 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 at no additional cost and have inspections or tests satisfactorily completed and make good such Work.

.4 The Contract Administrator will order part of the Work to be examined if the Work is suspected to be not in accordance with Contract. If, upon examination, such work is found not in accordance with Contract, correct such Work and pay cost of examination and correction. If such Work is found in accordance with Contract, 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 the Work. The 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 the Contractor's responsibility to perform the Work in accordance with the Contract.

.4 If defects are revealed during inspection and/or testing, the appointed agency will request additional inspection and/or testing to ascertain the full degree of defect. Correct the defect and irregularities as advised by the Contract Administrator at no cost to the City. The Contractor shall be responsible for the costs of the subsequent testing and inspection of the corrected Work. The City shall deduct such costs from the Contract, amount of which will be determined by the Contract Administrator.

1.3 ACCESS TO WORK

.1 The City, the Contract Administrator, and other authorities having jurisdiction shall have access to the Work. Do not cover or enclose systems prior to inspection.

1.4 REJECTED WORK

.1 Remove defective Work, whether the result of poor workmanship, use of defective products, or damage which has been rejected by the Contract Administrator as failing to conform to the Contract. Replace or re-execute in accordance with the Contract.

.2 Make good other Contractor's work damaged by such removals or replacement of defective Work.

.3 If, in opinion of the Contract Administrator, it is not expedient to correct defective Work or Work not performed in accordance with Contract, the City will deduct from the Contract Price the difference in the value between Work performed and that called for by the Contract, amount of which will be determined by the Contract Administrator.

1.5 REPORTS

.1 Submit draft inspection and test reports to the Contract Administrator, prior to inclusion with the operation and maintenance manuals.

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 INSTALLATION AND REMOVAL

.1 Provide temporary utilities controls in order to execute Work expeditiously.

.2 Remove from Site all temporary utilities when their use is no longer required.

1.2 DEWATERING

.1 Provide temporary drainage and pumping facilities to keep excavations and Site free from standing water.

1.3 WATER SUPPLY

.1 Provide potable water as required for construction use.

1.4 TEMPORARY HEATING, COOLING AND VENTILATION

.1 Provide temporary heating and cooling required during construction period, including attendance, maintenance, and fuel.

.2 Construction heaters used inside building must be vented to outside or be non-flameless type. Solid fuel salamanders are not permitted.

.3 Provide temporary heating, cooling, and ventilation in enclosed areas as required to:

- .1 Facilitate progress of the Work.
- .2 Protect the Work and products against dampness and cold.
- .3 Prevent moisture condensation on surfaces.
- .4 Provide ambient temperatures and humidity levels for storage, installation, and curing of materials.
- .5 Provide adequate ventilation to meet health regulations for safe working environment. A minimum of 6 air changes per hour of continuous ventilation is required in below grade drywell areas.

.4 Maintain temperatures of minimum 10 degrees C in areas where construction is in progress in the Tache Booster Pumping Station.

.5 Maintain temperatures of minimum 10 degrees C during heating season and maximum of 25 degrees C during cooling season in the McPhillips Regional Pumping Station until critical stage indicated D16.1(b) is achieved.

.6 Ventilating:

- .1 Prevent accumulations of dust, fumes, mists, vapours, or gases in areas occupied during construction.
- .2 Provide local exhaust ventilation to prevent harmful accumulation of hazardous substances into atmosphere of occupied areas.

.3 Dispose of exhaust materials in manner that will not result in harmful exposure to persons.

.4 Ventilate storage spaces containing hazardous or volatile materials.

.5 Ventilate temporary sanitary facilities.

.6 Continue operation of ventilation and exhaust system for time after cessation of work process to assure removal of harmful contaminants.

.7 Maintain strict supervision of operation of temporary heating and ventilating equipment to:

.1 Conform with applicable codes and standards.

.2 Enforce safe practices.

.3 Prevent abuse of services.

.4 Prevent damage to finishes.

.5 Vent direct-fired combustion units to outside.

.8 Be responsible for damage to the Work due to failure in providing adequate heat and protection during construction.

1.5 TEMPORARY POWER AND LIGHT

.1 Provide temporary construction power as required to facilitate construction activities.

.2 At McPhillips Station, provide temporary power (via portable genset, and portable cabling) to energize 120 / 208V UPS panelboard PNL-S712U located in the McPhillips Control Centre. This panel must not be taken down for longer than 30 minutes, and work must be performed overnight. Refer to single line 1-0640S-E0001.

.3 Provide temporary power and light as required for temporary dewatering pumping, construction power, lighting, and other requirements during shutdowns.

.4 The existing power supply may be utilized for power, provided that there are no operational impacts associated with the use of the power.

.1 Connect to existing power supply in accordance with Canadian Electrical Code.

.2 Electrical power and lighting systems installed under this Contract may be used for construction requirements provided that guarantees are not affected. Make good damage to electrical system caused by use under this Contract.

.5 All temporary power generation shall have residential grade mufflers and silencers.

1.6 TEMPORARY COMMUNICATION FACILITIES

.1 Provide and pay for temporary telephone, fax, data hook up, line and equipment necessary for own use.

1.7 FIRE PROTECTION

.1 Provide and maintain temporary fire protection equipment during performance of the Work required by insurance companies having jurisdiction and governing codes,

regulations, and bylaws. If fire alarm systems are disabled, provide (and include all costs) for a full-time (24-hours per day) fire watch person.

.2 Burning rubbish and construction waste materials is not permitted on site.

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.

1.2 INSTALLATION AND REMOVAL

.1 Prepare and submit Site plan indicating proposed location and dimensions of area to be fenced and used by Contractor, number of trailers to be used, avenues of ingress/egress to fenced area, and details of fence installation.

.2 Indicate use of supplemental or other staging area.

.3 Provide construction facilities in order to execute the Work expeditiously.

.4 Remove from Site all such work after use.

1.3 SCAFFOLDING

.1 Scaffolding in accordance with:

.1 CAN/CSA-S269.2 - Access Scaffolding for Construction Purposes

.2 C.C.S.M.c W210 - Manitoba, The Workplace Safety and Health Act

.2 Provide and maintain scaffolding and ladders.

1.4 HOISTING

.1 Provide, operate, and maintain any hoists required for moving of workers, materials, and equipment. Make financial arrangements with Subcontractors for their use of hoists.

.2 Hoists to be operated by qualified operator.

1.5 CONSTRUCTION PARKING

.1 Parking will be permitted on Site provided it does not disrupt performance of Work or access by the City.

.1 Ensure that access and parking for a minimum of one truck is provided adjacent to the pumping station, for use by the City.

.2 Provide and maintain adequate access to project Site.

.3 Construction parking must not impede delivery access to the Chlorine Building.

.4 At 360 McPhillips Street – where the McPhillips Regional Pumping Station, Chlorine Building, Collections Building and McPhillips Control Centre are located - Contractor parking can be accommodated on Hillock Avenue (a Use of Street Permit will be required). Alternately the old reservoir cells (at the west end of Hillock Avenue) could be used for Contractor trailers etc. The Contractor shall be responsible for fence and access

modifications to accommodate the use of the reservoir cells. Do not impact upon local businesses.

.5 At 866 Tache Avenue – where the Tache Booster Pumping Station is located - Contractor parking can be accommodated on Tache Avenue (a Use of Street Permit will be required). Contractor parking will be permitted within the fenced facility subject to City approval. Site to be restored to conditions acceptable to the City following Work.

1.6 EQUIPMENT, TOOL AND MATERIALS STORAGE

.1 Provide and maintain, in clean and orderly condition, lockable weatherproof sheds for storage of tools, equipment, and materials.

.2 Locate materials not required to be stored in weatherproof sheds on Site in manner to cause least interference with work activities.

1.7 SANITARY FACILITIES

.1 Provide sanitary facilities for work force in accordance with governing regulations and ordinances.

.2 In the event that the City allows the Contractor to use facility washrooms, the Contractor must clean the washrooms at the end of each work day.

.3 Post notices and take precautions as required by local health authorities. Keep area and premises in sanitary condition.

1.8 OFFICES

.1 Provide office heated to 20 degrees C, lighted, and ventilated, of sufficient size to accommodate Site meetings and furnished with drawing laydown table.

.2 Provide marked and fully stocked first-aid case in a readily available location.

.3 Subcontractors to provide their own offices as necessary. Direct location of these offices.

.4 Supply temporary office facilities for the Contract Administrator on Site, meeting the following requirements:

.1 Minimum floor area of 20 square metres, with windows and a door entrance complete with suitable lock satisfactory to the Contract Administrator.

.2 Suitable for all-weather use and capable of maintaining a temperature range between 20 and 25 degrees C.

.3 Equipped with fluorescent lights and 120 volt ac electrical wall outlets

.4 Furnished with one desk, one filing cabinet, and two chairs, all satisfactory to the Contract Administrator.

.5 All of the temporary structures provided by the Contractor for this project shall be stabilized in a sufficient manner to prevent the temporary structure from being overturned by wind forces as defined in the National Building Code (NBC). The stabilization provided shall be designed by a Professional Engineer registered in the Province of Manitoba. Detailed drawings and design notes for the stabilization

works bearing the Engineer's seal shall be provided to the Contract Administrator for review.

.6 The Contractor shall be responsible for installation, maintenance, removal, operating costs, and service installation costs for the field office as described herein.

1.9 LAYDOWN AND STORAGE

.1 All construction materials shall be stored at designated storage areas. Stored combustible materials shall be separated by clear space to prevent fire spread and allow access for manual fire fighting equipment, including fire hoses, extinguishers, hydrants, etc.

.2 Pressurized dry chemical fire extinguishers of suitable capacity or equally effective extinguishers as per NFPA 10 shall be provided where:

.1 Flammable liquids are stored or handled.

.2 Welding or flame cutting is performed.

1.10 DISPOSAL OF WASTE MATERIALS

.1 Spoiled and waste materials shall not be dumped, under any circumstances, in any locations other than those approved by the local authorities. Any cost for permits and fees for disposing of waste materials shall be at the Contractor's expense.

.2 Disposal of all excavated and waste materials shall be in accordance with the requirements of the appropriate provincial regulatory agencies.

.3 When working anywhere within the Works, the Contractor shall at the end of each day remove the rubbish and leave the Site in a clean and tidy state, to the satisfaction of the Contract Administrator. If this is not done, the City may clean the Site and deduct such costs from the Contract, amount of which will be determined by the Contract Administrator.

1.11 FACILITY ELECTRICAL SUPPLY AND DISTRIBUTION

.1 If service interruptions are necessary, such interruptions shall be made only at times approved by the Contract Administrator.

1.12 WARNINGS AND TRAFFIC SIGNS

.1 All Work affecting Site access must be authorized by the Contract Administrator. Provide a minimum of two weeks notice to the Contract Administrator when Work will affect Site access.

.2 When Work is performed within public areas, provide and erect adequate warning signs as necessary to give proper warning. Place signs sufficiently in advance to enable public to respond to directions.

.3 Provide and maintain signs and other devices required to indicate construction activities or other temporary or unusual conditions resulting from the Work.

Part 2 Products

.1 Not Used.

Part 3 Execution

.1 Not Used.

END OF SECTION

Part 1 General

1.1 INSTALLATION AND REMOVAL

.1 Provide temporary controls in order to execute the Work expeditiously.

.2 Remove from Site all such work after use.

1.2 HOARDING

.1 Provide hoarding and ventilation for the building as required to maintain operation of the pumping station.

1.3 GUARD RAILS AND BARRICADES

.1 Provide secure, rigid guard rails and barricades around deep excavations, open shafts, open stair wells, open edges of floors and roofs, and any other fall hazards

.2 Provide as required by governing authorities.

1.4 WEATHER ENCLOSURES

.1 Provide weather tight closures to unfinished door and window openings, tops of shafts, and other openings in floors and roofs.

.2 Close off floor areas where walls are not finished; seal off other openings; enclose building interior work for temporary heat.

.3 Design enclosures to withstand wind pressure and snow loading.

1.5 FIRE ROUTES

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

1.6 SITE EASEMENTS

.1 Manitoba Hydro maintains a site easement of five metres on either side of the overhead transmission lines on the Site that run parallel to the east face of the McPhillips Pumping Station and from the southeast corner of the McPhillips Pumping Station to Manitoba Hydro's substation at 1149 Logan Avenue. The easement extends to any excavations in the area and no structure shall be more than 3.65 metres above the ground level or 5.2 metres from the overhead conductors.

.2 For the final installation of the new air cooled condensing unit and the associated fencing Manitoba Hydro has consented to an encroachment in accordance with the following conditions:

.1 No construction or improvement other than shown in the drawings is deemed to be permitted by Manitoba Hydro's consent.

.2 The top of the structure or fence must maintain 5.2 metres of clearance from the overhead conductors. If the fence is made from a conductive material, it must be grounded according to requirements from the Contractor's engineer.

.3 Any removal or relocation of Manitoba Hydro and/or Centra Gas facilities that are, in the opinion of Manitoba Hydro and/or Centra Gas necessary or desirable as a result of the proposed construction and subsequent development will be at the sole expense of the Contractor.

.4 Any damage to Manitoba Hydro and/or Centra Gas infrastructure must be reported and repaired, at no cost to Manitoba Hydro, Centra Gas or the City. In the event that Manitoba Hydro or Centra Gas perform the repairs, the Contractor will be responsible for the costs. All damages must be repaired prior to any operations, such as backfilling.

.5 It is the Contractor's responsibility to ensure that the installation shall conform to the most current version of the Canadian Electrical Code.

.6 Prior to commencing any construction contact "Click Before you Dig".

.7 If any amendments are made to the design, further consent will be required by Manitoba Hydro.

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 the 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 the Contract or in event of non-conformance with the Contract the City shall deduct such costs from the Contract, amount of which will be determined by the Contract Administrator.

1.2 QUALITY

.1 Products, materials, equipment and articles incorporated in the 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 the 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 Contactor's 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.

.3 Unless otherwise indicated in the Specifications, maintain uniformity of manufacture for any particular or like item throughout each pumping station and the project.

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 event of failure to notify the Contract Administrator at commencement of the 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 the Work.

.3 Store products subject to damage from weather in weatherproof enclosures.

.4 Store cementitious products clear of earth or concrete floors, and away from walls.

.5 Keep sand, when used for grout or mortar materials, clean and dry. Store sand on wooden platforms and cover with waterproof tarpaulins during inclement weather.

.6 Store sheet materials, lumber, and similar products on flat, solid supports and keep clear of ground. Slope to shed moisture.

.7 Store and mix paints in a heated and ventilated room. Remove oily rags and other combustible debris from Site daily. Take every precaution necessary to prevent spontaneous combustion.

.8 Remove and replace damaged products at own expense and to 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 the Work.

1.7 MANUFACTURER'S INSTRUCTIONS

.1 Unless otherwise indicated in the 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 the Specifications and the 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 REMEDIAL WORK

.1 Perform remedial work required to repair or replace parts or portions of the 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 the Work.

1.9 FASTENINGS

.1 Provide metal fastenings and accessories in same texture, colour, and finish as adjacent materials, unless indicated otherwise.

.2 Prevent electrolytic action between dissimilar metals and materials.

.3 Use non-corrosive hot dip galvanized steel fasteners and anchors for securing exterior work, unless stainless steel or other material is specifically requested in the affected Specification section.

.4 Space anchors within 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.

1.10 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 the highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify the Contract Administrator if the required Work is such as to make it impractical to produce the required results.

.2 Do not employ anyone unskilled in their required duties.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

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

.2 Submit written request to the Contract Administrator in advance of cutting or alteration which affects:

- .1 Structural integrity of elements of project 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.

.3 Include in the written request:

- .1 Identification of project.
- .2 Location and description of the affected Work.
- .3 Statement on necessity for cutting or alteration.
- .4 Description of the proposed Work and products to be used.
- .5 Alternatives to cutting and patching.
- .6 Effect on the Work of the City or separate contractor.
- .7 Written permission of affected separate contractor.
- .8 Date and time the Work will be executed.
- .9 Submit datasheet of concrete scanning device for review prior to utilizing. Indicate concrete depths, as well as confirm the ability of the device to perform measurements through this depth.

1.2 MATERIALS

.1 Required for original installation.

.2 Change in Materials: Submit request for substitution in accordance with Section 01 33 00 - Submittal Procedures. Clearly indicate the requested substitution.

1.3 PREPARATION

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

.2 After uncovering, inspect conditions affecting the performance of the Work.

.3 Beginning of cutting or patching means acceptance of the existing conditions.

.4 Provide supports to assure the structural integrity of surroundings; provide devices and methods to protect other portions of the Work from damage.

.5 Provide protection from elements for areas which are to be exposed by uncovering the Work; maintain excavations free of water.

.6 Exercise care where cutting holes in existing concrete elements so as not to damage existing reinforcing or conduit.

.1 For reinforced concrete floors, 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.

.7 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.

1.4 EXECUTION

.1 Remove and replace defective and non-conforming Work.

.2 Provide openings in non-structural elements of the Work for penetrations of the electrical Work.

.3 Execute the Work by methods to avoid damage to other Work, and which will provide proper surfaces to receive patching and finishing.

.4 Cut rigid materials using masonry saw or core drill. Pneumatic or impact tools are not allowed on masonry work without prior approval. Where significant removals are required, the Contractor to engage a Professional Engineer and provide sealed Shop Drawings for modifications.

.5 Restore work with new products in accordance with the requirements of the Contract.

.6 Seal penetrations for pipes, sleeves, ducts, conduit, and other systems through surfaces.

.7 Penetrations though a floor above another space shall have a pipe sleeve extending above the floor to prevent water running to the floor below.

.8 At penetration of fire rated wall, ceiling, or floor construction, completely seal voids with approved fire stopping material, full thickness of the construction element.

.9 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 the Work in tidy condition, free from accumulation of waste products and debris, other than that caused by the City or other contractors.

.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 the Site.

.3 Clear snow and ice from access to building, bank/pile snow in designated areas only.

.4 Make arrangements with and obtain permits from authorities having jurisdiction for disposal of waste and debris.

.5 Provide on-site containers for collection of waste materials and debris. Asbestos Containing Material shall be kept separate from other waste material and debris.

.6 Dispose of waste materials and debris off site. Asbestos Containing Material shall be shipped off site to an approved landfill in a separate covered vehicle.

.7 Clean interior areas prior to 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 premises at 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 surface to be cleaned and as recommended by cleaning material manufacturer.

.11 Schedule cleaning operations so that resulting dust, debris, and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

.12 Clean and maintain washroom facilities utilized by construction staff on a daily basis.

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 OPERATION AND MAINTENANCE MANUALS

.1 Prepare operation and maintenance manuals 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 the form of approved Shop Drawings, product data, supplemented by bulletins, component illustrations, exploded views, technical descriptions of items, and parts lists.

.3 One advance copy of the operation and maintenance manuals shall be submitted prior to Total Performance of the Work for review and comments. After review and acceptance by the City, five hard copies and one electronic (PDF) copy of the final operation and maintenance manuals shall be submitted. The final electronic copy shall be provided on a flash memory drive.

.4 For the guidance of the City's operation and maintenance personnel, the Contractor shall prepare operation and maintenance 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 operation and maintenance manuals shall be in simple language to guide the City in the proper operation 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, facilities 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 All equipment and systems documentation shall have project specific equipment tags clearly indicating the systems.

.2 Brochures/catalogue excerpts of all components of the Work.

.3 Survey record of underground systems (cables, conduit, piping, etc). Provide precise location of all buried systems.

.4 Documentation of all test results.

.5 Complete set of equipment and assembly drawings.

.6 Installation, start-up, individual equipment operation and maintenance manuals.

.7 Any specific requirements from the Specifications.

.8 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.

.9 Include 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.

.10 Names, addresses, and telephone numbers of all major Subcontractors and suppliers.

.11 Certificate of Inspection from the Inspection Authority.

.12 Testing and commissioning documentation.

.13 Warranty certificate, signed and dated.

.14 Written process narratives outlining the programming of the PLC systems for individual processes or systems.

.15 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

.7 Provide separate operation and maintenance manuals as follows:

.1 Tache Booster Pumping Station Electrical / Controls Upgrades

.2 McPhillips Pumping Station Electrical / Controls Upgrades

.3 McPhillips Pumping Station Chiller, HVAC and HVAC Instrumentation Upgrades

.8 Modify and supplement the operation and maintenance manuals as required by the Contract Administrator.

.9 Format to be as follows:

.1 Binders: vinyl, hard covered, 3 'D' ring, with spine and face pockets.

.2 When multiple binders are used correlate data into related consistent groupings. Identify contents of each binder on spine.

.3 Drawings: provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

1.3 AS-BUILT / RECORD DRAWINGS

.1 After award of Contract, the Contract Administrator will provide a complete set of Drawings for the purpose of maintaining project as-built and record Drawings Accurately mark up deviations from the Contract caused by the Site conditions and changes ordered by the Contract Administrator. Update daily.

.2 The Contractor shall keep one (1) complete set of white prints at the Site during the Work, including all addenda, change orders, Site instructions, clarifications, and revisions for the purpose of the as-built and record Drawings. As the Work on-site proceeds, the Contractor shall clearly mark up the white prints in red pencil all the Work which deviated from the original Contract. The marked up information is to include locations of all devices, circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all equipment.

.3 Identify Drawings as "Project Record Copy". Maintain in good condition and make available for inspection on-site by the Contract Administrator at all times.

.4 On completion of each facility, submit record / as-built Drawings to the Contract Administrator for review.

1.4 SPARE PARTS

.1 Submit spare parts as indicated in the individual Specification sections.

1.5 MAINTENANCE TOOLS

.1 Submit maintenance tools as indicated in the individual Specification sections.

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 RELATED SECTION

.1 Section 01 33 00 – Submittal Procedures

.2 Section 01 51 00 – Temporary Utilities

.3 Section 01 56 00 – Temporary Barriers and Enclosures

.4 Section 02 82 00 – Asbestos Abatement

1.2 REFERENCES

.1 Canadian Standards Association (CSA)

.1 CSA S350, Code of Practice for Safety in Demolition of Structures.

.2 CSA Z797 – Code of Practice for Access Scaffold.

.3 ASTM C612, Standard Specification for Mineral Fibre Block and Board Thermal.

.2 Department of Justice Canada (Jus)

.1 Canadian Environmental Assessment Act (CEAA).

.2 Canadian Environmental Protection Act (CEPA).

.3 National Fire Protection Association (NFPA)

.1 NFPA 241-13, Standard for Safeguarding Construction, Alteration, and Demolition Operations.

.4 National Research Council Canada (NRC)

.1 National Building Code of Canada (NBC).

1.3 SUBMITTALS

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

.2 Provide the following submittals before starting any work of this Section:

.1 Schedule of demolition activities.

.1 When preparing the schedule of demolition activities, the following must be considered:

.1 Coordination with City regarding ongoing site operations. Limit the number of interruptions during regular business hours.

.2 Coordination with City for shutoff, capping, and continuation of utility services.

.3 Coordination with City regarding their continued occupancy of portions of the existing building while demolition activities are taking place.

.2 The schedule of demolition activities must indicate:

.1 Detailed sequence of demolition and removal work, with starting and ending dates for each activity.

.2 Interruption of utility services.

.2 Written demolition plan.

.1 The written demolition plan must:

.1 Indicate the extent of temporary facilities and supports required. In the event where significant structural modifications are required, the demolition plan must be prepared by a qualified professional engineer registered and licensed in the province of Manitoba.

.2 Indicate the methods of removal and demolition.

.3 Indicate the locations of temporary partitions and means of egress to be used by both City and Contractor.

1.4 EXISTING CONDITIONS

.1 City will occupy portions of building immediately adjacent to selective demolition area:

.1 Conduct selective demolition so that City's operations will not be disrupted.

.2 Obtain written approval from the Contract Administrator for any proposed disruptions.

.3 Provide not less than ten Calendar Days' notice to the Contract Administrator of activities that will affect City's operations.

.2 Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities and as follows:

.1 Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Contract Administrator.

.3 Should material resembling spray or trowel applied asbestos or any other designated substance be encountered in course of demolition, stop work, take preventative measures, and notify the Contract Administrator immediately. Do not proceed until written instructions have been received.

.4 Salvage items identified by the Contract Administrator. Remove, protect, and store salvaged items as directed by the Contract Administrator. Deliver to City as directed.

.5 Storage or sale of removed items or materials on Site will not be permitted.

.6 Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

.7 Maintain fire protection facilities in service during selective demolition operations.

.8 Maintain HVAC and plumbing in service during selective demolition operations.

Part 2 Products

2.1 MATERIALS

.1 Design support components as required for demolition Work as necessary. In the event that significant structural modifications are required, the Contractor shall provide demolition plans prepared by a qualified professional engineer registered and licensed in the province of Manitoba.

.1 Design, specifications, work procedures, or other records created for this Work to be submitted to the Contract Administrator for review prior to commencement of Work.

.2 Use repair materials identical to existing materials:

.1 If identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

.2 Use materials whose installed performance equals or surpasses that of existing materials.

.3 Comply with material and installation requirements specified in individual technical Specification sections.

Part 3 Execution

3.1 EXAMINATION

.1 Verify that utilities have been de-energized, disconnected, and capped.

.2 Survey existing conditions and correlate with requirements indicated to determine the extent of structure demolition required.

.3 Inventory and record the condition of items to be removed and reinstalled, and items to be removed and salvaged.

.4 When unanticipated mechanical, electrical, or structural elements are encountered, investigate and measure the nature and extent of the element.

.5 Perform engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during structure demolition operations.

.6 Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

.1 Coordinate existing services indicated to remain and protect them against damage during selective demolition operations.

.2 Locate, identify, de-energize, disconnect, and seal or cap off indicated utilities serving areas to be selectively demolished.

.1 Arrange to shut off affected utilities with utility companies.

.2 If utility services are required to be removed, relocated, or abandoned before proceeding with selective demolition, provide temporary utilities that bypass area of selective demolition and that maintain continuity of service to other parts of building.

.3 Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

.4 Coordinate with associated trades for shutting off, disconnecting, removing, and sealing or capping utilities.

.5 Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

.1 Conduct selective demolition and debris removal operations to ensure minimum interference with roads, parking areas, walks, walkways, and other adjacent occupied and used facilities:

.1 Do not close or obstruct roads, parking areas, walks, walkways, or other adjacent occupied or used facilities without permission from the Contract Administrator. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

.2 Erect temporary protection such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.

.3 Protect existing site improvements, appurtenances, and landscaping to remain.

.2 Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain in accordance with Sections 01 51 00 – Temporary Utilities and 01 56 00 – Temporary Barriers and Enclosures, and as follows:

.1 Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

.2 Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.

.3 Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

.4 Cover and protect furniture, furnishings, and equipment that have not been removed.

.3 Provide temporary enclosures for protection of existing building and construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities in accordance with Sections 01 51 00 - Temporary Utilities and 01 56 00 - Temporary Barriers and Enclosures.

.1 Provide temporary weather tight enclosure for building exterior.

.2 Where heating or cooling is needed and permanent enclosure is not complete, provide insulated temporary enclosures.

.3 Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.

.4 Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise in accordance with Section 01 51 00 - Temporary Utilities.

.5 Provide and maintain shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of construction to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

.6 Provide temporary power via genset or other temporary means for power requirements.

.7 Strengthen or add new supports when required during progress of selective demolition.

3.4 POLLUTION CONTROLS

.1 Provide temporary enclosures or other suitable methods reviewed and accepted by the Contract Administrator to limit spread of dust and dirt. Comply with governing environmental protection regulations and as limited below:

.1 Do not use water when it may damage existing construction or create hazardous or objectionable conditions such as ice, flooding, and pollution.

.2 Wet mop floors to eliminate tracking of dirt, wipe down walls and doors of demolition enclosure. Vacuum carpeted areas.

.2 Remove debris to prevent spillage on adjacent surfaces and areas.

.3 Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

.4 Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

3.5 SELECTIVE DEMOLITION

.1 Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

.1 Proceed with selective demolition systematically.

.2 Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

.3 Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

.4 Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame cutting operations. Maintain fire watch and portable fire suppression devices during flame cutting operations.

.1 A hot work permit is required to be completed by the Contractor and submitted to the Contract Administrator for review for hot works such as welding, cutting, or open flames or sparks, prior to the commencement of such work each day.

.5 Maintain adequate ventilation when using cutting torches.

.6 Remove decayed, vermin infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-Site.

.7 Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

.8 Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

.9 Dispose of demolished items and materials promptly.

.10 Return elements of construction and surfaces that are to remain to condition existing before selective demolition operations began.

.2 Comply with the Contract Administrator's requirements for using and protecting stairs, walkways, facility unloading areas, building entries, and other building facilities during selective demolition operations.

.3 Existing Items to Remain:

.1 Protect construction indicated to remain against damage and soiling during selective demolition.

.2 Items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

.4 Concrete:

.1 Demolish in small sections.

.2 Cut concrete full depth at junctures with construction to remain and at regular intervals, using power driven saw, then remove concrete between saw cuts.

.3 Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete indicated for selective demolition.

.4 Neatly trim openings to dimensions indicated.

.5 Concrete and Masonry Reinforcing:

.1 Locate location of reinforcing steel in concrete structures and masonry walls prior to cutting or coring using non destructive, non ionizing radio frequency locators.

.2 Core concrete and masonry surfaces to avoid reinforcing steel, electrical conduit, or water pipes; adjust core location and coordinate with the Contract Administrator where concrete and masonry features interfere with core drilling.

.3 Notify the Contract Administrator immediately for further instructions where coring or cutting will damage existing concrete and masonry features.

.6 Concrete Slabs on Grade: Saw cut perimeter of area to be demolished, then break up and remove.

.7 Masonry:

.1 Demolish in small sections.

.2 Cut masonry at junctures with construction to remain, using power driven saw, then remove masonry between saw cuts.

.3 Provide new lintels as required in masonry openings in accordance with Section 05 50 00 – Metal Fabrications.

.8 Air Conditioning Equipment: Removal of equipment to be coordinated with the City.

3.6 CLOSEOUT ACTIVITIES

.1 Promptly repair damage to adjacent construction caused by selective demolition operations and as follows:

.1 Patch to produce surfaces suitable for new materials where repairs to existing surfaces are required,

.2 Completely fill holes and depressions in remaining existing masonry walls remain with an approved masonry patching material applied according to manufacturer's written recommendations.

.3 Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

.2 Arrange for legal disposal and remove demolished materials to accredited landfill site or alternative disposal site (recycle centre):

.1 Promptly dispose of demolished materials.

.2 Do not allow demolished materials to accumulate onsite.

.3 Do not burn demolished materials.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Both confirmed asbestos and presumed asbestos have been identified at the McPhillips Regional Pumping Station, McPhillips Chlorine Building, and McPhillips Collections Building (also referred to as the Old Pump Building) which will or may be affected by the Work. Refer to the following Hazardous Materials Information Systems (HMIS) reports for further details:

.1 HMIS Confirmed Asbestos and Presumed Asbestos Report – McPhillips Pumping Station – PUMP BUILDING (BLDG A), 2019-07-03;

.2 HMIS Confirmed Asbestos and Presumed Asbestos Report – McPhillips Pumping Station – CHLORINE BUILDING (BLDG B), 2019-03-03; and

.3 HMIS Confirmed Asbestos and Presumed Asbestos Report – McPhillips Pumping Station – OLD PUMP BUILDING (BLDG C), 2019-07-03.

.2 The presumed asbestos containing materials (ACMs) detailed in the appended HMIS 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 as indicated on the Drawings. This includes but is not limited to:

.1 the sweatwrap pipe insulation and parging over fiberglass on the rain water leader to be relocated in the electrical and control rooms of the McPhillips Regional Pumping Station;

.2 the mastic and plaster on the ceramic tiles on the housekeeping pad and floor in the McPhillips Regional Pumping Station affected by the installation of the new chiller, CHLR-M640; and

.3 the parging cement on the chilled water supply, chilled water return, and fan coil piping to be removed in the McPhillips Regional Pumping Station.

.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 on the Contract documents and as indicated in Appendix B 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 Contractor’s workers

.2 Visitors

.3 Contract Administrator and his designated on-site staff

.7 Comply with requirements of this section when performing the following Work:

.1 Removing non-friable ACMs by breaking, cutting, drilling, abrading, grounding, sanding, or vibrating to accommodate work at locations indicated on the

Drawings. If the Work is done by means of power tools that are attached to dust-collecting devices equipped with HEPA filters.

.2 Removing of all friable ACMs by wetting.

.3 Removing of ACM from a pipe, duct, or similar structure using a glove bag.

.8 The Contractor shall ensure that work does not impeded with the ongoing operations of the facility. The facility will continue to be operated by City staff.

1.2 REFERENCE STANDARDS

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.205-94, Sealer for Application of Asbestos Fibre Releasing Materials.

.2 Department of Justice Canada (Jus)

.1 Canadian Environmental Protection Act, 1999 (CEPA).

.3 Health Canada/Workplace Hazardous Materials Information System (WHMIS) 2015

.1 WHMIS Safety Data Sheets (SDS).

.4 Transport Canada (TC)

.1 Transportation of Dangerous Goods Act, 1992 (TDGA).

.5 Underwriters' Laboratories of Canada (ULC)

1.3 DEFINITIONS

.1 Amended Water: water with non-ionic surfactant wetting agent added to reduce water tension to allow wetting of fibres.

.2 Asbestos Containing Materials (ACMs): materials identified herein, and in the appended HMIS Confirmed Asbestos and Presumed Asbestos reports for each building.

.3 Asbestos Abatement Monitoring & Inspection Agent: a person qualified to provide asbestos abatement monitoring and inspection services in the jurisdiction where the services are to be provided. The Asbestos Abatement Monitoring & Inspection Agent shall be retained by the Contractor via the cash allowance included in the Contract.

.4 Asbestos Work Area: area where work takes place which will, or may disturb ACMs.

.5 Authorized Visitors: Contract Administrator, or designated representative, and representative of regulatory agencies.

.6 Friable Materials: material that when dry can be crumbled, pulverized, or powdered by hand pressure and includes such material that is crumbled, pulverized, or powdered.

.7 Glove Bag: 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.

.5 Must incorporate internal closure strip if it is to be moved or used in more than one specific location.

.8 HEPA vacuum: High Efficiency Particulate Air filtered vacuum equipment with filter system capable of collecting and retaining fibres greater than 0.3 microns in any dimension at 99.97% efficiency.

.9 Minor Amounts of ACMs: less than or equal to 0.1 m^2 of friable material containing chrysotile asbestos.

.10 Non-Friable Material: material that when dry cannot be crumbled, pulverized, or powdered by hand pressure.

.11 Occupied Area: any area of building or work site that is outside the Asbestos Work Area.

.12 Polyethylene: 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 FR Polyethylene: fiber re-enforced polyethylene.

.14 Sprayer: garden reservoir type sprayer or airless spray equipment capable of producing mist or fine spray. Must have appropriate capacity for scope of Work.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit proof satisfactory to Asbestos Abatement Monitoring & Inspection Agent 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 proof of insurance in accordance with D11.2.

.5 Submit to Asbestos Abatement Monitoring & Inspection Agent and 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.

.6 Submit proof satisfactory to Asbestos Abatement Monitoring & Inspection Agent and to the Contract Administrator that the Contractor's employees and all visitors to the area have had instruction on hazards of asbestos exposure, respirator use, dress, entry and exit from Asbestos Work Area, and aspects of work procedures and protective measures while working in Asbestos Work Areas, and the use, cleaning, and disposal of respirators and protective clothing.

.7 Submit proof that the Contractor's supervisory personnel have attended asbestos abatement course, of not less than two days duration, approved by the Asbestos Abatement & Inspection Agent and to the Contract Administrator.

.8 Submit documentation including test results, fire and flammability data, and WHMIS Safety Data Sheets (SDS) for chemicals or materials including:

.1 Encapsulants;

.2 Amended water;

.3 Slow drying sealer.

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 more stringent requirement applies. Comply with regulations in effect at the time the Work is performed.

.2 Health and Safety:

.1 Safety Requirements: Provide all requirements for workers and Authorized Visitor protection.

.1 Protective equipment and clothing to be worn by 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 worker and marked as to efficiency and purpose, suitable for protection against asbestos and acceptable to Provincial Authority having jurisdiction. The respirator to be fitted so that there is an effective seal between the respirator and the worker's face, unless the respirator is equipped with a hood or helmet. The respirator to be cleaned, disinfected, and inspected after use on each shift, or more often if necessary, when issued for the exclusive use of one worker, or after each use when used by more than one worker. Replace damaged or deteriorated respirator parts prior to the respirator being used by a worker and, when not in use, store respirators in a convenient, clean, and sanitary location. The Contractor 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 worker who is required to wear a respirator. Do not assign a worker 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 for all of the Contractor’s personnel and worn by every worker who enters the work area, and the protective clothing 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. It includes suitable footwear, and it to be repaired or replaced if torn.

.2 Eating, drinking, chewing, and smoking are not permitted in Asbestos Work Area.

.3 Before leaving Asbestos Work Area, the worker or Authorized Visitor must decontaminate his or her protective clothing prior to removing the protective clothing by using a vacuum equipped with a HEPA filter or by damp wiping. If the protective clothing will not be reused, decontamination is not required and place the protective clothing 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 work area, and removed from the work area frequently and at regular intervals.

.4 Ensure workers and Authorized Visitors wash hands and face when leaving Asbestos Work Area.

.5 Ensure that no person required to enter an Asbestos Work Area has facial hair that affects seal between respirator and face.

.6 Visitor and Contract Administrator Protection:

.1 Provide protective clothing and approved respirators to the Contract Administrator and Authorized Visitors to Asbestos Work Area.

.2 Instruct the Contract Administrator and Authorized Visitors in the use of protective clothing, respirators, and procedures.

.3 Instruct the Contract Administrator and Authorized Visitors in proper procedures to be followed in entering into and exiting from Asbestos Work Area.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Place materials defined as hazardous or toxic in designated containers.

.2 Handle and dispose of hazardous materials in accordance with the CEPA, TDGA, and Regional and Municipal regulations.

.3 Disposal of asbestos waste generated by removal activities must comply with Federal, Provincial/Territorial, and Municipal regulations. Dispose of asbestos waste in sealed double thickness 6 mils bags or leak proof drums. Label containers with appropriate warning labels.

.4 Provide manifests describing and listing waste created. Transport containers by approved means to licenced landfill for burial.

1.7 EXISTING CONDITIONS

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

1.8 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.

.2 Co-ordinate Work schedule with the Asbestos Abatement Monitoring & Inspection Agent.

1.9 PERSONNEL TRAINING

.1 Before beginning Work, provide via the Asbestos Abatement Monitoring & Inspection Agent satisfactory proof that every 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.

.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 competent, qualified person.

Part 2 Products

2.1 MATERIALS

.1 Drop and Enclosure Sheets:

.1 Polyethylene: 0.15 mm thick.

.2 FR polyethylene: 0.15 mm thick woven fibre reinforced fabric bonded both sides with polyethylene.

.2 Wetting Agent: 50% polyoxyethylene ester and 50% 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.

.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 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 bag.

.5 A high strength double throw zipper and removable straps, if the 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 8 hours and designed for purpose of trapping residual asbestos fibres.

.1 Sealer: flame spread and smoke developed rating less than 50.

.7 Encapsulant: Serpiflex Shield or approved equal in accordance with B7.

Part 3 Execution

3.1 SUPERVISION

.1 Minimum of one supervisor for every ten workers is required.

.2 Approved supervisor must remain within Asbestos Work Area during disturbance, removal, or other handling of asbestos-containing materials.

3.2 PROCEDURES

.1 Before beginning Work at each access to Asbestos Work Area, install warning signs in both official languages in upper case 'Helvetica Medium' letters 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 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 Asbestos Work Area using measures appropriate to work to be done.

.1 Use FR polyethylene drop sheets over flooring such as carpeting that absorbs dust and work areas where dust or contamination cannot otherwise be safely contained.

.2 When removing ACM from piping or equipment where the "glove-bag" method is not used, erect enclosure of polyethylene sheeting around work area, shut off mechanical ventilation system serving work area, and seal ventilation ducts to and from work area.

.4 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.

.5 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 is to be inspected at regular intervals for damage and defects and repaired or replaced as appropriate. 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 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 the bag to obtain the full capacity of the bag.

.5 Insert nozzle of garden reservoir type sprayer into the bag through the valve and wash down the pipe and interior of bag thoroughly. Wet the surface of the insulation in the lower section of the bag.

.6 To remove the bag after completion of stripping, wash top section and tools thoroughly. Remove the air from the top section of the bag through the elasticized valve using a HEPA vacuum. Pull the polyethylene waste container over the glove bag before removing the bag from the pipe. Release one strap and remove freshly washed tools. Place tools in water. Remove the second strap and zipper. Fold over into waste container and seal.

.7 After removal of the bag, ensure that the 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 the pipe and ends of insulation with slow drying sealer to seal in any residual fibres.

.8 Upon completion of the Work shift, cover exposed ends of remaining pipe insulation with polyethylene taped in place.

.6 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.

.7 Cleanup:

.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 for 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 final thorough clean-up of Asbestos Work Areas and adjacent areas affected by Work using HEPA vacuum.

3.3 AIR MONITORING

.1 From beginning of Work until completion of cleaning operations, the Asbestos Abatement Monitoring & Inspection Agent shall take air samples on a daily basis outside of the Asbestos Work Area enclosure in accordance with Health Canada recommendations.

.1 Contractor will be responsible for monitoring inside enclosure in accordance with applicable Provincial Occupational Health and Safety Regulations.

.2 Submit daily air monitoring results and recommendations to the Contract Administrator.

.2 If air monitoring shows that areas outside Asbestos Work Area enclosure 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.

.3 Ensure that respiratory safety factors are not exceeded.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 The City of Winnipeg (CW) Standard Construction Specifications

- .1 CW 2160 Concrete Underground Structures and Works
- .2 CW 3230 Full-Depth Patching of Existing Slabs and Joints
- .3 CW 3410 Asphaltic Concrete Pavement Works

.2 Canadian Standards Association (CSA)

- .1 CAN/CSA-A23.1, Concrete Materials and Methods of Concrete Construction.
- .2 CAN/CSA-A23.2, Methods of Test for Concrete.
- .3 CAN/CSA-A3000-A5, Portland Cement.
- .4 CAN/CSA-G30.18, Billet-Steel Bars for Concrete Reinforcement.

1.2 SUBMITTALS

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

.2 Provide signed and sealed (by a Manitoba registered Professional Engineer) Shop Drawing submittals for:

- .1 Reinforcing steel
- .2 Chain link fence
- .3 Concrete mix design

.3 Shop Drawings

- .1 Submit placing drawings prepared in accordance with Drawings to clearly show size, shape, location and all necessary details of reinforcing.

.4 Construction Method

- .1 No work shall commence on construction of water pumping station concrete work until after the Contract Administrator's review of the Contractor's construction method submission.
- .2 The Contractor shall prepare for the Contract Administrator's review a construction method submission detailing:
  - .1 construction sequence to be followed including all methods to be employed to ensure no damage occurs to existing structures or adjacent properties within or adjacent to the Works,
  - .2 proposed method of construction,
  - .3 specialized equipment to be used; and
  - .4 any design revisions proposed to accommodate the Contractor's proposed construction method.
- .3 The Contractor shall respond to any concerns that may be raised by the Contract Administrator after review of construction method submission.

Part 2 Products

2.1 MATERIALS

.1 Portland cement: to CAN/CSA-A3000-A5, Type HS or HSb.

.2 Reinforcing bars: to CAN/CSA-G30.18, Grade 400.

.3 Premoulded joint filler:

.1 Bituminous impregnated fibreboard: to ASTM D1751.

.4 Joint sealer/filler: to CAN/CGSB-19.24, Type 1, Class B.

.5 Sealer: proprietary poly-siloxane resin blend.

.6 Other concrete materials: to CAN/CSA-A23.1.

.7 Void Form: Frost Cushion as manufactured by Beaver Plastics or approved equal in accordance with B7.

2.2 MIXES

.1 Proportion concrete in accordance with CAN/CSA-A23.1 and CW 2160.

.2 Concrete: concrete design shall be in accordance with the Drawings, and performance specification; and shall have the following properties:

.1 Cement: Type HS or HSb.
.2 Minimum Compressive Strength @ 28 days: 35 MPa
.3 Slump: 80 +/- 20 mm
.4 Air Content: 5 – 8% +/- 1%
.5 Maximum Water/Cement Ratio = 0.40

.3 Class of exposure: S-1 to CAN/CSA-A23.1.

.4 Nominal maximum size of coarse aggregate: 20mm and to CAN/CSA-A23.1.

.5 Air content: concrete to contain purposely entrained air in accordance with CAN/CSA-A23.1.

.6 Admixtures: to CAN/CSA-A23.1.

.7 Grout: Sika Grout 212 or approved equal in accordance with B7.

.8 Masonry Fill: concrete design shall be in accordance with performance specification and shall have the following properties:

.1 Cement: Type GU.
.2 Minimum Compressive Strength @ 28 days: 20 MPa
.3 Slump: 200 mm
.4 Air Content: nil

.5 Maximum Water/Cement Ratio = 0.49

.9 Bonding Agent: ACRYL-STIX or approved equal in accordance with B7.

Part 3 Execution

3.1 GENERAL

.1 Complete cast-in-place concrete work in accordance with CAN/CSA-A23.1.

.2 Make neat openings in walls and floor slabs using concrete coring and cutting equipment and methods.

.1 Note, both confirmed asbestos and presumed asbestos have been identified at the McPhillips Regional Pumping Station, McPhillips Chlorine Building and McPhillips Collections Building (also referred to as the Old Pump Building) which will or may be affected by the Work. Refer to Section 02 82 00 – Asbestos Abatement for details.

.3 Fill openings left in concrete after removal of piping or other equipment with watertight, non-shrink grout. Finish new surfaces flush with the existing surface and match the surrounding surface texture. Primer and paint shall be applied in accordance with Section 09 91 23 - Painting if the surrounding surfaces have a paint finish.

.4 Mix and apply grout in accordance with the manufacturer's instructions.

.5 Mix and apply bonding agent in accordance with the manufacturer's instructions.

.6 Neatly grout any concrete surface that has been broken and had the aggregate exposed with a smooth finish similar in texture to that of the surrounding concrete.

.7 Apply concrete bonding agents between new concrete or grout and existing concrete surfaces. Remove all loose, pitted, and scaled concrete and apply bonding agent in accordance with the manufacturer's instructions.

.8 De-scale exposed reinforcing steel and have all rust removed before applying grout.

3.2 FORMING

.1 Construct formwork and falsework in accordance with CAN/CSA-A23.1 and CSA S269.1.

.2 Use void form under all grade beams; do not cast grade beams against ground.

3.3 INSERTS

.1 Cast in sleeves, ties, slots, anchors, reinforcement, frames, conduit, bolts, waterstops, joint fillers, and other inserts required to be built-in. Sleeves and openings greater than 100 mm x 100 mm not indicated must be approved by the Contract Administrator.

3.4 FINISHES

.1 Formed surfaces exposed to view: sack rubbed finish in accordance with CAN/CSA-A23.1.

.2 Interior floor slabs: initial finishing operations followed by final finishing comprising mechanical floating and steel trowelling as specified in CAN/CSA-A23.1 to produce hard, smooth, dense trowelled surface free from blemishes.

.3 Equipment pads: provide smooth trowelled surface. Provide chamfers at all outer edges.

.4 Pavements, walks, curbs and exposed site concrete:

- .1 Screed to plane surfaces and use floats.
- .2 Provide round edges and joint spacings using standard tools.
- .3 Trowel smooth to provide lightly brushed non-slip finish.

3.5 CONTROL JOINTS

.1 Cut form control joints in slabs on grade at locations indicated or to match existing, in accordance with CAN/CSA-A23.1 and install specified joint sealer/filler.

3.6 EXPANSION AND ISOLATION JOINTS

.1 Install premoulded joint filler in expansion and isolation joints to full depth of slab flush with finished surface.

3.7 CURING

.1 Cure and protect concrete in accordance with CAN/CSA-A23.1.

- .1 Do not use curing compounds where bond is required by subsequent topping or coating.

3.8 SEALING

.1 Following curing, apply poly-siloxane resin blend sealer at 4 m^2/L or approved equal in accordance with B7.

3.9 SITE TOLERANCES

.1 Concrete floor slab finishing tolerance in accordance with CAN/CSA-A23.1.

3.10 QUALITY CONTROL

.1 Provide inspection and testing of concrete and concrete materials in accordance with CSA A23.1 and carried out by a testing laboratory designated by the Contract Administrator. Quality control tests for concrete will be used to determine the acceptability of the concrete supplied. Contractor to include all costs.

.2 Provide, without charge, samples of concrete and constituent materials required for quality control tests and provide assistance and use of tools and construction equipment as is required.

.3 The frequency and number of concrete quality control tests will be in accordance with the requirements of CSA A23.1.

.4 Non-destructive methods for testing concrete will be in accordance with CSA A23.2.

.5 An outline of the quality control testing is as follows:

.1 Samples of concrete for test specimens will be taken in accordance with CSA A23.2-1C.

.2 Slump tests will be performed in accordance with A23.2-5C. If measured slump falls outside limits specified, a second test will be made. In the event of a second failure, the Contract Administrator reserves right to refuse the batch of concrete represented.

.6 Non-destructive methods for testing concrete will be in accordance with CSA A23.2. Air content test will be performed in accordance with CSA A23.2-4C. If measured air content falls outside limits specified in Table CW 2160.1, a second test will be made at any time within the specified discharge time limit for the mix. In the event of a second failure, the Contract Administrator reserves the right to reject the batch of concrete represented.

.7 Compressive strength test specimens will be taken in accordance with CSA A23.2-3C.

.8 Compressive strength tests at 28 days will be the basis for acceptance of all concrete supplied. For each 28 day test the strength of two companion standard-cured test specimens will be determined in accordance with CSA A23.2-9C. Test result will be the average strength of both specimens.

.9 Field Inspection: A minimum of 24 hours notice shall be given to the Contract Administrator prior to the pouring of any concrete to allow for observation of reinforcing steel.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 City of Winnipeg (CW) Standard Construction Specifications

.1 CW 2160, Concrete Underground Structures and Works

.2 American Concrete Institute (ACI)

.1 SP-66, ACI Detailing Manual 2004.

.1 ACI 315, Details and Detailing of Concrete Reinforcement.

.2 ACI 315R, Manual of Engineering and Placing Drawings for Reinforced Concrete Structures.

.3 CSA International

.1 CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete.

.2 CSA-A23.3, Design of Concrete Structures.

.3 CSA-G30.18, Carbon Steel Bars for Concrete Reinforcement.

.4 CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.5 CAN/CSA-G164, Hot Dip Galvanizing of Irregularly Shaped Articles.

.6 CSA W186, Welding of Reinforcing Bars in Reinforced Concrete Construction.

.4 Reinforcing Steel Institute of Canada (RSIC)

.1 RSIC, Reinforcing Steel Manual of Standard Practice.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 The Contractor shall submit Shop Drawings for the Contract Administrator's approval two weeks prior to the fabrication of any reinforcing steel.

.3 The Contractor shall provide, without charge, the samples of reinforcing steel required for quality control tests and provide such assistance and use of tools and construction equipment as is required.

.4 Prepare reinforcement drawings in accordance with RSIC Manual of Standard Practice and ACI 315.

.5 Shop Drawings:

.1 Submit Shop Drawings stamped and signed by a professional engineer registered in the Province of Manitoba.

.1 Indicate placing of reinforcement and:

.1 Bar size, grade, spacing, and bend;

.2 Hooks, spacing and supporting devices;

.3 Lists of components; and

.4 Quantities of reinforcement.

.2 Detail lap lengths and bar development lengths to CSA-A23.3.

1.3 QUALITY ASSURANCE

.1 Submit:

.1 Mill Test Report: Upon request, provide the Contract Administrator with certified copy of mill test report of reinforcing steel a minimum of 4 weeks prior to beginning reinforcing work.

.2 Upon request, submit in writing to the Contract Administrator the proposed source of reinforcement material to be supplied.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and acceptance requirements: deliver materials to the Site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and Handling Requirements:

.1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

.1 Reinforcing steel: billet steel, grade 400, deformed bars to CSA-G30.18.

.2 Reinforcing steel: weldable low alloy steel deformed bars to CSA-G30.18.

.3 Cold-drawn annealed steel wire ties: to ASTM A82/A82M.

.4 Chairs, bolsters, bar supports, spacers: to CSA-A23.1/A23.2.

.1 Bar accessories shall be of type approved by the Contract Administrator. They shall be made from a non-corroding material and they shall not stain, blemish, or spall the concrete surface for the life of the concrete. Bar chairs are to be PVC; galvanized bar chairs are not acceptable.

.2 Bar accessories shall include bar chairs, spacers, clips, wire ties, wire (18 gauge minimum), or other similar devices that may be approved by the Contract Administrator. Bar accessories are not shown on the Drawings. The supply and installation of bar accessories shall be considered incidental to the supply and placing of reinforcing steel.

.5 Plain round bars: to CSA-G40.20/G40.21.

.6 Replace defective or damaged materials with new.

2.2 FABRICATION

.1 Fabricate reinforcing steel in accordance with CSA-A23.1/A23.2, ACI 315, CW 2160, and Reinforcing Steel Manual of Standard Practice by the Reinforcing Steel Institute of Canada.

.2 Ship bundles of bar reinforcement, clearly identified in accordance with bar bending details and lists.

Part 3 Execution

3.1 FIELD BENDING

.1 Do not field bend or field weld reinforcement except where authorized by the Contract Administrator.

.2 When field bending is authorized, bend without heat, applying slow and steady pressure.

.3 Replace bars which develop cracks or splits.

3.2 PLACING REINFORCEMENT

.1 Place reinforcing steel as indicated on placing drawings and in accordance with CSA-A23.1/A23.2.

.2 Use plain round bars as slip dowels in concrete.

.1 Paint portion of dowel intended to move within hardened concrete with one coat of asphalt paint.

.2 When paint is dry, apply thick even film of mineral lubricating grease.

.3 Prior to placing concrete, obtain the Contract Administrator's approval of reinforcing material and placement.

.4 Ensure cover to reinforcement is maintained during concrete pour.

.5 A minimum of 24 hours notice shall be given to the Contract Administrator prior to the pouring of any concrete to allow for observation of reinforcing steel.

3.3 CLEANING

.1 Leave the Work area clean at end of each day.

.2 Final cleaning: upon completion, remove surplus materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 ASTM International

- .1 ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
- .2 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 CSA International

- .1 CSA G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
- .2 CAN/CSA G164, Hot Dip Galvanizing of Irregularly Shaped Articles.
- .3 CSA S16.1, Design of Steel Structures.
- .4 CSA W48, Filler Metals and Allied Materials for Metal Arc Welding (Developed in co-operation with the Canadian Welding Bureau).
- .5 CSA W59, Welded Steel Construction (Metal Arc Welding).

.3 The Master Painters Institute (MPI)

- .1 Architectural Painting Specification Manual.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

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

.2 Submit the qualifications of the fabricator, qualifications of the welders, Shop Drawings, mill certificates, and welding procedures to the Contractor Administrator for acceptance,

.3 Product Data: Submit Shop Drawings sealed by an engineer registered in the province of Manitoba clearly indicating materials, core thickness, finishes, connections, joints, method of anchorage, number of anchors, supports, reinforcement, details and accessories for the Contract Administrator's approval at least two weeks prior to fabrication. Indicate field measurements on Shop Drawings.

1.3 QUALIFICATION

.1 Fabricator to be fully approved by the Canadian Welding Bureau, in conformance with CSA Standard W.47.1. Welding to be done by currently licensed welders only.

.2 Fabricator to be fully certified in conformance with CSA Standard W47.2. All welding to be done in a licensed welding shop. Obtain Contract Administrator's approval to do field welding.

1.4 QUALITY ASSURANCE

.1 Certifications: submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

.2 Delivery and acceptance requirements: deliver materials to the Site in original factory packaging, labelled with manufacturer's name and address.

.3 Storage and handling requirements:

.1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.

.2 Replace defective or damaged materials with new.

Part 2 Products

2.1 GENERAL

.1 All materials shall be of a type acceptable to the Contract Administrator and shall be subject to inspection and testing by the Contractor Administrator.

.2 Material intended for use in the various assemblies shall be new, straight, and clean, with well defined profiles.

2.2 MATERIALS

.1 Steel sections and plates: to CSA G40.20/G40.21, Grade 350W.

.2 Steel pipe: to ASTM A53/A53M seamless, standard weight, galvanized finish.

.3 Welding materials: to CSA W59.

.4 Welding electrodes: to CSA W48 Series.

.5 Bolts and anchor bolts: to ASTM A307.

.6 Stud Anchors: to ASTM A108, Grade 1020.

.7 Aluminum: to CAN/CSA S157 and the Aluminum Association ‘Specifications for Aluminum Structures’. Aluminum for plates shall be Type 6061-T651. Aluminium plate shall have an approved raised oval or multi-grip pattern.

.8 Isolating Sleeves

.1 “Nylite” – headed sleeve as manufactured by SPAE-Nauru of Kitchener, Ontario, or approved equal in accordance with B7.

.9 Aluminum welding shall be in accordance with the requirements of CSA W59.2-M1991.

.10 Hot Dipped Galvanized Steel Repair Material

.1 Galvalloy and Gal-Viz

.11 Grout: non-shrink, non-metallic, flowable, 15 MPa at 24 hours.

.12 Anchor bolts and fasteners: ASTM A276, Type 316 stainless steel, of ample section to safely withstand the forces created by operation of the equipment or the load to which they will be subjected.

.13 Quantity and size of the fasteners shall be as recommended by the manufacturer or as shown on the Drawings.

.14 Provide exposed fastenings of same material and finish as the metal to which applied unless indicated otherwise.

.15 Supply all items complete with all anchors and fastenings.

2.3 FABRICATION

.1 Fabricate work square, true, straight, and accurate to required size, with joints closely fitted and properly secured.

.2 Confirm measurements for all fabrications before fabricating.

.3 Use self-tapping shake-proof flat headed screws on items requiring assembly by screws or as indicated.

.4 Where possible, fit and shop assemble work, ready for erection.

.5 Ensure exposed welds are continuous for length of each joint. File or grind exposed welds smooth and flush.

.6 Seal exterior steel fabrications to provide corrosion protection in accordance with CAN3-S16.1.

.7 Remove and grind smooth burrs, filings, sharp protrusions, and projections from metal fabrications to prevent possible injury. Correct any dangerous or potentially harmful installations as directed by the Contract Administrator.

.8 All aluminum surfaces in contact with concrete shall be isolated using alkali-resistant bituminous paint meeting the requirements of CGSB 31-GP-3M.

.9 Aluminum plate shall have an approved raised oval or multi-grip pattern with edges straight and true and shall be cut as far as practical to maintain continuity of the pattern at abutting edges.

.10 Pieces shall be of the sizes indicated on the Drawings and shall not be built up from scrap pieces.

.11 Exterior covers shall be supplied with a hasp for a padlock.

2.4 FINISHES

.1 Galvanizing: hot dipped galvanizing with zinc coating 600 g/m^2 to CAN/CSA-G164.

.2 Paint for shop primed ferrous metal surfaces: MPI EXT 5.1D Alkyd G5 (semi gloss) finish, premium grade. Colour Schedule will be provided by the Contract Administrator.

.3 Zinc primer: zinc rich, ready mix.

2.5 ISOLATION COATING

.1 Isolate aluminum from the following components by means of bituminous paint:

.1 Dissimilar metals except stainless steel, zinc, or white bronze of small area.

.2 Concrete, mortar, and masonry.

.3 Wood.

2.6 SHOP PAINTING

.1 Apply one shop coat of primer to metal items, with exception of galvanized or concrete encased items.

.2 Use primer unadulterated, as prepared by manufacturer. Paint on dry surfaces, free from rust, scale, or grease. Do not paint when materials and air temperatures are lower than 7 degrees C.

.3 Clean surfaces to be field welded; do not paint.

.4 Touch up surfaces after installation.

.5 Top coat as per Section 09 91 23 – Painting.

2.7 ANGLE LINTELS

.1 Steel angles: Galvanized, sizes indicated for openings. Provide 150 mm minimum bearing at ends.

.2 Weld or bolt back-to-back angles to profiles as indicated.

2.8 CHANNEL AND HSS ACCESSORIES

.1 Fabricate accessories from steel, sizes as indicated.

.2 Weld channels together to form continuous frame, sizes as indicated.

.3 HSS to be sealed with 6.35 mm steel plate welded completely at each end and ground smooth.

.4 Finish: Shop painted to Section 09 91 23 - Painting, colour as shown on Drawings or as directed by the Contract Administrator. Touch up as required after installation.

Part 3 Execution

3.1 EXAMINATION

.1 Verification of conditions: verify conditions of substrates previously installed under other sections or contracts are acceptable for metal fabrications installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate.

.2 Inform the Contract Administrator in writing of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Contract Administrator.

3.2 ERECTION

.1 Do steel welding work in accordance with CSA W59 unless specified otherwise.

.2 Do aluminum welding work in accordance with CSA W59.2 unless specified otherwise.

.3 Erect metalwork square, plumb, straight, and true, accurately fitted, with tight joints and intersections.

.4 Provide suitable means of anchorage acceptable to the Contract Administrator such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

.5 Exposed fastening devices to match finish and be compatible with material through which they pass.

.6 Supply components for work by other trades in accordance with Shop Drawings and schedule.

.7 Make field connections with bolts to CSA S16 or weld field connection.

.8 Deliver items over for casting into concrete and building into masonry together with setting templates to appropriate location and construction personnel.

.9 Touch-up rivets, field welds, bolts and burnt or scratched surfaces with primer after completion.

.10 Repair damaged galvanized surfaces and field welds with self-fluxing, low temperature, zinc-based alloy rods in accordance with ASTM A780, Repair of Damaged Hot Dip Galvanizing Coatings. The general procedure shall be to allow a small amount of the repair alloy to flow then spread by brushing briskly with a wire brush. Brushing shall be sufficient to obtain a bright finish. Repeat process three times to ensure a proper thickness is achieved. Temperatures shall be kept below 177ºC (350ºF) at all times. All heating of structural steelwork shall be done in the presence of the Contract Administrator.

.11 Isolate aluminum surfaces in contact with concrete using alkali-resistant bituminous paint meeting the requirements of CGSB 31-GP-3M.

.12 Install electrochemical isolation gaskets and sleeves to electrically isolate dissimilar metals.

3.3 CLEANING

.1 Leave Work area clean at end of each day.

.2 Final cleaning: upon completion remove surplus materials, rubbish, tools, and equipment.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by metal fabrications installation.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM).

- .1 ASTM C208, Specification for Cellulosic Fibre Insulating Board.
- .2 ASTM C591, Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
- .3 ASTM C612, Standard Specification for Mineral Fibre Block and Board Thermal Insulation.
- .4 ASTM C726, Standard Specification for Mineral Fibre Roof Insulation Board.
- .5 ASTM C728, Standard Specification for Perlite Thermal Insulation Board.
- .6 ASTM C1126, Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
- .7 ASTM C1289-07, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
- .8 ASTM E96/E96M, Standard Test Methods for Water Vapour Transmission of Materials.

.2 Canadian Gas Association (CGA).

- .1 CAN/CGA-B149.1, Natural Gas and Propane Installation Code Handbook.
- .2 CAN/CGA-B149.2, Propane Storage and Handling Code.

.3 Canadian General Standards Board (CGSB)

- .1 CGSB 71-GP-24M, Adhesive, Flexible, for Bonding Cellular polystyrene Insulation.

.4 Underwriters Laboratories of Canada (ULC).

- .1 CAN/ULC-S604, Standard for Type A Chimneys.
- .2 CAN/ULC-S701, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Coverings.
- .3 CAN/ULC-S102, Surface Burning Characteristics.
- .4 CAN/ULC-S702, Standard for Thermal Insulation, Mineral Fibre, for Buildings.
- .5 CAN/ULC-S704, Standard for Thermal Insulation Polyurethane and Polyisocyanurate, Boards, Faced.

.5 Health Canada/Workplace Hazardous Materials Information System 2015 (WHMIS).

- .1 Material Safety Data Sheets (MSDS).

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 data sheet.

.3 Manufacturer's Instructions:

.1 Submit manufacturer's installation instructions.

.4 Quality Assurance:

.1 Submit product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.

Part 2 Products

2.1 INSULATION

.1 Rigid board: Polyisocyanurate thermal insulation board to CAN/ULC-S704, thickness and locations as indicated on Drawings. Acceptable material: Johns Manville “AP Foil-faced” or approved equivalent in accordance with B7.

2.2 ACCESSORIES

.1 Fasteners and adhesives: to be as recommended by the insulation manufacturer, installed per manufacturer’s instructions.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

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

3.2 INSTALLATION

.1 Install insulation after building substrate materials are dry.

.2 Install insulation to maintain continuity of thermal protection to building elements and spaces. Fit insulation tight around electrical, plumbing and heating pipes and ducts, around exterior doors and windows, and other penetrations and protrusions. Cut and trim insulation neatly to fit spaces.

.3 Install insulation boards in parallel rows. Butt joints tightly, offset vertical joints. Interlock boards at corners. Use longest pieces possible to reduce number of joints. Cut and trim insulation neatly to fit spaces. Use only insulation boards free from chipped or broken edges. Use largest possible dimensions to reduce number of joints.

.4 Install insulation over foundation waterproofing with concrete anchors complete with nailing discs or washers. Provide a minimum of five (5) anchors per 600 x 1200 mm of insulation board. Provide additional anchors spaced at 300 mm on centre around perimeter of openings, corners, and abutments. Ensure concrete anchors are securely seated. Replace loose fasteners or provide additional fastener adjacent to loose fasteners. Install insulation to maintain continuity of thermal protection to building elements and spaces.

.5 Fit insulation tight around electrical boxes, plumbing and heating pipes and ducts, around exterior doors and windows, and other protrusions.

.6 Offset both vertical and horizontal joints in multiple layer applications.

3.3 EXAMINATION

.1 Examine substrates and immediately inform Contract Administrator in writing of defects.

.2 Prior to commencement of work ensure:

.1 Substrates are firm, straight, smooth, dry, free of snow, ice or frost, and clean of dust and debris.

3.4 CLEANING

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

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)

.1 ASTM C919, Standard Practice for Use of Sealants in Acoustical Applications.

.2 Canadian General Standards Board (CGSB)

.1 CGSB 19-GP-5M, Sealing Compound, One Component, Acrylic Base, Solvent Curing (incorporating Amendment No. 1).

.2 CAN/CGSB-19.13, Sealing Compound, One-component, Elastomeric, Chemical Curing.

.3 CGSB 19-GP-14M, Sealing Compound, One Component, Butyl-Polyisobutylene Polymer Base, Solvent Curing.

.4 CAN/CGSB-19.17, One-Component Acrylic Emulsion Base Sealing Compound.

.5 CAN/CGSB-19.24, Multi-component, Chemical Curing Sealing Compound.

.6 CAN/CGSB-19.21 Sealing and Bedding Compound, Acoustical

.3 General Services Administration (GSA) - Federal Specifications (FS)

.1 FS-SS-S-200, Sealants, Joint, Two-Component, Jet-Blast-Resistant, Cold Applied, for Portland Cement Concrete Pavement.

1.2 SUBMITTALS

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

.2 Submit manufacturer's product data to describe:

.1 Caulking compound.

.2 Primers.

.3 Sealing compound, each type, including compatibility when different sealants are in contact with each other.

.4 Safety data sheets.

.3 Submit manufacturer's instructions.

.1 Installation instructions for each product used.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, handle, store, and protect materials in accordance with the manufacturer’s written instructions.

.2 Deliver and store materials in original wrappings and containers with manufacturer's seals and labels intact. Protect from freezing, moisture, water, and contact with ground or floor.

1.4 ENVIRONMENTAL CONDITIONS

.1 Environmental Limitations:

.1 Do not proceed with installation of joint sealants under following conditions:

.1 When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 5 degrees C.

.2 When joint substrates are wet unless required by the manufacturer.

.2 Joint-Width Conditions:

.1 Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.

.3 Joint-Substrate Conditions:

.1 Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

.4 Comply with requirements of Workplace Hazardous Materials Information System 2015 (WHMIS) regarding use, handling, storage, and disposal of hazardous materials; and regarding labelling and provision of Material Safety Data Sheets (SDS) acceptable to Labour Canada.

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

Part 2 Products

2.1 SEALANT MATERIALS

.1 Type 1 – Silicones One Part: to CAN/CGSB-19.13. Acceptable material: Dow Corning 795, GE Silpruf, Tremco Spectrum 2.

.2 Type 2 – Silicones One Part: to CAN/CGSB-19.22-M89 (Mildew resistant). Acceptable material: Dow Corning 786 or approved equal in accordance with B7.

.3 Type 3 – Acrylic Latex One Part: to CGSB 19-GP-5M. Acceptable material: Tremco 100 Latex Caulk, GE Acrylasil Latex Caulk.

.4 Type 4 – Butyl: to CGSB 19-GP-14M. Acceptable material: Tremco Butyl Sealant or approved equal in accordance with B7.

.5 Type 5 – Rubber/Synth Rubber: To CGSB 19.24. Acceptable material: Tremco Acoustical/Curtainwall Sealant, LePage PL Acousti-seal

2.2 ACCESSORIES

.1 Preformed compressible and non-compressible back-up materials:

.1 High-density foam: Extruded closed cell polyvinyl chloride (PVC), extruded polyethylene, closed cell, Shore A hardness 20, tensile strength 140 to 200 kPa, extruded polyolefin foam, 32 kg/m density, or neoprene foam backer, size as recommended by manufacturer.

.2 Bond breaker tape: Polyethylene bond breaker tape that will not bond to sealant.

.2 Joint cleaner: non-corrosive and non-staining type, compatible with joint forming materials and sealant recommended by sealant manufacturer.

.3 Primer: as recommended by manufacturer.

2.3 SEALANT SELECTION

.1 Perimeters of exterior openings where frames meet exterior facade of building: Sealant Type 1.

.2 Miscellaneous flashing joints and metal cladding: Sealant Type 1.

.3 Perimeter of washroom fixtures (e.g., sinks, urinals, water closets, vanities, etc.): Sealant Type 2.

.4 Interior paintable joints: Sealant Type 3.

.5 Bedding aluminum doorsills: Sealant Type 4.

2.4 JOINT CLEANER

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

.2 Primer: as recommended by manufacturer.

Part 3 Execution

3.1 PROTECTION

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

3.2 SURFACE PREPARATION

.1 Examine joint sizes and conditions to establish correct depth to width relationship for installation of backup materials and sealants.

.2 Clean bonding joint surfaces of harmful matter including dust, rust, oil grease, and other matter which may impair Work.

.3 Do not apply sealants to joint surfaces treated with sealer, curing compound, water repellent, or other coatings unless tests have been performed to ensure compatibility of materials. Remove coatings as required.

.4 Ensure joint surfaces are dry and frost free.

.5 Prepare surfaces in accordance with manufacturer's directions.

3.3 PRIMING

.1 Where necessary to prevent staining, mask adjacent surfaces prior to priming and caulking.

.2 Prime sides of joints in accordance with sealant manufacturer's instructions immediately prior to caulking.

3.4 BACKUP MATERIAL

.1 Apply bond breaker tape where required to manufacturer's instructions.

.2 Install joint filler to achieve correct joint depth and shape, with approximately 30% compression.

3.5 MIXING

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

3.6 APPLICATION

.1 Sealant.

- .1 Apply sealant in accordance with manufacturer's written instructions.
- .2 Mask edges of joint where irregular surface or sensitive joint border exists to provide neat joint.
- .3 Apply sealant in continuous beads.
- .4 Apply sealant using gun with proper size nozzle.
- .5 Use sufficient pressure to fill voids and render joints solid.
- .6 Form surface of sealant with full bead, smooth, free from ridges, wrinkles, sags, air pockets, and embedded impurities.
- .7 Tool exposed surfaces before skinning begins to give slightly concave shape.
- .8 Remove excess compound promptly as work progresses and upon completion.

.2 Curing.

- .1 Cure sealants in accordance with sealant manufacturer's instructions.
- .2 Do not cover up sealants until proper curing has taken place.

.3 Cleanup.

- .1 Clean adjacent surfaces immediately and leave Work neat and clean.
- .2 Remove excess and droppings, using recommended cleaners as work progresses.
- .3 Remove masking tape after initial set of sealant.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Department of Justice Canada (Jus)

.1 Canadian Environmental Protection Act (CEPA), c. 33

.2 Environmental Protection Agency (EPA)

.1 EPA Test Method for Measuring Total Volatile Organic Compound Content of Consumer Products, Method 24 (for Surface Coatings).

.3 Health Canada / Workplace Hazardous Materials Information System 2015 (WHMIS)

.1 Material Safety Data Sheets (SDS).

.4 Master Painters Institute (MPI)

.1 MPI Architectural Painting Specifications Manual.

.5 National Fire Code of Canada

.6 Society for Protective Coatings (SSPC)

.1 SSPC Painting Manual, Volume Two, 8th Edition, Systems and Specifications Manual.

.7 Transport Canada (TC)

.1 Transportation of Dangerous Goods Act (TDGA), c. 34 .

1.2 SCOPE OF WORK

.1 The scope of work includes, but is not limited to:

.1 Paint interior walls where existing paint is disturbed, damaged, or removed as a result of the Work.

.2 Existing paint is presumed to be lead based, mitigate and provide appropriate safety precautions when disturbing or removing existing paint.

.3 Paint all new interior piping in accordance with this Specification.

.4 Any new metal surfaces, not already factory finished, shall be painted in accordance with this Specification. Touch up any equipment factory painted, including existing equipment affected by the Work or equipment supplied by the City.

.5 Existing structural steel shall be painted in accordance with this Specification as indicated in the Drawings

.6 All concrete repairs, patching, and new concrete shall be painted (to match existing look as closely as possible) in accordance with this Specification.

1.3 SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's product data and installation and application instructions for each paint and coating product to be used.

.2 Provide color samples to the Contract Administrator for approval before application.

.3 Submit manufacturer's product data and installation and application instructions for the use and application of paint thinner.

.4 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.5 Extra Materials:

.1 Identify and submit colour and paint type (code and sample) in relation to established colour schedule and finish formula.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Packing, Shipping, Handling, and Unloading:

.1 Pack, ship, handle, and unload materials in accordance with manufacturer's written instructions.

.2 Acceptance at Site:

.1 Identify products and materials with labels indicating:

.1 Manufacturer's name and address.

.2 Type of paint or coating.

.3 Compliance with applicable standard.

.4 Colour number in accordance with established colour schedule.

.3 Remove damaged and rejected materials from Site.

.4 Storage and Protection:

.1 Provide and maintain dry, temperature controlled, secure storage.

.2 Store materials and supplies away from heat generating devices.

.5 Store temperature sensitive products above minimum temperature as recommended by manufacturer.

.6 Keep areas used for storage, cleaning, and preparation clean and orderly.

.7 Remove paint materials from storage only in quantities required for same day use.

Part 2 Products

2.1 MATERIALS

.1 Only paint materials listed in the MPI Approved Products List (APL) are acceptable for use on the project, except where other products are specified.

.2 Paint materials for each coating formula to be products of a single manufacturer.

.3 Colour schedule will be determined by the Contract Administrator. Selection of colours will be from manufacturer's full range of colours.

.4 Paint Finishes: Except for Formula 1 (epoxy) use MPI finishing formulae as specified below:

.1 Formula 1: for wood to receive paint finish: MPI EXT 6.4B - Alkyd GR (semi-gloss) finish premium grade.

.2 Formula 2: for shop primed and unprimed ferrous metal surfaces (Alkyd):

.1 MPI EXT 5.1D Alkyd G5 (semi-gloss) finish premium grade.

.2 Touch-up shop primer (if used) with primer provided by the manufacturer.

.3 One coat marine alykd metal primer CGSB-1-GP-48M.

.4 Two coats semi-gloss enamel CAN/CGSB-1.57.

.5 Acceptable products: Pratt and Lambert, Benjamin Moore, Glidden, Cloverdale, or Northern Paint.

.6 Provide color samples to the Contract Administrator for approval before application.

.7 Paint and primer shall be from the same manufacturer.

.3 Formula 3: for galvanized and zinc-coated metal: MPI EXT 5.3B - Alkyd G5 (semi-gloss) finish premium grade.

.4 Formula 4: for concrete walls and ceilings apply: MPI EXT 3.1A - Latex G5 (semi-gloss) finish premium grade.

.1 One coat latex primer-sealer CAN/CGSB-1.119.

.2 Two coats semi-gloss enamel CAN/CGSB-1.57.

.3 Acceptable products: Pratt and Lambert, Benjamin Moore, Glidden, Cloverdale, or Northern Paint.

.4 Primer to be white.

.5 Paint and primer shall be from the same manufacturer.

.5 Formula 5: for concrete floors apply: MPI EXT 3.2D – Alkyd floor enamel #59 low gloss finish premium grade. Sprinkle with clean silica sand to provide slip-resistant surface acceptable to Contract Administrator.

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 data sheet.

3.2 GENERAL

.1 Perform preparation and operations for interior painting in accordance with MPI Architectural Painting Specifications Manual except where specified otherwise.

.2 Apply paint materials in accordance with paint manufacturer's written application instructions.

3.3 EXAMINATION

.1 Investigate existing substrates for problems related to proper and complete preparation of surfaces to be painted. Report to the Contract Administrator.

.2 Do not proceed with work until conditions fall within acceptable range as recommended by manufacturer.

3.4 PREPARATION

.1 Protection:

.1 Cover or mask floors, walls, and equipment adjacent to areas being painted to prevent damage and to protect from paint drops and splatters. Use non-staining coverings.

.2 Protect items that are permanently attached such as fire labels on doors, frames, and name plates on equipment.

.2 Surface Preparation: Clean and prepare surfaces in accordance with MPI Painting Specification Manual requirements. Refer to MPI Manual in regard to specific requirements and as follows:

.1 Remove dust, dirt, and other surface debris by vacuuming, wiping with dry, clean cloths.

.2 Wash surfaces with a biodegradable detergent and bleach where applicable and clean with warm water using a stiff bristle brush to remove dirt, oil, and other surface contaminants.

.3 Rinse scrubbed surfaces with clean water until foreign matter is flushed from surface.

.4 Allow surfaces to drain completely and allow to dry thoroughly.

.3 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.

.4 Where possible, prime 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.

.5 Clean metal surfaces to be painted by removing rust, loose mill scale, welding slag, dirt oil, grease, and other foreign substances in accordance with MPI requirements. Remove traces of blast products from surfaces, pockets, and corners to be painted.

.6 Touch up and prime surfaces as specified in applicable section. Major touch-up includes cleaning and painting of field connections, welds, rivets, nuts, washers, bolts, and damaged or defective paint and rusted areas.

3.5 APPLICATION

.1 Apply paint in accordance with manufacturer's application instructions unless specified otherwise.

.2 Apply each coat of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.3 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.4 Sand and dust between each coat to remove visible defects.

.5 Finish top, bottom, edges, and cutouts of doors after fitting as specified for door surfaces.

.6 Do not paint over galvanized metal, aluminium, stainless steel, brass or bronze, rubber, plated surfaces, machined surfaces, hangers, and nameplates.

.7 Ventilate area of work by use of approved portable supply and exhaust fans.

.8 Provide temporary heating where permanent facilities are not available to maintain minimum recommended temperatures.

.9 Apply paint finish only in areas where dust is no longer being generated by related construction operations such that airborne particles will not affect the quality of the finished surface.

.10 Apply paint only when surface to be painted is dry, properly cured, and adequately prepared.

.11 Apply each coat of paint as a continuous film of uniform thickness. Repaint thin spots or bare areas before next coat of paint is applied.

.12 Allow surfaces to dry and properly cure after cleaning and between subsequent coats for minimum time period as recommended by manufacturer.

.13 Sand and dust between each coat to remove visible defects.

.14 Paint both sides and edges of backboards for electrical equipment before installation. Leave equipment in original finish except for touch-up as required.

3.6 PUMPS

.1 Do not apply primer or paint to pumps.

3.7 MECHANICAL/ELECTRICAL EQUIPMENT

.1 Do not paint exposed electrical conduit, ductwork, and hangers unless otherwise indicated.

.2 Paint new piping. Colour and texture to match adjacent surfaces, except as noted otherwise. Do not paint valves.

.3 Touch up scratches and marks on factory painted finishes and equipment with paint as supplied by the manufacturer of the equipment.

.4 Do not paint over nameplates, brass or bronze surfaces, or machined surfaces.

.5 Paint both sides and edges of backboards for electrical equipment before installation. Leave equipment in original finish except for touch-up as required, and paint conduits, mounting accessories, and other unfinished items.

3.8 RESTORATION/CLEANUP

.1 Clean and re-install hardware items removed before undertaken painting operations.

.2 Remove protective coverings and warning signs as soon as practical after operations cease.

.3 Protect freshly completed surfaces from paint droppings and dust to approval of the Contract Administrator. Avoid scuffing newly applied paint.

.4 Restore areas used for storage, cleaning, mixing and handling of paint to clean condition as approved by the Contract Administrator.

.5 Remove over-spray, paint splatter, and spills from exposed surfaces that were not intended for painting. Remove smears and spatter immediately as operations progress, using appropriate methods as per manufacturer's instructions.

3.9 STANDARDS OF ACCEPTANCE

.1 Walls: No defects visible from a distance of 1000 mm at 90 degrees to surface when viewed using final lighting source.

.2 Ceilings: No defects visible from floor at 45 degrees to surface when viewed using final lighting source.

.3 Mechanical systems: No visible defects from a distance of 1000 millimetres at 90 degrees to surface when viewed using final lighting source.

.4 Final coat to exhibit uniformity of colour and uniformity of sheen across full surface area.

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

1.2

.1 Section 23 05 00 - Common Work Results for HVAC.

1.3 QUALIFICATIONS

.1 Work shall be installed by qualified workmen who are fully familiar with this work and have a working knowledge of the systems components.

.2 Contractor shall be fully familiar with governing regulations having jurisdiction on this Project.

1.4 PLUMBING CODES

.1 Work shall be installed in accordance with local code requirements except where more stringent requirements are specified under this section.

.2 Where local code requirements are at variance with this section of the Specifications, the Work shall be installed in accordance with the local code requirements at no additional cost to this Contract.

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 National Research Council Canada (NRC)

.1 National Plumbing Code of Canada [2015] (NPC).

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 datasheets and include product characteristics, performance criteria, physical size, finish, and limitations.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver, store. and handle in accordance with Section 01 61 00- Common Product Requirements.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

Part 2 Products

2.1 CAST IRON PIPING AND FITTINGS

.1 Above ground storm: to CAN/CSA-B70.

.1 Joints:

.1 Hub and spigot:

.1 Caulking lead: to CSA B67.

.2 Mechanical joints:

.1 Neoprene or butyl rubber compression gaskets with stainless steel clamps.

2.2 COPPER TUBE AND FITTINGS

.1 Above ground sanitary, storm, and vent Type DWV to: ASTM B306.

.1 Fittings

.1 Cast brass to CAN/CSA-B125.

.2 Wrought copper to CAN/CSA-B125.

.2 Solder: Tin-antimomy only 95-5, Type TA to ASTM B32.

Part 3 Execution

3.1 APPLICATION

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

3.2 INSTALLATION

.1 Install in accordance with Manitoba Plumbing Code.

3.3 DRAINAGE/VENTING

.1 Slope piping up in direction of flow according to the National Plumbing Code. (Pipe sizing shown on Drawings are generally based on a 1% slope).

.2 Fit piping with drain valves at low points to facilitate complete system drainage.

3.4 TESTING

.1 Hydraulically test to verify grades and freedom from obstructions.

3.5 PERFORMANCE VERIFICATION

.1 Cleanouts:

.1 Ensure cleanouts are accessible and that access doors are correctly located.

.2 Open and cover with linseed oil and re-seal.

.3 Verify that cleanout rods can probe at least as far as the next cleanout.

.2 Test to ensure traps are fully and permanently primed.

.3 Storm water drainage:

.1 Verify domes are secure.

.2 Verify provisions for movement of roof system.

.4 Ensure that fixtures are properly anchored, connected to system, and effectively vented.

.5 Affix applicable label (storm, sanitary, vent, pump discharge etc.) c/w directional arrows every floor or 4.5 m (whichever is less).

END OF SECTION

Part 1 General

1.1 SUBMITTALS

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

.2 Shop Drawings to show:

- .1 Mounting arrangements.
- .2 Operating and maintenance clearances.

.3 Shop Drawings and product data to be accompanied by:

- .1 Detailed drawings of bases, supports, and anchor bolts.
- .2 Points of operation on performance curves.
- .3 Electrical data.
- .4 Wiring diagrams.
- .5 Manufacturer's certification of current model production.
- .6 Certification of compliance to applicable codes.
- .7 For the Air-Cooled Chiller and Condenser:
  - .1 Drawings indicating components, assembly, overall dimensions, weights, loading and lifting points, materials and components of construction, and size of field connections.
  - .2 Indicate equipment, piping and connections, valves, strainers, and thermostatic valves.
  - .3 Chiller capacity and efficiency ratings in accordance with reference standards.
  - .4 Type and quantity of refrigerant used.
  - .5 Acoustic data.
  - .6 Integral control systems including the interfaces, communication protocol, system trending capabilities, and full plant control functions.

.4 Closeout Submittals:

- .1 Provide operation and maintenance data for incorporation into manual as specified in Section 01 78 00 - Closeout Submittals.
- .2 Operation and maintenance manual must be approved by, and final copies deposited with, the Contract Administrator before final inspection.
- .3 Operation data to include:
  - .1 Control schematics for systems including environmental controls.
  - .2 Description of systems and their controls.
  - .3 Operation instruction for systems and component.
  - .4 Description of actions to be taken in event of equipment failure.
- .4 Maintenance data to include:
  - .1 Servicing, maintenance, operation, and trouble-shooting instructions for each item of equipment.
  - .2 Data to include schedules of tasks, frequency, tools required, and task time.

.5 Performance data to include:

.1 Equipment manufacturer's performance datasheets with point of operation as left after commissioning is complete.

.2 Testing, adjusting, and balancing reports as specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

.6 Approvals:

.1 Submit draft operation and maintenance manual to Contract Administrator for approval. Submission of individual data sheets will not be accepted – group submission documents together.

.2 Make changes as required and re-submit as directed by Contract Administrator.

.7 As-built Drawings:

.1 Identify each Drawing in lower right hand corner in letters at least 12 mm high as follows: - "AS BUILT DRAWINGS: THIS DRAWING HAS BEEN REVISED TO SHOW MECHANICAL SYSTEMS AS INSTALLED" (Signature of Contractor) (Date).

.2 Submit to Contract Administrator for approval and make corrections as directed.

.3 Perform testing, adjusting, and balancing for HVAC using as-built Drawings.

.4 Submit completed reproducible as-built Drawings with operation and maintenance manuals.

.8 Submit copies of testing, adjusting and balancing report and as-built Drawings for inclusion in final operation and maintenance manual.

1.2 MAINTENANCE

.1 Furnish spare parts in accordance with Section 01 78 00 - Closeout Submittals as follows:

.1 Six filter cartridge or set of filter media for each filter or filter bank in addition to final operating set.

.2 Provide one set of special tools required to service equipment as recommended by manufacturers.

Part 2 Products

2.1 MATERIALS

.1 Not Applicable.

Part 3 Execution

3.1 PAINTING REPAIRS AND RESTORATION

.1 Do painting in accordance with Section 09 91 23 - Painting.

.2 Prime and touch up marred finished paintwork to match original.

.3 Restore to new condition finishes which have been damaged.

3.2 CLEANING

.1 Clean interior and exterior of all systems. Vacuum interior of ductwork, fan, and filter.

3.3 DEMONSTRATION AND TRAINING

.1 Contract Administrator will use equipment and systems for test purposes prior to acceptance. Supply labour, material, and instruments required for testing.

.2 Supply tools, equipment, and personnel to demonstrate and instruct operating and maintenance personnel in operating, controlling, adjusting, trouble-shooting and servicing of all systems and equipment during regular work hours, prior to acceptance.

.3 Use operation and maintenance manual, as-built drawings, and audio visual aids as part of instruction materials.

3.4 PROTECTION

.1 Protect equipment and systems openings from dirt, dust, and other foreign materials with materials appropriate to system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)

.1 ANSI/ASME B1.20.1, Pipe Threads, General Purpose (Inch).

.2 ANSI/ASME B16.22, Wrought Copper and Copper-Alloy Solder Joint Pressure Fittings

.3 ANSI/ASME B16.24 - 2016, Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500

.4 ANSI/ASME B18.2.1, Square and Hex Bolts and Screws (Inch Series).

.5 ANSI/ASME B18.2.2, Square and Hex Nuts (Inch Series).

.6 ANSI/ASME B40.100, Pressure Gauges and Gauge Attachments.

.7 ANSI/ASME B31.5, Refrigeration Piping and Heat Transfer Components.

.8 ANSI/ASME B31.9, Building Service Piping.

.2 American Society for Testing and Materials (ASTM)

.1 ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

.2 ASTM A563, Standard Specification for Carbons and Alloy Steel Nuts.

.3 ASTM B32-08, Standard Specification for Solder Metal.

.4 ASTM B280-18, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

.5 ASTM D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

.6 ASTM D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

.7 ASTM D2564 Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

.8 ASTM D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.

.3 Canadian Standards Association (CSA)

.1 CSA-B137 Series, Thermoplastic pressure piping compendium - Fourth Edition.

.2 CAN/CSA W48-06, Filler Metals and Allied Materials for Metal Arc Welding (Developed in cooperation with the Canadian Welding Bureau).

.3 CSA B52, Mechanical Refrigeration Code

.4 Canadian General Standards Board (CGSB)

.1 CAN/CGSB 14.4-M88, Thermometers, Liquid-in-Glass, Self-Indicating, Commercial/Industrial Type.

.2 CAN/CGSB-41.22, Fibreglass-Reinforced Plastic Corrosion- Resistant Equipment.

.5 Environment Canada (EC)

.1 EPS1/RA/1, Environmental Code of Practice for the Elimination of Fluorocarbon Emissions from Refrigeration and Air Conditioning Systems.

.6 Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS)

.1 MSS SP59, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation

.2 MSS SP69, Pipe Hangers and Supports - Selection and Application.

1.2 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Include:

.1 Product data,

.2 Catalog cut sheets.

1.3 CLOSEOUT SUBMITTALS

.1 Submit maintenance and operation data for thermometers and pressure gauges in accordance with Section 01 78 00 - Closeout Submittals.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store, and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver materials to Site in original factory packaging, labelled with manufacturer's name and address.

Part 2 Products

2.1 PIPE MATERIAL SCHEDULE

.1 Pipe material with reference numbers shall be as follows:

System	Type
Chilled Glycol	1
Refrigerant	2

2.2 PIPING SPECIFICATIONS

.1 Piping shall be as follows:

SERVICE	PRODUCT
Type 1	

	SERVICE	PRODUCT
	above ground inside building all sizes	Schedule 80 PVC Distribution Piping
Type 2		
	all sizes	Type "ACR" degreased copper pipe with long radius smooth bore elbows.

.2 Fire and Smoke Rating (for PVC and ABS piping).

.1 In accordance with CAN/ULC-S102.

.1 Maximum flame spread rating: 25.

.2 Maximum smoke developed rating: 50.

2.3 TYPE 2 – COPPER TUBE AND FITTINGS

.1 Tubing:

.1 Hard copper to ASTM B280, type ACR B (nitrogenized). Processed for refrigeration installations, deoxidized, dehydrated, and sealed.

.2 Fittings:

.1 Service: design pressure 2070 kPa and temperature 121°C.

.2 Brazed wrought copper to ASME B16.22.

.3 Joints: silver solder, 45% Ag - 80% Cu - 5% P and non-corrosive flux for copper to steel or brass; Silfoss-15 for copper to copper.

.3 Flanged:

.1 Bronze or brass, to ASME B16.24, Class 150 and Class 300, tongue and groove type.

.2 Gaskets: suitable for service.

.3 Bolts, nuts, and washers: to ASTM A307, heavy series.

.4 Valves:

.1 7/8 ODS and under: Class 500, 3.5 MPa, globe or angle non-directional type, diaphragm, packless type, with forged brass body and bonnet, moistureproof seal for below freezing applications, brazed connections.

.2 Over 7/8 ODS: Class 375, 3 MPa, globe or angle type, diaphragm, packless type, back-seating, cap seal, with cast bronze body and forged brass bonnet, moisture-proof seal for below freezing applications, brazed connections, non-rotating, self aligning swivel disc, PTFE seat, -40^0C - 163^0C.

.3 Ball valves 7 3/8 ODS to 3 1/8 ODS: maximum WP 4MPa, -40^0C to 149^0C, live loaded stem seal, double "O" ring hermetically sealed body, blowout proof stem, seal cap "O" ring sealed, valve position indicators, forged brass body bonnet, brass cap, triple sealed plated steel item, PTFE ball seals and gasket, extended copper connections, helium leak test to maximum 0.28 g/yr.

.4 Check valves 7/8 ODS to 3 1/8 ODS cast bronze body, brass bonnet, PTFE seat, internal parts removable minimum opening pressure 3.5 kPa, maximum WP 3.5 kPa - 29^{0}C to 149^{0}C, UL and CSA approved.

.5 Check valves 3/8 ODS to 7/8 ODS: brass construction, PTFE seal, removable piston, maximum WP 3.5 kPa, -40^{0}C to 149^{0}C, suitable for high side, low side, and hot gas. UL and CSA approved, maximum opening pressure 3.5 kPa.

2.4 TYPE 1 - PVC DISTRIBUTION PIPING

.1 General:

.1 Piping, fittings, flanges, flange gaskets, primer, cement to be product of one manufacturer.

.2 Equipment manufacturers as listed or approved equal in accordance with B7.

.2 Piping: to CSA-B137 and ASTM D1784.

.1 Schedule 80.

.2 To be smooth and free from imperfections.

.3 Fittings:

.1 Pressure rating: same as for pipes.

.2 NPS 1/2 to 4: solvent welded type.

.3 NPS 6 and over: solvent welded type.

.4 Solvent Welded Fittings: to ASTM D2467, solvent welded type, from PVC, compatible with piping.

.5 Field fabricated fittings: not permitted.

.4 Provisions for Pipe Movement:

.1 Offsets: locations, shapes, dimensions to be as indicated.

.5 Flanged Joints:

.1 Flanges: PVC, Vanstone style, conforming dimensionally to ANSI/ASME B16.1, for 1,355 kPa: slip-on full faced, solvent welded to pipe.

.2 Gaskets: EPDM Gaskets for glycol service, 3 mm thick.

.3 Bolts and nuts: to ASTM A307, Grade B, ANSI B18.2.1, ANSI B18.2.2: stud bolts, carbon steel, semi-finished with heavy hex nuts, complete with washers.

.6 Valves:

.1 Ball valves:

.1 100 mm and under – PVC, PTFE ball seals with EPDM, socket ends, vented freeze protection. Chemline Type 21 or approved equal in accordance with B7.

.2 150 mm - Lug style, PVC butterfly valve and disc, EPDM seat and seals, 403 stainless steel shaft, plastic handle. Chemline Type 57LIS or approved equal in accordance with B7.

.3 200mm - Lug style, PVC butterfly valve and disc, EPDM seat and seals, 403 stainless steel shaft, gear operated actuator. Chemline Type 57LIS or approved equal in accordance with B7.

.4 Up to NPS 2: socket weld ends.

.5 NPS 2 1/2 and over: flanged ends.

.2 Spring (silent) check valves:

.1 50 mm and under - True union, full port, PVC ball check, EPDM seals, socket ends. Chemline BT or approved equal in accordance with B7.

.2 65 mm to 100 mm - Single union, full port, PVC ball check, EPDM seals, socket ends. Maximum working pressure 690 kPa at 50°C. Chemline BC or approved equal in accordance with B7.

.3 150 mm to 200 mm - Wafer style, PVC body, spacer and disc, 316 stainless steel, EPDM seals. Maximum working pressure 760 kPa for 150 mm and 600 kPa for 200 mm at 40°C. Chemline WP or approved equal in accordance with B7.

.4 Up to NPS 2: socket weld ends.

.5 NPS 2 1/2 and over: flanged ends.

.7 Strainers: PVC, Y-type, having full port full flow openings with hex cap and fluoroelastomer 0-ring cap seal.

.1 Screens: Type 316 stainless steel with 40 mesh stainless steel wire cloth.

.2 Pressure rating: 1035 kPa.

.3 For PVC piping systems under NPS 4, use Chemline Y-Strainer or approved equal in accordance with B7.

2.5 PIPE HANGERS

.1 Finishes:

.1 Pipe hangers and supports: galvanized after manufacture.

.2 Use hot dipped galvanizing process.

.2 Upper attachment structural: suspension from lower flange of I-Beam:

.1 NPS 2 1/2 or greater: malleable iron beam clamp, eye rod, jaws and extension with carbon steel retaining clip, tie rod, nuts, and washers, UL listed to MSS-SP58.

.3 Upper attachment structural: suspension from upper flange of I-Beam:

.1 NPS 2 1/2 or greater: malleable iron top-of-beam jaw-clamp with hooked rod, spring washer, plain washer, and nut UL listed.

.4 Upper attachment to concrete:

.1 Ceiling: carbon steel welded eye rod, clevis plate, clevis pin, and cotters with weldless forged steel eye nut. Ensure eye 6 mm minimum greater than rod diameter.

.2 Concrete: carbon steel pre-cut anchor rods for chemical anchoring with epoxy-based adhesive.

.5 Hanger rods: threaded rod material to MSS SP58:

.1 Ensure that hanger rods are subject to tensile loading only.

.2 Provide linkages where lateral or axial movement of pipework is anticipated.

.6 Pipe attachments: material to MSS SP58:

.1 Oversize pipe hangers and supports.

.7 Adjustable clevis: material to MSS SP58 UL listed, clevis bolt with nipple spacer and vertical adjustment nuts above and below clevis.

.1 Ensure "U" has hole in bottom for rivetting to insulation shields.

.8 Yoke style pipe roll: carbon steel yoke, rod, and nuts with cast iron roll, to MSS SP58.

.9 U-bolts: carbon steel to MSS SP58 with 2 nuts at each end to ASTM A563.

2.6 HANGERS AND SUPPORTS

.1 General: all supports to have large load bearing surfaces and be as approved by pipe manufacturer.

.2 Supports: adjustable clevis hangers sized to suit the O.D. of the pipe.

.3 Pipe hangers and trapeze hangers: supported by mild steel rod of the correct diameter to suit the hanger, as recommended by the steel manufacturer.

.4 Maximum load of any hanger rod:

Rod Diameter	Maximum Safe Load
6 mm	136 kg
9 mm	277 kg
13 mm	512 kg
16 mm	821 kg
19 mm	1229 kg

2.7 RISER CLAMPS

.1 PVC pipe: galvanized carbon steel to MSS SP58, type 42, UL listed.

.2 Bolts: to ASTM A307.

.3 Nuts: to ASTM A563.

2.8 THERMOMETERS

.1 Industrial, variable angle type, liquid filled length: to CAN/CGSB14.4.

.1 Up to 1500 mm above finished floor: 75 mm diameter dials.

.2 Above 1500 mm: 125 mm diameter dials.

2.9 THERMAL WELLS

.1 316 stainless steel inserted using PVC saddles.

2.10 PRESSURE GAUGES

.1 112 mm, dial type: to ASME B40.100, Grade 1A, stainless steel bourdon tube having 0.5% accuracy full scale unless otherwise specified.

.2 Provide:

.1 Snubber for pulsating operation.

.2 Diaphragm assembly for corrosive service.

.3 Gasketted pressure relief back with solid front.

.4 Bronze stop cock.

.5 Oil filled for high vibration applications.

2.11 RELIEF VALVE

.1 Sized to accommodate thermal expansion requirements. Manufactured by Watts or approved equal in accordance with B7.

2.12 PIPE SEAL SYSTEM

.1 Modular sealing-element unit, designed for field assembly and filling annular space between pipe and sleeve or pipe and core.

.1 Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

.2 Pressure Plates: Reinforced nylon polymer.

.3 Connection Bolts and Nuts: Steel with two part zinc dichromate and corrosion inhibiting coating.

.2 Standard of Acceptance: Link Seal or approved equal in accordance with B7.

Part 3 Execution

3.1 GENERAL

.1 Provide sufficient hangers, supports, anchors, guides, vibration dampeners, flexible connectors, restraints, and sway braces that will cope with the loads, moments, and stresses developed in the piping system and prevent these loads and moments from being transferred to the equipment to which the piping is connected.

.2 Connect all piping systems to equipment without springing the pipes or transferring any loads or moments to the equipment.

.3 The use of tees in bullhead configuration is unacceptable.

3.2 INSTALLATION OF PVC PIPING SYSTEMS

.1 As indicated and in accordance with of PVC manufacturer's recommendations.

.2 Joints:

.1 Solvent weld throughout except at flanges and unions.

.2 Threaded joints not permitted.

.3 Make joints in accordance with ASTM D2855 and to manufacturer's recommendations, using both primer and solvent welding cement.

.4 Make connections to other materials or fittings using appropriate adapters and to manufacturer's recommendations.

.3 Maintain minimum 300 mm distance between PVC pipes and nearest heated pipe.

3.3 INSTALLATION OF REFRIGERATION PIPING

.1 Brazing Procedures

.1 Bleed an inert gas into the pipe during brazing operations.

.2 Remove all valve internal components, solenoid valve coils, and sight glasses.

.3 Do not apply heat near any expansion valves and bulbs.

.2 Piping Installation

.1 Hot gas lines:

.1 Pitch at least 1:240 down in direction of flow.

.2 Provide a trap at the base of risers greater than 1800 mm high and at each 6000 mm thereafter.

.3 Provide an inverted deep trap at the top of the risers.

.4 Provide double risers for compressors having capacity modulation.

.1 Large riser: install traps as specified.

.2 Small riser: size for 5.1 m/s at minimum load. Connect upstream of traps on large riser.

.3 Pressure and Leak Testing

.1 Close valves on factory charged equipment and other equipment not designed for test pressures.

.2 Leak test to CSA B52 before evacuation to 2MPa and 1MPa on high and low sides respectively.

.3 Test Procedure: Build pressure up to 35 kPa using nitrogen and leave for 8 hours.

.4 Field Quality Control

.1 Close the service valves on the factory charged equipment for the site test and inspection.

.2 Ambient temperatures shall be at least 13 degrees Celsius for at least 12 hours before and during dehydration.

.3 Use copper lines for largest practical size to reduce evacuation time.

.4 Use a vacuum pump capable of pulling 5 Pa absolute.

.5 Measure the system pressure with a vacuum gauge. Take the readings with the valve between the vacuum pump and system closed.

.6 Triple evacuate system components containing gases other than the correct refrigerant or that lost the holding charge as follows:

.1 Twice to 14 Pa absolute and hold for four hours.

.2 Break vacuum with refrigerant to 14 kPa.

.3 Final to 5 Pa absolute and hold for at least 12 hours.

.4 Isolate pump from system, record the vacuum and time readings until stabilization of the vacuum.

.5 Submit the test results to the Contract Administrator.

.7 Charging:

.1 Charge the system through the filter-drier and charging valve on the high side. Charging through the low side shall not be permitted.

.2 With the compressors off, charge only the amount necessary for proper operation of system. If system pressures equalize before system in fully charged, close charging valve and start up. With the unit operating, add the remainder of the charge to the system.

.3 Re-purge the charging line if the refrigerant container is changed during the charging process.

.8 Checks:

.1 Conduct checks and measurements as per manufacturer's operation and maintenance instructions.

.2 Record and report the measurements to the Contract Administrator.

3.4 CHANGES IN PIPE SIZES

.1 Install eccentric reducers at pipe size changes to ensure positive drainage or positive venting as appropriate.

3.5 HANGERS AND SUPPORTS

.1 Support vertical piping and risers in accordance with manufacturer's recommendations.

.2 Support valves independently of adjacent piping.

.3 Concentrated loads: support directly or support pipe adjacent to load.

.4 Changes in direction: support as close to fitting as possible.

.5 Pipe movement: as indicated.

.6 Valves: support so as to resist operating torque.

.7 Hanger spacing:

.1 Cast Iron:

Pipe Size	Rod Diameter	Max. Spacing
NPS 1-1/4 & under	10 mm	2450 mm
NPS 1-1/2 to NPS 2	10 mm	3000 mm
NPS 2-1/2 to NPS 3-1/2	12 mm	3650 mm
NPS 4	16 mm	3650 mm
NPS 6"	19 mm	3650 mm

.2 Copper:

Pipe Size	Rod Diameter	Max. Spacing
NPS 1 & under	10 mm	1825 mm
NPS 1-1/4 to NPS 1-1/2	10 mm	2450 mm
NPS 2 and NPS 2-1/2	12 mm	2750 mm

.3 PVC:

Pipe Size	Rod Diameter	Max. Spacing
NPS 1 1/2 & under	10 mm	1500 mm
NPS 2 to NPS 3	12 mm	2200 mm
NPS 4	12 mm	2500 mm
NPS 6	19 mm	3200 mm
NPS 8	19 mm	3700 mm

.8 Alignment of piping at expansion loops and offsets: align to avoid damage by movement of piping against fixed structures.

.9 Install hangers within 300 mm of each horizontal elbow.

.10 Where floor or roof structural system consists of joists, support piping by means of angles spanning the top chords of adjacent joists. Determine number of spanned joists by the incident load of piping.

.11 Hanging of piping directly from roof decking is not allowed, unless special permission is obtained from the Contract Administrator.

.12 Support groups of horizontal pipes by trapeze hangers constructed of angle iron with steel rods, conforming to the above concerning isolation of copper piping, pipe covering protection saddles, and roller supports. Provide pipe covering protection saddles insulated pipe at trapeze supports.

.13 Support several individual hanger rods from a trapeze hanger, as required.

.14 Hanger rods: sufficient threaded length to allow for vertical adjustment of hangers after pipe is in place. Use two nuts on each rod, one above the clevis or angle iron and one below.

.15 Where pipe or equipment is supported from floors or walls, fabricate structural steel supports using unistrut except where provision is required for adjustment. Where details of construction are not indicated, submit drawings to the Contract Administrator for approval before fabrication.

.16 Provide vertical piping other than risers through floors with suitable supports and sway braces. Locate clamps immediately below a coupling. Brace risers up to 50 mm size at intervals not over 2100 mm.

3.6 VALVE INSTALLATION

.1 Install in accordance with manufacturer's recommendations.

.2 Install shut-off valves with unions, couplings or flanges on supply and return piping connections to each piece of equipment to facilitate repair or shutdown.

.3 Fit low points of all liquid filled systems with drain valves to facilitate complete drainage of systems. Install with 19 mm (3/4") hose end connections or piped to hub drains.

.4 Install shut-off valves on both sides of all pumps, size of adjacent piping and not pump connection size.

.5 Install valves with stems in the horizontal or upright position.

3.7 PIPELINE STRAINERS

.1 Install suction diffuser with strainer on the inlet side of all pumps.

.2 Install strainers in horizontal piping with basket under pipe or in vertical piping in the down leg only.

.3 Provide valved sediment blowoff for basket on strainers 38 mm (1 1/2") and larger.

.4 Install in locations to allow access for removal of screen.

3.8 CHECK VALVES

.1 Install check valves on the discharge of all pumps not having integral discharge check valves.

3.9 THERMOMETERS

.1 Install thermometers in wells on piping. Provide heat conductive material inside well.

.1 Install in locations as indicated.

.2 Install wells as indicated only for balancing purposes.

3.10 PRESSURE GAUGES

.1 The pressure gauge selected should have a full scale pressure such that the operating pressure occurs in the middle half.

.2 Install pressure gauges in following locations:

.1 Install in locations as indicated.

.3 Install gauge cocks for balancing purposes, and elsewhere as indicated.

3.11 PIPE SEAL SYSTEM

.1 The below grade exterior concrete wall is to be cored to accommodate the specified pipe and seal.

.2 Install pipe seal systems in exterior concrete walls at piping entries into the building.

.3 Select type, size, and number of sealing elements required for pipe size and hole size.

.4 Centre piping in the wall penetration, ensure the piping is adequately supported on both sides of the penetration. The seal shall not support the weight of the pipe assembly.

.5 Loosen rear pressure plate to allow the installation of the seal assembly.

.6 Ensure the bolt heads are facing the installer and slide the seal assembly into the annular space at the bottom position and work both sides up towards the top position of the annular space. Use a liquid detergent to assist the installation in the annual space if the fit is tight. Use of grease is prohibited.

.7 Tighten and torque the bolts in accordance with the manufacturer's instructions.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and requirements for the identification of equipment, piping, valves, pipe components, duct work, actuators, and controllers, including the installation and location of identification systems.

1.2 REFERENCES

.1 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-1.60-97, Interior Alkyd Gloss Enamel.

.2 CAN/CGSB 24.3, Identification of Piping Systems.

.2 The City of Winnipeg, Water and Waste Department

.1 Identification Standard

1.3 SUBMITTALS

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

.2 Submit product data for paint colour samples and other products specified in this section.

.3 Submit samples of nameplates, labels and tags prior to fabrication of these items.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling, and unloading:

.1 Deliver, store, and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 MANUFACTURER'S EQUIPMENT NAMEPLATES

.1 Metal or plastic laminate nameplate mechanically fastened to each piece of equipment by manufacturer.

.2 Lettering and numbers raised or recessed.

.3 Information to include, as appropriate:

.1 Equipment: manufacturer's name, model, size, serial number, and capacity.

.2 Motor: voltage, Hz, phase, power factor, duty, and frame size.

2.2 SYSTEM NAMEPLATES

.1 Colours:

.1 Hazardous: red letters, white background.

.2 Elsewhere: black letters, white background (except where required otherwise by applicable codes).

.3 Naming convention: as indicated on the Drawings and the City of Winnipeg, Water and Waste Identification Standard.

.2 Construction:

.1 3 mm thick laminated plastic, matte finish, with square corners, letters accurately aligned and machine engraved into core.

.3 Sizes:

.1 Conform to following table:

Size # mm	Sizes (mm)	No. of Lines	Height of Letters (mm)
1	10 x 50	1	3
2	13 x 75	1	5
3	13 x 75	2	3
4	20 x 100	1	8
5	20 x 100	2	5
6	20 x 200	1	8
7	25 x 125	1	12
8	25 x 125	2	8
9	35 x 200	1	20
10	35 diameter	1	5

.2 Use maximum of 25 letters/numbers per line.

.4 Nameplate by Location:

.1 Glycol feed system, expansion tank, air separators, pumps, fan coils: use size #7 or #8.

.2 Supply air fans, cooling coils, heating coils, chiller, condenser: use size #9.

.3 All valves, pipeline devices: use size #10.

.4 All control devices: use size #2 or 3.

.5 All other items confirm with Contract Administrator.

2.3 IDENTIFICATION OF PIPING SYSTEMS

.1 General

.1 The labels to identify the contents of the piping system are to include a background colour, commodity identification legend, and direction of flow by arrows.

.2 Labels installed are to be in accordance with CAN/CGSB 24.3.

.3 Commodity identification legend shall be block text all in capitals in sizes and colours listed herein.

.4 Arrows indicating the direction of flow shall be in sizes listed in Part 2.3.4 and colours listed in Part 2.3.3. Use double headed arrows where flow is reversible. The background colour marking shall be the full circumference of the pipe or insulation. The background colour marking shall be of length and colour identified herein.

.2 Materials for piping identification

.1 All sizes 20 mm and smaller: Waterproof and heat resistant pressure sensitive plastic marker tags.

.2 All other sizes: Pressure sensitive plastic-coated cloth or vinyl with protective over-coating, waterproof contact adhesive undercoating, suitable for ambient of 100 percent relative humidity and continuous operating temperature of 150 degrees Celsius and intermittent temperature of 200 degrees Celsius.

.3 Colours and Legends:

.1 Where a commodity is not listed obtain directions from the Contract Administrator.

.2 Colours for commodity identification legend, arrows, and background colours to the following table.

Commodity	Background Colour	Legend/Arrow Colour	Legend
Chilled Glycol Supply	Match existing pipe colouring	Match existing legend/arrow colouring	CH. GLYCOL SUPPLY
Chilled Glycol Return	Match existing pipe colouring	Match existing legend/arrow colouring	CH. GLYCOL RETURN
Refrigerant Suction	Yellow	Black	REF. SUCTION
Refrigerant Liquid	Yellow	Black	REF. LIQUID
Refrigerant Hot Gas	Yellow	Black	REF HOT GAS
Refrigerant Safety Vent	Yellow	Black	REF VENT
Storm Water	Green	White	STORM
Sanitary	Green	White	SAN

.4 Sizes:

.1 Pipe marker size to the following table.

Outside Diameter of Pipe or Covering	Minimum Letter and Number Height	Minimum Length of Colour Field
19 mm to 32 mm	13 mm	200 mm
38 mm to 51 mm	19 mm	200 mm
64 mm to 150 mm	32 mm	300 mm
200 mm to 250 mm	64 mm	600 mm
Over 250 mm	89 mm	800 mm

2.4 LANGUAGE

.1 Identification in English.

Part 3 Execution

3.1 TIMING

.1 Provide identification only after painting, as specified Section 09 91 23 – Painting, has been completed.

3.2 NAMEPLATES

.1 Locations:

.1 In conspicuous location to facilitate easy reading and identification from operating floor.

.2 Standoffs:

.1 Provide for nameplates on hot and/or insulated surfaces.

.3 Protection:

.1 Do not paint, insulate, or cover.

3.3 LOCATION OF IDENTIFICTION ON PIPING SYSTEMS

.1 Pipe markers shall be positioned so that they can be easily seen from the normal angle of approach, such as the below the centreline of the pipe if the pipe is overhead and above the centreline if the pipe is below eye level.

.2 Pipe markers shall be located

.1 On straight pipe runs at six metre intervals
.2 Close to all valves
.3 Where pipes pass through walls or floors
.4 Branches
.5 Fittings or junction boxes
.6 Adjacent to changes in direction
.7 At the beginning and end points of each run and at each piece of equipment

3.4 LOCATION OF IDENTIFICATION ON DUCTWORK SYSTEMS

.1 On both sides of visual obstruction or where run is difficult to follow.

.2 At point immediately upstream of major manually operated or automatically controlled dampers. Where this is not possible, place identification as close as possible, preferably on upstream side.

.3 Identification easily and accurately readable from usual operating areas and from access points.

.1 Position of identification approximately at right angles to most convenient line of sight, considering operating positions, lighting conditions, risk of physical damage or injury, and reduced visibility over time due to dust and dirt.

3.5 CONTROLLERS

.1 Controllers: Secure tags with non-ferrous chains, cable ties, or closed "S" hooks.

.2 Install one copy of flow diagrams and equipment schedule (reduced in size if required) in each operating and maintenance manual.

3.6 CLEANING

.1 Proceed in accordance with Section 01 74 11 - Cleaning.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Testing, Adjusting, and Balancing (TAB) is used throughout this section to describe the process, methods, and requirements of testing, adjusting, and balancing for HVAC.

.2 TAB will be conducted in accordance with requirements of Contract documents and as specified in this section.

.3 TAB Standard means the testing and balancing standard under which the TAB personnel's qualifications are approved and include one of the following:

.1 Associated Air Balance Council, (AABC) National Standards for Total System Balance, MN-1-2002; or

.2 Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), HVAC TAB HVAC Systems - Testing, Adjusting and Balancing-2002.

1.2 SUBMITTALS

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

.2 Submit, prior to commencement of TAB, the qualifications of the TAB personnel as detailed in Item 1.3.

.3 Submit, in advance of the start of construction, confirmation in writing of the adequacy of provisions for TAB and other aspects of design and installation pertinent to the success of TAB as detailed in Item 1.8.

.4 Submit, prior to commencement of TAB, the proposed method for completing TAB.

.5 Submit the preliminary TAB Report as detailed in Item 1.15.

.6 Submit the TAB Report as detailed in Item 1.16.

1.3 QUALIFICATIONS OF TAB PERSONNEL

.1 Submit names of personnel to perform TAB and documentation confirming their qualifications under a TAB Standard to the Contract Administrator a minimum of two months prior to conducting TAB.

1.4 GENERAL REQUIREMENTS OF TAB

.1 TAB shall be performed in accordance with the requirements of the TAB Standard.

.2 The recommendations and suggested practices contained in the TAB Standard are mandatory.

.3 Use TAB Standard provisions, including checklists and report forms to satisfy the Contract requirements.

.4 Use TAB Standard for TAB, including qualifications for TAB personnel and calibration of TAB instruments.

.5 Where instrument manufacturer calibration recommendations are more stringent than those listed in TAB Standard, use manufacturer's recommendations.

.6 TAB Standard quality assurance provisions such as performance guarantees form part of this Contract.

.1 For systems or system components not covered in the TAB Standard, use TAB procedures developed by qualified TAB personnel.

.2 Where new procedures and requirements applicable to the Contract requirements have been published or adopted by the body responsible for the TAB Standard used (Associated Air Balance Council, National Environmental Balancing Bureau, or Testing, Adjusting and Balancing Bureau), requirements and recommendations contained in these procedures and requirements are mandatory.

1.5 PURPOSE OF TAB

.1 Verify proper and safe operation, determine actual point of performance, and evaluate qualitative and quantitative performance of equipment, systems and controls at design, average, and low loads using actual or simulated loads.

.2 Adjust and regulate equipment and systems to meet specified performance requirements and to achieve specified interaction with other related systems under normal and emergency loads and operating conditions.

.3 Balance systems and equipment to regulate flow rates to match load requirements over full operating ranges.

1.6 EXCEPTIONS

.1 TAB of systems and equipment regulated by codes, standards must be completed to the satisfaction of authority having jurisdiction.

1.7 CO-ORDINATION

.1 Schedule time required for TAB (including repairs, re-testing) into project construction and completion schedule to ensure completion before acceptance of project.

.2 Do TAB of each system independently and subsequently, where interlocked with other systems, in unison with those systems.

1.8 PRE-TAB REVIEW

.1 Review the Contract before construction is started and confirm in writing to the Contract Administrator the adequacy of provisions for TAB and other aspects of design and installation pertinent to the success of TAB.

.2 Review the specified standards and report to the Contract Administrator in writing any proposed procedures which vary from standard.

.3 During construction, co-ordinate the location and installation of TAB devices, equipment, accessories, measurement ports, and fittings.

1.9 START-UP

.1 Follow start-up procedures as recommended by the equipment manufacturer unless specified otherwise.

1.10 OPERATION OF SYSTEMS DURING TAB

.1 Operate systems for the length of time required for TAB and as required by the Contract Administrator for verification of TAB reports.

1.11 START OF TAB

.1 Notify the Contract Administrator 3 Calendar Days prior to start of TAB.

.2 Start TAB when the building is essentially completed, including:

.1 Installation of doors and other construction affecting TAB,

.2 Application of weather-stripping, sealing, and caulking.

.3 Provisions for TAB installed and operational.

.3 Prior to start-up, verification of normal and safe operation of mechanical, associated electrical, and control systems affecting TAB is required. The following is also required including but not limited to:

.1 Proper thermal overload protection in place for electrical equipment.

.2 Air systems:

.1 Filters in place, clean.

.2 Duct systems clean.

.3 Ducts are airtight to within specified tolerances.

.4 Correct fan rotation.

.5 Volume control dampers installed and open.

.6 Coil fins combed, clean.

.7 Access doors, installed, closed.

.8 Outlets installed, volume control dampers open.

.3 Liquid systems:

.1 Flushed, filled, vented.

.2 Correct pump rotation.

.3 Strainers in place, baskets clean.

.4 Isolating and balancing valves installed, open.

.5 Calibrated balancing valves installed, at factory settings.

.6 Chemical treatment systems complete, operational

1.12 APPLICATION TOLERANCES

.1 Do TAB to following tolerances of design values:

.1 HVAC systems: plus or minus 5%.

.2 Hydronic systems: plus or minus 10 %.

1.13 ACCURACY TOLERANCES

.1 Measured values accurate to within plus or minus 2 % of actual values.

1.14 INSTRUMENTS

.1 Calibrate instruments in accordance with requirements of the most stringent of referenced standard for either applicable system or HVAC system.

.2 Calibrate instruments within 3 months of TAB. Provide certificate of calibration to the Contract Administrator.

1.15 PRELIMINARY TAB REPORT

.1 Submit for review and approval of the Contract Administrator, prior to submission of formal TAB report, a sample of proposed TAB sheets. Include:

.1 Details of instruments used.

.2 Details of TAB procedures employed.

.3 Calculations procedures.

.4 Summaries.

1.16 TAB REPORT

.1 Format in accordance with referenced TAB Standard.

.2 TAB report to show results in SI units and to include:

.1 Project record drawings.

.2 System schematics.

.3 Submit 3 copies of TAB Report to the Contract Administrator for verification and approval, in English in D-ring binders, complete with index tabs.

1.17 VERIFICATION

.1 Reported results contained in the TAB Report are subject to verification by the Contract Administrator.

.2 Provide personnel and instrumentation to verify up to 30% of reported results contained in the TAB Report.

.3 The number and location of verified results are as directed by the Contract Administrator.

.4 Results that are not to the satisfaction of the Contractor Administrator will be required to be repeated. The Contractor to pay costs to repeat TAB as required to satisfaction of Contract Administrator.

1.18 SETTINGS

.1 After TAB is completed to the satisfaction of Contract Administrator, replace drive guards, close access doors, lock devices in set positions, and ensure sensors are at required settings.

.2 Permanently mark settings to allow restoration at any time during the life of facility. Do not eradicate or cover markings.

1.19 COMPLETION OF TAB

.1 TAB is considered complete when the final TAB Report detailed in Item 1.16 is received and approved by the Contract Administrator.

1.20 AIR SYSTEMS

.1 Standard: TAB to most stringent of TAB Standard.

.2 Complete TAB of the following systems, equipment, components, controls:

.1 Fans.

.2 Dampers.

.3 Qualifications: personnel performing TAB current member in good standing of AABC.

.4 Quality assurance: perform TAB under direction of a supervisor qualified to standards of AABC.

.5 Measurements: to include, as appropriate, for systems, equipment, components, and controls: air velocity, static pressure, flow rate, pressure drop (or loss), temperatures (dry bulb, wet bulb, dewpoint), duct cross-sectional area, RPM, electrical power, voltage, noise, and vibration.

.6 Locations of equipment measurements: to include as appropriate:

.1 Inlet and outlet of dampers, filter, coil, fan, and other equipment causing changes in conditions.

.7 Locations of systems measurements to include as appropriate: main ducts, main branch, sub-branch, and run-out (or grille, register or diffuser).

1.21 PROJECT CONDITIONS

.1 City Occupancy: The facilities are intended to operate continuously and the City will operate the site and existing building during the entire TAB period. Cooperate with City during TAB operations to minimize conflicts with City operations.

Part 2 Products

2.1 NOT USED

.1 Not used.

Part 3 Execution

3.1 GENERAL PROCEDURES FOR TESTING AND BALANCING

.1 Coordinate the location requirements for test probes to prevent the cutting of insulation, ducts and pipes.

.2 Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices with permanent identification material to show final settings.

.3 Take and report testing and balancing measurements in SI units.

3.2 HYDRONIC SYSTEMS

.1 Prepare test reports for all pumps, coils and chiller associated with the final upgraded HVAC system. Obtain relevant documentation to determine TAB procedures or requirements for the installed system. The City will endeavor to supply Shop Drawings and equipment data for existing equipment, however if no information is available, the Contractor shall contact the manufacturers to obtain said information.

.2 Crosscheck the summation of required coil and chiller flow rates with pump design flow rate.

.3 Verify that hydronic systems are ready for testing and balancing:

.1 Check air pressure in expansion tank.

.2 Check that glycol makeup system has adequate pressure pump to the highest vent in the system.

.3 Check that control valves are in their proper position.

.4 Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

.5 Verify that motor starters are equipped with properly sized thermal protection.

.6 Check that air has been purged from the system.

.4 Chilled Glycol Loop

.1 Adjustment of the hydronic pumps to deliver total design flow rate

.1 Position valves for full flow through the coils and heat exchangers.

.2 Determine the flow of the pump through the installed triple duty valve.

.2 Measurement of the pump's total dynamic head

.1 Measure the discharge pressure of the pump directly at the pump outlet flange or in the discharge pipe prior to any valves.

.2 Measure the inlet pressure of the pump directly at the pump inlet flange or in the suction pipe prior to any valves or strainers.

.3 Convert the pressure to pump head and correct for any differences in gauge heights.

.4 Verify the pump impeller size by measuring the total dynamic head with the discharge valve closed. Note the point on the manufacturer's pump curve at zero flow and verify that the pump has the specified impeller size.

.5 With all the valves open, read the pump's total dynamic head. Adjust the triple duty valve on the pump discharge until design water flow is achieved.

.3 Monitor motor performance during procedures and do not operate motor in an overload condition.

.4 Adjustment of flow measuring devices installed in mains and branches

.1 Measure flow in main and branch pipes.

.2 Adjust main and branch balancing valves for design flows.

.3 Re-measure each main and branch after all balancing valves have been adjusted.

.5 Adjustment of flow measuring devices installed at devices to design water flows

.1 Measure flow at all devices.

.2 Adjust each device to the design flow.

.3 Re-measure each device after all the devices have been adjusted.

.4 Perform temperature tests after all flows have been balanced.

.6 Verify final system conditions as follows:

.1 Re-measure and confirm that the total glycol flow is within design tolerances.

.2 Re-measure all the final operating data, total dynamic head, electric parameters and static profile of the pumps.

.3 Mark all final settings.

.4 Verify that all memory stops have been set.

.5 Motors

.1 Motors, 373 W and Larger: Test the motors at the final balanced conditions and record the following data:

.1 Manufacturer's name, model number, and serial number.

.2 Motor horsepower or watts rating.

.3 Motor rpm.

.4 Phase/Hertz

.5 The nameplate and measured voltage at each phase

.6 The nameplate and measured amperage at each phase

.7 Starter size and thermal-protection-element rating

.8 Service factor and frame size

.2 For motors driven by a variable frequency drive, test the manual bypass of the controller to prove proper operation.

.6 Chiller and Condenser

.1 Balance water flow through the evaporators to within specified tolerances with the pump operating per design sequence. Record the following data with the chiller operating at design conditions:

.1 Evaporator-glycol entering and leaving temperatures, pressure drop, and flow rate.

.2 Power factor on the chiller display panel.

.3 Kilowatt input on the chiller display panel.

.4 Capacity: Calculate in tons of cooling.

.5 Verify condenser fan rotation and record fan and motor data including number of fans and entering and leaving air temperatures

.7 Heat Transfer Coils

.1 Measure, adjust, and record the following data for each glycol cooling coil:

.1 Entering and leaving glycol temperature

.2 Glycol flow rate

.3 Glycol pressure drop for main cooling coil

.4 Dry-bulb temperature of entering and leaving air

.5 Wet-bulb temperature of entering and leaving air

.6 Airflow

.2 Measure, adjust, and record the following data for each electric heating coil:

.1 Nameplate data

.2 Airflow

.3 Entering- and leaving-air temperature at full load

.4 Voltage and amperage input of each phase at full load

.5 Calculated kilowatt at full load

.6 Fuse or circuit-breaker rating for overload protection

.7 Operation of air flow proving switch

3.3 AIR SYSTEMS

.1 Prepare test reports for both fans and outlets associated with the final upgraded HVAC system. Obtain relevant documentation to determine TAB procedures or requirements for the installed system. The City will endeavor to supply Shop Drawings and equipment data for existing equipment, however if no information is available, the Contractor shall contact the manufacturers to obtain said information.

.2 Crosscheck the summation of required outlet volumes with required fan volumes.

.3 Prepare single-line schematic diagram of systems for the purpose of identifying HVAC components.

.4 Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

.5 Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

.6 Verify that motor starters are equipped with properly sized thermal protection.

.7 Check condensate drains for proper connections and functioning.

.8 Check for proper sealing of air-handling-unit components.

.9 Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

.1 Measure total airflow.

.1 Set outside air, return air and relief air dampers for proper position that simulates minimum outdoor air conditions.

.2 Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.

.3 Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

.4 If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

.2 Measure fan static pressures as follows:

.1 Measure static pressure directly at the fan outlet or through the flexible connection.

.2 Measure static pressure directly at the fan inlet or through the flexible connection.

.3 Measure static pressure across each component that makes up the air-handling system.

.4 Report any artificial loading of filters at the time static pressures are measured.

.3 Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

.10 Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

.1 Measure airflow of submain and branch ducts.

.2 Adjust sub-main and branch duct volume dampers for specified airflow.

.3 Re-measure each sub-main and branch duct after all have been adjusted.

.11 Verify final system conditions.

.1 Re-measure and confirm minimum outdoor air, return and relief airflows are within design. Readjust to design if necessary.

.2 Re-measure and confirm total airflow is within design.

.3 Re-measure all final fan operating data, rpms, volts, amps, static profile.

.4 Mark all final settings.

.5 Test system in economizer mode. Verify proper operation and adjust, if necessary.

.6 Measure and record all operating data.

.7 Record final fan-performance data.

3.4 EXISTING SYSTEMS

.1 Perform a preconstruction inspection of existing equipment that is to remain and be reused.

.1 Obtain manufacturer's Shop Drawings and equipment data where not available from the City.

.2 Measure and record the operating speed, airflow, and static pressure of each fan

.3 Measure motor voltage and amperage. Compare the values to motor nameplate information

.4 Check the condition of filters

.5 Check the condition of coils

.6 Report on the operating condition of the equipment and the results of the measurements taken include any deficiencies to the Contract Administrator.

.2 Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

.1 New filters are installed

.2 Coils are cleaned and the fins are combed

.3 Condensate drain pans are clean

.4 Fans are clean

.5 Deficiencies noted in the preconstruction report are corrected.

.3 Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

.1 Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed.

.2 Verify that the indicated airflows of the renovated work result in fan speeds that are within the acceptable limits defined by equipment manufacturer.

.3 Adjust fan speeds within the limits of the installed sheaves and belts to achieve design airflow.

.4 Balance system to design airflows indicated.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Reference Standards:

.1 American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)

.1 ANSI/ASHRAE/IESNA 90.1-13, SI; Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 ASTM International Inc.

.1 ASTM B209M-14, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).

.2 ASTM C449/C449M-07(2013), Standard Specification for Mineral Fiber-Hydraulic-Setting Thermal Insulating and Finishing Cement.

.3 ASTM C553-13, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

.4 ASTM C612-14, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

.5 ASTM C921-10(2015), Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

.3 Canadian General Standards Board (CGSB)

.1 CGSB 51-GP-52Ma, Vapour Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation.

.4 Underwriters Laboratories of Canada (ULC)

.1 CAN/ULC-S102-10, Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.

.2 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.

1.2 SUBMITTALS

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

.2 Product Data:

.1 Provide manufacturer's printed product literature and datasheets for duct insulation and include product characteristics, performance criteria, physical size, finish, and limitations.

.3 Manufacturers' Instructions:

.1 Provide manufacture's written duct insulation jointing recommendations and special handling criteria, installation sequence, and cleaning procedures.

1.3 QUALITY ASSURANCE

.1 Qualifications:

.1 Installer: must be a specialist in performing work of this section, have at least 3 years successful experience in this size and type of project, and be a member of Thermal Insulation Association of Canada (TIAC).

.2 Submit the qualifications of the installer upon request by Contract Administrator.

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver, store, and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver materials to Site in original factory packaging, labelled with manufacturer's name, address, and ULC markings.

Part 2 Products

2.1 INSULATION

.1 Chilled glycol, condensate drains and rain water drainage piping shall be insulated with mineral fiber standard pipe insulation with an all service lap jacket. Insulation shall be 25 mm (1") thickness for pipe sizes up to 100 mm (4") pipe size and 35 mm (1-1/2") thickness for pipe sizes 100 mm (4") and larger.

.2 Refrigerant piping shall be insulated with 12 mm (1/2") thick flexible closed-cell elastomeric insulation preformed to match pipe O.D.

2.2 JACKETS

.1 Exposed mineral fiber pipe insulation shall be finished with a polyvinyl chloride (PVC) jacket, one piece moulded type c/w preformed shapes as required. Use solvent weld adhesive compatible with insulation to seal pipes and joints.

.2 Outdoor pipe insulation requiring metal jacket shall be enclosed in a sheet aluminium jacket secured with 12 mm (1/2”) stainless steel bands.

.3 Elastomeric insulation shall be sealed at all joints with the insulation manufacturer's adhesive and finished with two coats of finishing coat. Insulation installed exposed outdoors must be protected against ultraviolet radiation as recommended by insulation manufacturer.

2.3 VAPOUR BARRIER ADHESIVE

.1 Vapour barrier adhesive shall be Benjamin Foster 30 36, Bakelite 120 09 or approved equal in accordance with B7.

Part 3 Execution

3.1 APPLICATION

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

.2 Ensure surfaces are clean, dry, and free from foreign material.

.3 Apply so that the finished application has the full specified thickness or insulation.

.4 Any paste used for the finish applications shall be of a non-mildewing type.

.5 Pipe insulation shall be carried continuously through walls and floors.

.6 Rigid and board style insulation shall be impaled on No. 9 insulation pins at 300 mm (12”) on centre and secured with 50 mm (2”) diameter speed washers. Insulation shall be layered with joints and cut ends staggered and painted with insulation cement.

.7 Insulation specified for piping shall be applied to the entire system including flanges, valves, elbows, and all other appurtenances.

.8 Insulate fittings and elbows with formed rigid insulation sections. Flexible insulation is not acceptable.

3.2 JACKETING

.1 The testing of the individual systems shall be completed by the trade responsible for installing the system.

.2 Jacket exposed pipe and fittings with a preformed PVC cover.

.3 The aluminium pipe jacket shall be secured to the insulation using stainless steel bands. Bands shall be located at a maximum of 400 mm (16") on centre and locked in place with link seal band locks. Aluminium sheathing shall be wrapped with a 100 mm (4") lap at both longitudinal and transverse joints, and with the exposed wrap end at either the 4 or 8 o'clock position and lapped down to shed weather and dirt.

3.3 SEALING

.1 Seal all cold pipe insulation with all service jacket along the longitudinal laps with vapour barrier adhesive. Also adhere 73 mm (3") wide butt strips smoothly and securely over all end joints with the vapour barrier adhesive to ensure continuous vapour barrier.

.2 Seal all exterior foil type vapour jacket duct insulation with 100 mm (4") wide RFFRK self adhesive tape applied over all retaining pins, longitudinal and butt joints, and along other breaks in the vapour barrier to provide a continuous vapour seal.

.3 Seal all Elastomeric Insulation on cold pipe at all joints and at insulation ends with Insulation Adhesive

3.4 CLEANING

.1 Clean in accordance with Section 01 74 11 - Cleaning.

.1 Remove surplus materials, excess materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 GENERAL

1.1 REFERENCES

.1 American Society for Testing and Materials International (ASTM)

.1 ASTM E202, Standard Test Methods for Analysis of Ethylene Glycols and Propylene Glycols.

.2 Health Canada/Workplace Hazardous Materials Information System 2015 (WHMIS)

.1 Material Safety Data Sheets (SDS).

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications, and datasheets for the glycol-based heat transfer fluid. Include product characteristics, performance criteria, and limitations.

.3 Submit the percentage by volume of glycol and the following fluid properties of the glycol-based heat transfer fluid: thermal conductivity, density, viscosity, and specific heat.

.4 Submit written documentation provided by the manufacturer of the glycol-based heat transfer fluid demonstrating compliance to the corrosion standards of ASTM D1384 (less than 0.5 mil penetration per year for all system metals).

.5 Submit a manufacturer’s certificate of analysis that guarantees the content of the delivered glycol-based heat transfer fluid product. The manufacturer’s certificate shall be furnished with the glycol-based heat transfer fluid and presented to the Contractor at the time of delivery. A copy shall be forwarded to the Contract Administrator.

.6 Submit log books and operation and maintenance manuals in accordance with Section 01 78 00 – Closeout Submittals and as described in Item 2.1.1.

.7 Provide a refractometer as described in Item 3.2.8.

Part 2 PRODUCTS

2.1 GENERAL

.1 Provide test equipment, log books, and written operating manuals associated with the glycol system. Manual to include detailed schematic drawings showing all special fittings, timers, controllers, etc. for each system.

2.2 GLYCOL

.1 Provide a 30% by volume solution of industrial grade inhibited propylene glycol-based

heat transfer fluid. The solution is to be premixed by the supplier with the correct ratio of distilled water. Field mixing of glycol solution is unacceptable. Glycol solution is to be delivered to the Site by tank or in drums.

.2 The fluid must be industrially inhibited, with phosphate-based and copper corrosion inhibitors to passivate the system and buffer the acidic degradation products of glycol. Silicate-based inhibitors, typical of automotive antifreeze, are not acceptable.

.3 The fluid must be dyed to facilitate leak detection.

.4 The fluid must be easily analyzed for glycol concentration and inhibitor level, and easily reinhibited using replacement inhibitor readily available from the fluid manufacturer.

.5 The fluid manufacturer shall provide an annual analysis free of charge to the City. The analysis shall report glycol concentration, freeze point temperature, inhibitor level, pH reserve alkalinity, and contaminants such as: chloride, sulfate, nitrite, nitrate, and total hardness. Recommendations on additions of glycol or inhibitors shall also be given as needed.

.6 The fluid must pass ASTM D1384 (less than 0.5 mil penetration per year for all system metals).

.7 The water used to dilute the concentrated inhibited glycol-based heat transfer fluid must be either distilled or deionised water.

.8 Acceptable fluid products are DOWFROST HD, PR100-50 & AFCO 0392, or approved equal in accordance with B7.

2.3 CLEANING OF FLUID SYSTEMS

.1 Supply necessary auxiliary equipment and chemicals required to perform piping systems cleaning, de-greasing, and chemical treatment as described under Part 3 Execution.

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 GLYCOL SYSTEMS

.1 The system shall be cleaned and flushed prior to the installation of the industrially inhibited glycol-based heat transfer fluid to remove dirt, weld slag, filings, solder flux, oil, etc. The system should be cleaned using an aggressive commercially available cleaning product as recommended by an industrial cleaning company. All necessary replacements and repairs should be made at this time.

.2 After the system has been cleaned, the system shall be flushed with clean water and circulated for a minimum of 72 hours.

.3 The system piping shall be hydrostatically tested to ensure that there are no leaks. This may be done using the flush water in the system.

.4 The clean water shall be drained from the system and disposed of in a manner in accordance with the requirements of the authority having jurisdiction. ,

.5 Provide and install a 50 mm (2") fill connection if required. The 50 mm (2") fill connection shall be fitted with a Camlock fitting to accept the tanker truck hose (if required). The Contractor shall also inform the glycol supplier of the distance in feet between the tanker truck and the location of the fill connection, so that the truck has an adequate supply of hose. After system filling, this fitting will be removed and replaced with a pipe cap. The carrier shall be responsible for connecting the hose to the system and all required tanker truck operations.

.6 A refractometer shall be provided by the Contractor and left with the City. This refractometer shall be used to measure the freezing point in degrees Fahrenheit of the inhibited glycol/water solution in the system.

.1 Acceptable manufacturers: Extech Instruments, Misco Products, Reichert Industrial Fluid, or approved equal in accordance with B7.

.7 The Contractor shall take a fluid sample with the manufacturer's supplied test kit after the system has been circulating for a minimum of 24 hours. The manufacturer shall provide a thermal fluid analysis report to the Contract Administrator in writing. The Contractor shall be responsible to complete any changes in the heat transfer solution if it does not meet with these Specifications.

.8 The Contractor will provide a system nameplate permanently encased in clear, plastic with, but not limited to, the following information: date, description of heat transfer fluid, manufacturer's name, address and telephone numbers for normal and emergency contact, percent glycol by volume, freeze point, total system volume in gallons, a copy of or reference to the Material Safety Data Sheet (SDS), instructions for sampling the fluid, and the address to which the sample is to be sent. Include a notation that the samples will be analyzed free of charge and that recommendations will be provided for adjusting glycol concentration, adding corrosion inhibitors, and for filtering maintenance must be performed (via annual analysis by the manufacturer) in order to prevent corrosion of the piping system components, degradation of piping system materials, degradation of the glycol, sludge formation in the system, or freezing of the solution.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and installation procedures for control of air flow rates.

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheets. Include product characteristics, performance criteria, and limitations.

1.3 OPERATING INSTRUCTIONS

.1 Provide three sets of control sequences complete with description of operating sequence.

.2 Where adjustment devices, throttling devices, and gauges are installed, mark clearly and identify the readings required for the intended performance of system.

1.4 DELIVERY, STORAGE, AND HANDLING

.1 Packing, shipping, handling and unloading:

.1 Deliver, store, and handle in accordance with Section 01 61 00 - Common Product Requirements.

.2 Deliver, store, and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 ELECTRONIC CONTROL

.1 Product requirements for electronic control are specified in Section 40 92 00 – Automation – Primary Control Devices.

Part 3 Execution

3.1 CHILLER M640

.1 Chiller - Run Conditions:

.1 The chiller shall be enabled to run whenever:

.1 Called to run by the controller YK-M6400.

.2 To prevent short cycling, the chiller shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.

.3 The chiller shall run subject to its own internal safeties and controls.

.2 Refrigerant Detection:

.1 The chiller shall shut down and an alarm generated if the R-1234ze air concentration is greater than 800 ppm (adjustable) as detected by the refrigerant monitor AIT-M6401.

.3 Chilled Glycol Pump Lead/Standby Operation:

.1 The two chilled glycol pumps P-M641 and P-M642 shall run anytime the chiller is called to run.

.2 The lead pump shall start prior to the chiller being enabled and shall stop only after the chiller is disabled. The pumps shall therefore have:

.1 A user adjustable delay on start, and

.2 a user adjustable delay on stop.

.3 The delay times shall be set appropriately to allow for orderly chilled water system start-up, shutdown, and sequencing.

.4 The two pumps shall operate in a lead/standby fashion.

.1 The lead pump shall run first.

.2 On failure of the lead pump, the standby pump shall run and the lead pump shall turn off.

.5 The designated lead pump shall rotate upon one of the following conditions (user selectable):

.1 manually through a software switch;

.2 if pump runtime (adjustable) is exceeded;

.3 daily;

.4 weekly; or

.5 monthly.

.6 Alarms shall be provided as follows:

.1 Chilled Glycol Pump (P-M641)

.1 Failure: Commanded on, but the status is off.

.2 Running in Hand: Commanded off, but the status is on.

.3 Runtime Exceeded: Status runtime exceeds a user definable limit.

.2 Chilled Glycol Pump (P-M642)

.1 Failure: Commanded on, but the status is off.

.2 Running in Hand: Commanded off, but the status is on.

.3 Runtime Exceeded: Status runtime exceeds a user definable limit.

.4 Chiller:

.1 The chiller shall be enabled by a user adjustable time after pump statuses are proven on. The chiller shall therefore have a user adjustable delay on start.

.2 The delay time shall be set appropriately to allow for orderly chilled glycol system start-up, shutdown, and sequencing.

.3 The chiller shall run subject to its own internal safeties and controls.

.4 Alarms shall be provided as follows:

.1 Chiller Failure: Commanded on, but the status is off.

.2 Chiller Running in Hand: Commanded off, but the status is on.

.3 Chiller Runtime Exceeded: Status runtime exceeds a user definable limit.

.5 Chiller Chilled glycol Supply Setpoint:

.1 The chiller shall maintain a chilled glycol supply temperature setpoint of 6.5°C (adjustable).

.2 If the space temperature sensor (TT-M6301) in the electrical room is 2°C (adjustable) above the cooling set point, the chiller will reset the glycol supply temperature set point to maintain 4.5°C (adjustable).

.6 Chilled Water Temperature Monitoring:

.1 The following temperatures shall be monitored:

.1 Chilled glycol supply. (TT-M6403)

.2 Chilled glycol return. (TT-M6404)

.2 Alarms shall be provided as follows:

.1 High Chilled Glycol Supply Temp: If the chilled glycol supply temperature is greater than 13°C (adjustable).

.2 Low Chilled Glycol Supply Temp: If the chilled glycol supply temperature is less than 3°C (adjustable).

.3 High Chilled Glycol return Temp: If the chilled glycol supply temperature is greater than 18°C (adjustable).

.4 Low Chilled Glycol return Temp: If the chilled glycol supply temperature is less than 8°C (adjustable).

3.2 AIR HANDLING UNIT

.1 Run Conditions:

.1 The unit shall run according to the following modes:

.1 HAND: With the H-O-A switch in HAND position the supply fans shall start and run continuously, subject to safeties and alarms.

.2 OFF: With the H-O-A switch in OFF position the supply fans shall stop.

.3 AUTO: With the H-O-A switch in the AUTO position the PLC shall energize the supply fans, subject to safeties and alarms.

.2 Start-up

.1 On a signal from the PLC the system will prove the minimum outside air damper (XV-M6144) has opened, the outside (FV-M6145) and relief air dampers (FV-M6147 and FV-M6148) are closed, and the return damper (FV-M6146) is open.

.2 When dampers are proven the supply fans (FN1, FN2 & FN3) will energize through the associated soft starters.

.3 Shutdown

.1 On a signal from the PLC or in Off-mode the return damper (FV-M6146) will move to a normally open position. All outside air dampers (XV-M6144 & FV-M6145) and relief dampers (FV-M6147 and FV-M6148) move to a normally closed position.

.2 The supply fans deenergize.

.4 The unit shall maintain:

.1 A 24°C (adjustable) Elect room cooling setpoint. (TT-M6301)

.2 A 18°C (adjustable) supply air heating setpoint. (TT-M6011)

.2 Zone Temperature Alarms shall be provided as follows:

.1 High Zone Temp: If the zone temperature (TSH-M6001) is greater than 35°C (adjustable).

.2 Low Zone Temp: If the zone temperature (TSL-M6001) is less than 8°C (adjustable).

.3 Supply air temperature Setpoint Adjust:

.1 The occupant shall be able to adjust the supply air temperature heating setpoint (TT-M6011).

.4 Freeze Protection:

.1 The outside (FV-M6145) and relief air dampers (FV-M6147 and FV-M6148) shall close and the return air damper (FV-M6146) shall open upon receiving a freezestat (TSL-M6043) status and display an alarm.

.5 Carbon Monoxide Detection.

.1 The controller shall measure the return air CO concentration (AE-M6902-1,2).

.2 Alarms shall be provided as follows:

.1 High Return Air Carbon Monoxide Concentration: If the return air CO concentration is greater than 12.5 ppm (adjustable).

.2 Occupational Exposure Limit Air CO Concentration: If the return air CO concentration is greater than 22.5 ppm (adjustable).

.3 The outside and relief air dampers shall open to 10% and the return air damper shall open to 90% if the return air CO concentration is greater than 12.5 ppm (adjustable).

.6 Refrigerant Leak Detection:

.1 The refrigerant monitor (AIT-M6401) shall monitor the R-1234ze concentration.

.2 Alarms shall be provided as follows:

.1 Refrigerant Leak Detected: If the R-1234ze air concentration is greater than 800 ppm (adjustable).

.3 Chiller shall shut down if the R-1234ze air concentration is greater than 800 ppm (adjustable).

.4 The outdoor damper (FV-M6145) and relief air dampers (FV-M6147 and FV-M6148) shall open to 25% and the return air damper (FV-M6146) shall open to 75%.

.7 Supply/Return Air Smoke Detection:

.1 The unit shall shut down and generate an alarm upon receiving a supply/return air smoke detector status.

.8 Supply Fans (FN1, FN2 & FN3):

.1 The supply fans shall run anytime the unit is commanded to run, unless shutdown on safeties. To prevent short cycling, the supply fan shall have a user definable (adjustable) minimum runtime.

.2 Alarms shall be provided as follows for each fan:

.1 Supply Fan Failure: Commanded on, but the status is off.

.2 Supply Fan in Hand: Commanded off, but the status is on.

.3 Supply Fan Runtime Exceeded: Status runtime exceeds a user definable limit (adjustable).

.9 Electric Heating with Silicon-Controlled Rectifier (HCE-M601)

.1 The controller shall measure the supply air temperature (TT-M6011) and modulate the heating coil to maintain its heating setpoint.

.2 The heating shall be enabled whenever:

.1 Outside air temperature (TT-M6041) is less than 10°C (adjustable).

.2 AND the supply air temperature (TT-M6011) is below heating setpoint.

.3 AND the supply fan status is on.

.4 AND the cooling is not active.

.3 Mixing Dampers.

.1 The minimum outdoor air damper (XV-M6144) shall open.

.2 The return air damper (FV-M6146) shall open.

.3 The outdoor damper (FV-M6145) and relief air dampers (FV-M6147 and FV-M6148) shall close.

.10 Chilled Glycol Cooling

.1 The controller shall measure the space temperature (TT-M6301) in the electrical room and modulate the chiller (CHLR-M640) to maintain its cooling setpoint.

.2 The cooling shall be enabled whenever:

.1 Outside air temperature (TT-M6041) is above 13°C (Adjustable)

.2 AND the electrical room temperature (TT-M6301) is above the cooling setpoint.

.3 AND the supply fan status is on.

.4 AND the heating is not active.

.3 Mixing Dampers

.1 The minimum outdoor air damper (XV-M6144) shall open.

.2 The return air damper (FV-M6146) shall open.

.3 The outdoor damper (FV-M6145) and relief air dampers (FV-M6147 and FV-M6148) shall close.

.11 Free Cooling using Mixing Dampers:

.1 The controller shall measure the supply air temperature (TT-M6011) and modulate the mixing air dampers in sequence to maintain a 15°C (adjustable) setpoint.

.2 The free cooling mode shall be enabled whenever:

.1 Outside air temperature (TT-M6041) is less than 14°C (adjustable).

.2 AND the outside air temperature (TT-M6041) is less than the station temperature (TT-M6045).

.3 AND the supply fan status is on.

.3 The chiller (CHLR-M640) shall turn down to 10% output.

.4 The chilled glycol pump (P-M641 or P-M642) shall remain operational.

.12 Final Filter Differential Pressure Monitor:

.1 The controller (PDA-M6021) shall monitor the differential pressure (PDS-M6021) across the final filter.

.2 Alarms shall be provided as follows:

.1 Final Filter Change Required: if Final filter differential pressure exceeds 125 pa (adjustable).

.13 Mixed Air Temperature:

.1 The controller shall monitor the mixed air temperature (TT-M6042) and use as required for free cooling and pre-heating

.2 Alarms shall be provided as follows in Heating Mode:

.1 High Mixed Air Temp: If the mixed air temperature is greater than 32°C (adjustable).

.2 Low Mixed Air Temp: If the mixed air temperature is less than 7°C (adjustable).

.14 Supply Air Temperature:

.1 The controller shall monitor the supply air temperature (TT-M6011).

.2 Alarms shall be provided as follows in Heating Mode:

.1 High Supply Air Temp: If the supply air temperature is greater than 49°C (adjustable).

.2 Low Supply Air Temp: If the supply air temperature is less than 7°C (adjustable).

3.3 IDENTIFICATION

.1 Provide in accordance with Section 23 05 54 - Mechanical Identification.

3.4 MANUFACTURER'S INSTRUCTIONS

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

3.5 TRAINING

.1 Provide one 4-hour on-site training session on complete operations and maintenance of the system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE).

.2 Electrical Equipment Manufacturers Advisory Council (EEMAC).

.3 Canadian Standards Association (CSA International).

.1 CSA-B214, Installation Code for Hydronic Heating Systems.

.4 National Electrical Manufacturers' Association (NEMA).

.1 NEMA MG 1, Motors and Generators.

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings and product data:

.1 Provide manufacturer's printed product literature and datasheets for pump, circulator, and equipment, and include product characteristics, performance criteria, physical size, finish, and limitations. Indicate point of operation and final location in field assembly.

.2 Submit manufacturer's detailed composite wiring diagrams for the pump control systems showing factory installed wiring and equipment on packaged equipment as required for controlling devices or ancillaries, accessories, and controllers.

.3 Provide completed Contractor’s Field Requirements forms as described in Section 01 43 00 – Contractor’s Field Requirements.

.4 Provide spare parts in accordance with Section 01 78 00 Closeout Submittals and as indicated in this section.

1.3 DELIVERY, STORAGE, AND HANDLING

.1 Deliver materials to Site in original factory packaging, labelled with manufacturer's name and address.

Part 2 Products

2.1 VERTICAL IN-LINE CIRCULATORS

.1 Volute: cast iron radially split, with tapped openings for venting, draining, and gauge connections, with flanged suction and discharge connections.

.2 Impeller: stainless steel.

.3 Shaft: 416 stainless steel shaft that is guided by a carbon graphite lower throttle bushing.

.4 Seal assembly: mechanical for service to 110 degrees C.

.5 Coupling: The pump shall include a spacer coupling of high tensile aluminum, split to allow the servicing of the mechanical seal without disturbing the pump or motor. Coupling shall incorporate tapered washer shaft jacking design

.6 Motor: Motors shall be NEMA Premium efficient and shall be the size, voltage, and enclosure called for in the Drawings. Motors shall have heavy-duty grease lubricated ball bearings, completely adequate for the maximum load for which the pump is designed.

.7 Capacity: as indicated on schedules in the Mechanical Drawings.

.8 Design pressure: 1725 kPa.

.9 Spare Parts

.1 For each type of pumps and drives, the following spare parts shall be supplied along with the pumps. The supplier may also recommend spare parts other than those listed below if necessary.

Parts	No. of Sets for Each Model of Pump
Shaft with keys, washers, bolts and lock nut	One
Impeller	One
Bearings (Pump)	Two
Bearings (Motor), Brushes and Washers	Two
Mechanical Seal - Set	One
Coupler Assembly	One
Set of Fasteners	One
Gasket Set for casing and impeller seal	One

2.2 SUCTION DIFFUSERS

.1 Provide suction diffusers of the size noted on Drawings.

.2 Units shall consist of angle type body, flanged system connection, integrated Flow Cone, carbon/stainless steel straightening vane and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection. The unit shall include a disposable fine mesh strainer which shall be removed after system start-up. Unit shall have pressure/temperature ports at the suction and discharge to allow for measurement of differential pressure across the unit.

.3 Orifice cylinder shall be designed to withstand pressure differential equal to pump shut-off head and shall have a free area equal to five times cross section area of pump suction opening. Vane length shall be no less than 2-1/2 times the pump connection diameter. Unit shall be provided with adjustable support foot to carry the weight of suction piping.

Unit shall be rated for 175 psi (1,207kPa) maximum working pressure and 250°F (121°C) maximum working temperature

2.3 TRIPLE DUTY VALVES

.1 Furnish and install as shown on Drawings, an angle pattern valve designed to perform the functions of a non-slam check valve, throttling valve, shutoff valve, and calibration balancing valve.

.2 The valve shall be a heavy-duty cast iron construction with standard 125 psig (862 kPa) ANSI flanged connections and rated for a maximum working pressure of 175 psig (1207 kPa) at 250°F (121°C). The valve shall be fitted with a bronze seat, replaceable brass disc with EPDM seat insert, stainless steel stem, and chatter-preventing spring and calibrated nameplate. The valve design shall permit repacking under full system pressure.

.3 The valve shall be equipped with brass readout valve (with integral check valve) for taking differential pressure readings across the orifice for accurate system balance.

Part 3 Execution

3.1 GENERAL

.1 Comply with Section 01 43 33 – Contractor's Field Requirement in relation to delivery, storage, installation, and testing.

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

3.2 INSTALLATION

.1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 In line circulators: install as indicated by flow arrows.

.1 Support at inlet and outlet flanges or unions.

.2 Install with bearing lubrication points accessible.

.3 Ensure that pump body does not support piping or equipment.

.1 Provide stanchions or hangers for this purpose.

.2 Refer to manufacturer's installation instructions for details.

.4 Use suction diffusers and triple duty valves on pump suction and discharge.

.5 Check rotation prior to start-up.

.6 Install pressure gauge test cocks.

3.3 START-UP

.1 General:

.1 In accordance with manufacturer's recommendations.

.2 Procedures:

.1 Before starting the pump, check that the cooling water system over-temperature and other protective devices are installed and operative.

.2 After starting the pump, check for proper and safe operation.

.3 Check the installation, operation of mechanical seals, and packing gland type seals. Adjust as necessary.

.4 Check the pump base for free-floating. Ensure there are no obstructions under the base.

.5 Verify the operation of the over-temperature and other protective devices under low- and no-flow conditions.

.6 Eliminate air from the scroll casing.

.7 Adjust the flow rate through the water-cooled bearings to the manufacturer's recommendations.

.8 Adjust the flow rate from the pump shaft stuffing boxes to the manufacturer's recommendations.

.9 Adjust the alignment of the piping and conduit to ensure true flexibility.

.10 Eliminate cavitation, flashing, and air entrainment.

.11 Adjust the pump shaft seals, stuffing boxes, and glands.

.12 Measure the pressure drop across the strainer when clean and with flow rates as finally set.

.13 Replace the seals if the pump is used to degrease the system or if the pump is used for temporary heat.

.14 Verify the lubricating oil levels.

3.4 TRAINING

.1 Provide one 4-hour on-site training session on complete operations and maintenance of the system.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials and application of electric duct heaters.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CSA C22.2 No.46-M1998(R2001), Electric Air-Heaters.

1.3 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit product data and include:

.1 Element support details.
.2 Heater: total kW rating, voltage, phase.
.3 Number of stages.
.4 Rating of stage: rating, voltage, phase.
.5 Heater element watt/density and maximum sheath temperature.
.6 Maximum discharge temperature.
.7 Physical size.
.8 Unit support.
.9 Performance limitations.
.10 Clearance from combustible materials.
.11 Internal components wiring diagrams.
.12 Minimum operating airflow.
.13 Pressure drop operating airflow.

.3 Provide completed Contractor's Field Requirements forms as described in Section 01 43 00 – Contractor's Field Requirements.

Part 2 Products

2.1 DUCT HEATERS

.1 Elements:

.1 Open coil c/w protective screens on both sides.

.2 Staging:

.1 Staged heaters: balanced line current at each stage.

.2 Each stage: uniform face distribution.

.3 Controls:

.1 Remote control via remote 0-10V signal, which proportionally controls the heat output, 0 – 100%.

.2 Controls mounted in a CSA Type enclosure and to include:

.1 Integral disconnect switch.

.2 Magnetic contactors.

.3 Control transformers.

.4 Silicon Controlled Rectifier controller.

.3 Where controls are mounted in heater, exercise care in mounting contactors to minimize switching noise transmission through ductwork.

.4 High temperature cut-out and air proving switch.

.4 Electrical:

.1 Size as indicated.

.2 575V, 3Ø.

.3 Main isolation disconnect switch.

.5 Acceptable materials: Caloritech, E.H. Price, Thermolec or approved equal in accordance with B7.

Part 3 Execution

3.1 INSTALLATION

.1 Make power and control connections to CSA C22.2 No.46.

3.2 FIELD QUALITY CONTROL

.1 Perform functional tests of all equipment to ensure proper operation and controls.

3.3 TRAINING

.1 Provide one 4-hour on-site training session on complete operations and maintenance of the system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE)

.1 Standard 90.1-2016, Energy Standard for Buildings Except Low-Rise Residential Buildings.

.2 Electrical Equipment Manufacturers Advisory Council (EEMAC)

.3 National Electrical Manufacturers' Association (NEMA)

.1 NEMA MG 1-2016, Motors and Generators.

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit Shop Drawings and product data sheets for all devices included within this section.

.3 Submit completed Contractor's Field Requirements forms as described in Section 01 43 00 – Contractor's Field Requirements Contractor's for the air cooled condenser and chiller described in section 2.10 of this section.

.4 Submit spare parts as described in section 2.9.2 and 2.10.6 of this section in accordance with Section 01 78 00 - Closeout Submittals.

.5 Submit one of each specialty tool that is required for the maintenance of the equipment as described in this section.

.6 Submit operation and maintenance manuals for the chilled glycol system in accordance with Section 01 78 00 - Closeout Submittals.

1.3 DEMONSTRATION AND TRAINING

.1 Demonstrate operation and maintenance of equipment and systems to City's personnel two (2) weeks prior to date of final inspection.

.2 The City will provide list of personnel to receive instructions, and will coordinate their attendance at agreed-upon times.

.3 Manufacturer to provide authorized representative to demonstrate operation of equipment and systems as indicated in various sections.

.4 Instruct City's personnel, and provide written report that demonstration and instructions have been completed.

.5 Submit schedule of time and date for demonstration of each item of equipment and each system two (2) weeks prior to designated dates, for Consultant's approval.

.6 Submit reports within one (1) week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.

.7 Give time and date of each demonstration, with list of persons present

.8 Demonstrations required for the following Equipment. Ensure equipment has been inspected and put into operation in accordance with manufacturer's instructions and various sections:

.1 Chiller – Section 23 82 00

.2 Condensing Unit – Section 23 82 00

.3 Water Treatment – Section 23 08 02

.4 Controls - Section 23 09 33

1.4 DELIVERY, STORAGE AND HANDLING

.1 Deliver materials to Site in original factory packaging, labelled with manufacturer's name and address.

Part 2 Products

2.1 AUTOMATIC AIR VENT

.1 Standard float vent: brass body and NPS 1/8 connection and rated at 690 kPa working pressure.

.2 High capacity vent for air separator: SNC TO INSERT SPEC

2.2 AIR SEPARATOR

.1 Furnish and install on the glycol cooling system an air separator as shown on the Drawings. Separator to be full size of system piping with appropriate flanged end connections.

.2 Acceptable materials: Amtrol, Armstrong, Bell & Gossett or approved equal in accordance with B7.

2.3 EXPANSION TANKS

.1 Furnish and install, as shown on Drawings, a vertical ASME rated full bladder expansion tank.

.2 Acceptable materials: Expanflex or approved equal in accordance with B7.

2.4 VALVES

.1 Valves: as much as is possible from a single manufacturer (see Section 23 05 05 – Piping and Fittings).

.2 Drain valves up to and including 19 mm (3/4"): compression stops or hose bibs, rough brass, with garden hose thread outlet.

.3 Butterfly valves: may be substituted for gate valves on shut-off service.

2.5 STRAINERS (WATER SERVICE)

.1 See Section 23 05 05 – Piping and Fittings.

.2 NPS 1/2 to 2: bronze body to ASTM B62, screwed connections, Y pattern, 20 mesh screen. Acceptable material: Sarco Figure 16, Armstrong or Keckley or approved equal in accordance with B7.

.3 NPS 2 1/2 to 12: cast iron body to ASTM A278/A278M, Class 30 flanged connections, 3 mm perforations. Acceptable material: Sarco Figure CI-125, Armstrong or Keckley or approved equal in accordance with B7.

.4 Blowdown connection: NPS 1.

.5 Screen: stainless steel.

.6 Working pressure: 860 kPa.

2.6 VIBRATION ISOLATORS

.1 Provide in locations noted on the Drawings, controlled flex expansion compensators. Joints: screwed, flanged, or weld ends to suit system pipe.

2.7 FLEX CONNECTORS

.1 Flex connectors: 400 mm long 316 stainless steel corrugated/bellow internals with 316 stainless steel braided jacket located at building to pad interface and for equipment as required. Manufactured by Flextech or approved equal in accordance with B7.

2.8 CIRCUIT BALANCING VALVES (CBV)

.1 General:

.1 Y style globe valve, designed to provide precise flow measurement and control, with valved ports for connection to differential pressure meter.

.2 Accuracy:

.1 Readout to be within plus or minus 2% of actual flow at design flow rate.

.2 Construction: cast iron, 1.2 MPa, 121 degrees C, screwed ends, Teflon disc, screw-in bonnet.

.1 Flow control: at least four (4) full turns of handwheel with digital handwheel and tamperproof concealed mechanical memory.

.3 Drain connection:

.1 NPS3/4 valved and capped, suitable for hose socket.

.2 Incorporated into valve body or provided as separate item.

2.9 SIDEARM FILTERS

.1 Cast iron and steel filter housing complete with flow indicators.

.2 Provide adequate filters to complete initial system cleaning and provide the City with 6 spare filters at time of system turnover.

2.10 AIR-COOLED CHILLER AND CONDENSER (CHLR-M640 & CDR-M640)

.1 Pre-Shipment Verification

.1 Contractor to pay all costs associated with the pre-shipment verification by two City representatives of the chiller and air-cooled condenser. Costs to include personnel transport, accommodations, and meal allowance for two City representatives to accommodate the pre-shipment verification.

.2 Product Description

.1 Provide and install as shown on the Drawings a factory assembled chiller and air cooled condensing unit.

.2 The chiller shall include multiple Turbocor, magnetic bearing, and variable-speed centrifugal compressors. Integrated variable frequency drive shall operate with inlet guide vanes.

.3 The chiller and condenser shall operate with **HFO-1234ZE** refrigerant. With a **420 kg** maximum system refrigerant weight to meet **CSA B52**.

.4 The evaporator, condenser, and expansion valve shall be configured to operate as a single refrigerant circuit unless otherwise specified. The chiller unit compressors shall be designed for mechanical and electrical isolation to facilitate service and removal.

.3 Warranty and Maintenance

.1 The chiller and condenser manufacturer's warranty shall be for a period of two years from the date of Total Performance.

.2 The warranty shall apply if the failure is as a result of defective parts, materials or workmanship as provided by the equipment manufacturer or the Contractor's installation. The warranty shall cover the following:

.1 Parts,

.2 Any rentals associated with the repairs,

.3 Software upgrades,

.4 Replacement of refrigerant lost, and

.5 Labour costs for the repair or replacement of parts.

.3 Maintenance of the chiller and condenser equipment, while under warranty, is mandatory and shall be the responsibility of the City unless supplied by the manufacturer.

.4 One of each specialty tool that is required for the maintenance of the equipment shall be provided to the City for the maintenance of the equipment.

.4 Design Requirements

.1 Unit shall consist of one or more magnetic bearing, oil-free centrifugal compressors with integrated variable frequency drive, refrigerant flooded evaporator, air cooled condenser, and operating controls with equipment protection.

.2 Performance: Refer to chiller schedule shown on Drawings for specific operating conditions. The chiller shall be capable of stable operation down to 35 tons.

.3 Acoustics: Sound pressure for the unit shall not exceed the following specified levels, and be less than 74 dBA, measured a 1 meter (3.28 feet). Sound data shall be measured according to AHRI Standard 370-2011.

.4 Chiller shall be equipped for single-point power connection.

.5 Evaporator shall be designed to allow for the flow rate to be reduced to the rate of 1 gpm per ton without entering laminar flow to allow for variable chilled water flow and facilitate chilled water pump energy savings. The chiller shall be able to operate in a stable fashion at this condition for at least 8 hours continuously.

.6 Each compressor shall be electrically and mechanically isolated so that if a compressor fails or needs service it can be serviced or removed from the chiller without disabling the other compressors or the chiller. The chiller shall be able to operate with the remaining compressors with one or more compressors removed.

.7 All chillers with shall be equipped with a load balancing valve for capacity control and supply chilled temperature stability.

.8 All chillers equipped with two or more compressors shall be equipped with individual compressor staging valves to channel discharge gas from the outlet of the compressor to the evaporator in order for the ramp up during a high pressure ratio application.

.9 All painted surfaces shall be provided with a two-layer zinc coated paint capable of withstanding 1500 hour salt spray exposure under ASTM standard B117.85

.5 Chiller Components

.1 Compressor

.1 Compressors shall be of semi-hermetic centrifugal design and operate oil-free with two-stages of compression, magnetic bearings, movable inlet guide vanes, and integrated variable frequency drive system.

.2 Automatically positioned and controlled inlet guide vanes shall operate with compressor speed controls.

.3 The compressor shall be capable of coming to a controlled stop in the event of a power failure. The unit shall be capable of initializing an automatic restart in the case of power failure.

.4 Each compressor shall have integrated microprocessor control capable of capacity and safety control.

.5 Each compressor shall be installed with individual suction, discharge, and motor cooling refrigerant line isolation valves. Chillers without discharge line isolation valves that rely on non return valves in discharge line for compressor removal shall not be accepted.

.6 Refrigerant discharge line shall have a combination of shut off and check valves. Blank seal valves shall not be accepted.

.7 Guide vanes: Modulating with factory mounted electric operator, suitable for capacity reduction down to fifteen (15) percent of specified load without hot gas bypass.

.2 Prime Mover

.1 Permanent-magnet, synchronous hermetically sealed motor of sufficient size to effectively provide compressor horsepower requirements. Motor shall include soft-start capabilities with an inrush current of no more than 2 amps. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.

.2 Compressor motor and chiller unit shall include variable-frequency speed controls to match cooling load demand to compressor speed and inlet guide vane position.

.3 Each compressor shall be equipped with a 5% impedance AC line reactor and individual disconnect or circuit breaker.

.3 Evaporator

.1 Evaporator shall be shell-and-tube type and have separate shells. Heat exchangers shall be designed, constructed, tested, and stamped according to the requirements of the ASME Code, Section VIII Code Case 1518-5. They shall have a copper wall of 0.025 in. wall thickness. In the evaporator, refrigerant shall be in the shell and water inside the tubes. The water sides shall be designed for a minimum of 150 PSIG. Evaporator shall be designed for 30%Turn down ratio on flow rate. The water connections for the evaporator and condenser shall be grooved suitable for Victaulic couplings or flanged. Vents and drains shall be provided. The refrigerant side of each vessel shall bear the ASME Code stamp, code case section VII. Vessels shall pass a test pressure of 1.1 times the working pressure but not less than 100 psig. Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports. The evaporator water connections shall also be equipped with right-hand or left-hand connection, interchangeable.

.2 The evaporator shall be provided with spring loaded reseating-type pressure relief valves according to ASHRAE-15. Rupture disks are not acceptable.

.3 A perforated plate designed for vapor disengagement shall be installed inside the evaporator above the tubing to assure effective liquid droplet removal to prevent liquid damage to compressors and equalized suction pressure across evaporators with multiple compressors.

.4 Tubes shall be individually replaceable and have internally and externally enhanced surfaces designed for refrigeration duty. Tubes shall have smooth full tube wall landings at the tube-sheet ends and at intermediate tube supports. Tubes shall be mechanically roller expanded into steel tube sheets containing a minimum of three concentric grooves. The use of sealants to provide a proper seal is not be acceptable for this application.

.5 Provide factory-mounted and wired thermal dispersion switches and water flow switches on the evaporator to prevent unit operation with no water flow. Differential pressure switches are not acceptable as thermal dispersion provides the accuracy required for this application.

.4 Air-Cooled Condenser

.1 Air cooled packaged chillers and controls shall be capable of reliable operation between 32°F and 105° ambient air temperature.

.2 Air-cooled condenser coils shall utilize coated aluminum fins which shall meet ASTM B117 1000hr salt spray test. The coating shall be epoxy

based type and shall effectively repel water and inhibits dust and bacterial accumulation.

.3 Condenser coils frame shall be made of Marine Grade Aluminum alloy 5052 to offer corrosion resistance to marine atmospheres.

.4 Condenser coils and fans shall be arranged such that one fan operates with one coil section so that the failure of a fan will not affect the CFM across any coil beyond that fan.

.5 Condenser shall be equipped with an oversized liquid line and mechanical float to assure liquid sub-cooling necessary for effective cooling of the compressor.

.6 Condenser shall be equipped with packaged variable speed fans capable of delivering minimum of 14,000 CFM and maximum 890 rpm. The fans shall have a minimum diameter of 910 mm in order to provide higher air flow at lower speed and lower noise level. The sound pressure level at highest speed shall not exceed 68dB(A) in the inlet side.

.7 For installations at high altitudes or with restricted air, special High Flow type fans shall be used and shall be capable of delivering minimum of 14,800 CFM and maximum 1000 rpm. The fans shall have a minimum diameter of 910 mm in order to provide higher air flow at lower speed and lower noise level. The sound pressure level at highest speed shall not exceed 72dB(A) in the inlet side

.8 Condenser fan motors shall be ECM type high efficiency, direct drive, 3-phase, insulation class “F”, current protected, Totally Enclosed Air Over (TEAO), double sealed, and with permanently lubricated ball bearings.

.9 The fans shall balanced dynamically and statically and direct drive. Also, the blades shall be corrosion resistant designed for low noise, full airfoil cross section, providing vertical air discharge from extended orifices. The guards shall be constructed of heavy duty 14 gauge steel and painted.

.10 Condenser coils shall be positioned in such a manner as to resist damage without the use of hail guards. If this cannot be accomplished, corrosion resistant hail guards must be provided and manufacturer to provide documentation demonstrating that the hail guards do not affect the performance of the fans.

.11 All headers must include a cover to protect the coils from damage and all refrigerant piping must be with the unit framing. Units that arrive on Site with exposed headers and refrigerant piping extending past the unit framing, shall be modified onsite by contractor no additional cost to the owner. Modifications are subject to approval by the Contract Administrator.

.5 Liquid Level Controls

.1 Control of refrigerant flow shall utilize a single or multiple 6,000 step electronic expansion valve (EXV), to operate within the full range from full load to the lowest loading capacity for the chiller. Fixed orifice metering devices or float controls using hot gas bypass are not acceptable. The EXV liquid line shall have a sight glass with moisture

indicator and temperature sensor connected to control system for validation of sub-cooling.

.2 The EXV valve shall be controlled by evaporator level float control for better efficiency and to avoid compressor slugging. EXV superheat control shall not be acceptable as a primary control method, however shall be included as a redundant feature.

.3 Evaporator shall be provided with a capacitive type liquid level transducer with a resolution of not less than 1024 discrete steps. Transducer shall be wired to the chiller control system. Evaporator liquid level measurement shall be used in electronic expansion valve control algorithm with a minimum level set point to ensure adequate liquid seal is maintained in condenser to provide compressor motor cooling during operation. Evaporator liquid level shall be clearly displayed on graphical operator interface in a minimum of two screens. Chillers without direct level measurement are prohibited due to possible over heating damage that may occur in compressors when liquid seal is lost.

.6 Chiller Controls

.1 The controller fitted to the oil-free centrifugal chiller package shall be an embedded real time microprocessor device that utilizes control software written specifically for chiller applications. User operation shall be accomplished using a panel mounted color touch-screen interface. The status of the compressors and all system parameters including compressor alarms and temperature trends shall be viewable.

.2 Chiller control system shall have the capability to store one year of operational data. No less than 60 points of information shall be sampled at a maximum of 15 minute intervals.

.3 Chiller control system shall have full web based remote control capability including the capability for remote operation and software updates.

.4 There shall be a backup superheat control on inlet of the compressor in order to control the EXV in the event of a failure of the primary level sensing device.

.5 A cover is to be included to protect the touch screen interface from environmental conditions. The cover shall be hinged with stoppers and opaque.

.6 Controller Features:

.1 Selectable control mode – leaving chilled water, entering chilled water, or suction pressure control.

.2 12 inch, 65,000 colors, touch panel operator interface operating windows XP embedded.

.3 Chiller documentation shall be viewable via touch panel in pdf format.

.4 Operator interface shall be capable of connecting directly to compressors via serial communication protocol and display compressor information using

Turbocor compressor monitoring/ commissioning software.

.5 Chiller control panel shall contain a minimum of three processors; all control functionality shall be carried out on a dedicated real time processor and data served to a remote graphical user interface via an open Ethernet protocol. Proprietary protocols between any PC based or micro based processor are strictly prohibited.

.6 Bacnet MS/TP, Bacnet IP, or Lon capable.

.7 Chiller control shall be capable of controlling the total number of compressors and the individual refrigerant circuits serving the chilled water stream.

.8 Chiller control panel user interface shall be capable of remote control via an internet connection without the use of any third party gateway device or additional hardware or software.

.9 Chiller control shall be able to operate in headless mode (no touch panel connected) and utilize standard windows XP or higher computer to display user interface via Ethernet connection.

.10 Ability to place all outputs in a manual state (hand, off, auto) via graphical user interface.

.11 Alarm screen shall be capable of filtering faults into specific categories such as compressor, chiller, and system faults in order to provide rapid diagnosis and separation of failure modes.

.12 Ability to turn on/off duty standby chilled water pumps.

.13 Ability to operate chiller isolation valves for both evaporator and condenser

.14 Multiple compressors staging algorithm shall operate at the optimized power curves of each compressor simultaneously and shall reset automatically every second during operation. Compressor staging methods that operates using simple incremental percent of demand shall not be accepted.

.15 Continuous data logging for operational trending and bin analysis shall be exportable to “CSV” format. (12 months data stored).

.16 Built-in stepper motor controls for EXVs.

.17 Controls lockup protection.

.18 Ramp rate control - Peak energy demand limiting algorithms.

.19 Three levels of alarm safety for minimum chiller down time.

.20 Chiller control software shall employ an active fault avoidance algorithm to reduce chiller capacity and/or power level in the case the chiller approaches within 10% of any trip limit value such as suction pressure, discharge pressure, chiller amp limit, leaving chilled water temperature limit etc.

.21 Store up to 32,000 alarm and fault events stored with date / time stamp.

.22 Real time data trending viewable via touch panel.

.23 Chiller load profile charts viewable via touch panel.

.24 Chiller control graphical user interface shall be capable of displaying data in SI or I-P units without affecting control or BAS protocol units.

.25 Controls shall identify within 60 seconds a compressor that is not starting or ramping properly. Upon this identification, the compressor shall be disabled, the remaining compressors shall be operated in an optimized fashion and an alarm shall be sent to alert the operator.

.26 Chiller faults 14 possible conditions.

.27 Each compressor's alarm 9 possible conditions.

.28 Each compressor's fault 13 possible conditions.

.29 Each compressor's bearing fault 8 possible conditions. Each compressor's bearing fault 16 possible conditions.

.30 Each compressor's inlet guide vane position.

.7 Data on main display screen shall include:

.1 Entering and leaving chilled water temperatures.

.2 Ambient air temperature.

.3 7 states available.

.4 Active timers.

.5 Chiller enable status.

.6 Chiller water flow proof status.

.7 Indication of compressor readiness.

.8 Indication of clearance to run.

.9 Chiller set point.

.10 Total chiller kW.

.11 Total chiller current input.

.12 Three pages of data trends with zoom functionality.

.13 Graphical dial indicators that clearly indicate safe and unsafe operating values.

.14 Graphical representation of evaporator and condenser showing gas movement when chiller is running.

.15 Current alarms (announce and manual reset provision).

.16 Compressor actual rpm, maximum rpm, minimum rpm.
.17 Compressor alarm description and fault description.
.18 Compressor percentage motor demand.
.19 Compressor safety interlock status.
.20 Compressor modbus communication health status.
.21 Compressor suction and discharge pressures.
.22 Compressor suction and discharge temperatures.
.23 Compressor internal cooling system temperatures and status.
.24 Compressor motor kW and amps.
.25 Compressor pressure ratio.

.6 Acceptable manufacturer shall be Smardt Inc. or approved equal in accordance with B7.

.1 Where a manufacturer is approved as equal in accordance with B7, the following additional spare parts shall be provided:

.1 magnetic bearing compressor assembly with motor,
.2 thermostatic expansion valves,
.3 safety relief valves,
.4 fuse plugs,
.5 filters, driers and shells,
.6 air filters,
.7 pressure switches,
.8 fan motor,
.9 electrical contactors and accessories,
.10 auxiliary contact relays,
.11 starters,
.12 breakers,
.13 fuses/switch disconnects,
.14 transformers,
.15 relays,
.16 capacitors,
.17 damper actuator,
.18 spring return actuator,
.19 user interface,
.20 displays,
.21 controllers boards, and
.22 miscellaneous electronics boards.

Part 3 Execution

3.1 GENERAL

.1 Comply with Section 01 43 33 – Contractor's Field Requirements in relation to delivery, storage, installation, and testing.

.2 Comply with manufacturer's written recommendations, including product technical bulletins, product catalogue installation instructions, product carton installation instructions, and data sheets.

.3 Ensure adequate clearances for servicing and maintenance.

3.2 INSTALLATION OF CHILLER AND CONDENSING UNIT

.1 Provide emergency discharge piping to outdoors in accordance with CSA B52.

.2 Provide a manufacturer's factory-trained service engineer without additional charge to perform chiller start-up and on-site commissioning, including controls and flow verification. Provide leak testing, evacuation, dehydration, and charging of the chillers.

.3 The manufacturer or its approved representative will participate in and coordinate with the Contract Administrator, the City, the Contractor, controls sub-contractor and other trades to ensure proper application and integration of the chiller in the PLC control system. The proposed person should have experience in similar projects.

.4 Adjust chiller and condenser in alignment on concrete foundations, sole plates, sub-bases and isolation. Level, grout and bolt in place.

.5 Arrange piping for easy dismantling to permit tube cleaning.

.6 Provide and place the initial charge of refrigerant.

3.3 START-UP

.1 Units shall be field charged with HFO-R1234ZE refrigerant.

.2 Factory Start-Up Services: Provide factory supervised start-up on-site for a minimum of two working days ensure proper operation of the equipment

.3 During the period of start-up, the factory authorized technician shall instruct the City's personnel in proper care and operation of the equipment.

3.4 INSTALLATION OF PIPING

.1 Cut pipe accurately to measurements taken at Site and install without springing or forcing. Changes in direction: with fittings.

.2 Connected equipment, valves, etc., using unions up to 50 mm and flanges in sizes 63 mm and over.

.3 Slip on flanges: PVC flanges. Flange connections: made with a full complement of nuts and bolts.

.4 Grade liquid piping upward in direction of flow. Minimum grade: .25% 75 mm/31 m (3"/100 ft).

.5 Install piping parallel to walls whenever possible.

.6 Install drain valves on each pump and at low points in the mechanical system to provide complete drainage.

.7 Remove valve working parts prior to brazing or soldering operations.

.8 Provide shut off valves and unions or flanges at connections to each piece of equipment.

.9 Install strainers upstream of flow control equipment.

.10 Make reductions in pipe size using eccentric reducers or eccentric reducing couplings.

.11 Where change in direction of piping is shown as being used to take up expansion of the piping, such as at expansion loops or swing connections, spring piping cold when it is being installed.

.12 Blow out equipment with compressed air prior to making final piping connections.

.13 Butt welding joints in 63 mm piping and above to be made using backing rings, which to be installed fully in accordance with the manufacturer's recommendations. All nubs to be removed on completion of joints.

.14 Provide for the installation of refrigerant piping according to good refrigeration piping practice. Utmost care shall be taken at all times to ensure that piping is kept free of any foreign material.

.15 Piping shall be joined using wrought copper fittings matching the specified pipes. All joints shall be brazed.

.16 Install di-electric insulating couplings or isolating flanges between pipes or apparatus constructed of dissimilar metals.

.17 Install air vents at high points in water systems where air might be trapped.

.18 Bull head connections are not acceptable.

3.5 VALVE INSTALLATION

.1 Provide ball or butterfly valves in accordance with Section 23 05 05 – Piping and Fittings and as dictated by size in Part 2 of this section for all connections to control valves. Arrange for maximum effectiveness or as directed by the Contract Administrator.

3.6 DEMONSTRATION AND INSTRUCTIONS

.1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, and maintenance of each item of equipment at agreed upon times, at the equipment location.

.2 Instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.

.3 Instruct personnel on control and maintenance of sensory equipment and operational equipment associated with maintaining energy efficiency and longevity of service.

.4 Review contents of manual in detail to explain all aspects of operation and maintenance.

.5 Prepare and insert additional data in operations and maintenance manuals when the need for additional data becomes apparent during instructions.

.6 Provide sufficient amount of time required to instruct maintenance staff on the proper operation of all equipment

3.7 CLEANING

.1 Wipe equipment clean and remove traces of oil, dust, dirt, or paint spots.

.2 Maintain system in clean condition until final acceptance.

.3 Upon completion and verification of performance of installation, remove surplus materials, rubbish, tools, and equipment.

3.8 TRAINING

.1 Provide one 4-hour training session on complete operations and maintenance of the system.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This section covers items common to sections of Division 26 Electrical. This section supplements requirements of Division 1 General Requirements.

1.2 CODES AND STANDARDS

.1 Complete installation in accordance with CSA C22.1-2018 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 the completion and testing of the Work, and to render the system ready for operation.

.2 All materials, equipment, labor, work denoted on the drawing set 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, labor, work indicated will form part of his scope, and the Contractor shall include all costs (including materials, labor, etc) to perform the work.

.3 Prior to installing power and control cabling for process equipment, the Contractor shall review the equipment shop drawings, and to ensure that cabling requirements are understood. There may be variations in wiring requirements with process and HVAC equipment, that may require alternate wiring requirements from that shown on the drawings. Include such wiring and connections in tender at no additional costs.

.4 The intent of the Drawings and Specifications is to indicate labor, products, and services necessary for a complete, installed, tested, commissioned and functional installation.

.5 The electrical 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 and cables and general location of electrical equipment. They do not show all structural, architectural and mechanical details. In some cases, conduit or wiring is only shown diagrammatically on the drawings. The details on exact cable or conduit routing, and exact

equipment installation location is to be determined on site and coordinated with all other trades.

.7 Where circuit numbers are shown adjacent to equipment, the electrical contractor shall 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, 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 Various package unit types of equipment are included in the work. It is the responsibility of the Contractor to familiarize himself with the requirements of the equipment vendor, and to include all materials and labor for a complete and working installation. In some cases this means that motors, valves, actuators, etc need to be wired and connected in the field. The Contractor shall include all costs to perform such services as part of his tender submittal. Coordination between the equipment vendor and the Contractor shall be performed prior to tender bid closing date, and all costs shall be included in the tender. Request for extras due to lack of coordination between the Contractor and the equipment vendors will not be accepted.

.10 These specifications along with the drawings and specifications of all other divisions shall be considered as an integral part of the drawing package. Any item or subject omitted from the specifications or the drawings but which is mentioned or reasonably specified in the drawings or specifications of other divisions, shall be considered as properly and sufficiently specified and shall be provided.

.11 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.

.12 Provide all items and Work that are not shown or specified but which are reasonably necessary to complete the Work.

.13 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 a Bid, in accordance with B4.

.14 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. Re-wire 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.

.15 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.

.16 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.

1.4 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 Provide these services for such period, and for as many visits as necessary, to put equipment in operation and to ensure that the City operating personnel are conversant with all aspects of its care and operation.

1.5 PERMITS, FEES, AND INSPECTION

.1 Submit to the Electrical Inspection Department and Supply Authority the necessary number of Drawings and Specifications required for examination and approval prior to commencement of the Work.

.2 Pay associated fees.

.3 Notify the Contract Administrator of changes required by Electrical Inspection Department and Supply Authority prior to making changes.

.4 Furnish a Certificate of Final Inspection and approvals from the Electrical Inspection Department and Supply 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 the Electrical Inspection Department and Supply Authority.

.3 Minimum enclosure type to be used is NEMA 12 unless otherwise specified.

1.7 ELECTRICAL EQUIPMENT MODIFICATION

.1 Where electrical equipment is field modified, arrange for special inspection from the Electrical Inspection Department and Supply Authority and pay all associated fees.

1.8 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.

1.9 EQUIPMENT IDENTIFICATION

.1 Identify electrical equipment with nameplates as follows:

.2 Nameplates:

.1 Lamicoid 3 mm thick plastic lamicoid nameplates, white face, black lettering, 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	6 mm high letters
Size 8	35 x 100 mm	3 lines	5 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.

1.10 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings on both ends of phase conductors of feeders and branch circuit wiring.

.1 Wire tags to be heat shrink type with black letters on white background.

.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.

1.11 MANUFACTURERS AND CSA LABELS

.1 Visible and legible, after equipment is installed.

1.12 WARNING SIGNS

.1 As specified and to meet requirements of the Electrical Inspection Department and Supply Authority and the Contract Administrator.

.2 Lamicoid 3 mm thick plastic engraving sheet, red face, white core, mechanically attached with self tapping screws, 20mm text.

1.13 WALL MOUNTED DRAWINGS

.1 Provide drawings in plexiglass holder adjacent to the main electrical distribution at both the McPhillips Pumping Station and the Tache Booster Pumping Station.

.1 Plexiglass holder to be designed for the purpose and allow for easy replacement of the drawing.

.2 Size: 432 x 279 mm minimum size.

.2 Drawings to be provided:

.1 1-0640B-E0001-001 Single Line Diagram
.2 1-0640B-E0006-001 Single Line Diagram
.3 1-0640B-E0007-001 Single Line Diagram
.4 1-0640C-E0003-001 Single Line Diagram
.5 1-0640M-E0002-001 Single Line Diagram
.6 1-0640M-E0030-001 Single Line Diagram
.7 1-0640M-E0032-001 Single Line Diagram
.8 1-0640M-E0034-001 Single Line Diagram
.9 1-0640M-E0036-001 Single Line Diagram
.10 1-0640M-E0046-001 Single Line Diagram
.11 1-0640M-E0047-001 Single Line Diagram
.12 1-0660M-E0007-001 Single Line Diagram

1.14 LOCATION OF OUTLETS

.1 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

1.15 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 For mounting heights, equipment to be mounted in accordance with Code requirements.

.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: 1800mm to top
.2 Light switches: 1420mm to top
.3 Wall receptacles: 900mm to top
.4 Control panels: 1800mm to top

.5 Emergency lights: 2400mm (minimum)

.6 Emergency stop switches: 1500mm to top

.7 Motor disconnect switches: 1800mm to top

.8 Fire Alarm Devices: In accordance with Code Requirements

1.16 CONDUIT AND CABLE INSTALLATION

.1 Sleeves through concrete: schedule 40 galvanized steel pipe, sized for free passage of conduit.

.2 For wall, partitions, and ceilings the sleeve ends shall be flush with the finish on both sides but for floors they shall extend 100 mm above finished floor level.

.3 Fire stop opening with ULC approved assembly for the installation conditions.

1.17 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 apprentice 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.

1.18 TESTING

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

.2 Perform tests on all electrical and instrumentation in accordance with the latest of NETA Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.19 SUBMITTALS

.1 Prior to delivery of any products to Site and sufficiently in advance of requirements to allow ample time for checking, submit Shop Drawings and submittals 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 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.

.4 CAN/CSA-C22.2 No. 239, Control and Instrumentation Cables.

1.2 SUBMITTALS

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

Part 2 Products

2.1 GENERAL

.1 Wire: to CAN/CSA-C22.2 No. 38

.2 Conductors:

.1 Size as indicated. Minimum size for power wires: 12 AWG unless noted otherwise on the Drawings.

.2 Stranded for 10 AWG and larger and as specifically indicated herein.

.3 All conductors to be copper.

.3 Voltage rating:

.1 Power circuits 480 V and less: 600 V

.2 Power circuits > 480 V: 1000 V

.3 Insulation of chemically cross-linked thermosetting polyethylene material rated RW90.

.4 Power supply conductor colour coding shall be in accordance with the Canadian Electrical Code. Wires sized 2 AWG and smaller to be factory-coded, taping will not be accepted.

.5 Control / Automation Wire Color Coding

.1 Utilize the following wire colours for the types of voltage/signals indicated:

.1	120VAC Line:	Black
.2	120VAC Control:	Red
.3	120VAC Neutral:	White
.4	24VDC Supply:	Blue
.5	24VDC Control:	Blue
.6	24VDC Common:	Brown

.7	4-20mA Signal:	White (+), Black (-)
.8	Protective Earth :	Green
.9	Signal Ground:	Green/Yellow

.6 Acceptable cable manufacturer: Belden, Nexans, General Cable, Southwire, or approved equal in accordance with B7.

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: chemically cross-linked thermosetting polyethylene rated type RW90, 1000 V.

.4 Inner jacket: polyvinyl chloride material.

.5 Armour: interlocking aluminum.

.6 Overall covering: polyvinyl chloride material.

.7 Fastenings:

- .1 One hole malleable iron / steel straps to secure surface cables 50 mm and smaller. Two hole steel straps for cables larger than 50 mm.
- .2 Channel type supports for two or more cables.
- .3 Threaded rods: 8 mm dia. to support suspended channels.
- .4 Stainless steel straps, hardware, channels, supports for Nema 4, Nema 4x, CSA enclosure type 4, CSA enclosure type 4X areas, all wet areas.

.8 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

.9 Acceptable cable manufacturer: Nexans, General Cable, Southwire, or approved equal in accordance with B7.

2.3 ACIC/CIC CONTROL CABLE

.1 Cable: to CAN/CSA-C22.2 No. 239, Control and Instrumentation Cables.

.2 Conductors: copper, stranded, size as indicated.

.3 Insulation: chemically cross-linked thermosetting polyethylene(XLPE) rated type RW90.

.1 Voltage: 600V insulation

.4 Shielding as indicated on the drawings:

.1 ISOS – Individually shielded pairs with overall shield

.2 OS – Overall shield

.3 A higher level of shielded cable may be substituted for unshielded or overall shielded cable, unless otherwise specified, provided that all appropriate shield grounding, as required by the Contract Administrator, is performed. All subsequent related changes, such as required conduit size, fittings, etc, are the responsibility of the Contractor.

.5 Armour Type: Aluminum Interlocked

.6 RoHS compliant.

.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: 8 mm dia. to support suspended channels.

.4 Stainless steel straps, hardware, channels, supports for Nema 4, Nema 4x, CSA enclosure type 4, CSA enclosure type 4X areas, all wet areas.

.8 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.

.9 Acceptable cable manufacturer: Nexans, General Cable, Southwire, or approved equal in accordance with B7.

2.4 ETHERNET CABLE - SHIELDED & NON-ARMORED

.1 Requirements:

.1	Cable:	Industrial Grade Cat 6, 600V, Shielded
.2	Shield Design:	100 % coverage Foil Shielded
.3	Conductors:	4 pair, Bonded pair, 23 AWG, copper, solid.
.4	Insulation:	Polypropylene
.5	Operating temperature:	-40°C to 75°C
.6	Installation temperature:	-25°C to 75°C
.7	Flame test:	CSA FT4
.8	cUL, CMR, RoHS compliant.	
.9	Traction stress maximum:	177.928 N
.10	Minimum bending radius:	101.600 mm

.11 Manufacturer:

.1 Belden 7953A

.2 Or approved equal in accordance with B7.

2.5 FIRE ALARM WIRING

.1 Refer to Section 28 31 02 – Multiplex Fire Alarm Systems for details.

.2 Low energy, 300 V, FAS 105 shielded cable: minimum #16AWG (or larger), with PVC insulation.

.3 Overall aluminum /polyester foil shield, with tinned copper drain wire.

.4 All fire alarm cables shall be installed in a separate, dedicated conduit system.

.5 Acceptable cable manufacturer: Belden, Nexans, General Cable, Southwire, or approved equal in accordance with B7.

2.6 INSULATED GROUND CONDUCTORS

.1 Insulated copper ground conductors:

.1 Size: as indicated on the Drawings, but in no case smaller than CEC required sizes.

.2 Type: soft drawn, stranded, flexible, high conductivity

.3 Shall meet the requirements of ASTM B8.

.4 Insulation: chemically cross-linked thermosetting polyethylene (XLPE) material, rated RW90

.5 Flame Test Rating:

.1 CSA FT4 (if exposed)

.2 CSA FT1 (if entirely within conduit)

.6 Insulation voltage rating: 600V

.7 Colour: green or green with yellow stripes as indicated on the Drawings.

.2 Acceptable cable manufacturer: Belden, Nexans, General Cable, Southwire, or approved equal in accordance with B7.

2.7 BARE GROUND CONDUCTORS

.1 Bare copper ground conductors:

.1 Size: as indicated on the Drawings, but in no case smaller than CEC required sizes.

.2 Type: soft drawn, stranded, flexible, high conductivity.

.3 Shall meet the requirements of ASTM B8.

.2 Acceptable cable manufacturer: Belden, Nexans, General Cable, Southwire, or approved equal in accordance with B7.

2.8 CABLE / WIRE TAGS

.1 Cable and conduit tags to be Brady B33-7515-7643 or approval equal in accordance with B7.

.2 Wire tags to be Brady polyolefin wire marking sleeves, suitable for the wire size

.3 All marking shall be typewritten in permanent ink.

.4 Affix tags using plastic tie-wraps

Part 3 Execution

3.1 GENERAL

.1 Do not splice cables. A continuous length is required for all feeds.

.2 Install in accordance with the manufacturer's recommendations, observing requirements for minimum bending radius and pulling tensions.

.3 Install in conduit as per Section 26 05 34 - Conduits, Conduit Fastenings, and Fittings. Alternatively, for armored cabling, provide cable tray for cable installation.

.4 Exercise care in stripping insulation from wire. Do not nick conductors.

.5 Provide bonding conductors as required by code as a minimum, or larger if indicated in the Contract documents.

.6 Provide scanning, coring, and drilling for installation of all wires and cables through concrete or structural members. Ensure damage to structures or other systems does not occur.

3.2 INSTALLATION OF TECK CABLES

.1 Provide cable tray for all Teck 90 cable runs.

.2 Surface mount runs less than 2 meters in length for direct connections to motors / equipment provided that cabling does not interfere with access into space, or with maintenance of systems. Provide clamps spaced a maximum of 1 m apart.

.3 Perform an insulation-resistance test on each conductor, prior to termination, utilizing a megohmmeter with a voltage output of 1000 volts DC. Individually test each conductor with all other conductors and shields grounded. The test duration shall be one minute. Investigate resistances less than 50 megaohms or deviations between parallel conductors. Conductors with insulation resistance values, at one minute, less than 25 megaohms or that deviate from other similar conductors by more than 50% will be rejected.

3.3 INSTALLATION OF CONTROL AND INSTRUMENTATION CABLES

.1 Provide cable tray or conduit for all control cables. All non-armored cables shall be installed in conduit. Armored control cables shall be installed in cable tray.

.2 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.

.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.

.4 ACIC cable may be installed in cable tray, provided that:

.1 The cable tray does not contain power cables unless specifically authorized by the Contract Administrator in writing.

.2 The ACIC cable voltage rating is equal or greater than the highest voltage contained in the cable tray.

.5 Provide separation of cables from sources of noise, including other cables.

.1 For analog signals, provide separation distances as follows:

.1	120 VAC, 8 AWG and smaller:	100 mm
.2	120 VAC, >8 AWG:	300 mm
.3	600 VAC power:	300 mm
.4	VFD or other high harmonic cable:	300 mm in metallic conduit/600 mm other raceway
.5	Medium Voltage:	450 mm

.2 For control signals < 50V, provide separation distances as follows:

.1	120 VAC, 8 AWG and smaller:	50 mm
.2	120 VAC, >8 AWG:	300 mm
.3	600 VAC power:	300 mm
.4	VFD or other high harmonic cable:	300 mm in metallic conduit/600 mm other raceway
.5	Medium Voltage:	450 mm

.3 For 120 VAC control signals, provide separation distances as follows:

.1	120 VAC, 8 AWG and smaller:	none
.2	120 VAC, >8 AWG:	metal barrier or 150 mm
.3	600 VAC power:	metal barrier or 150 mm
.4	VFD or other high harmonic cable:	150 mm in metallic conduit/300 mm other raceway
.5	Medium Voltage:	450 mm

.4 Advise the Contract Administrator if these separations cannot be achieved.

3.4 INSTALLATION OF ETHERNET COPPER CABLES

.1 Where surface mounted, provide clamps spaced a maximum of 1 m apart, unless otherwise indicated.

.2 Provide separation of Ethernet cables from sources of noise, including other cables.

.1 Provide separation distances as follows:

.1	Instrumentation/Control < 50:	50 mm

.2	120 VAC, 8 AWG and smaller:	100 mm
.3	120 VAC, >8 AWG:	300 mm
.4	600 VAC power:	300 mm
.5	VFD or other high harmonic cable:	300 mm in metallic conduit/600 mm other raceway
.6	Medium Voltage:	450 mm

.2 Advise the Contract Administrator if these separations cannot be achieved.

.3 Ethernet cables shall be installed in conduit.

3.5 INSTALLATION OF FIRE ALARM CABLING:

.1 Install in conduit as per Section 26 05 34 - Conduits, Conduit Fastenings, and Fittings.

.2 Install conductors to be entirely independent of all other wiring. Do not enter raceway, boxes, or enclosures occupied by other wiring except where necessary to connect to power supply, communication circuit, or ancillary devices.

.3 Shields to be grounded at one end only (source end).

.4 For data communication link A (DCLA) fire alarm circuits, install primary wiring circuit independent and separate from the alternate wiring circuit wiring - in separate conduit system having a minimum separation of:

.1 300mm when installed vertically

.2 1200mm when installed horizontally

.5 In accordance with CAN/ULC-S524, for data communication link A (DCLA) fire alarm circuits, the primary wiring circuit and alternate wiring circuit may share the same conduit under specific strict installation scenarios, as follows:

.1 For a distance of less than 3000mm where the primary and return conductors enter or exit field devices, control unit or transponder enclosures.

.2 For single conduit drops to individual field devices.

.3 For single conduit drops to multiple field devices installed in a single room not exceeding 100m².

3.6 TERMINATIONS AND SPLICES

.1 Wire nuts are permitted only in the following circuits:

.1 Lighting circuits.

.2 Power receptacle and motor circuits.

.2 Terminate wiring on terminal blocks located inside junction boxes for other circuits:

.1 Fire alarm,

.2 Controls and instrumentation,

.3 Communications,

.3 Exercise care in stripping insulation from wire. Do not nick conductors.

.4 Strictly follow the manufacturer's instructions with regards to tool size and application methods of terminations and compounds.

.5 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 B7.

3.7 INSTALLATION IN CONDUIT

.1 Utilize cable grips, appropriately selected to accommodate the type and geometry of the cable.

.2 Utilize cable pulling lubricant, compatible with the cable and conduit.

3.8 CABLE INDENTIFICATION

.1 Provide cable tags at both ends for all cables.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

.1 ANSI/IEEE 837, Qualifying Permanent Connections Used in Substation Grounding.

.2 Canadian Standards Association, (CSA International)

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings and product data:

.1 Provide manufacturer's printed product literature and datasheets.

.2 Indicate connection details.

Part 2 Products

2.1 EQUIPMENT

.1 Grounding conductors: bare stranded copper, soft annealed, size as indicated.

.2 Insulated grounding conductors: green, type RW90.

.3 Grounding rod: copper clad steel, 21mm (3/4") diameter, length as indicated on the drawings – but in no case less than 10 feet long.

.4 Provide bonding of all existing (and new) bollards using a 2/0 AWG ground cable – these are not specifically shown on the drawings.

.5 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 connectors in accordance with manufacturer's instructions.

.2 Protect exposed grounding conductors from mechanical injury.

.3 Use mechanical connectors for grounding connections to equipment provided with lugs.

.4 Use Burndy compression connectors, or approved equal in accordance with B7, for all grounding splices and terminations, unless otherwise indicated.

.5 Soldered joints not permitted.

3.2 EQUIPMENT GROUNDING AND BONDING

.1 Install grounding connections to transformers.

.2 Install bonding connections to all equipment in accordance with minimum code requirements. Exceed minimum requirements where sizes and materials deviate from the code.

.3 For systems considered to be a “Station” or substation in accordance with the Canadian Electrical Code provide bonding of all metallic systems and equipment in accordance with the CEC, and **as directed by the AHJ**. **Not all bonding is shown on the Drawings. Minimum size is 2/0 AWG. Note that the electrical room at McPhillips Regional Pump Station WILL be considered a “station”, and therefore Section 36 of the CEC does apply, and all metallic components (existing and new) shall be bonded to ground as part of this work.**

.4 Include a separate green bonding wire in all power conduits including branch circuit wiring sized according to the largest power conductor in the conduit:

- .1 8 AWG green ground wire for up to 4 AWG power conductors.
- .2 6 AWG green ground wire for up to 2 AWG power conductors.
- .3 Larger as required by the Canadian Electrical Code.

.5 Install grounding and bonding connections for system, which include, but are not limited to communications, sound, fire alarm, controls, instrumentation, and intercommunication systems.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Perform tests before energizing electrical system.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings and product data:

.1 Provide manufacturer's printed product literature and datasheets.

.2 Indicate connection details.

Part 2 Products

2.1 FRAMING AND SUPPORT SYSTEM

.1 Materials:

.1 Indoors, dry locations: Conduit support structures shall employ an aluminum strut framing system together with the manufacturer’s connecting components and fasteners for a complete system.

.2 Exterior and wet locations: 316 stainless steel.

.2 Accessories:

.1 Exterior and wet locations: 316 stainless steel.

.2 Nuts, bolts, washers, machine screws, fittings, accessories: 316 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 B7.

2.3 SPACERS

.1 PVC coated malleable metal spacers, CSA approved for the purpose.

.2 Aluminum or stainless steel (wet 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 Secure equipment to solid masonry, tile, or 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, or cable clamps designed as accessories to basic channel members.

.5 Maximum spacing between conduit supports:

.1	16mm conduit:	1.0 m
.2	21mm conduit:	1.5 m
.3	27mm conduit	1.5 m
.4	35mm conduit	2.0 m
.5	41mm conduit and larger	2.5 m

.6 Fasten exposed conduit or cables to building construction or support system using straps.

- .1 One-hole straps to secure surface conduits and cables 50 mm and smaller.
- .2 Two-hole straps for conduits and cables larger than 50 mm.

.7 Suspended support systems.

- .1 Support individual cable or conduit runs with 8 mm dia threaded rods and spring clips.
- .2 Support two or more cables or conduits on channels supported by 8 mm dia threaded rod hangers where direct fastening to building construction is impractical.

.8 For surface mounting of two or more conduits use channels for supports of the conduits.

.9 For surface mounting of conduit on a concrete surface, provide PVC coated conduit spacers. Do not mount conduit directly onto concrete surfaces.

.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 where there is no wall support.

.13 Do not use wire lashing or perforated strap to support or secure 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 the 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 Station in accordance with the Canadian Electrical Code.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and components for splitters, junction, pull boxes, and cabinets.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CAN/CSA-C22.2 No.76, Splitters

1. CSA C22.2 No. 94.1, Enclosures for Electrical Equipment, Non-Environmental Considerations.
2. CSA C22.2 No. 94.2, Enclosures for Electrical Equipment, Environmental Considerations.
3. UL 508A, Standard for Industrial Control Equipment.

1.3 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings and product data:

.1 Provide manufacturer's printed product literature and datasheets.

.2 Indicate all wiring and connection details.

Part 2 Products

2.1 JUNCTION AND PULL BOXES

.1 Junction boxes and pull boxes installed in dry, non-hazardous, non-corrosive type of locations:

.1 Use CSA enclosure type 2 or greater for normal dry area.

.2 Use sealed, gasketted, CSA enclosure type 12 for sprinklered areas.

.3 To be constructed of sheet metal for normal dry areas.

.4 To be constructed of rigid PVC, FT4 materials for wet corrosive area (McPhillips Chlorine Building Chlorine Building Tank Room and Equipment Room).

.5 For boxes 100 mm square and smaller, screw-on type, flat covers.

.6 For boxes larger than 100mm square, box covers are to have a continuous piano hinge and clamps for opening.

.2 Junction boxes and pull boxes for wet or wet and corrosive locations:

.1 CSA enclosure type 4X, gasketted.

.2 Constructed of rigid PCV, FT4 rated materials.

.3 Utilize 316 stainless steel bolts, washers and mounting hardware.

2.2 CABINETS

.1 Where indicated on the drawings, provide cabinets in accordance with the bill of materials shown on the drawings.

.2 Cabinets installed in dry, non-hazardous, non-corrosive process locations:

.1 To CSA C22.2 No. 94.1 94.2 and UL 508A

.2 CSA enclosure type 12 or greater, gasketted.

.3 To be constructed of painted, mild steel.

.4 Back-plate with offsets for installation of devices.

.5 Continuous piano hinge, door with quarter turn latch and handle.

.3 Cabinets installed in exterior or wet, or corrosive locations (including in the McPhillips Chlorine Building Tank Room and Equipment Room):

.1 To CSA C22.2 No. 94.1, 94.2 and UL 508A

.2 Refer to the drawings for acceptable make / model / construction materials. In the absence of this information, comply with:

.1 CSA enclosure type 4X, gasketted.

.2 To be constructed of 316 stainless steel.

.3 Back-plate with offsets for installation of devices.

.4 Continuous piano hinge, door with quarter turn latch and handle.

Part 3 Execution

3.1 JUNCTION, PULL BOXES, AND CABINETS INSTALLATION

.1 Utilize CSA enclosure type 4X for:

.1 All exterior mounted equipment.

.2 All equipment located in the Chlorine Building Tank Room and Equipment Room (at McPhillips Station).

.3 All wet locations.

.2 Install pull boxes in inconspicuous but accessible locations.

.3 Mount cabinets with top not higher than 2 m above finished floor except where indicated otherwise.

.4 Install junction and pull boxes so as not to exceed 30 m of conduit run between devices. Add additional boxes so to meet all code requirements.

.5 Cabinets to be either floor mounted or cantruss back-mounted. For cantruss back-mounted cabinets, provide cantruss support structures behind cabinet for mounting.

3.2 IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install size 3 identification labels indicating system voltage and phase.

.3 Install a permanent label or lamacoid on the cover of all junction boxes indicating the circuit(s) contained within.

.1 Example: C711-13 (Panelboard PNL-C711, circuit 13)

END OF SECTION

Part 1 General

1.1 RELATED SECTIONS

.1 Section 01 33 00 Submittal Procedures

.2 Section 26 05 01 Common Work Results – Electrical

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.1, Canadian Electrical Code, Part 1.

Part 2 Products

2.1 OUTLET AND CONDUIT BOXES GENERAL

.1 Size boxes in accordance with CSA C22.1.

.2 Size outlet boxes as required to accommodate wiring devices.

.3 102 mm square or larger outlet boxes as required.

.4 Gang boxes where wiring devices are grouped.

.5 Provide blank stainless steel cover plates for boxes without wiring devices.

.6 Combination boxes with barriers where outlets for more than one system are grouped.

.7 Knock-out covers for sealing penetration holes.

2.2 BOXES FOR EMT CONDUIT

.1 General Requirements:

1. Stainless steel cover plates
2. To CSA 22.2 No. 18.

.2 Junction and Pull Boxes:

1. 102 mm (4”) square, galvanized steel boxes with knockouts.
2. Raised ground screw bump

.3 Device/Utility box, Surface Ceiling Mount:

.1 Application: for surface ceiling mounting of devices

.2 Material: drawn steel, galvanized

.3 Raised ground screw bump

.4 102 mm (4”) round or octagonal boxes with knockouts

.5 Depth: as required

.4 Device/Utility boxes, Surface Wall Mount:

1. Application: for surface wall mounting of light switches and receptacles.
2. Material: drawn steel, galvanized
3. Raised ground screw bump
4. Depth: 47.625 mm (1 7/8") minimum
5. Manufacturer / Model:
   a. Thomas & Betts Iberville BC1110
   b. Or approved equal in accordance with B7.

2.3 BOXES FOR PVC CONDUIT

.1 General Requirements:

.1 Mounting lugs as required.

.2 To CSA C22.2 No. 18.

.2 Junction and Pull Boxes:

.1 102 mm (4") square, PVC boxes with non-threaded hubs

.3 Device/Utility Boxes, Surface Ceiling Mount:

.1 Application: for surface ceiling mounting of devices

.2 102 mm (4") round or octagonal, PVC boxes with non-threaded hubs

.4 Device/Utility Boxes, Surface Wall Mount:

.1 Application: for surface mounting of light switches and receptacles

.2 Material: PVC

.3 Grounding strap.

.4 Light switches to be supplied with PVC toggle cover

.5 Manufacturer / Model:

.1 Thomas & Betts Carlon FS or FD series

.2 Or approved equal in accordance with B7.

2.4 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 General

.1 Provide boxes sized as required by the Canadian Electrical Code.

.2 Support boxes independently of connecting conduits.

.3 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Do not install reducing washers.

.4 Install fittings in accordance with the manufacturer's recommendations.

.5 Fill boxes with paper, sponges or foam or similar approved material to prevent entry of debris during construction. Remove upon completion of work.

.6 Provide correct size of openings in boxes for conduit, mineral insulated and armoured cable connections. Reducing washers are not allowed.

.7 Install all outlets surface mounted as required for the installation.

.8 Do not distort boxes during installation. If boxes are distorted, replace with new boxes.

.9 Install vapour barrier material to surround and seal all outlet boxes located on exterior walls of building. Maintain wall insulation.

.10 Vacuum clean interior of outlet boxes before installation of wiring devices.

.11 Extension rings shall not be utilized to accommodate conductor fill requirements.

.12 Confirm the direction of door swings on site, to confirm that outlet boxes for light switches are located on the latch side of the door.

.13 Provide lamacoid for all device boxes indicating the circuit(s) contained within.

.14 Provide permanent lamacoid label for all device boxes indicating the circuit(s) contained within.

.1 Example: C711-13 (Panelboard PNL-C711, circuit 13)

.2 Non-hazardous, dry office areas:

.1 Provide commercial series, sheet metal outlet boxes and fittings.

.2 Outlet boxes that penetrate opposite sides of a wall shall be offset to maintain the integrity of the fire separation. Boxes shall not be installed back-to-back.

.3 Exterior or exterior, wet, or corrosive areas (including the McPhillips Chlorine Building):

.1 Provide PVC outlet boxes, conduit boxes, and fittings.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA)

- .1 CAN/CSA C22.2 No. 18, Outlet Boxes, Conduit Boxes, and Fittings and Associated Hardware.
- .2 CSA C22.2 No. 45.1, Electrical Rigid Metal Conduit - Steel.
- .3 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
- .4 CSA C22.2 No. 211.2, Rigid PVC (Un-plasticized) Conduit.
- .5 CAN/CSA C22.2 No. 227.3, Flexible Non-metallic Tubing.

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings and product data:

- .1 Provide manufacturer's printed product literature and datasheets.

Part 2 Products

2.1 GENERAL

.1 Material Requirements:

- .1 Outdoor and Buried: PVC
- .2 Main Floor, Normal Area - Instrumentation / Process Related: Electrical Metallic Tubing (EMT)
- .3 Main Floor, Normal Area – Lighting, Power, Receptacles, Fire Alarm: EMT
- .4 Basement Floor, Normal Area – Lighting, Power, Receptacles, Fire Alarm: EMT
- .5 Chlorine Building Tank Room and Equipment Room: Rigid PVC, FT4 rated

2.2 ELETRICAL METALLIC TUBING

.1 Meet the requirements of C22.2 No. 211.2.

.2 Materials: steel, electroplated outside finish, aluminum painted inside walls.

.3 Minimum conduit size: 21 mm, unless specifically indicated on the Drawings or approved by the Contract Administrator.

2.3 RIGID METAL CONDUIT

.1 Threaded metal conduit, meets CSA C22.2 No. 45.1, rigid metal conduit - steel

.2 Minimum conduit size: 21 mm, unless specifically indicated on the Drawings or approved by the Contract Administrator.

2.4 RIGID PVC CONDUIT

.1 Meets CSA C22.2 No. 211.2.

.2 Minimum conduit size: 21 mm, unless specifically indicated on the Drawings or approved by the Contract Administrator.

2.5 FLEXIBLE METAL CONDUIT

.1 To CSA C22.2 No. 56, liquid-tight flexible metal.

.2 Minimum conduit size: 21 mm, unless specifically indicated on the Drawings or approved by the Contract Administrator.

2.6 CONDUIT FASTENINGS

.1 One hole steel straps to secure surface conduits 50 mm and smaller. Two hole steel straps for conduits larger than 50 mm.

.2 Strap material to match conduit material.

.3 Beam clamps to secure conduits to exposed steel work.

.4 Channel type supports for two or more conduits or as shown in the Drawings.

.5 316 stainless steel threaded rods, 8 mm dia., to support suspended channels.

2.7 CONDUIT FITTINGS

.1 Fittings: manufactured for use with conduit specified. Coating: same as conduit.

.2 All fittings to be liquid and dust tight.

.3 Enclosure Connections

.1 Connections in dry locations (bottom or side)

.1 Locknuts inside and outside enclosures.

.2 Insulated bushings Thomas & Betts Series 222 or approved equal in accordance with B7.

.2 Connections in wet locations and tops of enclosures in dry locations

.1 Liquid-tight threaded hubs.

.2 Insulated bushings Thomas & Betts Series 222 or approved equal in accordance with B7.

.3 Utilize insulated grounding bushings at all non-metallic enclosure entries for metallic conduit, or as required for bonding in accordance with Canadian Electrical Code and good practice.

.4 Elbows:

.1 Utilize factory elbows for 27mm and larger conduits.

.5 Threaded Hubs for Metal Conduit

.1 Liquid and dust tight with insulated throat.

.2 Approved products

.1 Thomas & Betts "Bullet Hub" 370AL Series.

.2 Or approved equal in accordance with B7.

.6 Fittings for Metal Conduit

.1 Cast metal.

.2 Gasketted covers.

.3 Approved products

.1 Crouse-Hinds Canada Ltd. "Condulet" series.

.2 Or approved equal in accordance with B7.

.7 Sealing Compound. As recommended by manufacturer.

2.8 CONDUIT SPACERS

.1 PVC coated malleable iron spacers, CSA approved for the purpose.

.2 Aluminum channel may be utilized where conduits are grouped, however a non-metallic spacer must be provided between the aluminum channel and concrete.

2.9 FISH CORD

.1 Polypropylene

2.10 CONDUIT TAGS

.1 Cable and conduit tags to be Brady B33-7515-7643 or approval equal in accordance with B7.

.2 All marking shall be typewritten in permanent ink.

.3 Affix tags using plastic tie-wraps

Part 3 Execution

3.1 ROUTING

.1 Locate conduits containing communication and low voltage conductors away from conduits containing power wiring.

.2 Route conduits on existing or new pipe rack or suspended channels where possible.

.3 Avoid routes that would interfere with any potential maintenance activities.

.4 Where not specifically shown in detail on the Drawings, review proposed conduit routing with the Contract Administrator prior to installation. Comply with all routing changes requested by the Contract Administrator.

3.2 INSTALLATION - GENERAL

.1 Provide conduit tags, for all conduits, at both ends, plus at every pull box and junction box.

.2 Install conduits to conserve headroom in exposed locations and cause minimum interference in spaces through which they pass.

.3 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.

.4 Remove and replace blocked conduit sections. Do not use liquids to clean out conduits.

.5 Do not include more than the equivalent of four (4) quarter bends. Provide pull boxes as required.

.6 Ensure electrical continuity in all metallic conduit systems.

.7 All conduits shown exposed in finished areas is to be free of unnecessary labels and trademarks.

.8 Seal conduits with duct seal where conduits are run between heated and unheated areas. Where conduits, cables, or cable trays pierce fire separations, seal openings with Dow Corning 3-6548 sealant. Seal all conduits entering or leaving exterior areas with approved seals.

.9 Where conduits pass through walls, group and install through openings. After all conduits shown on the Drawings are installed, close wall openings with material compatible with the wall construction, and provide fire stopping.

.10 For metallic conduits, install within a galvanized steel, schedule 40 sleeve for holes / penetrations through concrete walls and slabs.

.11 Install fish cord in empty conduits.

.12 Dry conduits out before installing wire.

.13 Install ground bonding wire in all conduits. Size bond / ground wire as per Canadian Electrical Code.

.14 Underground Conduits

.1 Slope conduits to provide drainage.

.15 Surface Conduits

.1 Run parallel or perpendicular to building lines.

.2 Group conduits wherever possible on suspended or surface channels.

.3 Provide a minimum space of 12 mm between conduits.

.4 Do not pass conduits through structural members except as indicated.

.5 Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

.6 Install spacers as required to provide a space between the conduits and the supporting surface, with a minimum space as follows:

.1 Above grade spaces not classified as Canadian Electrical Code Category 1 or 2:

.1 Drywall / Wood surfaces: no space required

.2 Masonry / concrete surfaces: 6 mm

.2 Below grade spaces: 12 mm

.16 Colour Coding

.1 Apply plastic tape or paint colour coded bands to conduits at points where conduit or cable enters wall, ceiling, or floor, and at 5 m intervals.

.2 Bands: 38 mm wide prime colour and 19 mm wide auxiliary colours.

.3 Band colours as per the following table:

System	**Prime Band**	**Aux. Band**
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

3.3 PVC CONDUIT

.1 Concrete Penetrations:

.1 Seal and firestop penetration around conduit with ULC approved assembly for the installation conditions.

.2 Maximum spacing between supports for rigid PVC conduit:

.1	27mm conduit	0.75 m
.2	35mm conduit	0.75 m
.3	41mm conduit	1.2 m
.4	53mm conduit	1.5 m
.5	63mm conduit	1.5 m
.6	78mm conduit	1.5 m
.7	91mm conduit and larger	2.0 m

3.4 METAL CONDUIT

.1 Bend conduit cold. Replace conduit if kinked or flattened more than 1/10th of its original diameter.

.2 Mechanically bend conduits over 19 mm in diameter.

.3 Concrete Penetrations:

.1 Sleeves for Conduit

.1 Install schedule 40 galvanized steel pipe, sized for free passage of conduit.

.2 Seal and firestop penetration around conduit with ULC approved assembly for the installation conditions.

.3 For wall, partitions, and ceilings the sleeve ends shall be flush with the finish on both sides but for floors they shall extend 50 mm above finished floor level or housekeeping pad level.

.4 Maximum spacing between supports for rigid metallic conduit:

.1	16mm conduit:	1.0 m
.2	21mm conduit:	1.5 m
.3	27mm conduit	1.5 m
.4	35mm conduit	2.0 m
.5	41mm conduit and larger	2.5 m

3.5 LIQUID-TIGHT FLEXIBLE CONDUIT

.1 Use as raceways at all motors, pipe-mounted control devices, and other devices subject to movement or water.

.2 At all motors, provide a short length before connecting to the motor terminal box. Minimum length shall be 450 mm plus four times the conduit diameter.

.3 Provide a separate ground wire within the flexible conduit, bonded to motor frames and system ground.

3.6 INSTALLATIONS IN CATEGORY 1 LOCATIONS

.1 Arrange to provide drainage at frequent intervals to suitable locations.

.2 Equip with approved fittings to permit the moisture to drain out of the system.

.3 Install the conduit with a minimum of 12 mm space from the supporting surface.

.4 Install every joint to be water-tight.

.5 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.

3.7 INSTALLATIONS IN CATEGORY 2 LOCATIONS

.1 Comply with all requirements of Category 1 locations.

3.8 INSTALLATIONS IN CATEGORY 2 WET LOCATIONS

.1 Comply with all requirements of Category 1 locations.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association, (CSA International)

.2 Insulated Cable Engineers Association, Inc. (ICEA)

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Shop Drawings and product data:

.1 Provide manufacturer's printed product literature and datasheets.

Part 2 Products

2.1 CABLE PROTECTION

.1 38 x 190 mm planks pressure treated, water repellent preservative.

Part 3 Execution

3.1 DIRECT BURIAL OF CABLES

.1 After sand bed specified in Section 31 23 10 - Excavating, Trenching, and Backfilling is in place, lay cables maintaining a 75 mm clearance from each side of trench to nearest cable. Do not pull cable into trench.

.2 Provide offsets for thermal action and minor earth movements. Offset cables 150 mm for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Underground cable splices are not acceptable.

.4 Minimum permitted radius at cable bends for rubber, plastic, or lead covered cables is 8 times the diameter of the cable; for metallic armoured cables, 12 times the diameter of the cables or in accordance with manufacturer's instructions.

.5 Cable separation:

.1 As shown on Drawings.

.6 After sand protective cover specified in Section 31 23 10 - Excavating, Trenching, and Backfilling is in place, install continuous row of 38 x 190 mm pressure treated planks as indicated to cover length of run.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 InterNational Electrical Testing Association (NETA) Acceptance Testing Specifications, 2017 (ATS-2017)

1.2 TESTING REPORT

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

.2 A draft individual inspection and test report shall be completed for each piece of equipment and sent to the Contract Administrator for review a maximum of one month after the completion of the inspections at the Site.

.3 Upon acceptance of all the individual inspection and test reports, prepare and submit to the Contract Administrator for review a draft overall inspection and test report that details all investigations and tests.

.4 The report shall include the following:

- .1 Summary of project.
- .2 Testing equipment used.
  - .1 Detail the type, manufacturer, model, and last calibration date of all testing equipment.
- .3 Description of equipment tested.
- .4 Description of all tests.
- .5 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.
- .6 Itemized list of all repaired deficiencies which shall include:
  - .1 Detailed description of the deficiency.
  - .2 The cost associated with the deficiency repair.
- .7 Itemized list of all un-repaired deficiencies encountered which shall include:
  - .1 Detailed description of the deficiency.

.5 The overall inspection and test report shall be neat and organized. Any omissions, inconsistencies, or incomplete work identified by the Contract Administrator shall be corrected and incorporated into the overall inspection and test report in the appropriate section and completely resubmitted.

.6 The Contractor shall furnish three paper copies and two electronic copies of the final overall inspection and test report.

.1 The electronic copies of the report, including the test forms, shall be provided in both PDF format and in native format (i.e Microsoft Word).

.7 The final overall inspection and test report shall be submitted a maximum of two weeks after the Contractor receives the mark-up of the draft overall inspection and test report from the Contract Administrator.

Part 2 Products

2.1 NOT USED

.1 Not Used

Part 3 Execution

3.1 SCOPE OF TESTING

.1 All Motor Control Centres (MCCs), including but not limited to:

.1 Surge Protector
.2 Power Meter
.3 CTs
.4 PTs (if present)
.5 Motor Starters
.6 VFDs
.7 Circuit Breakers
.8 Controls and communication equipment

.2 Transfer Switches

.3 Genset Load Bank

.4 All transformers greater than 45 kVA.

.5 Panelboards and CDPs greater than 100A.

.6 Fire alarm system

.7 Emergency lighting

.8 Grounding system

.9 All power cables greater than #6 AWG.

3.2 INPECTION, TESTING, AND MAINTENANCE PROCEDURES

.1 General

.1 All tests shall be performed based on NETA standard ATS-2017. Where manufacturer's specifications, tolerances, and/or published data are not available, refer to the appropriate tables in ATS-2017.

.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 individual inspection and test report.

.8 Where corrections or repairs are made, record both as found/as left test readings on the inspection form. 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 individual inspection and test 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 individual inspection and test report.

.8 The inspection forms may be updated during the Work by the City or the 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.

Table 260805-1

Insulation Resistance Correction Factors (20 °C)

Measured Temperature (°C)	Oil Immersed Insulation	Solid Insulation
-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

Table 260805-2

Insulation Resistance Correction Factors (40 °C)

Measured Temperature (°C)	Oil Immersed Insulation	Solid Insulation
-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, R_C = Resistance at corrected temperature.

R_M = Resistance at measured temperature.
T_C = Temperature to correct to in °C.
T_M = Measured temperature in °C.
T_K = Temperature Resistance Constant
(234.5 °C for copper, 226.0 °C for aluminum)

3.3 CABLES, < 1000 V (ALSO FEEDERS IN CONDUIT)

.1 Inspection and testing shall be comprised of the following:

.1 For cables/wires 4/0 AWG or larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate and correct values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.2 Torque all accessible bolted electrical connections.

.3 Inspect compression applied connectors for correct cable match and indentation.

.4 Inspect grounding and cable/conduit support.

.5 Verify that visible cable bends meet or exceed the minimum allowable bending radius.

.6 Measure length of cable/conduit and record in meters.

.7 If cables/wires are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

.8 Perform an insulation-resistance test on each 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 300 V rated cables, and 1000 Vdc for 600 V or 1000 V rated cables.

3.4 MOTOR CONTROL CENTRE AND DISTRIBUTION SWITCHBOARDS, 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect the MCC/switchboard physical, electrical, and mechanical condition including evidence of moisture or corona.

.3 Verify appropriate anchorage, required area clearances, physical damage, and correct alignment.

.4 Inspect all doors, panels, and sections for dents, holes, fit, and missing hardware.

.5 Verify that fuse and / or circuit breaker sizes and types correspond to Drawings and coordination study as well as to the circuit breaker's address for microprocessor-communication packages.

.6 Verify that current and potential transformer ratios correspond to Drawings.

.7 Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.8 Confirm correct operation and sequencing of electrical and mechanical interlock systems.

.9 Attempt closure on locked-open devices. Attempt to open locked-closed devices.

.10 Make key exchange with all devices included in the interlock scheme as applicable.

.11 Vacuum debris from the interior of the MCC / switchboard. Clean off all dust and adhesive residue from the MCC / switchboard.

.12 Use appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

.13 Inspect insulators for evidence of physical damage or contaminated surfaces.

.14 Verify correct barrier and shutter installation and operation.

.15 Exercise all active components.

.16 Inspect all mechanical indicating devices for correct operation.

.17 Verify that filters are in place and / or vents are clear.

.18 Test operation, alignment, and penetration of instrument transformer withdrawal disconnects, current-carrying and grounding contacts.

.19 Perform point to point ground-resistance tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and / or derived neutral points. Investigate point-to-point resistance values which exceed 0.5 ohm.

.20 Perform insulation-resistance tests at 1000 Vdc for one minute on each bus section, phase-to-phase and phase-to-ground.

.21 Inspect all surge arrestors if available.

.22 Inspect control power transformers.

.23 Inspect all current instrument transformers.

.24 Inspect potential transformers.

.25 Inspect all metering devices.

.26 Inspect and test air circuit breakers.

.27 Inspect and test protective relays.

.28 Inspect and test all associated motor starters.

.29 Inspect and test all moulded case feeder breakers. Feeder breakers with a frame size less than 250A, and without long, short, or ground fault settings, may be recorded on the MCC/Switchboard inspection form. Record test results on other breakers on the appropriate inspection form.

.1 Inspect and test all capacitors.

.2 Perform a system function test to prove the correct interaction of all sensing, processing, and action devices. Perform system function tests upon completion of the maintenance tests defined, as system conditions allow.

.30 Perform tests for the purpose of evaluating performance of all integral components and their functioning as a complete unit within each MCC cell.

.31 Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.

.32 Verify the correct operation of all sensing devices, alarms, and indicating devices.

.33 Affix an inspection sticker or inspection tag to each MCC line-up or switchboard in an appropriate place so that it will be conspicuous to all authorized personnel. This inspection notice must include, but is not limited to, equipment identifier, testing company name, date of inspection, and the inspector's name. The sticker shall not obscure any equipment nameplates, readouts, or indicators.

3.5 SURGE ARRESTORS, LOW VOLTAGE

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, grounding, and required clearances.

.4 Clean the unit.

.5 Verify that arrestors are electrically connected in their specified configuration.

.6 Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.7 Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.

.8 Verify that the stroke counter, if present, is correctly mounted and electrically connected.

.9 Perform insulation-resistance tests for one minute from each phase terminal to the case.

.10 Equipment rated >= 600V, utilize a test voltage of 1000 VDC.

.11 Equipment rated < 600V, utilize a test voltage of 500 VDC.

.12 Test the grounding connection. Resistance between the arrester ground terminal and the ground system should be less than 0.5 ohm.

3.6 CONTROL POWER TRANSFORMERS, < 1000 V

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

.3 Verify that primary and secondary fuse ratings or circuit breakers match available Drawings. Where Drawings are not available, note fuses that appear to be sized incorrectly, based upon application of the Canadian Electrical Code. Mark fuse sizes and type on the Drawings, where not shown.

.4 Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Test voltages shall be:

.1 windings < 250 V: 500 Vdc

.2 windings > 250 V: 1000 Vdc

3.7 CURRENT INSTRUMENT TRANSFORMERS

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect physical and mechanical condition.

.3 Ensure that CT shorting bars are removed or installed as required.

.4 Verify that current circuits are grounded and have only one grounding point in accordance with ANSI/IEEE C57.13.3.

.5 Perform an insulation resistance test of the current transformer primary and secondary windings, and wiring to ground at 1000 Vdc. Do not perform this test on solid-state devices. Investigate any resistance values less than 25 megaohms.

.6 Perform a polarity test of each current transformer in accordance with ANSI/IEEE C57.13.1.

.7 Perform a ratio-verification test using the voltage or current method in accordance with ANSI/IEEE C57.13.1. Note any ratio accuracies not within 0.5% of nameplate or manufacturer's published data.

.8 Perform an excitation test on transformers used for protection or relaying applications in accordance with ANSI C57.13.1.

3.8 METERING DEVICES, DIGITAL

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect physical and mechanical condition.

.3 Torque all bolted connections.

.4 Verify accuracy of voltage and current at a minimum of two points each.

.5 If required, calibrate meters in accordance with manufacturer's published data.

3.9 MOTORS, INDUCTION, AC, 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging. Air baffles and filter media should be clean. Cooling fans should operate. Slip ring wear and brushes should be within manufacturer's tolerances for continued use. Brush rigging should be intact.

.5 Clean the unit.

.6 Inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.7 Verify the application of appropriate lubrication and lubrication systems.

.8 Verify the absence of unusual mechanical or electrical noise or signs of overheating.

.9 Perform a rotation test to insure correct shaft direction.

.10 Perform insulation-resistance tests in accordance with ANSI/IEEE Standard 43. Test voltage shall be in accordance with manufacturer's published data or 500 Vdc.

.1 Where possible, test each winding separately. Ground all windings not under test.

.2 Ensure all cables and accessories are disconnected during the test.

.3 For motors <= 150kW (200 HP), the test duration is to be one (1) minute. Calculate the dielectric absorption ratio.

.4 For motors > 150kW (200 HP), the test duration is to be ten (10) minutes. Calculate the dielectric absorption ratio and polarization index.

.5 Correct test results to 40 °C.

.6 Investigate readings below 100 megaohms. Investigate dielectric absorption ratios less than 1.4 and polarization index ratios less than 2.0 for Class B insulation and Class F insulation.

.11 Where it is not possible to perform an insulation resistance test separately on each winding, perform a winding resistance test on each winding using a low-resistance ohmmeter.

.12 Measure running voltage and current and evaluate relative to load conditions and nameplate full-load amperes. Utilize a true RMS meter.

.1 Where powered by a VFD with bypass, perform test with the motor powered by the VFD and by the bypass starter.

.13 Perform insulation-resistance test on insulated bearings in accordance with manufacturer's published data, if applicable.

.14 Perform resistance tests on resistance temperature detector (RTD) circuits. RTD circuits should conform to design intent and/or machine protection device manufacturer's specifications.

3.10 MOTOR STARTERS, 600 V

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Record all adjustable settings, size of overload, etc.

.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 contactors for evidence of overheating or stress.

.8 Visually inspect and exercise circuit breaker.

.9 If power fuses are present, record fuse size and type. Measure the resistance of each fuse. Investigate inconsistent resistance values.

3.11 MOTOR SOFT STARTER, 600V

.1 Inspection and testing shall be comprised of the following:

- .1 Record the equipment nameplate data for inclusion in the individual inspection and test report
- .2 Inspect physical and mechanical condition.
- .3 Inspect anchorage, alignment, and grounding.
- .4 Inspect for evidence of corrosion.
- .5 Clean the unit.
- .6 Check the air filters.
- .7 Ensure vent path openings are free from debris and that heat transfer surfaces are not contaminated by oil, dust, or dirt.
- .8 Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
- .9 Visually inspect soft starter grounding to ensure continuity.
- .10 Cooling fans and heat sinks:
  - .1 Visually inspect and listen for any abnormal noises or vibration.
  - .2 Verify that fans rotate freely.
  - .3 Verify correct direction of airflow.
  - .4 Clean and verify integrity of heat sinks.
  - .5 Verify the operation of the grounding switch, if present.

.2 Record the following Parameters:

- .1 Motor voltage, current, frequency, nominal speed, nominal power.
- .2 Current limits.
- .3 Motor acceleration and deceleration time.

.3 Power fuses:

- .1 Record fuse data. Confirm that the fuses are of the correct type and rating. Utilize manufacturer's published data where available.
- .2 Measure fuse resistance.

.4 Bolted connections:

- .1 Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
- .2 Torque all bolted connections.

.5 Operator Interface:

- .1 Check the display and keypad for proper operation and communication.
- .2 Retrieve fault history log and note any faults.

.6 Grounding/Bonding measurements:

.1 Measure the resistance of the ground bonding connection between the soft starter and the main grounding bus in the corresponding electrical room.

.7 Control Wiring:

.1 Check for tightness of all accessible control wiring and torque any loose connections.

.8 Perform operational tests by initiating control devices.

.1 Start soft starter and observe motor and load for unusual noise or vibration.
.2 Verify operation of soft starter from local start/stop control signals.
.3 Verify operation of all local pilot lights.
.4 Verify the operation of any emergency stop switches.

.9 Voltage and Current Testing:

.1 With the motor under load, measure and record the following:
.1 Measure and record outgoing AC voltage and currents.

3.12 CIRCUIT BREAKERS, INSULATED-CASE/MOLDED CASE, 600 V

.1 Inspection and testing shall include the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.
.2 Record all adjustable settings.
.3 Inspect physical and mechanical condition.
.4 Inspect anchorage and alignment.
.5 Clean the unit.
.6 Torque all accessible bolted power connections.
.7 Operate the circuit breaker to insure smooth operation.
.8 Test all breakers utilizing the “Push-To-Trip” button, if equipped.
.9 Move operating handle to the off and on position.
.10 Restore breaker position to original position.

.2 For cables 4/0 AWG and larger, inspect bolted electrical connections for high resistance using a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

.3 For breakers with a frame size greater or equal to 250A, or as specified elsewhere in the Specification:

.1 Perform an insulation resistance test.
.2 Breakers rated < 600V, test voltage is to be 500 VDC.
.3 Breakers rated >= 600V, test voltage is to be 1000 VDC.
.4 Perform a contact/pole-resistance test.

3.13 TRANSFORMERS, LOW VOLTAGE, DRY-TYPE

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Clean the unit.

.5 Torque all accessible bolted power connections.

.6 Record the tap setting.

.7 Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Duration of the test is to be one minute. Calculate the dielectric absorption ratio.

.1 600 V windings shall be tested at 1000 Vdc.

.2 120/208 V windings shall be tested at 500 Vdc.

3.14 PANELBOARDS, LOW VOLTAGE

.1 Inspection and testing shall be comprised of the following:

.1 Record the equipment nameplate data for inclusion in the individual inspection and test report.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Clean the unit.

.5 Inspect breakers and verify mechanical operation by exercising all circuit breakers.

.1 Record breaker data on the inspection form.

.2 Test all breakers utilizing the “Push-To-Trip” button, if equipped.

.3 Move operating handle to the off and on position.

.4 Restore breaker position to original position.

.6 Test main and feeder/load breakers with a frame size >= 250A, or with long, short, or ground fault settings and complete a separate inspection form for each.

.7 Torque all accessible bolted power connections including incoming, load neutral, and ground connections.

.8 Perform insulation-resistance tests on each bus phase with all other phases grounded.

.9 The main breaker, if present, is to be open for the test. If no main breaker is present, disconnect the supply conductors.

.10 Open all load breakers.

.11 Test voltage for all 600/347 V panelboards to be 1000 Vdc.

.12 Test voltage for all 120/208 V panelboards to be 500 Vdc.

3.15 GROUNDING SYSTEM

.1 Inspection and testing shall be comprised of the following:

.1 Perform resistance tests between the main grounding electrode and grounded points in the electrical distribution system located in the switchgear, transformers, and MCCs. Investigate connections with a resistance greater than 0.5 milliohms.

3.16 FIRE ALARM SYSTEM

.1 Perform fire alarm Verification Inspection V.I, and submit report indicating the entire system is operational, and completely functional.

.2 Test and document central reporting functionality of the system.

.3 Test and submit documentation in accordance with the latest of:

.1 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.

.2 CAN/ULC-S537, Verification of Fire Alarm Systems.

3.17 GENSET LOAD BANK

.1 Perform testing in accordance with the manufacturer's instructions and recommendations.

.2 Perform 4 hour load test using the load test using the load bank (after complete installation of the entire system). If deficiencies are found, correct, and re-test entire system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C9-M2002(R2007), Dry-Type Transformers.

.2 National Electrical Manufacturers Association (NEMA)

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Ensure physical size is in accordance with the drawings, and all required clearances are maintained.

.3 Shop Drawings to include:

.1 Dimensioned drawing showing enclosure, mounting devices, terminals, taps, internal and external component layout.

.2 Technical data:

.1 kVA rating.

.2 Primary and secondary voltages.

.3 Frequency.

.4 Polarity or angular displacement.

.5 Full load efficiency.

.6 Regulation at unity pf.

.7 BIL.

.8 Insulation type.

.9 Sound rating.

.10 Physical dimensions.

.11 Connection diagram.

1.3 CONTROL SUBMITTALS

.1 Submit to Contract Administrator one copy of standard factory test certificates of each transformer and type test of each transformer in accordance with CSA C9. Electronic submissions are accepted.

1.4 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for dry type transformers for incorporation into manual specified in Section 01 78 00 - Closeout Submittals.

.2 Operation and maintenance instructions to include:

.1 Tap changing.

.2 Recommended environmental conditions.

.3 Recommended periodic inspection and maintenance.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Store transformers indoors in dry location.

Part 2 Products

2.1 MATERIALS

.1 Dry-type transformers: to CSA C9.

.2 Bushings: to EEMAC GL1-3.

2.2 TRANSFORMER CHARACTERISTICS

.1 Type: ANN

.2 Rating: 500 kVA, 3 phase, 60 Hz.

.3 220 degrees C insulation system class, 115 degrees C temperature rise.

.4 Impedance: 3 to 5.5 %.

.5 Primary winding: 4160 V, delta, BIL 30 kV.

.6 Secondary winding: 600 V, star, BIL 10 kV, four wire with neutral brought out and grounded.

.7 Meets all current Canadian energy efficiency regulations (OEE).

.8 Sound rating: 60 dBA or less.

.9 CSA Certified.

2.3 ENCLOSURE

.1 NEMA Type 1. Fabricated from sheet steel.

.2 Suitable for cable entry from bottom and both sides.

.3 Bolted removable panels for access to tap connections, enclosed terminals.

.4 Conductor entry:

.1 Knockouts.

.2 Potheads.

.3 Junction boxes.

.4 Bushings.

.5 Clamping rings.

.6 Entry for cable.

.5 Designed for floor mounting.

.6 Indoor, ventilated, self cooled type. Temperature of exposed metal parts not to exceed 65 degrees C rise.

.7 Refer to the drawings and specifications for the preferred transformer mounting method.

.1 Where transformer is floor mounted, provide 3.5" thick concrete housekeeping pad below transformer, extend the pad under the footprint of the transformer, plus a minimum of 2" beyond the transformer enclosure in all direction.

2.4 VOLTAGE TAPS

.1 - 5%, -2.5%, 0%, +2.5%, +5%.

2.5 NAMEPLATE

.1 Include all transformer data including actual impedance.

2.6 WINDINGS

.1 Primary and secondary coils:

.1 Copper.

.2 Coil and core assembly:

.1 Taps located at front of coils for accessibility.

2.7 TERMINATIONS

.1 Suitable for NEMA standard dual-hole lugs.

.2 Size:

.1 Primary side: suitable for lugs sized for 2 AWG cable.

.2 Secondary side: suitable for lugs sized for two runs of 350 MCM cable.

2.8 ACCESSORIES

.1 Over temperature switches

.1 Wired to internal terminal strip with labelled terminals.

.2 SPDT switch configuration.

.3 Two switches on center coil:

.1 Switch 1: 170°C setpoint

.2 Switch 2: 200°C setpoint

.4 Rated 5A @ 120 VAC.

.2 Grounding terminal: inside of enclosure.

2.9 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Equipment labels: nameplate text and size as per the lamacoid schedule.

Part 3 Execution

3.1 INSTALLATION

.1 Locate, install and ground transformers in accordance with manufacturer's instructions. Transformers are located in the main electrical room and as such the electrical room will be classified as an indoor station. Grounding and bonding of the room shall be in accordance with section 36 of the Canadian Electrical Code

.2 Set and secure transformers in place, rigid plumb and square.

.3 Connect primary terminals to medium voltage circuit.

.4 Connect secondary terminals to low voltage circuit.

.5 Energize transformers and check secondary no-load voltage.

.6 Adjust primary taps as per the drawings.

.7 Wire the normally closed set of contacts on winding temperature detector relay to the Station Programmable Logic Controller per the drawings.

.8 Use torque wrench to adjust internal connections in accordance with manufacturers' recommended values.

.9 Check transformer for dryness before putting it into service and if it has not been energized for some considerable time.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Energize transformers and apply incremental loads:

.1 At each load change, check ambient, enclosure, and winding temperatures.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 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)

1.3 PRODUCT DATA

.1 Submit product data 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% and 5% full capacity above and below normal.

.4 Windings: copper.

.5 Insulation: Class H, 220ºC.

.6 Temperature rise: 115ºC at continuous full load.

.7 Basic Impulse Level (BIL): 10 kV.

.8 Hipot: 4kV.

.9 Average sound level: To meet the local municipal & building codes and meet at minimum the following criteria:
45 dB max. up to 45 kVA
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 3R, type 4, type 4X, 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" thick concrete housekeeping pad below transformer, extend the pad under the footprint of the transformer, plus a minimum of 2" 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: in accordance with Section 26 05 01 - Common Work Results - Electrical.

2.2 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Label size: 7.

.3 Nameplate for each transformer, example as follows:

XFMR-M640 300 kVA, 600 – 480V, 3Ø, 3W FED FROM MCC-M710

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 Install non-combustible insulating board, extending 300mm around transformer on all sides, behind transformer to meet CEC code requirements.

.5 Remove shipping supports only after transformer is installed and just before putting into service.

.6 Loosen isolation pad bolts until no compression is visible.

.7 Make primary and secondary connections in accordance with wiring diagram.

.8 Mount transformers to reduce direct and transmitted noise. Mount core and coils of transformers.

.9 Make connections to transformers in flexible conduit, entering the enclosure below the coils.

.10 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 3-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.

.11 Energize transformers after installation is complete.

.12 Adjust tap connections to give a continuous rated secondary voltage, under load.

3.2 TESTING

.1 Utilize test form provided. Complete test form in full.

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

.3 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 SECTION INCLUDES

.1 Service equipment and installation.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures

.2 Section 01 74 11 - Cleaning

.3 Section 26 05 28 - Grounding - Secondary.

.4 Section 26 05 31 - Splitters, Junction, Pull Boxes, and Cabinets.

1.3 SUBMITTALS

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

.2 Manufacturer's instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.

.3 Submit Shop Drawings and indicate:

- .1 Outline dimensions.
- .2 Configuration of identified compartments.
- .3 Anchoring method and dimensioned foundation template.
- .4 Cable entry and exit locations.
- .5 Schematic and wiring diagrams as required.
- .6 Enclosure finish.

.4 Closeout Submittals: provide as-built Drawings and supplemental information including Shop Drawings, manufacturer’s instructions and testing documentation for inclusion in the operation and maintenance manual for the motor control centre as specified in Section 01 78 00 - Closeout Submittals.

1.4 WASTE MANAGEMENT AND DISPOSAL

.1 Separate and recycle waste materials where possible.

.2 Remove from Site and dispose of all packaging materials at appropriate recycling facilities.

.3 Collect and separate for disposal packaging material for recycling.

.4 Divert unused metal and wiring materials from landfill to metal recycling facility.

.5 Fold up metal banding, flatten, and place in designated area for recycling.

Part 2 Products

2.1 CUSTOMER SERVICE TERMINATION ENCLOSURE (CSTE)

.1 Main and branch lugs to match required size and quantity of incoming and outgoing conductors as indicated.

.2 Customer service termination enclosures (CSTE) for connection of utility conductors to consumer service conductors shall have the following features:

.1 CSA approved for outdoor use (CSA enclosure type 4X or greater).
.2 Primed and painted to resist corrosion.
.3 Hinged door with three point latching, for each compartment.
.4 Handle with provision for padlocking (keyed handle not acceptable).
.5 Copper bus bars sized to accommodate 100% equipment rating.
.6 Bus bar terminals shall be arranged to allow for bending radius of conductors.
.7 Copper ground lugs for grounds conductors.
.8 Provide built in provisions (with enclosure) to accept a utility meter, in accordance with Manitoba Hydro - Customer Metering Standards (latest).
.9 Service entrance rated breaker.
.10 Withstand and kAIC rating to meet the system fault levels.

2.2 METER SOCKET

.1 Requirements:

.1 C.Ts and P.Ts: Provide C.Ts and P.Ts in accordance with MB Hydro requirements for 600A, 347 / 600V 3 phase, 4 wire service.
.2 Meter socket type: Confirm requirements with Manitoba Hydro metering standards.
.3 Enclosure type: NEMA Type 3R

.2 Manufacturer:

.1 Thomas & Betts.
.2 Or approved equal in accordance with B7.

Part 3 Execution

3.1 INSTALLATION

.1 Install service equipment. Provide sand bedding and fiberglass pad installed in accordance with manufacturer's instructions.

.2 Connect to incoming service.

.3 Connect to outgoing load circuits.

.4 Make secondary grounding connections in accordance with Section 26 05 28 - Grounding - Secondary.

.5 Make provision for power supply authority's metering.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

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

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

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

1.3 SHOP DRAWINGS

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

Part 2 Products

2.1 PANELBOARDS

.1 Panelboards: to CSA C22.2 No.29 and product of one manufacturer.

.1 In addition to CSA requirements, manufacturer's nameplate must show fault current that panel including breakers has been built to withstand.

.2 208 and 240 V panelboards: bus and breakers rated for 10 kA (symmetrical) interrupting capacity, or higher as indicated on the Drawings.

.3 600 V panelboards and distributions: bus and breakers rated for 25 kA (symmetrical) interrupting capacity, or higher as indicated on the Drawings.

.4 Sequence phase bussing with odd numbered breakers on left and even on right, with each breaker identified by permanent number identification as to circuit number and phase – or otherwise indicated on the panel schedules on the Drawings.

.5 Panelboards: mains, number of circuits, and number and size of branch circuit breakers as indicated on the Drawings.

.6 All branch breakers shall be factory installed and shall be as located on the Drawings.

.7 Main Breaker:

.1 Main Breaker to be top or bottom mounted.

.2 Back-fed main breakers are not acceptable.

.8 Two (2) keys for each panelboard and key panelboards alike.

.9 Copper bus with neutral of same ampere rating as mains.

.10 Trim with concealed front bolts and hinges.

.11 Trim and door finish: baked grey enamel.

.12 Enclosure: dimensions to be as per manufacturer standards, but in no circumstances shall be greater than the space allocated on the Drawings.

.13 Acceptable manufacturers and models:

.1 Square D NQOD series.

.2 Or approved equal in accordance with B7.

2.2 BREAKERS

.1 Breakers: refer to Section 26 28 21 - Moulded Case Circuit Breakers.

.2 Breakers with thermal and magnetic tripping in panelboards except as indicated otherwise.

.3 Breakers with electronic, fully adjustable trip, where indicated as LSI, LI, LS, LSIG on the Drawings. L = Short time adjustable, S = Short time adjustable, I = Instantaneous adjustable, G = Ground adjustable; for all trip elements.

.4 Series rated breakers are not accepted. Provide fully rated breakers for all breakers.

2.3 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Nameplate for each panelboard size 7 engraved as follows:

.1 Line 1 is to be the panel identifier as indicated on the Drawings, for example "PNL-M712".

.2 Line 2 is to be the voltage and connection, for example "120/240V, 1Ø, 3W".

.3 Complete circuit directory with typewritten legend.

Part 3 Execution

3.1 INSTALLATION

.1 Locate panelboards as indicated and mount securely, plumb, true, and square to adjoining surfaces.

.2 Install surface mounted panelboards on plywood backboards. Where practical, group panelboards on common backboard.

.3 Mount panelboards to height of two (2) metres to top of cover.

.4 Connect loads to circuits.

3.2 TESTING

.1 Test in accordance with Section 26 08 05 – Acceptance Testing.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

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

.2 Submit product data sheets for sills, busbars, and compartments. Include product characteristics, physical size, and finish.

.3 Manufacturer's instructions: provide to indicate special handling criteria, installation sequence, and cleaning procedures.

.4 Submit Shop Drawings and indicate:

- .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.

.5 Submit Contractor’s Field Requirements forms for motor control centre (MCC). Refer to Section 01 43 33 Contractor’s Field Requirements for details.

.6 Closeout Submittals: provide as-built drawings and supplemental information for inclusion in the operation and maintenance manuals for MCC as specified in Section 01 78 00 - Closeout Submittals.

- .1 Include data for each type and style of starter.
- .2 Submit spare parts as described in Part 2.19 of this section.

Part 2 Products

2.1 SUPPLY CHARACTERISTICS

.1 600 V, 60Hz, wye connected, 3 phase.

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 Indoor NEMA Type 1A (gasketed) enclosure, front mounting.

.5 Suitability for Service Entrance: As Required.

.6 Class IIS (custom, smart MCC), Type B-T as indicated on the Drawings.

.7 Nameplates: white with black letters.

.8 SCCR: 25 kA minimum.

.9 Acceptable manufacturer:

.1 Schneider Electric Model 6; or

.2 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 top and/or 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: As indicated on the Drawings.

.2 Branch vertical busbars: 300 A or 600 A or greater as required.

.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 POWER METER

.1 Where indicated on the Drawings, provide a microprocessor based multifunction power meter.

.2 Requirements:

.1 Multifunction electrical measurement on 3 phase power systems.

.2 User programmable for voltage range to any PT ratio.

.3 Integrated display.

.4 Accept a direct voltage input range of up to 347 Volts Line to Neutral and a range of up to 600 Volts Line to Line.

.5 Accept a current input of up to 5 Amps nominal, 10 Amps full scale.

.6 Programmable for current to any CT ratio. The use of DIP switches for selecting fixed ratios shall not be accepted.

.7 Maximum burden of 0.0625 VA at 10 Amps.

.8 The meter shall have an accuracy of +/- 0.25% or better for volts and amps, and 1.5% for power and energy functions.

.9 The meter shall provide true RMS measurements of voltage, phase to neutral, and phase to phase; current for each phase and neutral.

.10 Function Requirements:

.1 Volts, Amps, kW, kVAR, PF, kVA (per phase)

.2 Frequency, kWh, kVAh, kVARh

.3 Harmonics measurement, individual, even, and odd, up to 15th.

.11 Operating Temperature: -20 to +60 °C ambient.

.12 Communications ports:

.1 10 Mbps or 10/100 Mbps Ethernet supporting Modbus-TCP.

.13 Desktop computer software:

.1 Provide desktop computer software (and licence) for integration of power metering system for data analysis and logging.

.2 Software licence shall not expire and shall be valid for lifetime of the meter.

.3 Shall be the most up to date version of the software.

.3 Acceptable Products:

.1 Schneider Electric PM8000 series.

.2 Or approved equal in accordance with B7.

2.8 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% 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 (In) – All TVSSs applied to the distribution system shall have a 20kA In rating regardless of their TVSS Type (includes Types 1 and 2) or operating voltage. TVSSs having an In 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.

2.9 VOLTAGE MONITORING RELAY

.1 Requirements,

.1 Suitable for direct connection to MCC bus having nominal operating voltage of 600 V line-to-line.

.2 Adjustable nominal input voltage via potentiometer from 500 V to 600 V.

.3 Undervoltage trip point:

.1 Adjustable from 88% to 92% of nominal voltage.

.4 Voltage unbalance:

.1 Adjustable from 2% to 10%.

.5 Phase loss detection:

.1 Triggered upon ≥ 15% unbalance.

.2 Response time ≤ 200 msec.

.6 Trip delay:

.1 Adjustable from 0.25 to 30 sec.

.7 Automatic reset (restart) delay:

.1 Adjustable from 0.25 to 64 sec.

.2 Adjustable random restart delay from 3 to 15 sec.

.8 Status and faults displayed on LED readout.

.9 Remote reset input.

.10 CSA approved.

.2 Relay output:

.1 Equipped with, at minimum, one Form C electromechanical dry contact output for monitoring.

.1 Relay contact to be normally open, held-closed during normal operation, and open upon an alarm condition.

.2 Actuate relay on any of the following:

.1 Phase A-B, B-C, or C-A voltage less than 550 V.

.2 Voltage unbalance greater than 10%.

.3 Rated at 10A resistive @ 250 VAC, 6A inductive (0.4 PF) @ 250 VAC.

.4 Mechanical life of 1x107 operations.

.3 Acceptable products:

.1 Littlefuse 460 series.

.2 Or approved equal in accordance with B7.

2.10 INTELLIGENT MOTOR PROTECTION RELAYS

.1 Intelligent Motor Protection Relays (IMPR's) shall be CSA and UL approved.

.2 IMPR's shall be fully programmable electronic relays.

.3 The IMPR shall feature a Test/Rest button.

.4 I/O shall consist of six discrete logic inputs, with a minimum of three relay outputs (1 NO) and one relay output for fault signaling (1 NO + 1 NC) or greater as indicated on the Drawings.

.5 Control voltage shall be as per Drawings.

.6 Network, electronic, and manual reset functions shall be supported.

.7 The following status and monitoring functions shall be provided based on user configurable parameters:

.1 Metering Measurement:

.1 Line Currents
.2 Ground current
.3 Average Current
.4 Current Phase Imbalance
.5 Thermal capacity Level
.6 Motor Temperature Sensor

.2 Statistics:

.1 Protection Fault Counts
.2 Protection Warning counts
.3 Diagnostic fault counts
.4 Motor Control Function counts
.5 Fault History

.3 Diagnostics:

.1 Internal watchdog results
.2 Controller Internal Temperature
.3 Temperature Sensor Connections
.4 Current Connections
.5 Control Commands (start, stop, run, check back and stop check back)
.6 Control configuration checksum
.7 Communication loss

.4 Motor Starters:

.1 Motor control states motor starter/LO1 starts/ LO2 starts
.2 Operating time
.3 Motor starts per hour
.4 Last start max current
.5 Last start time
.6 Time to trip
.7 Time to reset

.5 Fault Monitoring Diagnostic:

.1 Run command check
.2 Stop command check

.3 Run check back
.4 Stop check back

.6 Wiring/ Configuration errors:
.1 PTC Connection
.2 CT Reversal
.3 Current Phase Reversal
.4 Phase Configuration

.7 Fault Monitoring Internal:
.1 Stack Overflow
.2 Watchdog
.3 ROM Checksum
.4 EEROM
.5 CPU
.6 Internal Temperature

.8 Fault Monitoring Motor temp sensor:
.1 PTC Binary
.2 PTC Analog
.3 NTC Analog

.9 Fault Monitoring Thermal overload:
.1 Definite
.2 Inverse Thermal

.10 Fault Monitoring Current:
.1 Long Start
.2 Jam
.3 Current Phase Imbalance
.4 Current Phase Loss
.5 Overcurrent
.6 Undercurrent
.7 Internal Ground Current
.8 External Ground Current

.11 Fault Monitoring Communication loss:
.1 PLC to IMPR

.12 Protection:
.1 Thermal overload
.2 Current phase imbalance
.3 Current phase loss
.4 Current phase reversal
.5 Long start
.6 Jam (locked rotor during run)
.7 Undercurrent
.8 Overcurrent

.9 Ground current
.10 Motor temperature sensor
.11 Rapid cycle lockout

.13 Control Functions – Motor Control Modes:
.1 Local terminal strip
.2 Network

.14 Control Functions - Operating mode
.1 Overload
.2 Independent
.3 Reverser
.4 Two-step
.5 Two-speed
.6 Custom Mode

.15 Control Functions - Fault Management
.1 Manual reset
.2 Automatic reset
.3 Remote reset

.8 Metering and Monitoring

.1 The IMPR shall include accurate measurement processing functions to operate the different applications and carry out commissioning and maintenance.

.2 For measurement, the IMPR shall include current transformers up to 100 A, for all measurements required (current, power, voltage, frequency, etc). It is not possible to use external special CTs for measurement.

.9 Motor Protection Functions

.1 The IMPR shall integrate all motor protection functions described above.

.2 The thermal overload trip curve shall be selectable between inverse (I^2t) or definite time (Ixt) curve. The Auxiliary Fan Cooling application shall be also selectable.

.3 It shall include Ground Fault Protection internally, and it shall be possible to use an external zero sequence CT to accomplish this, without the need for additional modules or devices.

.10 Programming and configuration software

.1 The IMPR shall use user-friendly settings and operate multi-lingual software in a Windows environment with menus and icons for fast direct access to the data required, guided navigation to go through all the data for the same function on the same screen and with file management.

.2 The PC can be connected in a 1-to-1 configuration to a single controller, or in a 1-to-many configuration to multiple controllers.

.3 The IMPR shall provide a “Custom Mode”, a logic customized by the end user.

.11 Self-Test

.1 The IMPR shall be capable of self-tests. It shall perform internal checks such as a watch-dog check and RAM check, in order to maximize availability and minimize the risk of malfunctioning.

.12 Acceptable products:

.1 Schneider Electric TeSys T.

2.11 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.

2.12 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,

2.13 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.

2.14 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.

2.15 WIRING IDENTIFICATION

.1 Provide wiring and cable identification in accordance with Section 26 05 01 - Common Work Results - For Electrical and in accordance with the Drawings.

2.16 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 twenty-five (25) letters per nameplate.

.5 Identification to be English.

2.17 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.

2.18 SOURCE QUALITY CONTROL

.1 Provide manufacturer's type test certificates including short circuit fault damage certification up to short circuit values specified under bus bracing.

.2 The Contract Administrator to witness standard factory testing of complete MCC including operation of switches, circuit breakers, starters, and controls.

2.19 SPARE PARTS

.1 One (1) set of fuses of each type and size.

Part 3 Execution

3.1 INSTALLATION

.1 Provide housekeeping pad below the MCCs as per the Drawings.

.2 Set and secure MCC in place on channel bases, rigid, plumb, and square to building floor and wall.

.3 Make field power and control connections as indicated.

.4 Ensure correct overload settings are applied.

.5 Coordinate concrete pad with bevelled edges as shown on the Drawings, sized to suit MCC, install and level channel sills and mount MCC.

3.2 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Ensure moving and working parts are lubricated where required.

.3 Operate starters in sequence to prove satisfactory performance of MCC during 8 hour period.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Switches, receptacles, wiring devices, cover plates, and their installation.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA-C22.2 No.42-99(R2002), General Use Receptacles, Attachment Plugs and Similar Devices.

.2 CSA-C22.2 No.42.1-00, Cover Plates for Flush-Mounted Wiring Devices (Bi-national standard, with UL 514D).

.3 CSA-C22.2 No.55-M1986(July 2001), Special Use Switches.

.4 CSA-C22.2 No.111-00, General-Use Snap Switches (Bi-national standard, with UL 20, twelfth edition).

1.3 SHOP DRAWINGS AND PRODUCT DATA

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

Part 2 Products

2.1 SWITCHES – TWO POSITION, SINGLE POLE

.1 15 A, 120 V, single pole switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.

.2 Manually operated heavy duty ac switches with following features:

.1 Heavy duty mounting strap.

.2 Terminal holes approved for No. 10 AWG wire.

.3 Silver alloy contacts.

.4 One piece lexan toggle, lever, and cam.

.5 Suitable for back and side wiring.

.6 Green hex head grounding terminal.

.3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.4 Switches of one manufacturer throughout project.

.5 Acceptable manufacturer:

.1 Hubbell or approved equal in accordance with B7.

2.2 SWITCHES – TWO POSITION, DOUBLE POLE

.1 15 A, 120 V, double pole switches to: CSA-C22.2 No.55 and CSA-C22.2 No.111.

.2 Manually operated heavy duty ac switches with following features:

- .1 Heavy duty mounting strap.
- .2 Terminal holes approved for No. 10 AWG wire.
- .3 Silver alloy contacts.
- .4 One piece lexan toggle, lever, and cam.
- .5 Suitable for back and side wiring.

.3 Toggle operated fully rated for tungsten filament and fluorescent lamps, and up to 80% of rated capacity of motor loads.

.4 Switches of one manufacturer throughout project.

.5 Acceptable manufacturer:

- .1 Hubbell or approved equal in accordance with B7.

2.3 DUPLEX RECEPTACLES

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

- .1 Heavy duty nylon face with steel reinforcing plate in centre.
- .2 Suitable for No. 10 AWG for back and side wiring.
- .3 Break-off links for use as split receptacles.
- .4 Receptacle contacts to utilize spring steel clips to reduce contact fatigue.

.2 Receptacles of one manufacturer throughout project.

.3 Acceptable manufacturer:

- .1 Hubbell 8200 or approved equal in accordance with B7.

2.4 WELDING RECEPTACLES

.1 Welding receptacles with following features:

- .1 Current rating: 60A
- .2 Voltage rating: 600 VAC
- .3 Enclosure rating: Nema 3R/12, steel
- .4 Number of Poles: 3
- .5 Certification: ULC
- .6 Disconnect switch: non-fusible
- .7 Suitable for No. 14 AWG to No. 2 AWG copper

.2 Welding receptacles of one manufacturer throughout project.

.3 Acceptable manufacturer:

.1 Square D HU362AWAVW (60A, 3P) plus one accompanying plug end per receptacle, Appleton Powertite ACP6034BC

.2 Approved equal in accordance with B7.

2.5 COVER PLATES

.1 Cover plates for wiring devices to: CSA-C22.2 No.42.1.

.2 Cover plates from one manufacturer throughout project.

.3 Sheet steel utility box cover for wiring devices installed in surface-mounted utility boxes.

.4 Stainless steel, 1 mm thick cover plates wiring devices mounted in flush-mounted outlet box.

.5 Sheet metal cover plates for wiring devices mounted in surface-mounted FS or FD type conduit boxes.

.6 Weatherproof double lift spring-loaded cast aluminum cover plates, complete with gaskets for duplex receptacles as indicated.

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 01 - Common Work Results - Electrical.

.2 Receptacles:

.1 Install duplex receptacles in gang type outlet box when more than one receptacle is required in one location.

.2 Install welding receptacles in accordance with manufacturer’s recommendations. Mount at 1200mm above finished floor (to bottom of receptacle).

.3 Mount duplex receptacles vertically.

.4 Mount duplex receptacles at height in accordance with Section 26 05 01 - Common Work Results - Electrical.

.3 Cover plates:

.1 Protect stainless steel cover plate finish with paper or plastic film until painting and other work is finished.

.2 Install suitable common cover plates where wiring devices are grouped.

.3 Do not use cover plates meant for flush outlet boxes on surface-mounted boxes.

.4 Install a permanent label or lamacoid for all wiring devices indicating the circuit(s) contained within.

.1 Example: C711-2 (Panelboard PNL-C711, circuit 2)

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials for moulded-case circuit breakers and circuit breakers.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

1.3 REFERENCES

.1 Canadian Standards Association (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 SUBMITTALS

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

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 All breakers to be bolt-on style. Push on style, or stab-lok breakers will not be accepted.

.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 Acceptable manufacturer: Schneider Electric or approved equal in accordance with B7.

.16 Breakers sized 300A and larger shall be equipped with viewing window (visi) to allow the operator to view the open / close status of the breaker.

2.2 TRIP UNITS

.1 Trip elements to be as follows:

.1 Breakers sized less than 100A shall be equipped with thermal magnetic trip elements, unless indicated otherwise on the Drawings.

.2 Breakers sized 100A and greater shall have electronic, fully adjustable trip elements, unless indicated otherwise on the Drawings.

.3 Fully adjustable, electronic LSIG, LSI, LI, are to be provided as indicated on the Drawings.

.4 Switchgear, panelboards, CDPs, MCC and motor starter breakers shall utilize breakers by Schneider Electric based on the City of Winnipeg standards, with ratings in accordance with the single line Drawings.

.5 Meet the requirements of the CEC and the Drawings with respect to ground fault protection.

.2 Electronic trip units:

.1 Trip system shall be a Micrologic electronic trip unit with true RMS sensing.

.2 Current transformers shall be used to ensure accurate measurements from low current up to high currents.

.3 The following monitoring functions shall be integral parts of electronic trip units:

.1 A test connector shall be installed for checks on electronic and tripping mechanism operation using an external device.

.2 LED for load indication at 105 percent.

.3 LED for load indication at 90 percent of load for applications 600A and smaller.

.4 LED for visual verification of protection circuit functionality for applications 600A or smaller.

.5 LED for trip indication for applications above 600A.

.4 Micrologic trip unit functions shall consist of fully adjustable protection settings with the capability to be set and read locally by rotating a switch.

.1 Long-time pickup shall allow for adjustment to nine long-time pickup settings. This adjustment must be at least from 0.4 to 1 times the sensor plug (In), with finer adjustments available for more precise settings to match the application.

.2 Adjustable long-time delay shall be in nine bands. At six times Ir, from 0.5 to 24 seconds above 600A, and 0.5 to 16 seconds for 600A and below.

.3 Short-time pickup shall allow for nine settings from 1.5 to 10 times Ir.

.4 Short-time delay shall be in nine bands from 0.1–0.4 I^2t ON and 0–0.4 I^2t OFF.

.5 Instantaneous settings on the trip units with LSI protection shall be available in nine bands.

.1 Above 600A, from 2 to 15 times In

.2 600A, from 1.5 to 11 times In

.3 400A from 1.5 to 12 times In

.4 250A and below, from 1.5 to 15 times In

.6 Ground fault settings for circuit breaker sensor sizes 1200 amperes or below shall be in nine bands from 0.2 to 1.0 times In. The ground fault settings for circuit breakers above 1200 amperes shall be nine bands from 500 amperes to 1200 amperes.

.5 24V power supply for electronic trip breakers to be internal to panelboard.

.6 Electronic components shall withstand temperatures up to 221 °F (105 °C).

.3 Accessories

.1 General:

.1 Circuit breakers shall be equipped with ULC listed electrical accessories as noted on the Drawings or schedules.

.2 The addition of auxiliaries shall not increase the overall mounting size of the circuit breaker.

.3 The addition of mechanisms shall not mask or block device settings.

.2 Electrical auxiliaries: electrical auxiliaries, such as voltage releases (shunt and undervoltage releases) and indication switches as follows:

.1 Same field-installable auxiliary contacts for signaling different functions, such as open/ closed position, fault signal, electrical fault (including electrical leakage) signal.

.2 Electrical auxiliaries shall be separated from power circuits.

.3 Electrical auxiliaries shall be of the snap-in type and fitted with terminal blocks.

.4 Electrical auxiliary function and terminals shall be permanently engraved on the case of the circuit breaker and the auxiliary itself.

2.3 ACCESSORIES

.1 All main and branch breakers in switchgear are to include a permanently fixed attachment for padlocking the breakers in the OFF position.

Part 3 Execution

3.1 INSTALLATION

.1 Install circuit breakers within equipment.

.2 Circuit breaker pickup level and time delay settings shall be adjusted to values indicated by the coordination study, and as instructed by the Contact Administrator.

.3 Identification: In accordance with Section 26 05 01 – Common Work Results – Electrical, provide lamacoid plate on or adjacent to each breaker showing load being fed.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Materials and installation for fused and non-fused disconnect switches.

1.2 REFERENCES

.1 Canadian Standards Association (CSA International).

.1 CAN/CSA C22.2 No.4, Enclosed Switches.

1.3 SUBMITTALS

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

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheets and include product characteristics, performance criteria (including interrupting rating), enclosure rating, and limitations.

.3 Spare Parts:

.1 Submit spare parts as described in Part 2.1.8 of this section and in accordance with Section 01 78 00 - Closeout Submittals.

Part 2 Products

2.1 DISCONNECT SWITCHES

.1 CSA approved.

.2 Disconnect switches to be heavy duty, horsepower (motor) rated.

.3 Size to accommodate the required loads. Minimum sizes as indicated on Drawings.

.4 Disconnect switches shall be CSA enclosures type 2 (for interior dry, clean areas) and CSA enclosure type 4X (for exterior or wet area).

.5 Mechanically interlocked door to prevent opening when handle in ON position.

.6 Disconnects for motor loads to be heavy duty, motor rated.

.7 Disconnect switches shall have the appropriate interrupting rating (kAIC). Minimum rating is 10 kAIC. For interrupting ratings greater than 10 KAIC, utilize fused disconnects.

.8 Provide fuses as indicated on the Drawings (or as needed to increase the kAIC rating). Provide 3 spare fuses for every type.

.9 Provision for padlocking in on-off switch position.

.10 Switch mechanism: quick-make, quick-break action with self-wiping contacts.

.11 For switches 100A and over, provide non-tracking arc shrouds.

.12 Solderless pressure lugs for cable connectors.

.13 All switch poles to operate together, simultaneously with a common operating bar.

.14 Highly visible ON-OFF switch position indication on switch enclosure cover.

2.2 APPROVED MANUFACTURERS.

.1 Schneider Electric, Eaton, Hubbell or approved equal in accordance to B7.

.2 All disconnect switches to be of one manufacturer for the entire project. Split packages (multiple vendors) will be rejected.

Part 3 Execution

3.1 INSTALLATION

.1 Install disconnect switches.

.2 Connect line and load cables to all disconnect switches.

.3 Connect electrode ground to ground terminal within service entrance rated disconnect switches.

.4 Ensure neutral-ground bonding link is installed in service entrance rated disconnect switches.

.5 Install fusing.

.6 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - Electrical.

.7 Indicate equipment identifier, as shown on the Drawings, on size 4 nameplate.

END OF SECTION

Part 1 General

1.1 ACTION AND INFORMATIONAL SUBMITTALS

.1 Provide submittals and Shop Drawings 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

1.2 CLOSEOUT SUBMITTALS

.1 Submit operation and maintenance data for each type and style of motor in accordance with Section 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 01 – Common Work Results - 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 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.

2.3 SOFT STARTERS

.1 Design requirements:

.1 The Short Circuit Current Rating (SSCR) of the assembly must equal or exceed 25 kA.

.2 Ventilation system designed for ambient temperature range of 5°C to 35°C. Enclosure temperature not to exceed 45°C.

.2 Soft Starter Modules:

.1 Continuous rating: as indicated on the Drawings.

.2 Rated operation voltage: 600 VAC, 60 Hz.

.3 Control circuit voltage: 120 VAC, 60 Hz.

.4 Operating temperature range, without de-rating: -10°C to +40°C.

.5 Logic inputs: Qty 4, 24 VDC, programmable.

.6 Logic outputs: Qty 2, 24 VDC (open collector), programmable.

.7 Relay outputs: Qty 3, Form A (Normally Open).

.8 Analog outputs: Qty 1, 0-20 mA / 4-20 mA, programmable.

.9 Vibration resistance:

.1 1.5 mm peak from 2 to 13 Hz.

.2 1 gn from 13 to 200 Hz.

.10 Shock resistance: 16 g, 11 ms.

.11 Acceptable products:

.1 Schneider Electric ATS48 Series or approved equal in accordance with B7.

.3 Isolation Contactors:

.1 NEMA rated, size as indicated on the Drawings.

.2 120 VAC, 60 Hz coil.

.4 Bypass Contactors:

.1 IEC rated, size as indicated on the Drawings.

.2 120 VAC, 60 Hz coil.

.5 Control Transformers:

.1 Single phase, dry-type, with 600V primary and 120V secondary, complete with primary and secondary fusing, installed in enclosure with soft starter, as indicated.

.2 Calculate required size of the control transformer. The size shown on the Drawings is the minimum size. Provide size as required for appropriate operation of the starter, plus 20% spare capacity.

.6 Interval Timing Relays:

.1 Interval timing relay automatically switches state when energized and switches back to steady state after timing period lapses.

.2 Relay contact shall switch back to steady state while coil remains energized indefinitely.

.3 120 VAC, 60 Hz coil.

.4 Din rail mountable.

.5 Pins: 8.

.6 Power supply start.

.7 Time delay setting:

.1 Adjustable: 0.1 - 60 seconds.

.2 Rotary analog.

.8 Relay Outputs:

.1 Form B contacts: Quantity 1.

.2 Rated for 120 VAC, 60Hz.

.9 Acceptable products:

.1 Omron H3CR-A8E complete with Omron PF085A.

.7 Cooling:

.1 Provide cooling system as required to maintain an acceptable enclosure.

.2 Intake fan located at bottom of enclosure.

.3 Exhaust vent located at top of enclosure.

.8 Door-mounted soft starter Human Interface Module (HIM).

.9 Pilot Devices:

.1 Pushbuttons and selector switches: Heavy-duty, oil tight, NEMA rated, 30 mm, labelled as indicated.

.2 Indicating lights: Heavy-duty, oil tight, NEMA rated, 30 mm, LED bulb, type and color as indicated.

.3 Start pushbuttons to utilize a green cap and stop pushbuttons to utilize a red cap.

.10 Documentation:

.1 Provide door pocket with complete set of drawings for each starter.

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 01 - Common Work Results -Electrical.

2.7 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results - 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.

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 soft starter module fault to ensure the starter can be reset and put back into operation.

.2 Submit test results to the Contract Administrator.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 08 05 – Acceptance Testing and 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 CODES AND STANDARDS

The most recent adopted version of the following standards:

.1 CSA C22.1-15 – Canadian Electrical Code (CEC), Part I, Safety Standard for Electrical Installations.

.2 CSA C22.2 NO. 14 – Industrial control equipment

.3 CSA C22.2 NO. 47-13 – Air-cooled transformers (dry type)

.4 CAN/CSA-C802.2-12 – Minimum efficiency values for dry-type transformers

.5 CSA C282 – Emergency Electrical Power Supply for Buildings

.6 CAN3/CSA Z299.3 - Quality Assurance Program – Category 3

.7 CAN/CSA-E61131-2-06 (R2011) – Programmable Controllers - Part 2: Equipment Requirements and Tests (Adopted IEC 61131-2:2003, second edition, 2003-02, including Corrigendum 1:2004, with Canadian deviations)

.8 UL 60947 (series) –Low-Voltage Switchgear and Controlgear,

.1 UL 60947-1– Low-Voltage Switchgear and Controlgear - Part 1: General rules,

.2 UL 60947-4-1A – Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-Starters - Electromechanical Contactors and Motor-Starters,

.3 UL 61131-2 – Programmable Controllers – Part 2: Equipment requirements and tests.

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Submit Shop Drawings:

.1 Complete set of equipment drawings.

.2 Interconnecting wiring diagrams.

.3 Weight of all equipment.

.4 Dimensions of all equipment.

.5 Material list.

.6 Control panel schematics.

.7 Control interconnection diagrams / interface with the switchgear.

.8 Manufacturer's and vendor's written warranty.

.9 Emissions data (sound and environmental).

.10 List of replaceable components, including fuses, make, model, size.

.11 Single line drawing, showing all the connections, sizes, and components of the system.

.3 Product Data:

.1 Submit manufacturer's printed product literature, specifications and datasheets and include product characteristics, performance criteria, and limitations. Specific model shall be indicated.

.4 Submit Contractor's Field Requirements forms for generator load bank. Refer to Section 01 43 33 Contractor's Field Requirements for details.

.5 Operation and Maintenance Manual:

.1 Provide maintenance materials for incorporation into the operation and maintenance manuals in accordance with Section 01 78 00 – Closeout Submittals.

.2 Provide paper and digital copies of the manual specific to the product supplied. General operating instructions, preventative maintenance, wiring diagrams, schematics, and parts exploded views specific to the supplied model must be included.

1.3 QUALITY ISSURANCE

.1 Prior to shipment, the manufacturer shall factory test the medium voltage load bank at full load and full voltage level to assure compliance with the equipment specifications defined here-in.

.2 A certified test and compliance report shall be provided upon successful completion of performance tests.

Part 2 Products

2.1 GENERATOR LOAD BANK

.1 GENERAL:

.1 A 600 VAC nominal / 575 VAC utilization, air-cooled, automatic resistive load bank is required for permanent installation as a component of the standby power engine generator system. The load bank will be used for the periodic, scheduled, supervised maintenance exercising and testing of the standby generator system. The load bank shall be operable remotely in both manual and/or automatic controlled sequenced modes.

.2 Provide all control power sourced from load bank, including 24 VDC power supply for control panels.

.3 Provide remote HMI for manual controls and status of the load bank.

.2 INSTALLATION:

.1 The load bank shall be installed outdoors on a grade level concrete pad surrounded by bollards.

.3 LOAD BANK RATING:

.1 Load Power Capacity: 100 kW, 1.0Pf., resistive.

.2 Power Input Voltage: 600 V AC, 3Ø, 4W.

.3 Power Input Frequency: 60 Hz.

.4 Auxiliary Power Voltage (Fans, Heaters, & Controls): 600 V AC, 3Ø, 3W.

.5 Auxiliary Power Frequency: 60Hz.

.6 Load step resolution: 5kW.

.7 Ambient Operating Temperature: -45ºC to +40ºC.

.8 Duty Cycle: Continuous.

.9 Suitable for full load use with multiple 600V, 3Ø, 4W, natural gas powered generators rated 100 kW, 60 Hz, 0.8 Pf Lagging.

.4 GENERAL REQUIREMENTS

.1 The load bank shall be a completely self-contained, freestanding skid mounted unit which shall include all transformations, resistive load elements, load control devices, load element branch circuit fuse protection, main load bus and terminals, cooling system, system controller, local control panel, and malfunction detection system in a CSA enclosure Type 3R enclosure (c/w rodent / varmint screens) or enclosures.

.2 The load bank shall be complete with a remote indication and control panel, located within a separate building.

.3 The load bank shall be completely assembled as a single, unitized, structural steel skid supported unit. The load bank shall include the following principle elements which are supplied, installed, and connected by the manufacturer to form a complete working assembly:

.1 600VAC, 3Ø, 3W resistive load section, including, but not limited to:

.1 Tray mounted resistive load elements,

.2 Cooling fan(s) and fan motor(s),

.3 Airflow sensors, and

.4 Temperature sensors, safety interlocks, etc.

.2 Load bank control section, including, but not limited to:

.1 Load element 600V sub-distribution,

.2 Load element branch circuit fuse protection,

.3 Load element control contactors (120VAC control),

.4 600V:120V control transformer(s),

.5 Cooling fan breaker, motor starter, and motor overload protection,

.6 Load bank protective relaying and malfunction detection,

.7 Remote control panel,

.8 Local control panel,

.9 Control circuit disconnect, and

.10 600V incoming "auxiliary" cable terminations.

.4 The load bank shall require only the following connections to be completely operational:

.1 One (1) power feeder at 600VAC, 3Ø, 4W for connection to genset,

.2 One (1) external 120 VAC, 1Ø "auxiliary" supply, from one 15A, 1 pole circuit breaker for anti-condensation heaters,

.3 One RS485 (Belden 9841) communication cable connection between the load bank and the remote-control panel for remote control panel HMI and monitoring,

.4 One 24 VDC power supply cable between the load bank and the remote-control HMI panel, and

.5 One 2C #14 AWG, 600V type cable to the generator system master controls for interlocking/control of the "Load Dump" signals incorporated into the load. Signal will come from the auto transfer switch status in the Control Centre. In addition the Main Pumphouse transfer switch status shall be wired in series with the Control Centre transfer switch.

.5 The load bank shall be supplied complete with a separate remote-control panel in addition to the integral local control panel. The remote-control panel shall be enclosed in a CSA enclosure type 12 gasketed enclosure suitable for wall or floor mounting and shall be separately crated and shipped.

.6 All cable access shall be bottom or bottom side entry. Manufacturer to provide dimensioned layout drawing of cable access openings to equipment and associated requirements for the concrete support pad.

.7 The load bank shall be supported and assembled on a structural steel sub-base (support skid) suitable for installation outdoors on a concrete pad type foundation. The load bank shall incorporate anchor points for fixing the support skid to the concrete pad. All other load bank components or sub-assemblies shall be anchored to the support skid and shall not require direct anchoring to the concrete pad.

.8 The support skid shall be designed to support the weight of the complete unit, plus snow loading.

.5 ENCLOSURES

.1 The load bank enclosure shall be CSA enclosure type 3R, designed for outdoor installation, in -40C to +40C weather.

.2 The load bank low voltage load module enclosure shall be segregated into separate compartments for:

.1 600V resistive load elements,

.2 600V load element distribution, load element branch circuit fuse protection and load element control contactors, and

.3 Control and protection.

.3 The 600V resistive load bank low voltage load module enclosure(s) shall be of double wall construction to provide a cool exterior and thermal isolation of the load elements.

.4 Cooling airflow through the load bank low voltage load module enclosure shall be vertical with cold air intake at the bottom and hot air exhaust out the top.

.5 The load bank low voltage load module shall be equipped with a removable discharge plenum/elbow designed to provide vertical, weatherproof discharge of the exhaust cooling airflow complete with varmin screen and hood and to prevent the ingress of wind driven rain or snow into the resistive elements.

.6 All interior spaces of the load bank enclosure shall be accessible by hinged, bolted lockable doors. Bolt-on panels are NOT acceptable.

.7 The low voltage load bank module enclosure shall be equipped with ventilation louvers to provide the required cooling airflow as required.

.8 The ventilation intake louvers and the exhaust plenum/elbow shall be equipped with screens to prevent the ingress of birds, rodents, and vermin, and shall be removable only from within the enclosure, and so arranged to prevent the ingress of rain or wind driven snow.

.9 Door hardware, hinges, and closure bolts shall be stainless steel. Closure bolts shall be captive to prevent loss.

.10 The enclosure shall be painted with an industrial enamel using a ULC listed material and process.

.6 HEATING AND HEATING CONTROLS:

.1 The load bank enclosure (load cells and auxiliaries as required) shall be equipped with interior space heaters under thermostatic control which will heat the interior components to a temperature which will allow the load bank to be energized and have load immediately applied over the entire specified environmental temperature range (-40ºC to +40ºC).

.2 The load bank control system shall incorporate all necessary controls, contactors, and interlocks to allow manual control of heating during periods of low ambient temperatures and prevent the application of load to the transformer or load bank until the required interior temperatures for safe loading of the equipment (including the transformer) have been attained.

.3 Provide interlocks c/w indication of a low temperature “load lockout condition” on both the load bank internal control panel and the “remote” control panel.

.4 The enclosure heaters shall be powered from the common 120V 1Ø “auxiliary” supply.

.7 LOAD ELEMENTS:

.1 Load resistive elements shall be of open, helically wound chromium alloy electrical resistance wire. The resistance wire shall be sized to operate at 50% to 60% of the maximum continuous temperature rating of the wire. The element resistance wire shall be mechanically supported over its entire length in such a way that should a wire break, the broken wire segments will not short to adjacent conductors or to ground.

.2 Load elements shall be individually serviceable and replaceable in the field without major disassembly of the load bank. Load elements shall be installed in multiple resistor cases or trays which shall be removable in such a way that any element is easily accessible without disturbing any other elements.

.3 All materials used in the mounting and installation of the load elements shall be suitable for the temperatures encountered, both in normal operation and under fault conditions.

.4 Materials in direct contact with the element resistance wire shall be ceramic. Elements shall be fully supported across the entire length exposed to the cooling air stream by segmented ceramic insulators. The ceramic support insulator shall be installed upon, reinforced, and supported by stainless steel structures designed to accommodate the required thermal expansion of the insulator. Other materials which structurally support the load elements or form the cooling air duct within which the elements are mounted shall be steel or stainless steel.

.5 Plastics, glass reinforced plastic materials, and flammable materials are NOT acceptable for the installation, support, and mounting of load elements or in the construction of the load bank cooling air duct.

.6 The change in resistance due to temperature shall be minimized by maintaining conservative element power densities. The overall tolerance of the load bank shall be –0% to +5% kW at rated voltage. The load bank shall deliver rated kW at rated voltage.

.8 RESISTIVE LOAD ELEMENTS CIRCUIT PROTECTION AND CONTROL

.1 The resistive load element units shall be 3Ø delta connected, 600V rated and in fused branch circuits for each load element.

.2 Load element units shall be individually connected and individually fused. Load element unit circuit fuses shall be 200 KAIC, current limiting type, extremely fast acting, and 600V rated.

.3 Load control contactors shall be electrically operated, electrically held, rated with 50% spare capacity, contacts shall be silver surfaced, and contactor control voltage shall be 120V. One load control contactor shall be supplied for each load element unit.

.4 Load element unit power wiring shall be stranded: 150ºC insulated, -40 ºC rated.

.5 Main terminals shall be copper, with a maximum current density of 1000A per square inch of cross section.

.9 COOLING SYSTEM

.1 Forced air cooled by motor driven propeller fan.

.2 Cooling fan motor(s) shall be TEFC or TEAO (where the fan propeller is direct mounted on the motor), shall be 1800 RPM (maximum), 600V rated, 575V utilization voltage. Fan motor shall be controlled by a circuit breaker combination motor starter c/w non-self-resetting overloads sized for the motor running current in accordance with the motor manufacturer's recommendations and the CEC.

.3 The fan propeller shall be of aluminum or stainless steel with an airfoil profile. Flat bladed or non-airfoil profile fans are NOT acceptable.

.4 Direct drive cooling fans where the propeller is directly mounted on the motor shaft are preferred, belted drive fans may be acceptable.

.5 Where belted drive fans are proposed, the drive shall utilize a minimum of 2 belts, belts shall be standard B/C type, drive service factor shall be 1.5 x motor Hp (minimum), maximum reduction shall be 2.5:1. Pillow blocks shall be extra heavy duty, with an L10 bearing life of 60,000 hours (minimum).

.6 The cooling fan(s) shall operate at 600V AC line voltage. Load control circuits and fan motor controls shall operate at 120V 1Ø, via control power isolation transformers. Control circuit fuses shall be 100 KAIC current limiting types, 600V rated.

.7 Provide a malfunction detection system consisting of sensors within the load bank, load bank enable/disable permissive circuit, and alarms. Malfunction detection sensors shall include, but not be limited to:

.1 Cooling air intake temperature element(s) (mechanical switches, Resistance Temperature Detectors (RTDs), or thermocouples), with operating setpoint set to 48ºC,

.2 Exhaust air temperature sensors, with operating point set at not more than 41ºC above the maximum rated temperature rise, and

.3 Air pressure sensors (differential pressure type) to sense for loss of cooling airflow.

.10 OTHER REQUIREMENTS INCLUDE:

.1 The load controls shall be designed such that "Block Load" type operation (no load to full load in a single step) is possible.

.2 The load bank controls shall be configured for step loads operation (minimum), so the system can increase the load from 0 kW to 100 kW in 5 kW increments, as follows:

.1 2 steps of 5 kW,

.2 4 steps of 10 kW,

.3 1 steps of 50 kW.

.3 Provide both local and remote-control panels.

.1 The local panel shall consist of the following:

.1 Power supply for load bank control circuits.

.2 Malfunction detection/auto disconnect system.

.3 Cooling fan automatic start-stop control.

.4 Anti-condensation thermostatically controlled heater.

.5 Remote load dump circuit to allow use of remote dry contacts (close to run) to trip load bank off line. Unit shall be shipped with a clearly marked removable jumper to permit the "Load Dump" feature to be field activated.

.6 Input/output devices and control circuits for operation of load bank from remote control panel and automatic controller.

.7 Auxiliary dry contacts to indicate "normal operation"/"system failure".

.8 Local Manual Control Panel to include, but not be limited to, the following:

- Off/Manual/Auto/Remote mode control selector –switch,
- Manual Run/Stop pushbuttons,
- Bypass switch to override remote load dump,
- Master load switch, and
- Load step switches.

.2 Local and remote status annunciator with the following indications:

.1 Auxiliary 600 VAC power "On",

.2 600 VAC genset power connected,

.3 Local-manual run,

.4 Local-auto run,

.5 Remote mode,

.6 Load dump,

.7 Load dump bypass,

.8 Normal operation / System malfunction,

.9 Cooling failure,

.10 Master load on,

.11 Load step on (one for each load step), and

.12 Press-to-test pushbutton for indicators.

.3 The remote panel shall consist of a CSA type 2 enclosure, with hinge-open front door and have the following door-mounted features:

.1 Off/Manual/Auto;

.2 Manual Run-Stop pushbuttons,

.3 Bypass switch to override remote load dump,

.4 Master load switch,

.5 Load step switches,

.6 Automatic Test Start/Stop Pushbuttons, and

.7 Automatic Test Program selector switch.

.4 Status annunciator with the following indicators:

.1 Auxiliary 600 VAC power "On",

.2 Power connected,

.3 Transformer low temperature load bank operation inhibit indication,

.4 Remote -manual run,

.5 Remote -auto run,

.6 Remote mode,

.7 Load dump,

.8 Load dump bypass,

.9 Normal operation / System malfunction,

.10 Cooling failure,

.11 Master load on,

.12 Load step on (one for each load step), and

.13 Press-to-Test pushbutton for indicators.

.5 Access to data recording. If an external laptop / software are required, access to the data logger shall be possible through a front door mounted USB interface connector. Data recording shall be stored in memory at the load bank and shall be accessible by the remote-control panel.

.6 The load bank shall be equipped with a programmable automatic controller, which will be enabled when the load bank mode selector switch is placed in the "automatic" position.

.1 The automatic controller is NOT intended to operate when the generators are on-line supplying the facility loads or for the purposes of maintaining generator or plant loading.

.2 In load bank "automatic mode", the programmable automatic controller shall provide a minimum of three user selectable / user configurable programs to allow for the fully sequenced automatic testing of one connected generator.

.3 Test sequences provided and data recorded by the programmable automatic controller shall comply with the testing and data recording requirements of CSA C282 part 11 "Operation and maintenance program".

.4 Routine generator testing will be manually initiated by the City at frequencies determined by the City. Automatic clock or calendar-based initiation of routine testing is not contemplated or required for this system or facility.

.11 PROGRAMMED AUTOMATED TEST SEQUENCES

.1 In addition to the load bank test program, allow for a minimum of two additional use programmable load testing programs (spares), saveable to permanent memory storage.

.2 Stepped Load Application – Generator Testing (Program # 1 – Monthly Testing):

.1 Once the load bank has been set to "automatic mode", the automatic testing sequence shall be initiated by operator action (mechanical or "software" pushbutton).

.2 Upon operator initiation the program shall increase the load applied, to the generator under test, in a smooth controlled manner by applying a series of load steps to a selected "test load level" in a time delayed sequence. Selection of a "test load level" greater than the nameplate capacity of the generator shall not be possible.

.3 Loading and test requirements shall be in accordance with CSA C282 monthly testing requirements.

.4 The loading sequence shall allow the genset to warm up for a period of 5 minutes with no load. The genset loading shall ramp up and be run at 30% load for 15 minutes, 60% for 30 minutes, and 90% for 15 minutes thereafter.

.5 At the end of the above test duration the program shall decrease the generator loading to "no-load" in a smooth controlled manner by removing the load in a stepped manner and initiating a cool down sequence in accordance with genset manufacturer recommendations.

.6 After reducing generator loading to "no-load" the program shall terminate.

.7 The system shall perform automatic data recording, saved in memory and retrievable.

.8 The program shall automatically abort for the following events (including but not limited to):

.1 Load bank electrical fault,

.2 Loss of load bank cooling air,

.3 Excessive inlet or exhaust air temperatures,

.4 Loss or obstruction of power step down transformer cooling airflow,

.5 Excessive power step down transformer temperature,

.6 Other conditions which the load bank supplier deems necessary,

.7 Loss of generator supplied voltage (generator trip),

.8 Operation of an emergency shutdown device by the operator, and

.9 Loss of facility normal power.

.3 Stepped Load Application – Generator Testing (Program # 2 – Yearly Testing):

.1 Once the load bank has been set to "automatic mode", the automatic testing sequence shall be initiated by operator action (mechanical or "software" pushbutton).

.2 Upon operator initiation the program shall increase the load applied, to the generator under test, in a smooth controlled manner by applying a series of load steps to a selected "test load level" in a time delayed

sequence. Selection of a "test load level" greater than the nameplate capacity of the generator shall not be possible.

.3 Loading and test requirements shall be in accordance with CSA C282 yearly testing requirements.

.4 The loading sequence shall allow the genset to warm up for a period of 5 minutes with no load. The genset loading shall ramp up and be run at 30% load for 5 minutes, 60% for 5 minutes, 90% for 5 minutes and 100% load for 2 hours.

.5 At the end of the above test duration the program shall decrease the generator loading to "no-load" in a smooth controlled manner by removing the load in a stepped manner and initiating a cool down sequence in accordance with genset manufacturer recommendations.

.6 After reducing generator loading to "no-load" the program shall terminate.

.7 The system shall perform automatic data recording, saved in memory and retrievable.

.8 The program shall automatically abort for the following events (including but not limited to):

.1 Load bank electrical fault,

.2 Loss of load bank cooling air,

.3 Excessive inlet or exhaust air temperatures,

.4 Loss or obstruction of power step down transformer cooling airflow,

.5 Excessive power step down transformer temperature,

.6 Other conditions which the load bank supplier deems necessary,

.7 Loss of generator supplied voltage (generator trip),

.8 Operation of an emergency shutdown device by the operator, and

.9 Loss of facility normal power.

.12 PROGRAMMED AUTOMATED TEST DATA RECORDING REQUIREMENTS.

.1 Data Recording Requirements:

.1 The system shall generate an electronic time-stamped record of the testing (including but not limited to):

.1 Load step,

.2 Duration of test segments,

.3 Currents,

.4 Voltages,

.5 Power,

.6 Resistor unit parameters and status signals as indicated above,

.7 Successful completion of test or test failure, and

.8 Reason for test failure, etc.

.2 The recorded data shall be structured and formatted to be compatible with the requirements of CSA document "C282 Logbook-15, Emergency electrical power supply for buildings maintenance logbook".

.3 The test record shall be retained in non-volatile memory (SSD, "flash" memory, etc.) as an ASCII formatted columnar text file (".txt" format) and structured as indicated above. The test records shall be downloadable and shall be capable of being outputted to a USB drive via a USB interface supplied with the system. The file name shall include the date and time of the test (initiation).

.13 MANUFACTURER START-UP SERVICES

.1 The load bank manufacturer shall provide a factory trained service technician to supervise the testing, commissioning, and initial start-up of the load bank on-site (after the load bank has been installed and connected). Allow for a minimum of one day on-site to perform all of the on-site requirements defined here in. Note that the on-site requirements for training are in addition to the on-site requirements for system setup.

.14 QUALIFICATIONS AND ACCEPTABLE MANUFACTURER

.1 The load bank shall be the product of a firm regularly engaged in the design and manufacture of stationary generator load banks.

.2 The load bank manufacturer shall demonstrate at least five years experience with at least ten successful installations of load banks similar to the load bank specified herein.

.3 Approved manufacturer: Simplex or approved equal in accordance with B7.

.15 WARANTEE

.1 The load bank shall be supplied with a two-year manufacturer's warranty, which covers all materials and includes the provision of on-site service labor.

.2 The manufacturer shall demonstrate the availability of factory service technicians in support of the load bank.

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 INSTALLATION

.1 The following equipment shall be installed:

.1 Load bank system,

.2 Load bank auxiliary systems,

.3 Remote control panel,

.4 Modifications to transfer switches, and

.5 All other systems detailed on the vendor Shop Drawings, for a complete and working system.

.2 The Contractor shall supply and install anchors as required to fasten the load bank structural sub-base or vibration isolating devices (where provided) to the concrete pad.

.3 The Contractor shall supply and install interconnecting wiring between remote control panel and the local control panel.

.4 The Contractor shall provide 600V, normal power connection to the load bank for powering all accessories.

.5 Provide size 8 lamicoid.

3.3 TESTING

.1 LOAD BANK

.1 Inspect and test the load bank for initial system startup in accordance with the manufacturer's instructions and the requirements of the commissioning procedures.

.2 SYSTEM COMMISSIONING

.1 System commissioning testing shall demonstrate the performance of the combined generator sets, transfer switch, and load bank as an integrated system. The load bank supplier shall coordinate its testing, commissioning, and start-up activities with the operation of the generator and transfer switches.

.2 Initial site installation performance tests to prove generator system performance in conjunction with the load bank shall be performed in accordance with the requirements of CSA C282, Section 10.

.3 The "Operational Test" shall be performed in accordance with the requirements of CSA C282 Clause 10.2.1, the operational test shall be continued for a period of 1 hour, after which normal power shall be restored to the plant and satisfactory retransfer of the load and shutdown of the generator sets shall be demonstrated.

.4 Following the Operational Test, the "Maximum Site Design Load Test" shall be conducted by connecting the generator sets to the load bank individually and operating each generator set at its rated nameplate unity power factor capacity until stable engine and alternator temperatures have been achieved followed by an additional 6 hours at rated capacity. Load shall be applied immediately upon the engine reaching its rated speed and the rated nameplate load shall be applied in a single step.

.5 All data shall be recorded in accordance with the requirements of CSA C282 and a detailed report shall be submitted.

.6 The initial site installation performance tests shall be performed under the control and supervision of the manufacturer's factory trained technicians.

.3 Provide factory trained technicians to verify the completed installation and to perform an initial startup and testing.

3.4 TRAINING

.1 Provide demonstration by factory trained representative in use and maintenance of the load bank in coordination with the generator sets.

.2 Allocate a minimum of two separate 4-hour sessions for training. The date for each training session will be set by the City and will not be on 2 successive days.

.3 Training shall include, but not be limited to the following items:

.1 Overall system description and theory of operation.

.2 Automatic operation.

.3 Manual operation.

.4 Safeties and protective relaying.

.5 Recommended system checklists and log sheets.

.6 Recommended preventive maintenance.

.7 Instruction on the operation of the assembly, circuit breakers, and major components within the assembly.

3.5 FINAL ACCEPTANCE

.1 If required by the final field testing/commissioning results, make adjustments/or changes such that an efficient and fully operational installation is achieved. Final acceptance by the Contract Administrator will be conditional upon fulfillment of all requirements.

.2 For equipment subject to inspection by a government ministry, department, or agency, submit original copies of the test data reports and all other documentation required for the final field inspection of the equipment by the government ministry, department, or agency.

.3 Following completion of the Work, issue a history docket comprised of the quality certificates, inspection and test records, and any other relevant documents related to manufacture and testing.

END OF SECTION

Part 1 General

1.1 CODES AND STANDARDS

.1 Canadian Standards Association- CSA C22.2 No. 107.3- Uninterruptible Power Systems.

1.2 SUBMITTALS

.1 Provide shop drawing and O & M submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:

.1 Submit manufacturer's printed product literature, specifications, and datasheets and include product characteristics, performance criteria, and limitations.

.3 Submit Shop Drawings to include:

.1 System configuration with single-line diagrams.
.2 Functional relationship of equipment including weights, dimensions, and heat dissipation.
.3 Wiring diagrams, connections diagrams, terminal block layouts.
.4 Capacity data.
.5 Descriptions of equipment to be furnished.
.6 Size and weight of shipping units to be handled by installing contractor.
.7 Detailed installation drawings including all terminal locations.
.8 Bill of materials of components that can be replaced.
.9 Recommended spare parts.

1.3 CLOSEOUT SUBMITTALS

.1 Provide data for incorporation into operation and maintenance manual specified in Section 01 78 00 - Closeout Submittals

.2 Operation and maintenance manual to include:

.1 Operation and maintenance instructions concerning design elements, construction features, component functions, and maintenance requirements to permit effective operations maintenance and repair.
.2 Testing and commissioning report, both factory test and site testing reports.
.3 Technical Data:
.1 Approved Shop Drawings.
.2 Project data.
.3 Technical description of components.
.4 Parts lists with name and addresses of suppliers.
.5 Functional description of the equipment with block diagrams.
.6 Safety precautions.

.7 Instructions and step-by-step operating procedures.

.8 Routine maintenance guidelines, including illustrations.

.4 Provide spare parts as recommended in Part 1.2.3.8 and in accordance with Section 01 78 00 - Closeout Submittals.

1.4 SYSTEM START-UP

.1 Provide factory authorized service personnel to supervise start-up of system, checking, adjusting, and testing on Site

Part 2 Products

2.1 UNINTERRUPTIBLE POWER SUPPLY (UPS)

.1 Manufacturer and Model: APC Symmetra SYA8K16PXR or approved equal in accordance with B7.

.2 Conformance with CSA C22.2, No. 107.3.

.3 CSA/cUL approved.

.4 200% neutral required as indicated on Drawings.

.5 Technology

.1 Online, double-conversion, solid state topology with internal bypass switch.

.6 Design Requirements – UPS Module

.1 Voltage. Input/output voltage specifications of the UPS shall be:

.1 AC Input: 208 volts Line-Line, single phase.

.2 Output: 120/208 volts, single-phase, 3-wire plus ground.

.2 Frequency: 60 Hz

.7 Modes of Operation

.1 The UPS shall be designed to operate as an on-line system in the following modes:

.1 Normal: The inverter and the rectifier shall operate in an on-line manner to continuously regulate the power to the critical load. The input and output converters are capable of full battery recharge while simultaneously providing regulated power to the load for all line and load conditions within in the UPS specifications.

.2 Emergency/Battery: Upon failure of utility AC power, the critical AC load shall continue being supplied by the inverter without any switching. The inverter shall obtain its power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the AC input source.

.3 Recharge: Upon restoration of utility AC power, after a utility AC power outage, the UPS shall simultaneously recharge the battery and regulate the power to the critical loads.

.4 Automatic Bypass: The automatic bypass is used to provide transfer of critical load from the inverter output to the bypass. In the event of an emergency, this transfer is an automatic function.

.5 Manual Bypass Switch: The UPS shall be provided with an internal manual bypass switch (make before break) for supplying the load directly from the main supply, while the UPS is taken out for maintenance.

.6 Maintenance Bypass Cabinet: The maintenance service bypass cabinet provides power to the critical load bus from the bypass source during times when maintenance or service of the UPS frame is required or when removal of the frame is desired. The bypass panel provides a mechanical means of complete isolation of the UPS from the electrical wiring of the installation.

.8 Performance Requirements

.1 AC Input to UPS

.1 Voltage Configuration for Standard Units: single-phase, 120/208 VAC, 3-wire plus ground.

.2 Voltage Range: +10%, -20% of nominal.

.3 Frequency: Nominal frequency ±5%.

.4 Power Factor: Up to 0.9 lagging at nominal input voltage and full rated UPS output load.

.5 Current Distortion: <5% reflected THD maximum at full load.

.2 AC Output, UPS Inverter

.1 Voltage Configuration: single-phase, 120/208 VAC, 3-wire plus ground.

.2 Output Frequency: 60 Hz,

.3 AC Output Voltage Distortion. Maximum 5% at 100% Linear Load, phase to Neutral.

.4 Voltage Regulation: +/- 3% for 100% Linear or non Linear Load, phase to Neutral.

.5 Voltage Transient Reponses: +/- 5% maximum for 100% load step.

.3 Frequency: Nominal frequency ± 0.1 Hz in battery operation.

.4 Phase Displacement:

.1 20 degrees ±5 degree for balanced load.

.2 20 degrees ±1 degree for 50% unbalanced load.

.3 20 degrees ±3 degree for 100% unbalanced load.

.5 Output Power Rating: Rated kVA at 0.8 lagging power factor.

.6 Overload Capability:

.1 Greater than 130% for 4 seconds.

.2 105% continuous bypass operation.

.3 Bypass Operation; 50 A continuous for 8kVa Frame, 90A continuous for 16 kVa Frame.

.9 Environmental Conditions

.1 The UPS shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics:

.1 Operating Ambient Temperature

.1 UPS Module: 0°C to 40°C.

.2 Battery: 15°C to 25°C.

.2 Storage/Transport Ambient Temperature

.1 UPS Module: -15°C to 45°C.

.2 Battery: -15°C to 40°C.

.3 Relative Humidity

.1 0 to 95%, non-condensing.

.4 Altitude

.1 Operating: to 1000 meters above Mean Sea Level. Derated for higher altitude applications.

.10 Audible Noise

.1 Noise generated by the UPS under any condition of normal operation shall not exceed 62 dBA measured 1 meter from surface of the UPS.

.11 The UPS shall have capabilities of remote UPS monitoring

.12 The UPS shall have controls mounted in panel front.

.13 Factory Testing:

.1 Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification.

.14 Relay Card

.1 Provide status contacts for:

.1 UPS Fault.

.2 Summary Alarm.

.3 Low battery.

.4 On Battery / ON UPS status.

.5 On Bypass Status.

.15 Remote UPS Monitoring

.1 Simple Network Management Protocol (SNMP).

.2 Modbus TCP protocol and connection to a PLC for remote monitoring of the system.

2.2 BATTERY

.1 The UPS battery is of modular construction consisting of user-replaceable, hot-swappable, fused battery modules. Each battery module is monitored for voltage and temperature for use by the UPS battery diagnostic and battery charger circuitry.

.2 The batteries are of the valve-regulated lead acid (VRLA) type.

.3 The UPS incorporates a battery management system to continuously monitor the health of each removable battery module as well as external battery modules installed in extended run battery cabinets. This system notifies the user if a failed or weak battery module is found.

.4 Additional battery modules may be added to increase runtime by utilizing up to seven extended run battery cabinets. These cabinets will be hot-pluggable, allowing for easy and quick installation without the need for electrical wiring, electrician, or powering down of the UPS. The battery modules are monitored by each individual frame and this information passed upstream to the main intelligence modules. Acceptable Battery Module: APC Symmetra SYAXR9B9 or approved equal in accordance with B7.

.5 Each UPS Battery Module has a built in DC disconnect switch for transportation and to disconnect the battery module completely from the internal bus while installed in the UPS system.

2.3 MAINTENANCE BYPASS CABINET

.1 208V single-phase, 100A.

.2 Acceptable Manufacturer: APC Service Bypass Panel SBP16KP or approved equal in accordance with B7.

2.4 REMOTE UPS MONITORING

.1 Capable of remote UPS monitoring

2.5 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 01 - Common Work Results – Electrical.

.2 Nameplate for UPS to be size 8, example as followed:

UPS-Y712 120/208V, 1Ø, 3W

.3 Nameplate for each Maintenance Bypass Cabinet to be size 8, example as followed:

MTS-Y712 100A, 120/208V FED FROM PANEL A

.4 Nameplate for each Battery Cabinet (if required) to be size 8, example as followed.

BAT-Y712
208V

.5 Add separate UPS panelboard identifier as per panelboard spec, example as followed:

PNL-Y712U
120/208V, 1Ø, 3W
FED FROM UPS-Y712

Part 3 Execution

3.1 INSTALLATION

.1 Locate UPS and Maintenance Bypass Cabinets as indicated on the Drawings.

.2 Support and anchor the UPS as per manufacturer's instructions.

.3 Connect and configure UPS and Maintenance Bypass Cabinets as per manufacturer's Installation Manual.

.1 Wire input, output, and ground bus bars.
.2 Connect control cables.
.3 Connect AC main cables to main input terminal.
.4 Connect UPS output to load panel.
.5 Connection of internal batteries to be performed ONLY by factory authorized service personnel.

.4 Start-up UPS and make preliminary tests to ensure satisfactory performance. Do not power UPS without factory authorized service personnel present.

3.2 TRAINING

.1 Provide on-site demonstration by factory trained representative in use and maintenance of UPS system.

.1 Allocate a minimum of four hours for training the UPS.

.2 On-site Operational Training: During the factory-assisted start-up, operational training for Site personnel shall include, but shall not be limited to:

.1 Keypad operation,
.2 LED indicators.
.3 Start-up and shutdown procedures.
.4 Maintenance Bypass.
.5 AC disconnect operations.

.6 Alarm information.

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 25 kVAR per step for a total of six (6) steps. A moulded case circuit breaker in the MCC shall connect the power factor correction bank to the MCC with cable connection.

.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: 200 kVAR

.1 Actual capacitor kVAR will be higher due to reactors.

.3 Nominal Capacitance Stages:

.1 Two (2) 25 kVAR

.2 One (1) 50 kVAR

.3 One (1) 100 kVAR

.4 Insulation Class: 1 kV

.5 Minimum system short circuit capacity: 25 kA

.4 Capacitor bank characteristics:

.1 Fuse protected.

.2 Contactor controlled.

.3 Included transient suppressors.

.4 Included discharge resistors.

.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 Electrical losses shall be less than 0.5 W/kVAR

.4 Capacitor casing: seamless aluminum.

.5 Capacitor fluid shall be completely biodegradable (no polychlorinated bi-phenyls).

.6 Voltage Rating: 690V to protect against current and voltage overload due to harmonic distortion

.7 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 Class RK5 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 Filter tuning frequency shall be 4.1 x 60 Hz (245 Hz), unless otherwise approved by the Contract Administrator.

.2 Insulation rating: 220°C.

.3 Maximum temperature rise: 115°C.

.4 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 provide a user interface and 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 customer 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 Display target and actual power factor.

.6 Provide a 120VAC, 5A rated dry contact alarm output, indicating any internal alarm condition.

.11 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 lights on the doors of each capacitor stage.

.6 Provide filtered fans on the doors for cooling

.7 Provide appropriate warning labels indicating dangerous voltages in enclosure.

.8 Provide lifting lugs to allow for transport.

.9 Size: to fit within the proposed location as shown on the drawings.

2.2 CURRENT TRANSFORMER

.1 Current transformer for installation within MCC-M710.

.1 Optionally the current transformer for the power meter may be utilized, provided the CT burdens are verified to be adequate.

.2 Current transformer characteristics:

.1	Type:	Window
.2	Class of Accuracy:	0.5
.3	Rated Burden:	5 VA (minimum)
.4	Ratio:	400:5
.5	Nominal System Voltage:	600 VAC
.6	Frequency:	60 Hz
.7	Supply System:	3 phase, 3 wire

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 INSTALLATION

.1 Install and connect capacitors.

3.3 FIELD QUALITY CONTROL

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

3.4 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.

3.5 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

Part 1 General

1.1 REFERENCES

.1 American National Standards Institute (ANSI)

.1 ANSI C82.1-04, Lamp Ballasts-Line Frequency Fluorescent Lamp Ballast.

.2 ANSI C82.4-02(R2007), Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps Multi Supply Type.

.2 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE)

.1 ANSI/IEEE C62.41-1991, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

.3 ASTM International Inc.

.1 ASTM F1137-00(2006), Standard Specification for Phosphate/Oil and Phosphate/Organic Corrosion Protective Coatings for Fasteners.

.4 Canadian Standards Association (CSA International).

.5 ICES-005-07, Radio Frequency Lighting Devices.

.6 Underwriters' Laboratories of Canada (ULC).

.7 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 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 - 5 year warranty on all components.

.4 Compliance with IESNA LM-79 and LM-80.

2.2 LED DRIVERS

.1 All new luminaires shall be LED type, with LED drivers.

.2 Long life, 60,000 hours minimum.

2.3 FINISHES

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

2.4 LUMINAIRES

.1 Acceptable manufacturers and models:

.1 As indicated in luminaire schedule on the Drawings.

.2 Or approved equal in accordance with B7.

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 circuit(s) contained within.

.1 Example: C711-11 (Panelboard PNL-C711, circuit 11).

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 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 Remove surplus materials, excess materials, rubbish, tools, and equipment.

.2 Waste management: separate waste materials for recycling.

.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 REFERENCES

.1 Canadian Standards Association (CSA International)

.1 CSA C22.2 No.141 (2015), Unit Equipment for Emergency Lighting.

1.3 SUBMITTALS

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

.2 Data to indicate system components, mounting method, source of power, and special attachments.

Part 2 Products

2.1 EQUIPMENT

.1 Emergency lighting equipment: to CSA C22.2 No.141.

.2 Supply voltage: 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% 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 Or approved equal in accordance with B7.

2.2 WIRING OF REMOTE HEADS

.1 Conductors: RW90 type in accordance with Section 26 05 21 - Wires and Cables (0-1000 V), sized 10 AWG or greater 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 REFERENCE STANDARDS

.1 Government of Canada

.1 NBC (Latest), National Building Code of Canada.

.2 ISO 8201, Acoustics – Audible Emergency Evaluation Signal.

.3 Underwriter's Laboratories of Canada (ULC)

.1 CAN/ULC-S524, Installation of Fire Alarm Systems.
.2 ULC-S525, Audible Signal Appliances for Fire Alarm.
.3 CAN/ULC-S526, Visual Signal Appliances, Fire Alarm.
.4 CAN/ULC-S527, Control Units.
.5 CAN/ULC-S528, Manual Pull Stations.
.6 CAN/ULC-S529, Smoke Detectors.
.7 CAN/ULC-S530, Heat Actuated Fire Detectors.
.8 CAN/ULC-S536, Inspection and Testing of Fire Alarm Systems.
.9 CAN/ULC-S537, Verification of Fire Alarm Systems.

.4 NFPA 720 – Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment.

.5 NFPA 13 – Standard for the Installation of Sprinkler Systems.

.6 CSA C22.1 Canadian Electrical Code.

.7 Manitoba Building Code.

.8 Winnipeg Electrical By-law.

1.2 ACRONYMS AND ABBREVIATIONS

.1 Acronyms used in Multiplex Fire Alarm System:

.1 BPS – Booster Power Supply
.2 DCLA – Data Communication Link Style A
.3 DCLB – Data Communication Link Style B
.4 DCLC – Data Communication Link Style C
.5 DGP – Data Gathering Panels
.6 FACP – Fire Alarm Control Panel
.7 FAAP – Fire Alarm Annunciator Panel
.8 IDC – Initiating Device Circuit

.9 NAC – Notification Appliance Circuit

.10 N/O – Normally Open

.11 SLC – Signaling Line Circuit

.12 CO – Carbon Monoxide

1.3 SYSTEM DESCRIPTION

.1 Fully supervised, microprocessor based, fire alarm system, utilizing digital techniques for data control and digital multiplexing techniques for data transmission.

.2 System to carry out fire alarm and protection functions including; receiving alarm signals; initiating general alarm; supervising components and wiring; actuating annunciators and auxiliary functions; and initiating trouble signals.

.3 Zoned, non-coded single stage.

.4 Modular in design to allow for future expansion.

.5 System to be operable by personnel not requiring special computer skills.

.6 Provide all components required for a full and functioning fire alarm system. Not all devices, modules, end of line resistors, relays, etc. are shown on the Drawings. The Contractor is responsible for all components for a complete and working system.

.7 System to include but not limited to:

.1 Chubb Edwards addressable microprocessor based fire alarm central control unit. This includes but is not limited to: the main system memory, input output interfaces for alarm receiving, local annunciation/display, and program control/signaling, battery backup.

.2 Remote annunciator in separate enclosure with input output interfaces for alarm receiving and annunciation/display.

.3 Power supplies.

.4 Initiating/input circuits.

.5 Output circuits.

.6 Auxiliary circuits.

.7 Wiring.

.8 Manual and automatic initiating devices.

.9 Audible and visual signaling devices.

.10 Addressable relay modules.

.11 End of line resistors.

1.4 REQUIREMENTS OF REGULATORY AGENCIES

.1 System components: listed by ULC and comply with applicable provisions of National Building Code and Local/Provincial Building Code and meet requirements of local authority having jurisdiction.

1.5 DESIGN REQUIREMENTS

.1 The Contractor shall design conduit layout and wiring interconnection of all devices and systems.

.2 Perform voltage drop calculations and upsize wiring from what is shown on the Drawings or indicated in the Specifications, as required in order to comply with the CEC.

.3 The microprocessor based fire alarm panel shall be suitable for connection of all new fire alarm devices, plus 100% spare devices on each loop.

1.6 SHOP DRAWINGS AND SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures and Section 26 05 01- Common Work Results – Electrical.

.2 Include:

- .1 Descriptive product information for each individual system component including Manufacturer's name, model number, ratings, and power requirements.
- .2 Dimensional drawings of panels and associated equipment.
- .3 Itemized bill of material complete with part numbers.
- .4 Operating and programming instructions.
- .5 Complete point-to-point wiring diagrams of the system and device interconnection.
- .6 Supervisory power requirement calculations.
- .7 Alarm power requirement calculations.
- .8 Battery sizing calculations.
- .9 Voltage drop calculations for wiring runs.
- .10 Conduit fill calculations.
- .11 Detail assembly and internal wiring diagrams for control panels and annunciator panel.
- .12 Overall system riser diagram identifying control equipment, initiating zones, and signaling circuits; identifying terminations, terminal numbers, conductors, and raceways.
- .13 Details and performance specifications for control, annunciation, and peripherals with item by item cross reference to Specification for compliance.
- .14 Recommended types and quantities of spare parts.
- .15 Written schedule of active and spare addresses on each addressable circuit.

.3 Provide informational submittals including:

- .1 Service technician certifications.
- .2 Code-enforcement authority approval letter.

1.7 CLOSEOUT SUBMITTALS

.1 Provide operation and maintenance data for fire alarm system for incorporation into operation and maintenance manuals specified in Section 01 78 00 - Closeout Procedures.

.2 Include:

.1 Instructions for complete fire alarm system to permit effective operation and maintenance.

.2 Written documentation for logic modules as programmed.

.3 System program hard copy on flash drive.

.4 Documentation of system voltage, current, and resistance readings taken during system installation and testing.

.5 NFPA 72, Record of Completion: Submit to Contract Administrator and AHJ.

.6 NFPA 72, Inspection and Testing Form: Submit to Contract Administrator and AHJ.

.7 Technical data - illustrated parts lists with parts catalogue numbers.

.8 Copy of approved Shop Drawings with corrections completed and marks removed except review stamps.

.9 List of recommended spare parts and provision of spare parts for system.

1.8 QUALITY ASSURANCE

.1 Qualifications

.1 A technician with a minimum engineering technologist certification for fire alarm systems or a professional engineer registered in Province of Manitoba shall be available on-site.

.2 Service technician shall be formally trained by the fire alarm manufacturer.

.2 Regulatory Requirements

.1 Submit Shop Drawings and system design calculations for approval to the AHJ.

1.9 EXTRA MATERIALS

.1 Include:

.1 2 extra keys for all enclosures, including but not limited Fire Alarm Control Panels (FACP) and resetting/opening manual pull stations.

1.10 TRAINING

.1 Provide on-site training sessions by the fire alarm equipment manufacturer to train operational and maintenance personnel in the use and maintenance of the system. See Part 3.5 for more details.

1.11 INSPECTION

.1 Inspection to conform to CAN/ULC-S536. Submit inspection report to the Contract Administrator.

.1 No additional payment for the inspections will be made. Include all costs in the base price for the fire alarm system.

Part 2 Products

2.1 GENERAL

.1 Not all devices or modules are necessarily listed below. Provide any other components required for a complete and working fire alarm system.

.2 Acceptable Manufacturers:

.1 Edwards System Technology;

.2 or approved equal in accordance with B7.

.3 ULC Compliance

.1 Products manufactured within the scope of ULC shall conform to ULC standards and have a ULC listing mark.

.4 CSA Approval

.1 All electrical equipment shall be CSA approved.

2.2 MATERIALS

.1 Equipment and devices: ULC listed and labeled and supplied by single Manufacturer.

.2 Power supply: to CAN/ULC S524.

.3 Audible signal devices: to ULC S524.

.4 Visual signal devices: to CAN/ULC S526.

.5 Control unit: to CAN/ULC S527.

.6 Manual pull stations: to CAN/ULC S528.

.7 Thermal detectors: to CAN/ULC S530.

.8 Smoke detectors: to CAN/ULC S529.

.9 Smoke alarms: to CAN/ULC S531.

2.3 SYSTEM OPERATION: SINGLE STAGE SIGNALS ONLY

.1 Actuation of any alarm initiating device to:

.1 Indicate zone of alarm at central control units and remote annunciator.

.2 Cause audible signaling devices to sound continuously throughout facility and at central control unit.

.3 Cause indicated HVAC to shut down to provide required control of smoke movement.

.4 Indicate alarm and trouble signals to plant operations PLC system.

.5 Acknowledging alarm: indicated at central control units and remote annunciator.

.6 Possible to silence signals by "alarm silence" switch at control unit, after 60s period of operation.

.7 Subsequent alarm received after previous alarm has been silenced, to re activate signals.

.8 Actuation of supervisory devices to:

.1 Indicate respective supervisory zone at central control unit and at remote annunciator.

.2 Cause audible signal at central control unit to sound.

.3 Activate common supervisory sequence.

.4 Resetting alarm device not to return system indications/functions back to normal until control unit has been reset.

.9 Trouble on system to:

.1 Indicate circuit in trouble at central control unit.

.2 Activate "system trouble" indication, buzzer, and common trouble sequence. Acknowledging trouble condition to silence audible indication; whereas visual indication to remain until trouble is cleared and system is back to normal.

.10 Trouble on system: suppressed during course of alarm.

.11 Trouble condition on any circuit in system not to initiate alarm conditions.

2.4 CONTROL PANELS

.1 Requirements:

.1 Provide new single stage addressable fire alarm control panels. Provide all devices, accessories, and programming to accommodate the expansion of the system.

.2 Fire alarm control panel shall include:

.1 Indicating circuits;

.2 Notification circuits;

.3 Auxiliary Relays;

.4 Data Connection to Remote Annunciator; and

.5 24 VDC power output to Remote Annunciator.

.3 Provide additional required indications at the control panels, including but not limited to:

.1 Supervisory alarm;

.2 Alarm for each zone;

.3 Trouble for each zone;

.4 Alarm signaling circuit trouble;

.5 Annunciator circuit trouble;

.6 Remote annunciator trouble; and

.7 Signals silenced

.4 Auxiliary Relays:

.1 Plug-in type, supervised against unauthorized removal by common trouble circuit. Terminals capable of accepting 12-22 AWG wire.

.5 Acceptable manufacturer: Edwards iO1000 Intelligent Fire Alarm System or approved equal in accordance with B7.

2.5 REMOTE BOOSTER POWER SUPPLIES

.1 Provide power supplies to ensure functional devices. Power supplies are not shown on the Drawings.

2.6 ADDRESSABLE CONTROL MODULES

.1 Distributed throughout the facility in suitable electrical boxes and interconnected to the control panel utilizing multiplex data transmission techniques.

.1 Mounted in rooms with suitable environmental conditions or else installed in mounting box providing sufficient environmental protection.

.2 Control and monitor conventional notification appliance circuit via interface to addressable, intelligent device loop.

.1 Control and activate one Class B NAC, as commanded by the control panel.

.2 Relay trouble status of NAC to the control panel.

.3 Provide external power supply to power devices on the NAC circuit.

.3 Module address to be set on module in the field or electronically by loop controller.

2.7 ADDRESSABLE RELAY MODULES

.1 Distributed throughout facility in suitable electrical boxes and interconnected to the control panel utilizing multiplex data transmission techniques.

.1 Mounted in rooms with suitable environmental conditions, or else installed in mounting box providing sufficient environmental protection.

.2 Close one Form C dry contact as commanded by the control panel.

.1 Suitable for shutting of HVAC supply fan. Each fan will require individual relay module.

.3 Module address to be set on module in the field or electronically by loop controller.

.4 Acceptable Material: Edwards SIGA-CRH or approved equal in accordance with B7.

2.8 ADDRESSABLE MONITOR MODULES

.1 Distributed throughout facility in suitable electrical boxes and interconnected to CCU utilizing multiplex data transmission techniques.

1. Mounted in rooms with suitable environmental conditions or else installed in mounting box providing sufficient environmental protection.

.2 Provide interface between standard alarm input devices and FACP.

1. Each addressable monitor module to monitor one conventional Class B IDC and relay alarm and trouble condition of detectors on the circuit back to FACP.

.3 Module address to be set on the module in the field or electronically by loop controller.

.4 Acceptable Material: Edwards model SIGA-UM or approved equal in accordance with B7.

2.9 POWER SUPPLIES

.1 120 V, 60 Hz as primary source of power for system.

.2 Voltage regulated, current limited distributed system power.

.3 Primary power failure or power loss will activate common trouble sequence.

.4 Interface with battery charger and battery to provide uninterruptible transfer of power to standby source during primary power failure or loss.

.5 During normal operating conditions, fault in battery charging circuit, short, or open in battery leads to activate common trouble sequence and standby power trouble indicator.

.6 Standby batteries: sealed, maintenance free.

.7 Continuous supervision of wiring for external initiating and alarm circuits to be maintained during power failure.

2.10 INITIATING/ INPUT CIRCUITS

.1 Receiving circuits for alarm initiating devices such as manual pull stations, smoke detectors, and heat detectors, wired in DCLA, DCLB, or DCLC configuration to control panels as shown on Drawings.

.2 Alarm receiving circuits (active and spare): compatible with smoke detectors and open contact devices.

.3 Actuation of alarm initiating device: cause system to operate as specified in "System Operation" in Section 2.3.

.4 Receiving circuits for supervisory, N/O devices. Devices: wired in DCLA or DCLC configuration to FACPs as shown.

.5 Actuation of supervisory initiating device: cause system to operate as specified in "System Operation" in Section 2.3.

2.11 ALARM OUTPUT CIRCUITS

.1 Alarm output circuit: connected to signals, wired in class B configuration to control panels as shown.

.1 Signal circuits' operation to follow system programming; capable of sounding horns. Each signal circuit: rated at 2 A, 24 VDC; fuse protected from overloading/overcurrent.

.2 Manual alarm silence, automatic alarm silence and alarm silence inhibit to be provided by system's common control.

2.12 AUXILIARY CIRCUITS

.1 Auxiliary contacts for control functions.

.2 Alarm on system to cause operation of programmed auxiliary output circuits.

.3 Upon resetting system, auxiliary contacts to return to normal or to operate as pre-programmed.

2.13 WIRING

.1 Fire Alarm Cable (FAS)

.1 Use:

.1 Initiating Device Circuits (IDC).

.2 Notification Appliance Circuits (NAC).

.3 Data Communication Link Circuits (DCL).

.2 Cable: to CAN/CSA C22.2 No. 208-03.

.1 Rated FAS 105.

.3 Conductors:

.1 Twisted, stranded copper, with overall shield and tinned copper drain wire.

.2 Notification circuit conductors: stranded copper, minimum 12 AWG.

.3 Initiating Device Circuit conductors: stranded copper, minimum 16 AWG, twisted, stranded, copper with shield.

.4 Data Communication Link circuit conductors: stranded copper, minimum 16 AWG.

.4 Insulation:

.1 PVC.

.2 Voltage Rating: 300.

.3 Fire Rating: FT4.

.5 Acceptable Manufacturer:

.1 Belden or approved equal in accordance with B7.

.2 Building Wires

.1 Use:

.1 Control circuits.

.2 Requirements:

.1 As per Section 26 05 21- Wires and Cables (0-1000V).

.2 Minimum size: 14 AWG minimum and in accordance with manufacturer's requirements.

.3 Raceway

.1 Refer to Section 26 05 34 - Conduits, Conduit Fasteners, and Fittings.

2.14 MANUAL ALARM STATIONS

.1 Provide station manufacturer's approved back box for each manual alarm station.

.1 Station colour: red.

.2 Conventional manual alarm stations: pull lever, wall mounted surface type, non-coded, single pole normally open contact for single stage. English signage.

.3 Restoration to require use of key.

.1 Keys: identical throughout system for stations and control panels. New keys are to match the existing installation so that all keys are common throughout.

.4 Where weatherproof stations are required, provide stations with weatherproof housings with hinged access doors.

.2 Addressable manual pull station.

.1 Pull lever, surface wall mounted type, single action, single stage, electronics to communicate station's status to addressable module/transponder over 2 wires and to

supply power to station. Station address to be set on station in field or electronically by loop controller.

.2 Restoration to require use of key.

.1 Keys: identical throughout system for stations and control panels. New keys are to match the existing installation so that all keys are common throughout.

.3 Acceptable Materials: Edwards models SIGA-270 or approved equal in accordance with B7.

2.15 AUTOMATIC ALARM INITIATING DEVICES

.1 Conventional Heater Detector, Fixed Temperature

.1 Non restorable, rated for at least 90 degrees C.

.2 Supplied with metal mounting plate.

.3 ULC rated for 12.2m spacing or greater

.4 Alarm indication.

.5 Acceptable Materials: Edwards model CF200-2 or approved equal in accordance with B7.

.2 Conventional Heat Detector, rate of rise, Nema 4X Rated.

.1 Non restorable, rate 57 degrees C unless indicated otherwise.

.2 Nema 4X Rated enclosure

.3 Supplied with metal mounting plate

.4 Alarm indication

.5 Spot type: ULC rated for 15.2m spacing or greater

.6 Acceptable Materials: Edwards model CR135-2 in Nema 4X rated enclosure or approved equal in accordance with B7

.3 Addressable heat detectors, fixed temperature.

.1 Non restorable, rated 57 degrees C unless indicated otherwise.

.2 Electronics to communicate detector's status to addressable module/transponder.

.3 Detector address to be set on detector in field or electronically by loop controller.

.4 Plug in type with fixed base.

.5 Wire in base assembly with integral red alarm LED.

.6 Spot type: ULC rated for 15.2m spacing or greater.

.7 Acceptable Material: Edwards model SIGA-HFD or approved equal in accordance with B7.

.4 Addressable heat detectors, rate of rise.

.1 Self-restoring, rated 8.3 degrees C per minute.

.2 Electronics to communicate detector's status to addressable module/transponder.

.3 Detector address to be set on detector in field or electronically by loop controller.

.4 Plug in type with fixed base.

.5 Wire in base assembly with integral red alarm LED.

.6 Spot type: ULC rated for 15.2m spacing or greater.

.7 Acceptable Material: Edwards model SIGA-HRD or approved equal in accordance with B7.

.5 Heat detectors, high humidity, rate of rise.

.1 Self-restoring, rated 8.3 degrees C per minute.

.2 Suitable for use in high humidity indoor environments and areas that area subject to potential corrosive elements, spray washing, and below freezing temperatures.

.3 Spot type: ULC rated for 22m spacing or greater.

.6 Addressable smoke detector.

.1 Optical Smoke Detector.

.2 Electronics to communicate detector's status to addressable module/transponder.

.3 Detector address to be set on detector in field or electronically by loop controller.

.4 Plug in type with fixed base.

.5 Wire in base assembly with integral red alarm LED.

.6 Spot type: ULC rated for 9.1m spacing or greater.

.7 Acceptable Material: Edwards model SIGA-OSD or approved equal in accordance with B7.

.7 Smoke detector: air duct type with sampling tubes with protective housing.

.1 Air velocity rating range of 0.5 to 20 m/s, or greater.

.2 Sampling tube sized to fit duct size indicated on Drawings.

.3 Integral red alarm LED.

.4 Acceptable Material: Edwards model SIGA-SD or approved equal in accordance with B7.

2.16 FAULT ISOLATOR MODULES

.1 General:

.1 Provide fault isolator modules to automatically isolate wire-to-wire short circuits on an SLC loop.

.2 Isolator module to automatically open-circuit (disconnect) the SLC loop on a wire-to wire short. Upon the short circuit condition being corrected, the isolator module is to automatically reconnect the isolated section of the SLC loop.

.2 Requirements:

.1 Address setting not to be required.

.2 Completely automatic operation.

.3 It shall not be necessary to replace or reset the fault isolator module after its normal operation.

.4 Mounting:

.1 A standard 54 mm (2-1/8") deep x 102 mm (4") square electrical box,

.2 Surface-mounted backbox, or

.3 the Fire Alarm Control Panel.

.5 A single LED which shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

.6 Provide isolator complete with mounting plate and cover.

.3 Acceptable Material: Edwards model SIGA-IM to match existing fire alarm system or current equivalent Edwards model if no longer available.

2.17 COMBINATION AUDIBLE / VISUAL SIGNAL DEVICES

.1 General

.1 Utilize the ISO 8201 Clause 4.2 Temporal Tone standard for all signalling devices to indicate an alarm signal.

.2 Horn / Strobes – Unclassified Locations:

.1 24 VDC.

.2 Acceptable Materials: Edwards models G1AVWF or approved equal in accordance with B7.

2.18 VISUAL ALARM SIGNAL DEVICES

.1 Strobes – Unclassified Locations:

.1 Strobe type: flashing, 24 VDC. Refer to Drawings for brightness settings (15 cd, 30 cd, etc).

.2 Designed for surface mounting on walls.

.3 Means provided to synchronize flashes within corridors or rooms in the same field of view.

.4 Acceptable Material: Edwards model G1VRF or approved equal in accordance with B7.

2.19 END OF LINE DEVICES

.1 End of line devices to control supervisory current in notification appliance circuits and nonaddressable signalling circuits, sized to ensure correct supervisory current for each

circuit. Open, short, or ground fault in any circuit will alter supervisory current in that circuit, producing audible and visible alarm at the FACPs and remote annunciator.

.2 Secure identifying label to the front of the cover plate, listing the zone served.

.3 Where weatherproof end of line devices are required, provide stations with weatherproof housings with hinged access doors.

.4 Acceptable Material: Edwards model EOL-P1 or approve equal in accordance with B7.

2.20 REMOTE ANNUNCIATORS

.1 Remote annunciator in main building entranceway.

.2 LCD text annunciator with common controls.

.3 Remote expander LED zone annunciation.

.4 Enclosure for remote annunciator and expander.

.5 Acceptable Manufacturer: Edwards RLCD-C Annunciator c/w with RLED24 Remote Expander in a RA-ENC2 Enclosure or approved equal in accordance with B7.

2.21 AS BUILT DIAGRAM

.1 Update and provide new fire alarm system riser diagram: in glazed frame, minimum size 432 by 279 mm, mounted adjacent to annunciator panel. New documentation shall include the existing systems as well as the new systems.

.2 Updated and provide new facility base plans, indicating locations of zones, including room number labels: in glazed frame, minimum size 432 by 279 mm, mounted adjacent to annunciator panel.

2.22 ANCILLARY DEVICES

.1 Remote relay unit to initiate fan shutdown of mechanical equipment.

.1 Acceptable Material: Edwards SIGA-CRH or approved equal in accordance with B7.

Part 3 Execution

3.1 INSTALLATION

.1 Install systems in accordance with CAN/ULC S524, manufacturer's instructions and recommendations, and in accordance with applicable codes and standards.

.2 Install manual alarm stations and connect to alarm circuit wiring.

.1 Mount stations with operating lever/ring at 1.3 m above finished floor.

.2 Affix a notice to the wall near each manual station indicating that the alarm is local only and instructing occupants to phone 911 in case of fire.

.3 Provide all mounting accessories and devices as required in order to suit the location shown on the Drawings. The Drawings and Specifications do not specifically indicate all required manufacturer approved mounted accessories.

.4 Locate and install detectors and connect to alarm circuit wiring. Do not mount detectors within 1 m of air outlets. Maintain at least 450 mm radius clear space on ceiling, below and around detectors. Locate duct type detectors in straight portions of ducts.

.5 Connect alarm circuits to FACPs.

.6 Install horns and visual signal devices and connect to signaling circuits. Visual signals and combination visual devices must be installed at the elevations dictated by CAN/ULC S524.

.7 Connect signalling circuits to FACPs.

.8 Install end of line devices as required at end of conventional NACs and IDCs.

.1 End-of-line devices to be in a separate enclosure, mounted less than 1800mm AFF.

.9 Install remote annunciator panel and connect to main control panel for DC power. Connect to FACPs via data communications network.

.10 Install remote relay units to control fan shut down.

.11 Splices are not permitted.

.12 Provide necessary conduit, cable, and wiring to make interconnections to terminal boxes, annunciator equipment, and FACPs as required by equipment manufacturer.

.13 Ensure that wiring is free of opens, shorts, or grounds before system testing and handing over.

.14 Mount end-of-line resistors on terminal blocks.

.15 Identify circuits and other related wiring at FACPs, remote annunciator, and terminal boxes.

.16 Install identifying lamicoids adjacent to each device on all signalling circuits and initiating circuits, including each manual alarm station, automatic alarm initiating device, audible signal device, visual alarm signal device, and end-of-line device. Label each device in the format FAS-x-yyy, as shown in the Drawings. Identifying lamicoids are to have white lettering on a red background.

.1 Submit lamicoid label lettering to Contract Administrator prior fabrication and installation.

3.2 CONDUIT

.1 Install separate raceway system for the fire alarm system, independent of all other wiring.

.2 Conduit fill not to exceed 40%.

.3 Install pull boxes in each conduit at intervals not to exceed 30m. Pull boxes to be 100 mm square, minimum.

.4 Paint pull boxes, junction boxes, conduit bodies, and terminal cabinets red prior to installation. Provide touch-up painting prior to final acceptance testing.

3.3 FIELD QUALITY CONTROL

.1 Perform tests in accordance with Section 26 08 05 – Acceptance Testing and CAN/ULC standards.

.2 Fire alarm system:

.1 Test each device and alarm circuit to ensure manual stations, thermal, smoke, and flame detectors transmit alarm to control panel and actuate general alarm and ancillary devices.

.2 Check annunciator panels to ensure zones are shown correctly.

.3 Simulate grounds and breaks on (new or modified) alarm and signalling circuits to ensure proper operation of systems.

.4 Addressable circuits system style DCLA:

.1 Test each conductor on all (new or modified) DCLA addressable links for capability of providing 3 or more subsequent alarm signals on each side of single open circuit fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

.2 Test each conductor on all (new or modified) DCLA addressable links for capability of providing 3 or more subsequent alarm signals during ground fault condition imposed near midmost point of each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

.5 Addressable circuits system style DCLB:

.1 Test each conductor on all (new or modified) DCLB addressable links for capability of providing 3 or more subsequent alarm signals on line side of single open circuit fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

.2 Test each conductor on all (new or modified) DCLB addressable links for capability of providing 3 or more subsequent alarm signals during ground fault condition imposed near electrically most remote device on each link. Operate Acknowledge/Silence switch after reception of each of the 3 signals. Correct imposed fault after completion of each series of tests.

3.4 MOUNTING HEIGHTS

.1 Mount fire alarm equipment at heights specified or, if not specified, as indicated in the latest of CAN/ULC S524.

3.5 DEMONSTRATION AND TRAINING

.1 Provide on site lectures and demonstration by fire alarm equipment manufacturer of any fire alarm system components that do not match existing to train operational personnel in use and maintenance of fire alarm system.

.2 Prepare two classroom training session for City Operations personnel. Topics to be focussed on system functionality and operation, with a highlight on changes made to the existing system. Training sessions will not be on successive days and will be scheduled by the City.

.3 Prepare two classroom training session for City Electrical Maintenance personnel. Minimum duration to be three hours. Training sessions will not be on successive days and will be scheduled by the City. Topics to be focussed on but not limited to:

- .1 System functionality and operation;
- .2 Resetting of devices;
- .3 Alarms;
- .4 Remote notification;
- .5 Troubleshooting and maintenance; and
- .6 Overview of the panels and devices being used.

.4 Prepare and distribute appropriate training manual for use and reference during training sessions

.5 Training material shall be sent to the Contract Administrator for approval at least two (2) weeks prior to the commencement of the training sessions.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Materials, applications, installation, and verification for excavating, trenching, and backfilling.

1.2 REFERENCES

.1 City of Winnipeg (CW)

.1 CW3110 – Sub-Grade, Sub-Base, and Base Course Construction.
.2 CW3135 – Supply and Installation of Geogrid.
.3 CW3170 – Earthwork and Grading.
.4 CW3230 – Full-Depth Patching of Existing Slabs and Joints.
.5 CW3410 – Asphaltic Concrete Pavement Works.
.6 CW3520 – Seeding.

.2 American Society for Testing and Materials International (ASTM)

.1 ASTM C117, Standard Test Method for Material Finer Than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
.2 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
.3 ASTM D422-63, Standard Test Method for Particle-Size Analysis of Soils.
.4 ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
.5 ASTM D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
.6 ASTM D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

.3 Canadian General Standards Board (CGSB)

.1 CAN/CGSB-8.1, Sieves, Testing, Woven Wire, Inch Series.
.2 CAN/CGSB-8.2, Sieves, Testing, Woven Wire, Metric.

.4 Canadian Standards Association (CSA International)

.1 CAN/CSA-A3000, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
.1 CSA-A3001, Cementitious Materials for Use in Concrete.
.2 CAN/CSA-A23.1/A23.2, Concrete Materials and Methods of Concrete Construction/Methods of Test for Concrete.

1.3 DEFINITIONS

.1 Rock: any solid material in excess of 1 m^3 and which cannot be removed by means of heavy duty mechanical excavating equipment with a 0.95 to 1.15 m^3 bucket. Frozen material is not classified as rock.

.2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.

.3 Unclassified excavation: excavation of deposits of whatever character encountered in Work.

.4 Topsoil:

- .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping, and seeding.
- .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 mm in any dimension.

.5 Waste material: excavated material unsuitable for use in the Work or surplus to requirements.

.6 Borrow material: material obtained from locations outside area to be graded, and required for construction of fill areas or for other portions of the Work.

.7 Unsuitable materials:

- .1 Weak, chemically unstable, and compressible materials.
- .2 Frost susceptible materials:
  - .1 Fine grained soils with plasticity index less than 10 when tested to ASTM D4318, and gradation within limits specified when tested to ASTM D422 and ASTM C136:
  - .2 Coarse grained soils containing more than 20% by mass passing 0.075 mm sieve.

.8 Sub-grade: the natural in-situ material.

.9 Base course: the layer of material immediately underlying the pavement.

1.4 SUBMITTALS

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

.2 Submit an excavation plan to the Contract Administrator for review at least two weeks prior to commencement of the Work.

.3 Upon request, submit material test results to the Contract Administrator a minimum of two weeks before excavation begins.

Part 2 Products

2.1 MATERIALS

.1 Base Course Materials

.1 Base course material to be approved by the Contract Administrator.

.2 Base course material to consist of sound, hard, crushed rock or crushed gravel and to be free from organic or soft material that would disintegrate through decay or weathering.

.3 The base course material to be well graded and conform to the following grading requirements:

Canadian Metric	Percent of Total Dry Weight Passing each Sieve	
Sieve Size	Granular	Crushed Limestone
25 000	100%	
20 000	80-100%	100%
5 000	40-70%	40-70%
2 500	25-50%	25-60%
315	13-30%	8-25%
80	5-15%	6-17%

.4 Base course material when subjected to the abrasion test to have a loss of not more than 35% when tested in accordance with grading B of ASTM C131, Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.5 The material passing the 315 sieve to have a liquid limit not greater than 25 and a plasticity index not greater than 6.

.6 Where base course is being placed under an asphaltic concrete pavement, the aggregate retained on a No. 5 000 sieve to contain not less than 35% crushed aggregate as determined by actual particle count. Crushed aggregate to be considered as that aggregate having at least one fractured face.

Part 3 Execution

3.1 SITE PREPARATION

.1 Remove obstructions, ice, and snow from surfaces to be excavated within limits indicated.

3.2 EXCAVATION

.1 Locate underground services prior to commencing the work, and protect them at all times during construction.

.2 Hydrovac and expose all affected underground services prior to commencing the work.

.3 Excavate and properly dispose off-site in-situ material to the depth to accommodate the concrete as shown on the Drawings or as directed by the Contract Administrator.

.4 Hand trim, make firm, and remove loose material and debris from excavations.

.1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.

.5 Dispose of surplus suitable site material and unsuitable material such as frost heaving clays, silts, rocks, and rubble as per Section 3.2.5 of this section.

.6 Strip and stockpile topsoil from the Site in a manner which will prevent contamination of topsoil with underlying soil materials. Dispose of excess materials.

.7 During excavation, the Contractor will be advised by the Contract Administrator as to which areas have an unsuitable sub-grade. Extend the excavation either to the lower limit of the unsuitable material or to a depth as directed by the Contract Administrator.

.8 Remove wooden poles, concrete bases, abandoned foundations, tree stumps and roots encountered under new pavement and as shown on the Drawings to the top of subgrade or 1 m below the bottom of the pavement surface, whichever depth is greater.

.9 Backfill and compact over-excavated areas in accordance with the specifications.

3.3 PREPARATION OF SUB-GRADE

.1 Compact the sub-grade after the bottom of the excavation has been approved by the Contract Administrator.

.2 Compact areas of suitable sub-grade material, the full width of the excavation, to a minimum of 98% Standard Proctor Density.

3.4 QUALITY OF SUB-GRADE AND BASE COURSE LAYERS

.1 Determine the Standard Proctor Density for the sub-grade and base course materials at the optimum moisture content in accordance with ASTM Standard D698. The field density of each sub-grade and base course layer will be a percentage of the applicable Standard Proctor Density.

.2 Utilize quality control tests to determine the acceptability of the sub-grade and base course layers, as placed and compacted before the succeeding layer may be applied.

.3 Contractor to verify the field density of the compacted layers by Field Density Tests in accordance with ASTM Standard D1556, Test for Density of Soil in Place by the Sand-Cone Method, or ASTM Standard D2922, Test of Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth). Provide documentation to the Contract Administrator.

.4 The frequency and number of tests will be as directed by the Contract Administrator.

.5 Promptly fill holes made by the removal of samples from the layers with appropriate material and thoroughly compact so as to conform in every way with the adjoining material.

3.5 DEWATERING AND HEAVE PREVENTION

.1 Keep excavations free of water while the Work is in progress.

.2 Protect open excavations against flooding and damage due to surface run-off.

.3 Dispose of water in a manner not detrimental to public and private property, or portion of the Work completed or under construction.

.1 Provide and maintain temporary drainage outside of excavation limits.

3.6 BACKFILLING

.1 Vibratory compaction equipment is required. Obtain approval from the Contract Administrator prior to preforming work. Ensure that adjacent or nearby structures are not damaged in any way.

.2 Do not proceed with backfilling operations until completion of following:

.1 The Contract Administrator approved installations construction below finished grade.

.2 Inspection, testing, approval, and recording location of underground utilities.

.3 Removal of concrete formwork.

.4 Backfilling of voids with satisfactory fill as required.

.3 Areas to be backfilled to be free from debris, snow, ice, water, and frozen ground.

.4 Do not use backfill material which is frozen or contains ice, snow, or debris.

.5 Place backfill material in uniform layers not exceeding 100 mm compacted thickness. Compact each layer before placing succeeding layer.

.6 Backfilling around installations.

.1 Place bedding and surround materials.

.2 Do not backfill around or over cast-in-place concrete within 48 hours after placing of concrete.

.3 Place layers simultaneously on both sides of installed soil retaining Work to equalize loading. Difference not to exceed 150 mm.

3.7 RESTORATION

.1 Prior to construction, inspect the grassed, pavement, and gravel surfaces within and adjacent to the Site with the Contract Administrator to record the current condition. After construction and site cleanup is complete, re-inspect the condition with the Contract Administrator.

.2 Restoration of grassed areas removed or damaged as result of construction activities will be restored in accordance with CW 3520. Restoration of grassed areas will not be measured for payment and shall be included as part of the Work being done.

.3 Pavement damaged or removed as a result of construction activities will be restored in accordance with CW3230 and CW 3410. Restoration of the pavement will not be measured for payment and shall be included as part of the Work being done.

END OF SECTION

Part 1 General

1.1 GENERAL

.1 This section covers items common to sections of Division 40. This section supplements the requirements of Division 1.

1.2 CODES AND STANDARDS

.1 Complete installation in accordance with latest CSA C22.1 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.

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 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 the Contract Administrator of changes required by Electrical Inspection Department and Supply Authority prior to making changes.

.4 Furnish a Certificate of Final Inspection and approvals from Electrical Inspection Department and Supply 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 and Supply Authority.

.3 Minimum enclosure type to be used is 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 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 equipment with nameplates as follows:

.2 Nameplates:

.1 Lamicoid 3 mm thick plastic lamicoid nameplates, white face, black lettering, 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	20 x 200 mm	1	8 mm high letters
Size 7	25 x 100 mm	1 line	12 mm high letters
Size 8	25 x 100 mm	2 lines	6 mm high letters
Size 9	35 x 100 mm	3 lines	5 mm high letters
Size 10	35 diameter	1 line	5 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.

1.9 WIRING IDENTIFICATION

.1 Identify wiring with permanent indelible identifying markings on both ends of all conductors and circuit wiring.

.1 Wire tags to be heat shrink type with black letters on white background.

.2 Wire tags to be legible and visible after the system is installed (ie/ not blocked).

1.10 SUBMITTALS

.1 Provide submittals as indicated in the individual Specifications and in accordance with 01 33 00 – Submittal Procedures and 01 78 00 – Closeout Submittals.

1.11 AS-BUILT AND RECORD DRAWINGS

.1 The Contractor shall keep one (1) complete set of white prints at the Site during the Work, including all addenda, change orders, site instructions, clarifications, and revisions for the purpose of recording all changes in the Work.. As the Work on-site proceeds, the Contractor shall clearly record in red pencil all as-built conditions, which deviate from the original Contract. As-Built and Record Drawings to include circuiting of all devices, conduit, and feeder runs (complete with conductor size and number) and locations of all electrical and automation equipment.

1.12 OPERATION AND MAINTENANCE MANUALS

.1 Operation and Maintenance Manuals

.1 Refer to Section 01 78 00 – Closeout Submittals for general operation and maintenance manual requirements.

.2 In addition to the general requirements, provide the following information:

.1 Table of Contents – Arrange contents sequentially by systems under Section numbers. Label tabs of dividers between each to match section numbers in the Table of Contents.

.2 Systems Descriptions – A brief synopsis of each system typed and inserted at the beginning of each section. Include sketches and diagrams where appropriate.

.3 Manuals containing all pertinent information, drawings, and documents of the Contractor's supply and/or documentation included with the instruments supplied by others, such as:

.1 Mechanical drawings of the equipment.

.2 Installation drawings and procedures.

.3 Instrument model numbers.

.4 Equipment specifications.

.5 Detailed utility requirements.

.6 Replacement parts list with model numbers.

.7 Recommended preventative maintenance frequency.

.8 Troubleshooting procedures.

.9 Procedures for dismantling.

.10 Procedure to operate the equipment/instruments.

.11 Recommended cleaning procedure.

.12 Recommended list of supplies to be used in conjunction with the operation and maintenance of the equipment.

.13 Recommended spare parts list.

.4 A copy of all wiring diagrams completes with wire coding.

.5 Include type and accuracy of instruments used.

.6 Set of final reviewed Shop Drawings.

.7 Testing documentation including:

.1 Loop check report.

.2 Factory Acceptance Test (FAT) report.

.3 Site Acceptance Test (SAT) report.

.2 PLC Software Operation and Maintenance Manual:

.1 Provide a manual that contains, at minimum, all pertinent information, drawings, and documents associated with the PLC program(s) and associated integration, including:

.1 Printout of the entire PLC program(s). Printout to be sealed by the Contractor's professional engineer.

.2 Repair instructions for common issues.

.3 Printout of any related design documents, such as interface lists, etc.

.4 Flash drive in a sleeve containing the latest PLC program including configuration software.

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 DESIGN REQUIREMENTS

.1 Develop a demonstration and test procedure, along with test forms, for the FAT.

1.2 SUBMITTALS

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

.2 Submit the following for review at least 31 Calendar Days prior to FAT.

.1 Detailed test procedure and test forms for review.

.1 Incorporate all changes to the procedure and test forms requested by the Contract Administrator.

.3 Submit the following, to be received on the date of the FAT:

.1 Detailed listings of all control logic and software utilized to implement the control sequences, for the scenarios demonstrated as part of the FAT. Listings are to be neatly organized and commented as required. All supporting documents, including variable listings, are to be included.

.4 Submittal of the test results for review and acceptance.

1.3 CLOSEOUT SUBMITTALS

.1 Include all FAT documentation and test forms in the operating and maintenance manuals in accordance with Section 01 78 00 – Closeout Submittals.

1.4 DEMONSTRATION AND TESTING

.1 The location of the FAT will be in a Contractor supplied facility, within Winnipeg, Manitoba, Canada.

.2 Correct deficiencies and re-test until satisfactory performance is obtained.

.3 Acceptance of tests during the FAT will not relieve the Contractor from responsibility for ensuring that complete systems meet every requirement of the Contract.

1.5 COMPLETION OF FAT

.1 The FAT is considered to be complete only when full approval of the Contract Administrator has been received by the Contractor.

.2 Schedule additional re-tests until approval is obtained.

Part 2 Products

2.1 NONE USED.

.1 None Used.

Part 3 Execution

3.1 PROCEDURES

.1 All tests shall be documented.

.2 Produce test forms to allow for recording the results of the simulations and tests.

.3 Propose the desired date of the FAT to the Contract Administrator with at least seven (7) calendar days advanced notice. The Contract Administrator may, at their discretion, observe FAT based on the completeness of the submittal or other factors.

.1 Demonstration tests to include:

.1 Scope of the test, including hardware, software, programming, configuration, documentation etc.

.2 Hardware, including construction, visual inspection, wiring, labeling, agreement with Shop Drawing, requirements and acceptance criteria.

.3 Complete demonstration that the PLC program meets the requirements of the Electric and Electronic Control System For HVAC document described in Section 23 09 33 – Electric and Electronic Control System for HVAC.

.4 Test each I/O point from the terminal block to the PLC system.

.5 Testing of all status and alarm signals. Alarm assignments: Type, value, priority, etc shall be checked.

.6 Controller processor spare capacity.

.7 System programming and configuration capability.

.4 The Contract Administrator may request additional tests and simulations at the FAT.

.5 The Contract Administrator will review the system, simulations, and test results. Incorporate comments and feedback from the Contract Administrator into the system design.

3.2 Evaluation

.1 All evaluations will be pass/fail.

.2 The Contractor is expected to ensure that all required demonstrations are fully operable and meet required specifications, prior to the FAT. Upon failure of a required demonstration in the FAT, the Contractor shall provide subsequent re-tests to the satisfaction of the Contract Administrator.

.3 Acceptance of the FAT results by Contract Administrator is required prior to the shipment to site.

END OF SECTION

Part 1 General

1.1 SUBMITTALS

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

.2 Submit commissioning test plans, procedures and commissioning forms, in writing, at least 31 Calendar Days prior to commissioning.

.3 Submit Final Automation Commissioning Report as described in Part 1.5 of this specification.

1.2 COMMISSIONING FORMS

.1 Sample commissioning forms will be provided with the tender. The Contractor is responsible for providing all required testing and commissioning forms including checklists, forms, and reports as necessary. Microsoft Word versions of the sample commissioning forms can be provided after contract award.

.2 Supplement the provided forms as required to make a complete commissioning report package.

1.3 COMMISSIONING

.1 Carry out commissioning under direction of the Contract Administrator and in the presence of representatives of the Contract Administrator and the City.

.2 Inform and obtain approval from the Contract Administrator in writing at least 14 Calendar Days prior to commissioning or each test. Indicate:

- .1 Location and part of system to be tested or commissioned.
- .2 Testing/commissioning procedures and anticipated results.
- .3 Names of testing/commissioning personnel.
- .4 City personnel requirements to assist with commissioning.

.3 Correct deficiencies and re-test until satisfactory performance is obtained.

.4 Acceptance of tests will not relieve the Contractor from their responsibility of ensuring that complete systems meet every requirement of the Contract.

.5 Perform tests as required.

1.4 COMPLETION OF COMMISSIONING

.1 Commissioning to be considered as satisfactorily completed when objectives of commissioning have been achieved and reviewed by the Contract Administrator.

1.5 CLOSEOUT SUBMITTALS

.1 Submit to the Contract Administrator the Final Automation Commissioning Report in accordance with the requirements of Section 01 78 00 – Closeout Submittals.

.2 The Final Automation Commissioning Report to:

.1 Include measurements, final settings, and certified test results.

.2 Include completed commissioning forms.

.3 Bear signature of the commissioning technician and supervisor.

.4 Revise "as-built" documentation, commissioning reports to reflect changes, adjustments, and modifications as set during commissioning.

.5 Recommend additional changes and/or modifications deemed advisable in order to improve performance, environmental conditions, or energy consumption.

Part 2 Products

2.1 EQUIPMENT

.1 Provide sufficient instrumentation to verify and commission the installed system.

.2 Provide two-way radios for communication between field technicians.

.3 Test instrumentation accuracy tolerances: higher order of magnitude than equipment or system being tested.

.4 Independent testing laboratory to certify test equipment as accurate to within approved tolerances no more than 6 months prior to tests.

Part 3 Execution

3.1 STATUS PRIOR TO COMMISIONING

.1 Prior to commissioning, ensure that the following is completed:

.1 Installation of all panels and completion of all wiring connections.

.2 Testing wiring for continuity from the field device to the control panel.

.2 Provide a minimum of one qualified technician to test and commission the control system.

3.2 PROCEDURES

.1 Scope of the test includes hardware, software, programming, configuration, documentation etc.,

.2 Hardware, includes construction, visual inspection, wiring, labeling, agreement with Shop Drawing, requirements and acceptance criteria,

.3 Test each I/O point from the instrument to the PLC system.

.1 Test both states of discrete points.

.2 Test, at minimum, two values for analog points.

.3 Test communications of the PLC with the City's SCADA systems.

.4 Test each piece of equipment individually for complete functionality.

.5 Completely test the E-Stop functionality of each piece of equipment, as provided.

.6 All modifications to the software program, to bypass interlocks or sensors, shall be recorded and documented clearly in a separate document, and in the software.

.1 Any software bypasses that remain, prior to leaving the Site, must be authorized by the Contract Administrator or designated representative.

.7 All deficiencies must be corrected by the Contractor.

.8 Commission each system using procedures prescribed by the Contractor Administrator.

.9 Optimize operation and performance of systems by fine-tuning control loops and PID values.

3.3 SYSTEM SOFTWARE

.1 Load PLC system with appropriate program, fully tested and approved as part of the software FAT.

.1 Any changes made to the software after the FAT must be submitted for review and approval of the Contract Administrator.

.2 Any issues identified on Site must be communicated to the Contract Administrator. Approval is required prior to making any modifications.

.3 The Contractor is reminded that this facility is critical to operation of the City's water distribution system.

3.4 CHECKLISTS, FORMS, AND REPORTS

.1 Complete commissioning forms including checklists, forms, and reports for each instrument, loop, and control device.

.1 Instrument Loop Checklist.

.2 Discrete I/O Checklist

.3 Analog I/O Checklist

.4 Panel Hardware/ Software Checklist

3.5 DEMONSTRATION

.1 Demonstrate to the Contract Administrator operation of systems including sequence of operations under all potential conditions, start-up, shut-down interlocks and lock-outs.

END OF SECTION

Part 1 General SUMMARY

.1 Section Includes:

.1 Process and HVAC instrumentation.

1.2 REFERENCES

.1 National Electrical Manufacturers Association (NEMA).

.1 NEMA 250-2003, Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 Canadian Standards Association (CSA International).

.1 CSA-C22.1-2009, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.3 SUBMITTALS

.1 Submit Shop Drawings and manufacturer's installation instructions in accordance with Section 01 33 00 – Submittal Procedures.

.2 Manufacturer's Instructions:

.1 Include manufacturer's installation instructions for specified equipment and devices in operation and maintenance manuals in accordance with Section 01 78 00 – Closeout Submittals.

.3 Submit documentation as described in Section 40 80 11 - Automation Commissioning for devices listed within this section.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant.

.3 Operating conditions: 0 – 35 degrees C with 5 - 95% RH (non-condensing) unless otherwise specified.

.4 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

2.2 OUTDOOR/INDOOR TEMPERATURE ELEMENT AND TRANSMITTER (Wall mount)

.1 Requirements:

.1 Sensor:

.1 3- wire RTD, Pt100.

.2 Probe length 120mm.
.3 Probe diameter 6.25mm.
.4 Measurement range: -200 to 850 degree Celsius.
.5 Protective sheath for external mounting.

.2 Transmitter:
.1 Output signal: 4-20mA 2 wire with connection to HART.
.2 Accuracy: +/- 0.06 Degree Celsius.

.3 Enclosure:
.1 Transmitter is housed in a NEMA4X wall mount electrical enclosure with temperature element mounted externally.

.4 Operating Ambient Conditions:
.1 -40 to 85 degree Celsius, 98% relative humidity with condensation.

.5 Approvals: CSA or equivalent.

.2 Acceptable Products:

.1 Siemens SITRANS TH300,
.2 Or approved equal in accordance with B7.

2.3 HVAC TEMPERATURE ELEMENT AND TRANSMITTER (Duct mount)

.1 Requirements:

.1 Sensor:
.1 3- wire RTD, Pt100.
.2 Probe length 120mm.
.3 Probe diameter 6.25mm.
.4 Measurement range: -200 to 850 Degree Celsius.
.5 Insertion type element.

.2 Transmitter:
.1 Output signal: 4-20mA 2 wire with connection to HART.
.2 Accuracy: +/- 0.06 Degree Celsius.

.3 Enclosure:
.1 Transmitter is housed in a NEMA4X electrical enclosure with temperature element mounted.

.4 Operating Ambient Conditions:
.1 -40 to 85 degree Celsius, 98% relative humidity with condensation.

.5 Thermowell:
.1 Process Connection: 19 mm NPT(M) unless otherwise noted.
.2 Material: 316 stainless steel.
.3 Insertion Length: 140 mm minimum insertion.

.6 Approvals: CSA or equivalent.

.2 Acceptable Products:

.1 Siemens SITRANS TH300,

.2 Or approved equal in accordance with B7.

2.4 HVAC TEMPERATURE ELEMENT AND TRANSMITTER (Pipe mount)

.1 Requirements:

.1 Sensor:

.1 3- wire RTD, Pt100.

.2 Probe length 120mm.

.3 Probe diameter 6.25mm.

.4 Measurement range: -200 to 850 Degree Celsius.

.5 Insertion type element.

.2 Transmitter:

.1 Output signal: 4-20mA 2 wire with connection to HART.

.2 Accuracy: +/- 0.06 Degree Celsius.

.3 Enclosure:

.1 Transmitter is housed in a NEMA4X electrical enclosure with temperature element mounted.

.4 Operating Ambient Conditions:

.1 -40 to 85 degree Celsius, 98% relative humidity with condensation.

.5 Thermowell:

.1 Process Connection: 19 mm NPT(M) unless otherwise noted.

.2 Material: 316 stainless steel.

.3 Insertion Length: 89 mm minimum immersion.

.6 Approvals: CSA or equivalent.

.2 Acceptable Products:

.1 Siemens SITRANS TH300,

.2 Or approved equal in accordance with B7.

2.5 ROOM TEMPERATURE ELEMENT AND TRANSMITTER

.1 Requirements:

.1 Sensor:

.1 Device box cover type 2- wire RTD, Pt100.

.2 Measurement range: 0 to 50 Degree Celsius.

.3 Stainless steel or Powder coated white steel.

.2 Transmitter:

.1 Output signal: 4-20mA 2 wire with connection to HART.

.2 Accuracy: +/- 0.06 Degree Celsius.

.3 Enclosure:

.1 Transmitter is housed in a NEMA4X electrical enclosure with temperature element mounted.

.4 Operating Ambient Conditions:

.1 -40 to 85 degree Celsius, 98% relative humidity with condensation.

.5 Thermowell:

.1 Process Connection: 19 mm NPT(M) unless otherwise noted.

.2 Material: 316 stainless steel.

.3 Insertion Length: 89 mm minimum immersion.

.6 Approvals: CSA or equivalent.

.2 Acceptable Products:

.1 Siemens SITRANS TH300,

.2 Or approved equal in accordance with B7.

2.6 HAVC TEMPERATURE SWITCHES

.1 Requirements:

.1 Functionality: Field adjustable with reference dials for each pole.

.2 Output: Qty 2, individually adjustable, DPDT dry contacts.

.3 Operating Temperature: -20 to 40 degree Celsius minimum.

.4 Sensor: Local.

.5 Mounting: Duct.

.6 Enclosure Rating: NEMA Type 4X.

.7 Approvals: CSA or equivalent.

.2 Acceptable Products:

.1 Ashcroft B-Series,

.2 United Electric B402-120,

.3 Or approved equal in accordance with B7.

2.7 HVAC FILTER DIFFERENTIAL PRESSURE SWITCHES

.1 Requirements:

.1 Type: Electro-mechanical.

.2 Dry Contact: SPDT, rated for at least 0.2 Amps at 24VDC.

.3 Operating Temperature: 0°C to 35°C.

.4 Set Point: 125 Pa (0.5 “w.c), Field adjustable.

.5 Pressure Range: As Required.

.6 Enclosure Rating: NEMA 4 or NEMA 4X.

.7 Approvals: CSA or equivalent.

.8 Mounting: Surface, Duct or Wall.

.2 Acceptable Products:

.1 Ashcroft B-Series,

.2 United Electric 100 Series,

.3 Or approved equal in accordance with B7.

2.8 FLOW ELEMENT AND SWITCH, THERMAL MASS FLOW

.1 Requirements:

.1 General:

.1 Approvals: CSA or cUL.

.2 Function: Monitor process flow and provide contact closure at set point.

.2 Performance:

.1 Set Point: Field adjustable.

.2 Repeatability: <1 percent at constant temperature.

.3 Temperature, Operating: Sensor Element: -73 to +200 degrees Celsius.

.4 Pressure, Operating: To 2.4MPa at 21 degrees Celsius.

.3 Operating Ambient Conditions:

.1 -40 to 70 degrees Celsius.

.4 Features: Wetted Surfaces Materials: Type 316 stainless steel.

.5 Process Connections:

.1 Type: 3/4 inch (19 mm) MNPT.

.2 Connection Type: Insertion.

.6 Conduit Connection: 1 inch (25 mm) FNPT.

.7 Probe:

.1 Type: Spherical for liquids, twin tip for gases.

.2 Element: Insertion Length (From Tip of Probe to Process Connection): 50 mm, unless otherwise noted.

.8 Electronics:

.1 Location: Integral with element.

.2 Operating Temperature: Minus 40 to 50 degrees C.

.9 Signal Interface: Contact two SPDT or one DPDT, rated 6 amps at 24 VDC.

.10 Enclosure: Type: NEMA 4X.

.11 Power: 19.2 to 28.8 VDC.

.2 Acceptable Products:

.1 Magnetrol TD1/TD2,

.2 Or approved equal in accordance with B7.

2.9 FLOW TRANSMITTER (Differential Pressure)

.1 Requirements:

.1 Transmitter

.1 Power supply: Loop Powered.

.2 Display: LCD.

.3 Sensor Body: Stainless Steel.

.4 Electrical Connection: Screw terminal.

.5 Electrical Signal: 2 wire, 4-20 mA.

.6 Reference Accuracy: <±0.1% of span.

.7 Process Pressure Connection: ½" NPT.
.8 Enclosure: Stainless steel wetted parts,
.9 Approvals: CSA or cUL.

.2 Accessory: Stainless steel block and bleed manifold.
.3 Fluid: Water.
.4 Operating Ambient Conditions:
.1 -40 to 80 degrees Celsius.

.2 Acceptable Products

.1 Rosemount 3051Series.
.2 Or approved equal in accordance with B7.

2.10 LEVEL TRANSMITTER (Differential Pressure)

.1 Requirements:

.1 Transmitter
.1 Power supply: Loop Powered.
.2 Display: LCD.
.3 Sensor Body: Stainless Steel.
.4 Electrical Connection: Screw terminal.
.5 Electrical Signal: 2 wire, 4-20 mA.
.6 Reference Accuracy: <±0.1% of span.
.7 Process Pressure Connection: ½" NPT.
.8 Enclosure: Stainless steel wetted parts.
.9 Approvals: CSA or cUL.

.2 Accessory: Stainless steel block and bleed manifold
.3 Fluid: Water
.4 Operating Ambient Conditions:
.1 -40 to 80 degrees Celsius.

.2 Acceptable Products

.1 Rosemount 3051Series.
.2 Or approved equal in accordance with B7.

2.11 COMBUSTIBLE GAS MONITOR

.1 Requirements:

.1 Operating Voltage: 24 VDC.
.2 Gas Sensor Requirement: Methane.
.3 LEL detection.
.4 Graphical LCD Display.
.5 Remote sensor installation.
.6 Four form C relays including fault relay.
.7 CSA Approved.

.8 Operating Ambient Conditions:

.1 -40 to 75 degrees Celsius.

.2 5 to 95% relative humidity, non-condensing.

.2 Acceptable Products

.1 Scott Safety Meridian Universal Gas Detectors.

.2 Or approved equal in accordance with B7.

2.12 CARBON MONOXIDE DETECTION

.1 Requirements:

.1 Operating Voltage: 24 VDC.

.2 Gas Sensor Requirement: Carbon Monoxide.

.3 Graphical LCD Display.

.4 Remote sensor installation.

.5 Controller supports at least two remote sensors.

.6 Four form C relays including fault relay.

.7 CSA Approved,

.8 Operating Ambient Conditions:

.1 -40 to 75 degrees Celsius.

.2 5 to 95% relative humidity, non-condensing.

.2 Acceptable Products

.1 Scott Safety Meridian Universal Gas Detectors.

.2 Or approved equal in accordance with B7.

2.13 REFRIGERANT GAS MONITOR

.1 Requirements

.1 Power Supply: 120 VAC.

.2 Refrigerant: HF0-1234ze.

.3 Single sampling point type system.

.4 Refrigerant Range: 0 to 10,000 ppm.

.5 Sensitivity: 1 ppm.

.6 Graphic LCD Display.

.7 3 Alarm Relays, 1 Fault Relay.

.8 CSA Approved.

.9 Operating Ambient Conditions:

.1 0 to 50 degrees Celsius.

.2 5 to 90% relative humidity, non-condensing.

.2 Acceptable Products

.1 Bacharach HGM-SZ,

.2 Or approved equal in accordance with B7.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment and components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturer's recommended methods, procedures, and instructions.

.3 Support field-mounted panels, transmitters, and sensors on pipe stands or channel brackets.

.4 Electrical:

.1 Complete installation in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install communication wiring in conduit or utilizing ACIC cabling if shown on the Drawings.

.1 Provide complete conduit /cable system to link instrumentation and the control panel(s).

.2 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.3 Maximum conduit fill not to exceed 40%.

.4 Design Drawings do not show conduit layout.

3.2 TEMPERATURE SENSORS

.1 Stabilize to ensure minimum field adjustments or calibrations.

.2 Readily accessible and adaptable to each type of application to allow for quick easy replacement and servicing without special tools or skills.

.3 Duct installations:

.1 Do not mount in dead air space.

.2 Locate within sensor vibration and velocity limits.

.3 Securely mount extended surface sensor used to sense average temperature.

.4 Thermally isolate elements from brackets and supports to respond to air temperature only.

.5 Support sensor element separately from coils or filter racks.

.4 Averaging duct type temperature sensors.

.1 Install averaging element horizontally across the ductwork starting 300 mm from top of ductwork. Each additional horizontal run to be no more than 300 mm from the one above it. Continue until complete cross sectional area of ductwork is covered. Use multiple sensors where single sensor does not meet required coverage.

3.3 IDENTIFICATION

.1 Identify field devices with lamacoids. Install in a conspicuous location.

3.4 TESTING AND COMMISSIONING

.1 Calibrate and test field devices for accuracy and performance in accordance with Section 40 80 11 - Automation Commissioning.

3.5 TRAINING

.1 Provide one 4-hour training session on complete operations and maintenance of the system.

END OF SECTION

Part 1 General

1.1 SUMMARY

.1 Section Includes:

.1 Primary control devices including damper actuators.

1.2 REFERENCES

.1 Association (NEMA).

.1 NEMA 250-2003, Enclosures for Electrical Equipment (1000 Volts Maximum).

.2 Canadian Standards Association (CSA International).

.1 CSA-C22.1-2009, Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

1.3 SUBMITTALS

.1 Submit Shop Drawings and manufacturer's installation instructions in accordance with Section 01 33 00 – Submittal Procedures.

.2 Manufacturer's Instructions:

.1 Include manufacturer's installation instructions for specified equipment and devices in operating and maintenance manuals in accordance with Section 01 78 00 – Closeout Submittals.

Part 2 Products

2.1 GENERAL

.1 Control devices of each category to be of same type and manufacturer.

.2 External trim materials to be corrosion resistant. Internal parts to be assembled in watertight assembly.

.3 Operating conditions: 0 to 32 degrees Celsius with 5 to 95% RH (non-condensing) unless otherwise specified.

.4 Terminations: use standard conduit box with slot screwdriver compression connector block unless otherwise specified.

.5 Transmitters and sensors to be unaffected by external transmitters including portable two-way radios.

.6 Account for hysteresis, relaxation time, maximum and minimum limits in applications of sensors and controls.

2.2 ELECTRONIC MODULATING DAMPER ACTUATORS

.1 Requirements:

.1 General:

.1 Drawings, control diagrams, and schedules indicate estimated quantities of actuators for each motorized damper.

.2 Select actual quantity of actuators required to operate each damper in accordance with size of damper provided.

.3 Coordinate exact quantity of actuators with electrical work to ensure that necessary wiring and conduit is provided for installation.

.4 Equip modulating damper actuators with spring return fail safe function.

.2 CSA or cUL approved.

.3 Operating voltage: 120 VAC.

.4 Provide a 4-20 mA position signal for each modulating damper.

.5 Provide a 4-20 mA position feedback signal for each modulating damper.

.6 Ambient operating temperature -40 to 50 degree Celsius.

.2 Acceptable manufacturer:

.1 Schischek by Rotork Controls (Canada) Ltd., InMax,

.2 Or approved equal in accordance with B7.

2.3 ELECTRONIC ON-OFF DAMPER ACTUATORS

.1 Requirements:

.1 General:

.1 Drawings, Control Diagrams and schedules indicate estimated quantities of actuators for each motorized damper.

.2 Select actual quantity of actuators required to operate each damper in accordance with size of damper provided.

.3 Coordinate exact quantity of actuators with electrical work to ensure that necessary wiring and conduit is provided for installation.

.4 Equip on-off damper actuators with spring return fail safe function.

.2 CSA or cUL approved,

.3 Operating voltage: 120 VAC,

.4 Provide two auxiliary end-switch contacts, one for fully open and one for fully close, for each on/off damper.

.5 Ambient operating temperature -40 to +50 degree Celsius,

.2 Acceptable manufacturer:

.1 Schischek by Rotork Controls (Canada) Ltd., InMax,

.2 Or approved equal in accordance with B7.

Part 3 Execution

3.1 INSTALLATION

.1 Install equipment and components so that manufacturer's and CSA labels are visible and legible after commissioning is complete.

.2 Install field control devices in accordance with manufacturer's recommended methods, procedures, and instructions.

.3 Dampers mounted outdoors shall be protected from direct sun exposure, rain and snow.

.4 Support field-mounted panels, transmitters, and sensors on pipe stands or channel brackets.

.5 Electrical:

.1 Complete installation in accordance with Section 26 05 01 - Common Work Results - Electrical.

.2 Install communication and control wiring in conduit. Utilize armored cabling only when run on cable tray.

.1 Provide complete conduit /cable system to link instrumentation and the control panel(s).

.2 Provide complete cable tray system for armored cabling.

.3 Conduit sizes to suit wiring requirements and to allow for future expansion capabilities specified for systems.

.4 Maximum conduit fill not to exceed 40%.

.5 Design Drawings do not show conduit layouts or cable tray layouts. Provide as required, to suit the space.

.6 Terminate devices with leads in junction boxes with terminals.

.1 Wire nuts are not permitted.

.2 Protect leads in flexible conduit.

3.2 IDENTIFICATION

.1 Identify all instruments, control panels, and PLC panels with hard plastic lamacoid nameplates. Mount in a manner so that the tags are visible. Refer to Section 40 05 01 – Common Work Results – Automation.

3.3 TESTING AND COMMISSIONING

.1 Calibrate and test control devices for accuracy and performance in accordance with Section 40 80 11 – Automation Commissioning.

3.4 TRAINING

.1 Provide one 4-hour training session on complete operations and maintenance of the system.

END OF SECTION

Part 1 General

1.1 REFERENCES

.1 Canadian Standards Association (CSA International),

.1 C22.2 No.205-M1983(R2004), Signal Equipment.

.2 International Electrotechnical Commission (IEC),

.1 IEC 61131, Programmable Controllers.

.3 City of Winnipeg Design Standards,

.1 Tag Naming Standard, 612620-0014-40ER-0001 Rev. 00.

1.2 DEFINITIONS

.1 **"PLC"** means Programmable Logic Controller

.2 **"FAT"** means Factory Acceptance Testing. All FAT type testing to be performed at the equipment vendor facilities, utilizing the equipment vendor's labor, materials and test equipment

.3 **"I/O"** means Input/Output

1.3 SOFTWARE OWNERSHIP

.1 The City will fully own all PLC programming logic supplied and may utilize the software provided for any purpose including:

.1 Modification and revision.

.2 Use at other City facilities.

.2 The City may turn the software over to a 3rd party, for use at any City owned facility.

.3 Provide source code for all custom software and function blocks or any other software logic utilized in the application.

.1 Source code for base function blocks provided by the PLC manufacturer are not required.

1.4 DESIGN REQUIREMENTS

.1 Design, program, and implement a complete operating HVAC PLC control system.

.2 Provide a functional requirement description document of the HVAC PLC control system.

.3 The Contractor's HVAC PLC program design is to be based upon the hardware design Drawings, Section 23 09 33 – Electric and Electronic Control System for HVAC, and the HVAC equipment manufacturer's control recommendations.

.1 Utilize a tag naming convention that extends and does not conflict with the tag scheme utilized on site.

.2 Utilize the City of Winnipeg Identification Standard (Rev. 4 Updated 2019-02-08) within the functional requirements document and HVAC PLC program.

.4 Input conditioning to map inputs from physical inputs and networked devices to internal HVAC PLC tags.

.5 Output conditioning to map internal HVAC PLC tags to physical outputs and networked devices.

.6 The PLC software design is to be supervised and authenticated (sealed) by a professional engineer licensed to practice in Manitoba.

.7 Do not assume that the Contractor's internal standards or standard programming methodology will be acceptable for this project. No additional payment will be made for assumptions made regarding standard methods utilized by the Contractor.

.8 The Contract Administrator will review the overall design. Make changes as requested by the Contract Administrator.

1.5 SUBMITTALS

.1 All submittals to be in accordance with Section 01 33 00 – Submittal Procedures.

.2 Stage 1:

.1 Submit product datasheets and PLC panel hardware shop drawings.

.3 Stage 2:

.1 Submit a draft functional requirement document prior to initiating programming which includes:

.1 The general PLC program structure.

.2 The programming languages (ie ladder, function block) to be utilized.

.3 A sample section of code.

.4 HMI interface.

.5 SCADA interface map.

.6 Variable naming methodology.

.4 Stage 3:

.1 Submit a 25% complete functional requirement document submittal, including:

.1 Software logic printout.

.2 The primary purpose of this submittal is to ensure that the methodology being utilized is as per requirements prior to the bulk portion of the Work being completed. At this point, copies of code for similar pieces of equipment should not be completed.

.5 Stage 4:

.1 Submit a 99% complete functional requirement document submittal a minimum of 31 Calendar Days prior to the FAT, including:

.1 Complete software logic printout.

.6 Submit operation and maintenance manuals as described in Part 1.6 of this Specification.

.7 Submit spare parts as described in Part 2.4 of this Specification and in accordance with 01 78 00 – Closeout Submittals.

1.6 OPERATION AND MAINTENANCE MANUALS

.1 Operation and maintenance manuals to be submitted in accordance with Section 01 78 00 – Closeout Submittals.

.2 Include the following in the operation and maintenance manuals:

.1 Product datasheets.

.2 Hardware and software user manuals.

.3 PLC logic printout.

.4 Flash drive sleeve with USB memory stick containing PLC application program.

Part 2 Products

2.1 PROGRAMMABLE LOGIC CONTROLLER

.1 Part or Model numbers shall be as shown on the control panel Drawings. (refer to Drawing 1-0640M-A0050):

.2 Provide all required hardware for a complete installation.

2.2 ACCESSORIES

.1 Include the following accessories:

.1 One flash card, installed in the PLC processor, for running the application program.

.2 One spare flash card of the same size and configuration as that utilized in the processor.

.3 Serial or USB transfer cable for downloading the application program.

2.3 USB MEMORY STICK

.1 Provide a USB memory stick as part of the commissioning process, with the following:

.1 Latest application program, with documentation.

.2 PLC hardware user manuals

.3 PLC software user manuals.

.2 Locate the memory stick in a pocket in the control panel.

2.4 SPARE PARTS

.1 Supply the following spare parts (refer to Drawing 1-0640M-A0050 for model numbers):

.1 One power supply module.
.2 One processor module.
.3 One RTU module.
.4 One DI 24 VDC I/O module.
.5 One DO 24 VDC I/O module.
.6 One AI module.
.7 One AO module.

.2 Complete set of spare parts to be supplied prior to commissioning.

Part 3 Execution

3.1 HARDWARE INSTALLATION

.1 Update the processor and all updatable modules with the latest firmware before the FAT. Any latter firmware update requires a rechecking plan to be provided by the Contractor and approved by the Contract Administrator. The application rechecking plan should include a recheck of any part of the application software impacted by the firmware changes.

.2 The Contractor shall inform the Contract Administrator of any new firmware or software updates issued by the manufacturer after FAT. The Contractor shall inform the Contract Administrator if the installation of the new firmware or software update is required.

.3 Application rechecking due to firmware or software updates shall be performed at no additional cost.

.4 The Contractor to program the HVAC PLC at McPhillips stations and the City will provide HMI modification.

Following is required for The City to complete the HMI modification:

.1 A minimum of 3 weeks advance notice that HMI modification will be required.
.2 Contractor to provide I/O list, control narrative and description of what is to be displayed

.5 The contractor to provide updated I/O list to City. City to modify the existing PLC program in Tache Station

3.2 PLC PROGRAMMING SERVICES

.1 General Requirements:

.1 Program in a manner to make the program easy to follow and maintain.
.2 Insert comments into the program to clarify all items not readily apparent.
.3 Utilize commonly accepted good programming practices.

.4 Utilize function blocks to encapsulate common systems and sections of code.

.5 All field inputs to be checked against range limits. If a field input is outside of its range limits or the data cannot be otherwise propagated because of an equipment fault, the data is to be declared "bad" within the control system.

.6 All tag names are to be named and identified using positive logic. Where required, provide comments to clarify the states.

.7 Program PID control loops to provide bumpless transfer when switching between automatic and manual control modes.

.8 Configure alarms generated in the HVAC PLC into two types:

.1 Automatic reset alarms clear upon the alarm condition being removed. Provide logic as required to ensure that fast cycling of the alarm does not occur.

.2 Manual reset alarms require reset from the HMI. Utilize manual reset alarms where the initiating condition would be removed by the action resulting from the alarm. Ensure that manual reset alarms are configured such that a reset signal from the HMI will not clear the alarm unless the initiating condition is cleared.

.9 For any piece of equipment that has control from the HVAC PLC, provide a manual and auto control mode selector buttons on the equipment faceplate and allow for manual control of the equipment from the HMI. Provision of a hardwired local, hand, or manual control mode in the field does not eliminate this requirement.

.10 Avoid creating unnecessary tags and variables. Any unused and/or obsolete and/or non-functional tags, logic, logic sections, etc. to be removed and purged from the final version of the program.

.11 Purge and pack memory periodically to reduce memory fragmentation.

.2 Provide all required HVAC PLC programming.

3.3 PLC COMMISSIONING SERVICES

.1 Provide all required HVAC PLC commissioning services as per Section 40 80 11 – Automation Commissioning.

.2 Upon completion of commissioning, load latest software onto spare card in spare processor. Test spare card prior to turning over to the City.

3.4 TRAINING

.1 Provide one 4-hour on-site training sessions by the equipment vendor or manufacturer to train operational and maintenance personnel in the use and maintenance of the system.

END OF SECTION

Part 1 General

1.1 GENERAL REQUIREMENTS

.1 All control panels shall be built by a CSA/cUL-approved manufacturer and shall bear the CSA/cUL seal with the manufacturer's file number.

.2 All control panels shall be factory assembled and pre-wired. The control panel wiring shall be verified at the manufacturer's factory and completely tested before being shipped to the site.

.3 Supply, install, wire, and test all components inside the control panels according to the Specifications herein and the Drawings.

1.2 SUBMITTALS

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

.2 Prior to construction:

.1 Submit product datasheets for review and approval of the Contract Administrator prior to construction of the control panels.

.2 Submit stamped red-line mark-ups of the proposed modifications to the control panels. If significant modifications are proposed/required, the sealed Tender Drawings (included in this package) in AutoCAD format will be supplied to the Contractor for revision and reference.

.3 Prior to shipment:

.1 Submit electronic pictures of enclosure exterior and interior, including door interior.

.1 Pictures to be of sufficient resolution to read component labels.

.2 As-built drawings:

.1 Submit as-built drawings. Minor changes may be made via red-line mark-ups.

.2 Draft significant changes on AutoCAD drawings.

.3 Submit panel FAT report to Contract Administrator for review.

.4 Do not ship control panel until approval from the Contract Administrator is received.

.4 Provide spare parts as described in Part 3.5 and in accordance with 01 78 00 – Closeout Submittals.

1.3 INSPECTION

.1 A factory inspection of the control panels will be performed at the discretion of the Contract Administrator based upon the pre-shipment submittals.

.2 If requested, demonstrate and test the control panel in the presence of the Contract Administrator's designated representative.

Part 2 Products

2.1 GENERAL

.1 Construct the control panels in accordance with the supplied Drawings.

.2 Control devices of each category shall be of same type and manufacturer.

2.2 ENCLOSURES

.1 Install lamacoids as per the control panel layout Drawings.

.2 All indoor control panels shall be NEMA 12 or as shown on Drawings. Exterior panels shall be NEMA 4X.

.3 All enclosure angles and cut-outs shall be free of dents, gouges, or weld marks and shall present a clean, smooth appearance.

.4 No screws, fittings, or other fastenings shall be used on external panel faces, which must be free of any marks, scratches, or defaults.

.5 The door is to be a minimum 14 gauge steel plate, full height, and flush with adjacent surfaces.

.6 The exterior of the control panel shall be painted ANSI 61 grey.

.7 The interior of the control panel shall be painted gloss white.

.8 Component mounting plates shall be three (3) mm thick steel and shall be painted with one (1) coat of primer and one (1) coat of white baked enamel.

.9 All control panel doors shall be 900 mm (36 inches) wide maximum.

.10 All control panel doors shall open through 180 degrees without restriction.

.11 All control panels of a depth greater than or equal to 300 mm (12 inches) shall be equipped with a fluorescent lighting device located in the cabinet's upper portion with a door switch. Whenever the door is opened, the lighting system shall automatically be activated.

.12 Enclosure brand shall be Hoffman or approved equal in accordance with B7.

2.3 POWER SOURCE

.1 Each power source must be protected by a CSA approved circuit breaker or fuse.

.2 The location of each power source must be clearly shown.

.3 Panels powered by more than one (1) electrical source shall display on their door; "Caution: This panel is electrically powered by more than one source".

2.4 COMPONENTS

.1 Unless written approval for use of unapproved components is received from the Contract Administrator, all electrical materials (e.g., conduit, fittings, wireways, etc.) shall be CSA or cUL approved.

.2 Rails (DIN Rails)

.1 Rails used must be DIN Rail style TS 35mm, slotted.

.2 When used to mount terminals, rails shall be mounted on straight raisers (rail support / mounting feet) so as to raise them to the same height as the highest adjacent wiring duct.

.3 Raisers (rail support / mounting feet) shall not be used when rail hosts heavy components.

.3 Terminals

.1 Requirements:

.1 TS-35 DIN Rail mounting.

.2 Voltage rating:

.1 600V for general control circuits.

.2 600V for power circuits.

.3 Manufacturer: Phoenix Contact or approved equal in accordance with B7.

.2 Terminal blocks shall be designed for the size of the wires to be connected to them. Terminal blocks used for analog, digital, and power cables shall be identified and physically separated from each other.

.3 Each terminal shall bear an identification number on both sides.

.4 Drawings and templates supplied may not detail all hardware components such as labels, stoppers, rail lifters, end plates, separators, etc. The Contractor must supply and install such components when required.

.4 Ground Bus Bar

.1 Supply a ground bus bar in each control panel.

.2 Requirements:

.1 Tapped holes with screws.

.2 Bar to have sufficient connection points for all cables entering the control panel, plus 25% spare.

.3 Maximum one wire termination per screw.

.5 Pushbutton, Switch, and Indicator Light

.1 When required, all control panel pushbuttons, switches, and indicator lights shall be at least NEMA 12 (or better)-type devices.

.2 Manufacturer to be Schneider Electric or approved equal in accordance with B7.

.6 Programmable Logic Controllers

.1 As per section 40 94 43- Programmable Logic Controller (PLCs).

.7 General Purpose Relays

.1 Type: DPDT or as shown on Drawings.
.2 Indication: LED.
.3 Coil voltage: As per Drawings.
.4 Contact rating: 5A (120 VAC), 5A (24 VDC).
.5 Provide diode suppression for DC coils.
.6 Socket mounting: 35mm DIN rail
.7 Approvals: CSA.
.8 Manufacturer: Omron, Finder or approved equal in accordance with B7.

.8 I/O Relays

.1 Relay interface for PLC Discrete Inputs, 1PDT :
.1 Coil rating: 3.5 mA at 120 VAC.
.2 Contact material: Gold-plated silver tin oxide alloy.
.3 Contact switching voltage: 36 V dc max.
.4 Contact minimum switching current: 1 mA.
.5 Contact maximum inrush current: 50 mA.
.6 Wire Size: 26 to 14 AWG for both input and output side.
.7 Color: Gray body.
.8 Width: 6.2 mm.
.9 Bridging: Plug-in bridge.
.10 Approvals: cULus
.11 Standard of acceptance: Phoenix Contact 2966281.

.2 Relay interface for PLC Discrete Outputs, 1PDT :
.1 Coil rating: 9 mA at 24V dc.
.2 Contact material: Silver tin oxide alloy.
.3 Contact switching voltage: 5V ac min, 250 V ac max.
.4 Contact limiting continuous current: 6A.
.5 Wire Size: 26 to 14 AWG for both input and output side.
.6 Color: Gray body.
.7 Width: 6.2 mm.
.8 Bridging: Plug-in bridge.
.9 Approvals: cULus
.10 Standard of acceptance: Phoenix Contact 2966171.

.9 Analog Signal Isolators:

.1 Provide galvanic isolation between analog signals where not already provided by the programmable logic controller or other components.
.2 Input: 0-5V, 1-5V, 0-10V, and 4-20 mA (switch selectable).
.3 Output: 4-20 mA.
.4 Channels per isolator: 2 or 4.
.5 DC input resistance:
.1 Current inputs: 50 Ω.

.2 Voltage inputs: 1 MΩ.

.6 Performance:

.1 Output ripple: < 10 mV peak-to-peak measured across a 250 Ω resistor.

.2 Isolation: 1000V rms input-to-output and channel-to-channel.

.3 Common mode rejection: > 95dB @ 60 Hz, 500V rms maximum.

.7 Features:

.1 Adjustable zero and span for each channel via potentiometers.

.2 Removable wiring connectors.

.8 Environmental:

.1 Temperature range, operating: -40 to 70 degrees Celsius.

.2 Relative humidity, operating: 0 to -95 percent non-condensing.

.3 Ambient temperature effect: plus or minus 0.015 percent of span/ degrees C maximum.

.9 Manufacturers:

.1 Acromag,

.2 Moore Industries,

.3 MTL Instruments,

.4 Phoenix Contact.

.5 Or approved equal in accordance with B7.

.10 24 VDC Uninterruptible Power Supplies

.1 Approvals: CSA.

.2 Input: 100-240 VAC, 45-65 Hz.

.3 Output: 24VDC.

.4 Mounting: NS 35 DIN rail.

.5 Capable of redundant operation with redundancy module.

.6 Performance:

.1 Load regulation: < 2%.

.2 Temperature derating: 2.5 %/ degree Celsius from 60 degree Celsius.

.3 Output ripple: < 20 mV

.4 Efficiency: 90% (120 VAC) and 96% (Battery operation).

.7 Features:

.1 Capable of parallel operation.

.2 Dynamic Boost 15A.

.3 Input transient surge protection.

.4 Protection Class I

.8 Status lights:

.1 DC OK LED.

.2 Alarm LED.

.3 BAT MODE.

.4 Ready.

.5 Remote.

.6 BAT-Start.

.9 Energy Storage, lead AGM, VRLA technology, 24 V DC, 3.4 Ah

.10 Environmental:

.1 Temperature, operating: -25 to 70 degree Celsius.

.2 Humidity, operating: max 93%, non-condensing.

.11 Manufacturer and series:

.1 Phoenix Contact, TRIO-UPS-2G/1AC/24DC/10,

.2 Phoenix Contact, UPS-BAT/VRLA/24DC/3.4AH,

.3 Or approved equal in accordance with B7.

.11 Grounding

.1 All control panel components shall be adequately grounded in accordance with the component manufacturer, especially control system components.

.2 Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for back panels 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.

.12 Internal Wiring

.1 Panel wiring shall be installed in a neat and orderly manner.

.2 All conductors shall be securely fastened to terminals at both ends; no splices are allowed inside the panel.

.3 No more than two (2) conductors may be terminated under each terminal screw. All internal panel conductors shall be connected to the same side of a terminal block and external conductors to the other side. The only exception is for fused terminals which require connection to the field side for internal wiring.

.4 All wires and cables inside the control panels shall be identified on both ends with non-erasable markers.

.5 Identification for wire shall be in accordance with the supplied documents, such as wiring diagrams.

.1 Label both ends of each wire.

.2 Utilize machine printed non-slip labels. Wrap-around or self-adhesive markers shall not be permitted.

.3 Wherever possible wire labels shall be positioned to be read from the panel opening without removal of wire duct covers or other wiring.

.6 Individual conductors or wires exiting a cable shall be identified using wire and cable tags, with printed labels.

.7 The routing of all analog, digital, power, and networking wiring and cabling inside control panels shall be segregated as much as possible by the type of signal they are carrying.

.8 All wires shall be physically protected by wiring ducts with covers. The wiring ducts shall be of sufficient size to be filled to a maximum of 50% when all wires are inside.

.9 All analog twisted pair wiring shall be 18 AWG shielded such as Belden No. 8760, or approved equal in accordance with B7. Shield wires exiting the jacket must be

covered with a black heat shrink and the overall cable at the jacket end must also be covered with a heat shrink.

.10 All 24 VDC or 120 VAC discrete signal wiring shall be 16 AWG TEW stranded conductor.

.11 All 120 Vac power wiring shall be 14 AWG TEW stranded conductor, minimum.

.12 All 24 Vdc power wiring shall be 12 AWG TEW stranded conductor, minimum.

.13 The sizes and colours of wires shall be in accordance with the CSA and the Canadian Electrical Code.

.14 The panel builder shall group and form wiring into a loop when going from a fixed part of the panel to a door such that there is sufficient slack to minimize strand fatigue and breaking. Each end of the loop shall be properly supported.

.15 Ethernet Patch Cords

.1 Requirements:

.1 Cat-6.

.2 Jacket colour: Blue.

.16 Wiring Duct

.1 All wires shall be run in narrow slot wiring duct such as such as Panduit or approved equal in accordance with B7.

.2 Wiring duct shall be installed on both sides of the panel and between the DIN rails.

.3 Wire or cable, connected to internal device or arriving from external device, shall be uncovered by wiring duct for a maximum of 10 cm.

.17 Wire ties shall be non-metallic.

.18 Wiring shall be arranged to be readily accessible for inspection and maintenance.

.19 The wiring arrangement shall not interfere with access to panel-mounted devices or spaces for future equipment.

.13 Internal Lighting

.1 All control panels of a depth greater than or equal to 300 mm shall be equipped with a lighting device with a door switch. Whenever the door is opened, the lighting system shall automatically be activated.

.2 Fixture mounting: top-centre of enclosure, unless otherwise noted.

.3 Lights: LED, white.

.4 Manufacturer:

.1 Hoffman,

.2 Or approved equal in accordance with B7.

.14 Overcurrent Protection

.1 Panel-mounted devices and all control circuits shall be protected by appropriately sized fuses or circuit breakers.

Part 3 Execution

3.1 COMPONENT INSTALLATION

.1 Components on the front of the panel shall be identified with an individual permanent nameplate installed in an organized manner. The nameplate must identify the component's function.

.2 Each component inside the control panel shall be identified with a nameplate corresponding to the Drawings.

.3 All non-DIN rail mountable devices in the control panel shall be mechanically affixed to the back panel with either tapped or self-tapping screws.

.4 All control devices shall be mounted so that any component can be replaced without removing the sub-panel or other components.

.5 Components and/or auxiliary instruments mounted at the rear of the panel shall be readily accessible and their installation shall not be affected by, or interfere with, the removal of any panel instrument.

.6 Nameplates shall be made of hard plastic lamacoid material with a white background and engraved black letters for internal and external components. Refer to section 40 05 01 - Common Work Results – Automation.

.7 Supply and install all required fuses.

.8 Control devices must be spaced adequately to allow for cooling, replacement, servicing, and wiring access.

.9 Control devices shall be grouped according to voltage and function to reduce electrical noise.

.10 Cutouts for instruments shall be within the tolerances specified by the instrument manufacturer.

.11 If cutouts are specified for future instruments, the cutouts shall be covered by removable steel plates 3 mm (1/8 inch) thick. The cover plates shall be finished and painted with the same paint as applied to the front panel.

.12 If any panel-mounted item is not available for installation before the panel is scheduled for shipment, wiring from the terminal block to the panel location for the item shall be completed, wire ends shall be formed exactly to the configurations required, and identifying sleeves shall be applied, ready for connection.

.13 Panel areas designated for future equipment shall be kept clear of stiffening members, rear-mounted equipment, wiring, and all other interferences.

.14 Ample space shall be provided for the entrance of external cables into the panel and for routing the cables to terminating points within the panel.

3.2 IDENTIFICATION

.1 Perform terminal identification using a computerized device. Handwriting is not acceptable.

.2 Label terminals as shown on Drawings.

.3 Install label above each terminal block with terminal block name.

.4 Refer to spec section 40 05 01 for Equipment Identification.

3.3 TESTING

.1 Testing of the control panels shall be completed to the greatest extent possible prior to the FAT and shall include at minimum:

.1 Provide a signed and dated inspection sheet with all tests performed listed on it.

.2 The list of the various test procedures described hereunder is not restrictive and does not relieve the Contractor of his responsibility to perform any other work that is not mentioned but requested to verify the good operation of the control panels.

.3 Isolate all instruments and components of the control panels as required to protect them from any damage during tests.

.4 Provide the services of qualified personnel as well as tools and equipment required to perform all tests and inspection of the control panels.

.5 Tests to include:

.1 Power supply functionality,

.2 PLC component functionality,

.3 Point to point tests of all inputs and outputs,

.4 Power terminal voltage verification,

.5 Relays and switches functionality,

.6 Receptacle functionality,

.7 Communications / Ethernet switch functionality,

.6 If the panel is modified after tests have been performed, tests shall be repeated.

3.4 SHIPMENT

.1 Request for shipment of any panel having shortages of equipment is subject to approved in writing by the Contract Administrator. The Contract Administrator has sole discretion on either granting approval or not granting approval for shipment.

3.5 SPARE COMPONENTS

.1 Supply two spares of each fuse type and rating. Place in a clear plastic bag and attach to the panel door interior

END OF SECTION

Part 1 General

1.1 Description

.1 This section contains requirements for training the City staff, by persons retained by the Contractor specifically for the purpose of proper operation and maintenance of all equipment supplied and installed under this Contract.

.2 The Contract Administrator has the authority to determine if the training is sufficient based on the lesson plan submitted by the Contractor.

.3 Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

1.2 Submittals

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

.2 Submit training proposal complete with hour-by-hour schedule including brief overview of content of each segment to the Contract Administrator 30 Calendar Days prior to anticipated date of beginning of training.

.1 List name of trainers and type of visual and audio aids to be used.

.3 Submit training materials as described in Part 1.5 of this Specification.

1.3 Quality Assurance

.1 Provide competent instructors thoroughly familiar with all aspects of the instrumentation and controls system installed in the facility.

.2 The Contract Administrator reserves the right to review the credentials of the proposed instructor(s) and approved the proposed instructed or request an alternate.

1.4 Instruction

.1 Provide instruction to designated City personnel in adjustment, operation, maintenance, and pertinent safety requirements of the system installed.

.2 The training sessions shall be comprised of both classroom training and field training. As a minimum, they shall cover the following topics for each item of equipment or system:

.1 Safety.
.2 Operation.
.3 Troubleshooting.
.4 Preventative and predictive maintenance.
.5 Corrective maintenance.
.6 Parts.
.7 Local representation.

1.5 Training Materials

.1 Provide equipment, visual and audio aids, and materials necessary for training.

.2 Supply one manual for each trainee (for 20 personnel), plus 3 spare, describing in detail data included in each training program.

.1 Review contents of manual in detail to explain aspects of operation and maintenance

1.6 Training Program

.1 Operations Training

.1 Location:

.1 McPhillips Pumping Station (360 McPhillips Ave.).

.2 Tache Pumping Station (866 Tache)

.2 Duration: Session is not more than Four hours.

.3 Number of Sessions: Coordinate with Contract Administrator prior to training.

.4 Number of trainees: Coordinate with Contract Administrator prior to training.

.5 Audience: Operations and maintenance personnel.

.6 Content:

.1 General system overview.

.2 Description of system components.

.3 Presentation of the control panel and system operation.

.4 Presentation on the PLC controls.

.5 Presentation on the MCC, MCC soft starters and system operation.

.6 Presentation on changing of settings for all motor starters in the MCC

1.7 Monitoring of Training

.1 The Contract Administrator to monitor the training program and may modify the schedule and content.

Part 2 Products

2.1 General

.1 Not Applicable.

Part 3 Execution

3.1 Training

.1 Provide on-site training to City personnel, as indicated above.

END OF SECTION

Part 1 General

1.1 MAINTENANCE SERVICES

.1 Maintain equipment per manufacturer's recommendations up to the final completion of the construction.

1.2 SUPPORT SERVICES

.1 Duration:

.1 The duration of support services is to extend during the warranty period (one year past Total Performance), except for the Chiller, which is 2-years.

.2 Requirements:

.1 Provide telephone support for all products supplied (during regular business hours).

.2 Respond to emergency service calls (during regular business hours).

.3 Telephone Support:

.1 Telephone support to utilize service personnel knowledgeable in the products and have the required troubleshooting skills.

.2 No payment will be made for telephone support during the warranty period.

.4 Emergency Service Calls:

.1 Respond to service calls from the City when the system is not functioning correctly.

.2 Qualified control personnel to be available to provide on-site service upon a critical failure, whenever required.

.1 A critical failure is the inability to operate of any part of the critical system supplied by the Contractor.

.2 Critical systems include, but are not limited to:

.1 Communication networks.

.2 MCC.

.3 PLC system.

.4 Chiller system.

.3 Perform work continuously until system is restored to a reliable operating condition.

.4 Response Time:

.1 The response time to emergency service calls is to be less than four hours.

.5 Record each service call request, when received separately and include:

.1 Serial number identifying component involved.

.2 Location, date, and time call received.

.3 Nature of trouble.

.4 Names of personnel assigned.

.5 Instructions of work to be done.

.6 Amount and nature of materials used.

.7 Time and date work started.

.8 Time and date of completion.

.6 Costs:

.1 If the issue is determined to be due to poor workmanship or defect of the Contractor, no payment will be made to the Contractor.

.2 If the issue is determined to be due to failure of a physical component supplied and is covered under manufacturer's warranty, no payment will be made to the Contractor.

.3 If the issue is determined to be due to an issue outside of the Contractor's responsibility, the Contractor will not be paid for the service call to the Site (or for estimating the required work), but will be paid a mutually agreed upon value to correct the issue, at the discretion of the City.

Part 2 Products

2.1 NOT APPLICABLE.

.1 Not applicable.

Part 3 Execution

3.1 NOT APPLICABLE.

.1 Not applicable.

END OF SECTION