

CONTROL OF WORK

1. GENERAL

1.1 Plant and Hours of Construction

- .1 Furnish equipment which will be efficient, appropriate, and large enough to secure a satisfactory quality of work and a rate of progress which will insure the completion of the Work within the Contract time. If at any time such equipment appears to the Contract Administrator to be inefficient, inappropriate, or insufficient for securing the quality of work required or for producing the rate of progress aforesaid, the Contract Administrator may order the Contractor to increase the efficiency, change the character, or otherwise improve the equipment, and the Contractor shall conform to such order. Failure of the Contract Administrator to give such an order shall in no way relieve the Contractor of their obligations to secure the quality of the work and rate of progress required.
- .2 Normal construction activity shall take place only between the hours of 7:30 a.m. to 4:00 p.m., excluding Saturdays, Sundays, and legal holidays. Work by the Contractor shall occur within these hours unless prior arrangement have been made with the Contract Administrator.
- .3 Workers shall display visible identification as Contractors or visitors.

1.2 Occupying Private Land

- .1 The Contractor shall not (except after written consent from the proper parties) enter or occupy with personnel, tools, materials, or equipment any land outside the rights of way or property of the City. A copy of the written consent shall be given to the Contract Administrator.

1.3 Pipe Locations

- .1 Small interior piping of less than 100 mm (4") diameter is indicated diagrammatically on the Drawings and the exact location is to be determined in the field. Piping shall be arranged in a neat, compact, and workmanlike manner, with a minimum of crossing and interlacing, so as not to interfere with equipment or access ways, and, in general, without diagonal runs.

1.4 Care and Protection of Property and Premises

- .1 Co-ordinate use of premises under direction of the Contract Administrator.
- .2 The Contractor shall be responsible for the preservation of all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Work on the part of the Contractor, such property shall be restored by the Contractor, at their expense, to a condition equal or better to that existing before the damage was done, or they shall make good the damage in other manner acceptable to the Contract Administrator.
 - .1 Provide protection for existing building finishes and equipment during performance of Work.
 - .2 Provide necessary screens, covers, and hoardings.
- .3 Protect property surrounding the Site from damage during performance of Work.

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1.5 Interference with Existing Works

- .1 Construction of the Work shall allow for continual operation of the DBPS. Any interruptions in operation shall be coordinated with the Contract Administrator.
- .2 Execute Work with least possible interference or disturbance to facility operation, and normal use of premises. Coordinate with the Contract Administrator to facilitate the execution of Work to minimize disruption.
 - .1 City Operation staff will work around the Site during the entire construction period for execution of normal operations.
 - .2 Co-operate with the City staff in scheduling operations and maintenance to minimize conflict.
 - .3 Coordinate all outages, including power, with the City and the Contract Administrator in advance of the Work (minimum five (5) business days advance notice).
- .3 Complete the modification Work on the reactors in place without removing the reactors. The available space for completing the work is approximately between 3300 mm to 3600 mm upstream of the reactors and 300 mm to 900 mm downstream of the reactors, clearance varies between reactors. There is a minimum of 1200 mm lateral clearance from one side of the reactor. The lateral clearance on the opposite side varies between the reactors. These dimensions are provided to give the Contractor a general understanding of the available space. Field verify the exact dimensions prior to commencing the Work.
- .4 Make such minor modifications in the work relating to existing structures as may be necessary, without additional compensation.
- .5 Move existing miscellaneous equipment as required to complete the Work, without additional compensation.
- .6 Remove or alter existing work as required to prevent injury or damage to the existing work and to provide more space to complete the Work under this Contract.
- .7 Repair or replace portions of existing work which have been altered or damaged during construction operations to match existing or adjoining work, as directed by the Contract Administrator at no additional cost.
- .8 The Contractor shall have no claim for additional compensation by reason of delay or inconvenience in adapting their operations to the need for continuous treatment of water at the existing plant.

1.6 Protection and Relocation of Existing Structures and Utilities

- .1 Assume full responsibility for the protection of all buildings, structures, and utilities, public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, water pipes, hydrants, sewers, drains, and electric and telephone cables, whether or not they are shown on the Drawings. Carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operations shall be repaired by the Contractor at their expense.
- .2 Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be a part of the Work under the Contract and all costs in connection therewith shall be included in the Total Price Bid in the Bid Form.

CONTROL OF WORK

- .3 Submit a schedule to obtain approval from the Contract Administrator for any shut-down or closure of active service or facility including power, wastewater, water, and communications services. Adhere to approved schedule and provide notice to affected parties.
- .4 Protect, relocate, or maintain existing active services. When inactive services are encountered, cap off in manner approved by Contract Administrator.
- .5 Record locations of maintained, re-routed, or abandoned service lines.
- .6 Where Work involves breaking into or connecting to existing electrical services, give the Contract Administrator forty-eight (48) hours of notice for necessary interruptions. Interruption to treated water supply system requires a minimum of two weeks notice to the City and the Contract Administrator and requires City's approval. If interruptions to the treated water supply system is necessary, carry out the work during low water demand hours and keep duration of interruption minimum.
- .7 If directed by Contract Administrator, provide temporary services to maintain critical building and pumping station systems at no additional compensation.

1.7 Access to Site

- .1 Refer to General Conditions C8.
- .2 Provide and maintain access roads, sidewalk crossings, ramps, and construction runways as may be required for access to Work.
- .3 Maintain access to property including overhead clearances for use by emergency response vehicles.
- .4 Provide full access to/from the Site for personnel and vehicular traffic.
- .5 Design, construct, and maintain temporary "access to" and "egress from" work areas, including stairs, runways, ramps or ladders, and scaffolding, independent of finished surfaces and in accordance with relevant municipal, provincial, and other regulations.
- .6 Construct barriers in accordance with Section 01 56 00 - Temporary Barriers and Enclosures.

1.8 Inspection of Work Away from the Site

- .1 If work to be done away from the construction Site, it may be inspected on by the Contract Administrator during its fabrication, manufacture, or testing, or before shipment. Provide notice to the Contract Administrator of the place and time where such fabrication, manufacture, testing, or shipping is to be done. Such notice shall be in writing and delivered to the Contract Administrator in ample time so that the necessary arrangements for the inspection can be made.

1.9 Cooperation Within This Contract

- .1 All firms or persons authorized to perform any work under this Contract shall cooperate with General Contractor and his Subcontractors or trades and shall assist in incorporating the work of other trades where necessary or required.

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- .2 Cutting and patching, drilling, and fitting shall be carried out where required by the trade or subcontractor having jurisdiction, unless otherwise indicated herein or recommended by the Contract Administrator.

1.10 Cleanup and Disposal of Excess Material

- .1 During the course of the Work, the Contractor shall keep the site of their operations in as clean and as neat a condition as is possible. They shall dispose of all residue resulting from the construction work and, at the conclusion of the work, they shall remove and haul away any surplus excavation, broken pavement, lumber, equipment, temporary structures, and any other refuse remaining from the construction operations, and shall leave the entire Site of the Work in a neat and orderly condition.

1.11 Building Non-Smoking Environment

- .1 Comply with smoking restrictions. Smoking is only permitted in designated areas.

1.12 Documents Required

- .1 Maintain at job site, one (1) printed copy of each document as follows:
 - .1 Latest revisions of Construction Contract Drawings;
 - .2 Specifications;
 - .3 Addenda;
 - .4 Reviewed Shop Drawings;
 - .5 List of outstanding Shop Drawings;
 - .6 Proposed Change Notices (PCNs);
 - .7 Change of Work Orders (CWOs);
 - .8 Other modifications to the Construction Contract including RFIs and associated responses;
 - .9 Field Test Reports;
 - .10 Copy of approved Work Schedule;
 - .11 Health and Safety Plan and Other Safety Related Documents;
 - .12 Project meeting minutes; and
 - .13 Other documents as specified.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

SUBSTITUTION PROCEDURES

1. GENERAL

1.1 Description

- .1 Section includes administrative and procedural requirements for substitutions.

1.2 Definitions

- .1 Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
- .2 Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

1.3 Submittals

- .1 Submit Shop Drawings in accordance with Section 01 33 00.
- .2 Substitution Requests: Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
 - .1 Substitution Request Form: Use Form 01 25 00-1 to request substitution.
 - .2 Documentation: Show compliance with requirements for substitutions and the following, as applicable:
 - .1 Justification for use of the proposed equivalent item(s), including evidence, as applicable, that Contract specified material, product, or equipment is unobtainable or unobtainable within an acceptable time for Contract completion.
 - .2 Statement indicating why specified product or fabrication or installation cannot be provided, if applicable. If the Contractor is proposing the substitution because of unavailability of the product, submit a letter from the manufacturer or distributor stating the product is unavailable with an explanation of why it is unavailable with the Form 01 25 00-1.
 - .3 Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by City and separate contractors that will be necessary to accommodate proposed substitution.
 - .4 Detailed comparison of qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, electrical characteristics, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated and specified. Indicate deviations, if any, from the Work specified.
 - .5 Product data, including drawings and descriptions of products and fabrication and installation procedures.

SUBSTITUTION PROCEDURES

- .6 Certificates and qualification data, where applicable or requested.
 - .7 List of similar installations for completed projects with project names and addresses and names, telephone numbers, and addresses of engineers and owners.
 - .8 Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
 - .9 Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
 - .10 Cost information, including a proposal of change, if any, in the Contract Price.
 - .11 A prediction of any effects the proposed change will have on operation and maintenance costs, where applicable.
 - .12 Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is intended for applications indicated.
 - .13 Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- .3 Contract Administrator's Action: If necessary, Contract Administrator will request additional information or documentation for evaluation within five (5) Business Days of receipt of a request for substitution. The Contract Administrator will notify the Contractor of acceptance or rejection of a proposed substitution within fifteen (15) Business Days of receipt of request, or five (5) Business Days of receipt of additional information or documentation, whichever is later.
- .1 Forms of Acceptance: Change Work Order, Proposed Change Notice, or Field Instructions for minor changes in the Work.
 - .2 Use product specified if Contract Administrator does not issue a decision on use of a proposed substitution within time allocated.

1.4 Material and Workmanship

- .1 Whenever a material, article, system, or sub-system is specified or described by using the name and/or model of a proprietary product or trademark or the name of the manufacturer or vendor, the specified item shall establish the type, function, and quality required; it shall be understood that the words "or approved equivalent" are implied whether or not they follow the proprietary enumeration.
- .2 The Contract Administrator reserves the right to determine when proprietary items have no equivalency, and when uniformity of operations, interchangeability of parts, standard parts inventory, etc., are in the City's best interest.

SUBSTITUTION PROCEDURES

- .3 Requests for review of equivalency will be considered upon submission of sufficient information as described herein, to allow complete review.
- .4 Such requests will not be accepted from anyone other than the Contractor. Such submission must be made prior to purchase, fabrication, manufacture or use of the equivalent items under consideration.
- .5 The Contractor is responsible for all delays caused by its failure to submit complete and accurate information with any request for approval of any material, article, system, or subsystem as an equivalent.
 - .1 Contractor Risk:
 - .1 If the Contractor includes in their Bid or later proposes any material, product, or equipment that they consider equivalent to that specified, the Contractor assumes all risk of any sort associated with acceptance or rejection of proposed equivalent items.
 - .2 The Contractor shall have no right to make claim based upon their Bid that includes a proposed equivalent item(s) of work which resulted in a lower Bid amount for said item(s) or lower total Bid.
 - .2 Equivalency:
 - .1 An item will be considered equivalent to the item specified if:
 - .1 It is equal or better in design and strength in all subparts, quality, reliability and durability, operation, maintenance, and serviceability, as applicable; and
 - .2 It is equal or better in specified parameters in performance in all respects for the specific function(s) indicated in the Contract.
 - .3 Supplemental Requirements:
 - .1 Any tests required by the Contract Administrator to establish quality and performance standards shall be promptly conducted by or through the Contractor at no additional cost to the City.
 - .2 The Contractor shall submit any additional data requested by the Contract Administrator for the equivalency review.
 - .3 The Contractor shall satisfactorily accomplish all changes, including any engineering associated with use of equivalent items, at no additional cost to the City.
 - .4 The Contractor shall have no right of appeal to any decision rejecting the equivalency of any item.

1.5 Quality Assurance

- .1 Comply with the requirements specified in Section 01 45 00 - Quality Control.

SUBSTITUTION PROCEDURES

- .2 Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers at no cost to the City.

1.6 Procedures

- .1 Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

2. PRODUCTS

2.1 Substitutions

- .1 Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than fifteen (15) Business Days prior to time required for preparation and review of related submittals.
- .1 Conditions: Contract Administrator will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Contract Administrator will return requests without action, except to record noncompliance with these requirements:
 - .1 Requested substitution is consistent with the Contract Documents and will produce specified and indicated results.
 - .2 Requested substitution provides sustainable design characteristics that specified product provided.
 - .3 Substitution request is fully documented and properly submitted.
 - .4 Requested substitution will not negatively affect Contractor's construction schedule.
 - .5 Requested substitution has received necessary approvals of Authorities Having Jurisdiction.
 - .6 Requested substitution is compatible with other portions of the Work.
 - .7 Requested substitution has been coordinated with other portions of the Work.
 - .8 Requested substitution provides specified warranty.
 - .9 If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

3. EXECUTION

3.1 Contract Closeout

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

SUBSTITUTION PROCEDURES

**Form 01 25 00-1
SUBSTITUTION REQUEST**

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Claims for additional costs related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to design, including **Contract Administrator** design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: _____

Contract Administrator REVIEW AND ACTION

- Substitution approved – Make submittals in accordance with Specification Section 01 25 00.
- Substitution approved as noted – Make submittals in accordance with Specification Section 01 25 00.
- Substitution rejected – Use specified materials.
- Substitution Request received too late – Use specified materials.

Signed by: _____ Date: _____

Additional Comments: Contractor Subcontractor Supplier Manufacturer Contract Administrator

Other: _____

SUBSTITUTION PROCEDURES

**Form 01 25 00-1 (Continued)
SUBSTITUTION REQUEST**

Project: _____ Substitution Request Number: _____
_____ From: _____

To: _____ Date: _____

_____ Contract Administrator Project Number: _____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No. _____

Installer: _____ Address: _____ Phone: _____

History: New product 1-4 years old 5-10 years More than 10 years old

Differences between proposed substitution and specified product: _____

Point-by-point comparative data attached – REQUIRED BY Contract Administrator

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Contract Administrator: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other part of Work: No Yes, explain _____

Savings to Owner for accepting substitution: _____

Proposed substitution changes Contract Time: No Yes [Add] [Deduct] _____ days.

Supporting Data Attached: Drawings Product Data Samples Tests Reports _____

END OF SECTION

MEASUREMENT AND PAYMENT

1. GENERAL

1.1 Description

.1 Summary:

- .1 Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment.
- .2 See General Conditions C12.

1.2 Schedule of Values

- .1 Provide Schedule of Values with submission of monthly progress estimates.
- .2 Schedule of Values to be supported by evidence as Contract Administrator may reasonably direct and, when accepted by Contract Administrator, to be used as basis for progress estimates.

1.3 Measurement and Payment

- .1 No payment(s) will be made prior to the completion of Contract execution by both parties and all requisite bonds and insurance have been submitted and approved.
- .2 For each lump sum price item, the Contract Administrator will calculate payment based upon the Bid lump sum price for each item in the Form B: Prices and the Contract Administrator's estimate of the percentage of Work completed for each item.

1.4 Items covered by Contract Prices

- .1 In addition to covering the cost of various items of the Work, the Contract lump sum price shall cover the cost of furnishing all materials, tools, equipment, labour, services transportation, and incidentals necessary for executing the Work. Any item of work not specifically listed under Contract unit or lump sum prices shall be considered incidental to such other items as are listed. Payment for work performed under the various Divisions of the Contract shall be made at the respective lump sum price breakdown for that item.
- .2 All items not specifically included in the following measurement and payment clauses are incidental to the Work.
- .3 Insurance and bonding shall be considered incidental to the Work. There shall be no separate payment for these items.
- .4 The items listed in 2.1 coincide with the Unit Prices table in Form B: Prices.

2. MEASUREMENT AND PAYMENT

2.1 Payment

- .1 Mobilization and Demobilization:

MEASUREMENT AND PAYMENT

- .1 Basis of Payment: Payment for “Mobilization and Demobilization” shall be paid for at the Contract lump sum price for “Mobilization and Demobilization” listed in Form B: Prices and Payment for “Mobilization and Demobilization” and shall include all costs associated with mobilization and demobilization, site set up, and cleanup. Payment will be made on the following schedule:
 - .1 50% payment of the “Mobilization and Demobilization” lump sum price will be paid once the Contractor and the subcontractors arrive on Site and commence with the UV disinfection systems upgrade.
 - .2 25% payment of the “Mobilization and Demobilization” lump sum price will be paid once the UV disinfection systems are upgraded (including mechanical, electrical, and instrumentation and control upgrades).
 - .3 25% of the “Mobilization and Demobilization” lump sum price will be paid subsequent to the Contractor’s demobilization, and Site clean-up.
- .2 UV Reactor CFD Modelling and Validation:
 - .1 Basis of Payment: Payment for “UV Reactor CFD Modelling and Validation” shall be paid for at the Contract lump sum price for “UV Reactor CFD Modelling and Validation” listed in Form B: Prices and shall include all work related the completion of CFD Modelling by De Nora to evaluate UV dose delivery. The analysis by De Nora shall compare log inactivation and UV dose delivery by the UV reactors using the validation piping to as-built piping as installed at the WTP facility. This comparison shall be conducted using CFD-based UV dose models using current UVT levels and WTP flows.
 - .2 The Contractor shall not receive payment for this item or commence commissioning until the reactor validation is complete and the reports have been reviewed and approved by the Contract Administrator and the City. Reactor validation will allow assessment of whether UV reactors are meeting a 2-log *Giardia* inactivation or 2-log *Cryptosporidium* inactivation for a given UV dose, UVT, and flow.
- .3 UV Disinfection Equipment Supply:
 - .1 Basis of Payment: Payment for “UV Disinfection Equipment Supply” shall be paid for at the Contract lump sum price for “UV Disinfection Equipment Supply” listed in Form B: Prices and shall include all work related to the supply and documented receipt of all equipment to Site or the Contractor’s secured storage area, and verification by the Contract Administrator.
- .4 UV Disinfection Equipment Installation:
 - .1 Basis of Payment: Payment for “UV Disinfection Equipment Installation” shall be paid for at the Contract lump sum price for “UV Disinfection Equipment Installation” listed in Form B: Prices and shall include all work related to the installation, testing and commissioning of the retrofitted UV reactors, associated electrical systems, control panels, instrumentation, controls, appurtenances, and other site improvements as required in the Specifications, including:
 - .1 Mechanical upgrades, including replacement of all UV sensor wells, UV duty sensors, gaskets, bolting assemblies, wiper plate assemblies, and top baffles.

MEASUREMENT AND PAYMENT

- .2 Control updates to the existing UV control cabinets, including replacement of the existing Human Machine Interfaces (HMIs) with new hardware based on the Schneider Electric Magelis.
- .3 PLC/HMI programming, program transfers, and updates, including replacement of the existing local and master PLC/HMIs and associated network.
- .5 Fiber Optic & Network:
 - .1 Basis of Payment: Payment for “Fiber Optic & Network” shall be paid for at the Contract lump sum price for “Fiber Optic & Network” listed in Form B: Prices and shall include all work related to the installation, setup, connections, testing, and submission of completed and passed test forms for all network components and materials as required in the Specifications.
- .6 Calculated Dose Approach – Update and Test:
 - .1 Basis of Payment: Payment for “Calculated Dose Approach – Update and Test” shall be paid for at the Contract lump sum price for “Calculated Dose Approach – Update and Test” listed in Form B: Prices and shall include all work related to updating the dose approach for all reactors from the Setpoint Approach to the Calculated Dose Approach using empirical equations provided by De Nora and subsequent testing as required in the Specifications.
- .7 Training:
 - .1 Basis of Payment: Payment for “Training” shall be paid for at the Contract lump sum price for “Training” listed in Form B: Prices and shall include all work related to preparing and submitting documents required prior to training (training proposal and materials, As-Built Drawings, O&M manuals, and Running and Performance Test reports), conducting recorded training of operators in relation to the upgraded UV disinfection system as required in the Specifications, and submission of edited training videos.
- .8 CSA Special Inspections:
 - .1 Basis of Payment: Payment for “CSA Special Inspection” shall be paid for at the Contract lump sum price for “CSA Special Inspection ” listed in Form B: Prices and shall include all work related to the inspection(s), testing and recertification of all modified/upgraded electrical equipment as required in the Specifications. No payment will be made for this item prior to the associated permits are closed.
- .9 Supply of Spare Parts:
 - .1 Basis of Payment: Payment for “Supply of Spare Parts” shall be paid for at the Contract lump sum price for “Supply of Spare Parts” listed in Form B: Prices and shall include all work related to the documented receipt of all spare parts required for the Work.
- 3. PRODUCTS (NOT USED)**
- 4. EXECUTION (NOT USED)**

END OF SECTION

CONSTRUCTION PROGRESS SCHEDULE

1. GENERAL

1.1 Definitions

- .1 Activity: element of the Work performed during the course of the Project. Activity normally has an expected Duration, an expected cost, and expected resource requirements. Activities can be subdivided into tasks.
- .2 Bar Chart (Gantt Chart) (in Microsoft Project and PDF): graphic display of schedule-related information. In a typical bar chart, activities or other Project elements are listed down the left side of chart, dates are shown across the top, and Activity Durations are shown as date-placed horizontal bars. Generally, the Bar Chart should be derived from commercially available computerized project management system.
- .3 Baseline: original approved plan or schedule (for Project, work package, or Activity), plus or minus approved scope changes. This will be used to determine whether items are behind schedule.
- .4 Construction Work Week: Monday to Friday, inclusive, providing five (5) Business Days for scheduling.
 - .1 Work of any kind shall not be permitted to be executed on any Saturday, Sunday, any day that may be designated by the Province of Manitoba or the City as a holiday, or AECOM office shutdown periods, including the first Monday in August and the period between December 27-December 31, except as stipulated below:
 - .1 Whenever, in the judgement of the Contract Administrator, it may be necessary or expedient to do work at night or on weekends or holidays, carry out such overtime at no additional cost to the City.
 - .2 Obtain the necessary permission and permits from the governing body to work on Sunday, nights, or holidays when this is necessary.
 - .2 Contract Administrator review time for Shop Drawings shall not include Saturdays, Sundays, holidays, or AECOM office shutdown periods, including the first Monday in August and the period between December 27-December 31.
- .5 Duration: number of work periods (not including holidays or other nonworking periods) required to complete Activity or other project elements. Usually expressed as Business Days or workweeks.
- .6 Project Schedule or Schedule: planned dates for performing activities and the planned dates for meeting Substantial Performance. A dynamic, detailed record of tasks or activities alongside a critical path that must be accomplished to satisfy Project objectives. Project Schedule must be displayed using a Gantt Chart highlighting the critical tasks. A preliminary schedule is provided for the Contractor's reference at the end of this section.
 - .1 Monitoring and control process involves using Project Schedule in executing and controlling activities and is used as basis for decision making throughout the Project life cycle.

CONSTRUCTION PROGRESS SCHEDULE

- .7 Project Planning, Monitoring and Control System: overall system operated by the Contract Administrator to enable monitoring of project work in relation to an established Substantial Performance.

1.2 Requirements

- .1 The Contractor shall provide the Contract Administrator with a Project Schedule on a weekly basis in the form of a Gantt chart showing time on the horizontal axis and tasks on the vertical axis.
- .2 Ensure details of Project Schedule are practical and contribute to Substantial and Total Performance in accordance with specified dates.
- .3 When possible, limit Activity Durations to maximum of approximately ten (10) Business Days, to allow for progress reporting.
- .4 Award of Contract, rate of progress, Certificate of Substantial Performance, and Certificate of Total Performance as defined times of completion are of the essence of this Contract. Ensure that this is understood.

1.3 Action and Informational Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit to the Contract Administrator, within twenty (20) Business days of Award of Contract, the Project Schedule.

1.4 Project Schedule

- .1 Develop a detailed Project Schedule and submit it to the Contract Administrator in accordance with Section 1.3 of this Specification.
 - .1 The Contract Administrator will review and return revised Schedule within five (5) Business Days.
 - .2 Revise the Project Schedule (if required) and resubmit within five (5) Business Days.
 - .3 Accepted revised Project Schedule will be used as baseline for updates.
- .2 Ensure the detailed Project Schedule includes, as a minimum, Activity types as follows:
 - .1 Award.
 - .2 Equipment procurement.
 - .3 Site measurement and confirmation of available space.
 - .4 Completion of CFD modeling.
 - .5 Submission of validation report.
 - .6 Submissions of Shop Drawings, samples.

CONSTRUCTION PROGRESS SCHEDULE

- .7 Submissions of Permits.
- .8 Mobilization to Site.
- .9 Date each reactor is taken out of service. There should be separate dates for each of the six (6) reactors.
- .10 Process mechanical modifications on each reactor.
- .11 Electrical, instrumentation, and control work for each reactor.
- .12 Reactor testing and commissioning.
- .13 Date of completion of modifications on each reactor. There should be separate dates for each of the six (6) reactors.
- .14 Date each reactor is put back into service. There should be separate dates for each of the six (6) reactors.
- .15 Upgrades to Flouride and Phosphoric Acid Metering Pump Control Panel.
- .16 Provision of spare parts.
- .17 Modeling, test results, and report submission.
- .18 Site Restoration.
- .19 Demobilization.
- .3 Twenty (20) Business Days are to be included in the project slack as approved by the Contract Administrator.

1.5 Project Schedule Reporting

- .1 Update Project Schedule weekly and in advance of Progress Meetings.
 - .1 Update shall reflect Activity changes, completions, and Activities in progress.
- .2 On a monthly basis, include an updated Schedule and a narrative report identifying Work status to date, comparing current progress to Baseline, presenting current forecasts, defining problem areas, anticipated delays, impact with possible mitigation, and associated updates to completed and upcoming costs.

1.6 Progress Meetings

- .1 Discuss the Project Schedule at the weekly job meetings in accordance with the Supplemental Conditions.
- .2 Identify activities that are behind schedule and provide measures to regain slippage. Activities considered behind schedule are those with projected start or completion dates later than current approved dates shown on the Baseline Project Schedule.

CONSTRUCTION PROGRESS SCHEDULE

1.7 Items Requiring Advance Notice

- .1 Provide advance notice to the Contract Administrator for items as specified in individual Specification Sections.
- .2 Items requiring advance notice include, but are not limited to, the following:

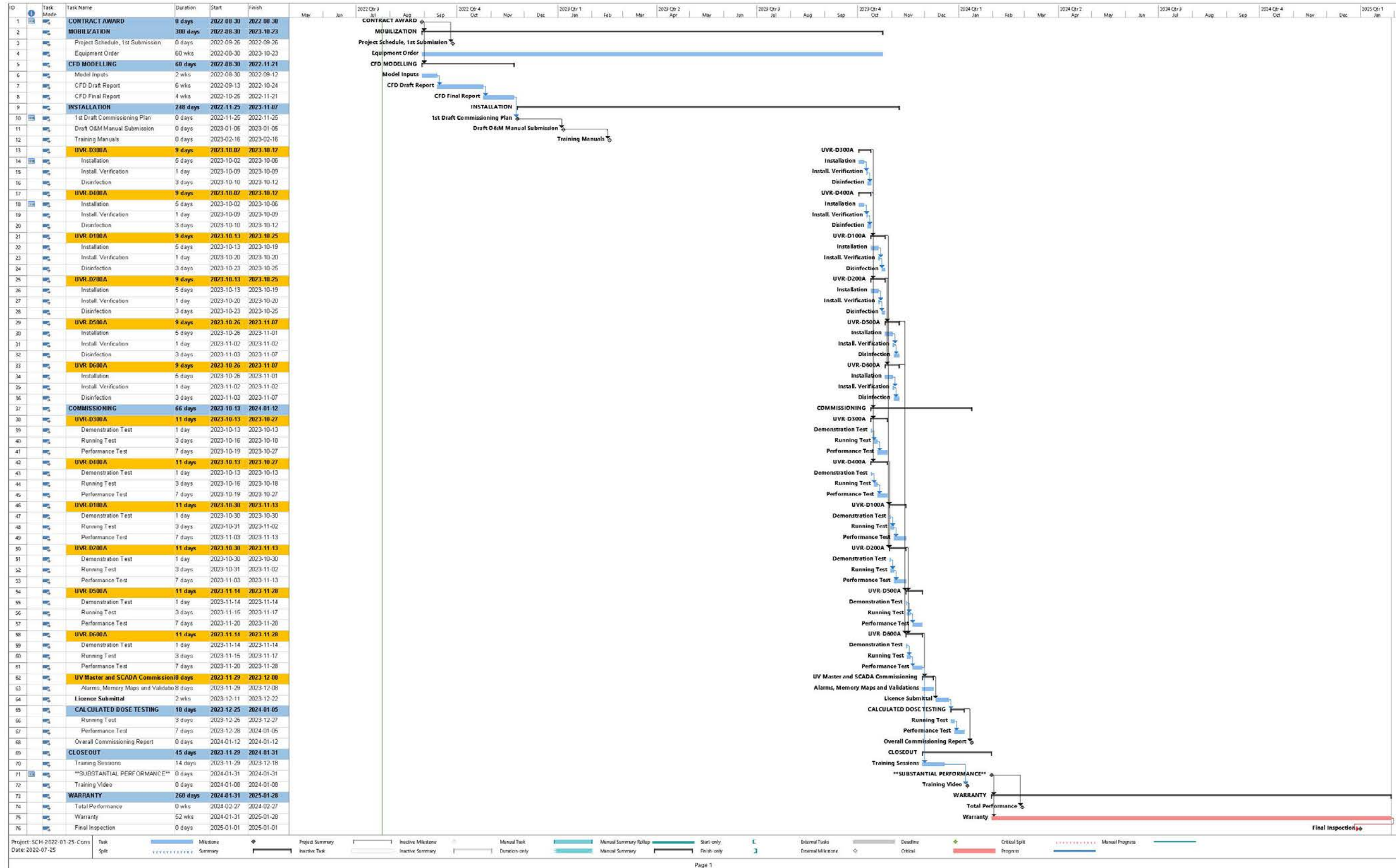
Table 1: Items Requiring Advance Notice

Section	Item	Description
01 25 00 Substitution Procedures	Request for Substitution	Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than fifteen (15) Business Days prior to time required for preparation and review of related submittals.
01 45 00 Quality Control	Notice	If the Work is designated for special tests, inspections, or approvals by the Contract Administrator, give notice of a minimum of five (5) Business Days requesting inspection.
01 50 00 Temporary Facilities	Fire-Prevention and Fire- Protection Program	Develop and supervise an overall fire-prevention and -protection program for personnel at Project Site. Submit to Contract Administrator ten (10) Business Days prior to mobilization to site. Review needs and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information
01 65 00 Equipment Installation	Notice	The Contractor shall inform the Contract Administrator, in writing, of the attendance at the Site of any Manufacturer's Representative for installation training at least ten (10) Business Days prior to arrival.
01 65 00 Equipment Installation	Notice	Inform the Contract Administrator at least fifteen (15) Business Days in advance of conducting the tests and arrange for the attendance of the Manufacturer's Representative. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Contractor and the Contract Administrator.
01 66 10 Delivery Storage, and Handling	Notice	Ten (10) Business days before delivery, notice shall be given to the Contract Administrator so that arrangements for receipt and inspection can be made. When the Contractor accepts the equipment delivery, they shall certify the delivery by completing Form 100 – Certificate of Equipment Delivery, attached to this specification.
01 78 00 Closeout Submittals	Warranty Management Plan	Submit warranty management plan, twenty (20) Business Days before planned pre-warranty conference, to Contract Administrator approval.
01 78 24 Training	Training Manuals	Submit training manuals to the Contract Administrator for review and approval at least three (3) weeks prior to commissioning.
01 78 24 Training	Training proposal	Submit a training proposal complete with schedule, lesson plan, and name of trainer(s) to the Contract Administrator twenty (20) Business Days prior to anticipated date of beginning of training.
01 91 31 Commissioning Plan	Commissioning Plan	Contractor is responsible for submitting a detailed Commissioning Plan for the commissioning of the UV systems at least twenty (20) Business Days prior to the planned start of commissioning. The plan shall comply with the requirements that have been established by the Contract Administrator.

CONSTRUCTION PROGRESS SCHEDULE

Section	Item	Description
01 91 51 Operating and Maintenance Manuals	Operating and Maintenance Manuals	One advance copy of the operating and maintenance manuals shall be submitted to the Contract Administrator for review and comments. After review and acceptance by the Contract Administrator, submit five hard copies and one electronic (Searchable PDF) copy of the final operating and maintenance manuals no later than four (4) weeks prior to commissioning of the Work.
40 05 00 Instrumentation and Control – General Requirements	Notice	After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed by the Contract Administrator.
40 05 00 Instrumentation and Control – General Requirements	Notice	Confirm that all calibrations, required forms and signoffs, and IO and loop checks have been completed prior to providing at minimum two (2) weeks' written notice to the Contract Administrator prior to commissioning for inspection of the following: Proper mounting, Proper connections.
46 66 23 Closed Vessel Medium Pressure UV Treatment Equipment	Validation Report	The validation report shall be submitted to the Contract Administrator at least twenty (20) Business Days prior to starting Commissioning.

CONSTRUCTION PROGRESS SCHEDULE



CONSTRUCTION PROGRESS SCHEDULE

2. **PRODUCTS (NOT USED)**
3. **EXECUTION (NOT USED)**

END OF SECTION

SUBMITTAL PROCEDURES

1. GENERAL

1.1 Description

- .1 Submit to the Contract Administrator the submittals required by individual Specification sections for review. Submit promptly and in an orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.
- .2 Do not proceed with Work affected by the submittal until reviewed by the Contract Administrator.
- .3 Present Shop Drawings, product data, and samples in SI Metric units.
 - .1 Where items or information is not produced in SI Metric units, converted units are acceptable.
- .4 Review submittals prior to submission to Contract Administrator. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and co-ordinated with requirements of Work and Contract Documents.
- .5 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.
- .6 Notify the Contract Administrator, in writing at the time of submission, of deviations from the requirements of the Contract Documents stating the reasons for deviations.
- .7 Verify that field measurements and affected adjacent Work are coordinated.
- .8 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 on resubmitted submittals to revisions other than the corrections requested by the Contract Administrator on previous submission.
- .9 After the Contract Administrator's review and return of copies, distribute copies to sub-trades as appropriate.
- .10 Keep one (1) reviewed hard 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:

SUBMITTAL PROCEDURES

- .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 or newer.
 - .2 Electronic files that contain more than ten (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 215.9 mm by 279.4 mm (8.5" by 11"), 279.4 mm by 431.8 mm (11" by 17"), or 559 mm by 864 mm (22" by 34"). 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 preconstruction meeting.
- .4 Schedule of Submittals:
- .1 Prepare a table listing all anticipated submittals required to complete the Work. A preliminary table is provided for the Contractor's reference in **Appendix F**.
 - .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:

SUBMITTAL PROCEDURES

- .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 (1) 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.

SUBMITTAL PROCEDURES

- .7 Timeliness:
 - .1 Schedule and submit submittals 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 ten (10) Business Days after receipt, unless otherwise specified.
 - .3 Resubmittals will be subject to the 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.

SUBMITTAL PROCEDURES

.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 (1) copy of all Shop Drawings and Product Data.

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 In general, all equipment to be installed at the Site will require Shop Drawings, which shall be submitted to the Contract Administrator.
- .3 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.
- .4 All Shop Drawings are to include details as follows:
 - .1 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.
 - .2 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.
 - .3 Indicate clearances for operation, maintenance, and replacement of operating equipment devices.
- .5 Electrical and instrumentation and control system Shop Drawings to include additional details as follows:
 - .1 Elevation layouts, bill of materials (BOM), fuse charts, schematics, interconnections, point-to-point wiring diagrams, loop wiring diagrams, motor control diagrams, single line diagram, 3-line diagram, and CSA/cUL panel plates in addition to the other wiring and detail requirements of the Contract.
 - .1 Panel plates shall be included in submissions, to be affixed on the front exterior door of the enclosure. They shall contain all information required under CSA C22.1 and C22.2. At a bare minimum the short circuit current rating (SCCR) of panel plates shall be equal to the MCC or Panelboard from which they are fed from.
 - .2 Wiring diagrams shall mark conductor identification, field terminals, changes, etc.
 - .3 Detailed listing of all nameplates.
 - .2 Instrument Loop Diagrams (ILDs) – detailed drawings showing typical interconnections for the specified instrumentation and control devices. The Contractor is to reproduce an ILD for each device and record all relevant as-built information on each sheet for

SUBMITTAL PROCEDURES

submission at the completion of the Work. Modify the Drawings if necessary and fill in all terminal and wiring numbers, etc. from the relevant Shop Drawings as they become available.

- .1 Loop wiring diagrams shall follow ISA 5.4 for standard drawing layout, symbols, and wiring depictions.
- .3 Motor Control Schematics (MCS) – when these are included, they are detailed drawings showing typical interconnections of motor control equipment. The Contractor is to reproduce a MCS for each motor and record all relevant as-built information on each sheet for submission at the completion of the Work. Modify the Drawings if necessary and fill in all terminal and wiring numbers, etc. from the relevant Shop Drawings as they become available.
- .4 Equipment descriptive data and detailed information for the system hardware and software (i.e., cutsheets or product literature). Failure to provide product literature or cutsheets with drawing submissions is grounds for marking the submission “Revise and Resubmit” without review.
 - .1 High-light only relevant information for the products provided. The intent of the literature is a technical review of the products suitability, technical ratings and limitations, and the installation/application. Do not include sales literature, or custom-made sheets, or sales declarations. Only manufacturer issued technical literature will be accepted.
 - .2 Where products have configurable part numbers, the part number options shall be broken down and either circled in red or highlighted in yellow.
 - .3 All cutsheets and product literature shall be provided showing CSA or cUL markings either circled in red or highlighted in yellow.
 - .4 Where hazardous location products are required, they shall also be submitted with their CSA or cUL certificates, and CSA or cUL required wiring diagrams for hazardous installations. The control system wiring diagrams shall capture these requirements, provide intrinsically safe barriers and methods as required, and provide notes for the electrical installer.
- .5 Drawings for cabling:
 - .1 Provide Termination drawings with complete list of materials and nameplate engraving list.
 - .2 Provide Interconnection wiring diagrams for the complete system showing every fibre in each cable.
- .6 Records of as-built information for the complete instrumentation and control system.
 - .1 Provide Enclosure/Cabinet temperature control calculations for heating and cooling loads. Appropriate temperature control shall be provided whenever required and maintain the enclosures CSA/NEMA rating.
 - .1 Temperature calculations shall be provided whenever Variable Frequency Drives (VFD), Variable Speed Drives (VSD), internally mounted transformers,

SUBMITTAL PROCEDURES

or other components/devices may produce sufficient heat within the enclosure, or as requested by the Contract Administrator.

- .6 Notify the Contract Administrator in writing of any deviations in Shop Drawings from the requirements of the Contract.
 - .1 Contract Administrator will not assume the responsibility for searching out deviations in the Contractor's drawings.
- .7 Submit Shop Drawings stamped and signed by professional engineer registered or licensed in the Province of Manitoba as required in the Specifications. If required, the following components require sealed Shop Drawings:
 - .1 Reinforcing steel.
 - .2 Metal fabrications.
- .8 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.
- .9 Submittals shall be in one (1) 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 (1) electronic PDF copy.
- .10 Shop Drawings will be returned to the Contractor with one (1) 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.

SUBMITTAL PROCEDURES

- .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.
- .11 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.
- .12 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.
- .13 Only two (2) reviews of Shop Drawings will be made by the Contract Administrator at no cost. Each additional review will be charged to the Contractor at the Contract Administrator's scheduled rates. The Contract Administrator's charges for the additional Work will be deducted from the 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, supplemented 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) Form 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. The link to the City's RFI form is provided below:

[https://www.winnipeg.ca/infrastructure/templates/ExecutionControl/Request_for_Information_\(RFI\)_v2.0.docx](https://www.winnipeg.ca/infrastructure/templates/ExecutionControl/Request_for_Information_(RFI)_v2.0.docx)
 - .2 Number RFI's consecutively in one sequence in order submitted, in a numbering system established by the Contract Administrator.

SUBMITTAL PROCEDURES

- .3 Submit one (1) distinct subject per RFI request. Do not combine unrelated items on one (1) 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 ten (10) Business 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 Business Day. When the RFI submission is received by the Contract Administrator after noon, the review period commences on the subsequent Business 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 ten (10) Business Days, the Contract Administrator shall confer with the Contractor within five (5) Business 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 ten (10) Business 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 ten (10) Business 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 ten (10) Business 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 fourteen (10) Business 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 01 78 00 - Closeout Submittals for closeout submittal requirements.

SUBMITTAL PROCEDURES

1.7 Miscellaneous Submittals

- .1 Prepare and submit submittals required Contract Documents.
- .2 Copies: Submit one (1) electronic copy to Contract Administrator. Method of electronic submission to be coordinated with Contract Administrator after execution of the Contract.
 - .1 Submit hard copies for paint samples and other submittals where specifically required under individual Specifications sections.
- .3 The Contract Administrator will review submittals for general conformance with design concept and intent, and general compliance with Contract.
- .4 The Contract Administrator's review does not relieve Contractor from compliance with requirements of Contract nor from errors in submittals or Contractor's design.
- .5 The 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 the Contract Administrator's option, the Contract Administrator's review comments and review stamp will be placed either directly on submitted copies of submittals or on separate submittal review comment form.
- .7 Where work is to be designed by the 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.

1.8 General Requirements for Submittals

- .1 Details regarding submittals can be found in the individual Specification Sections.
- .2 Required submittals include, but are not limited to those listed in **Appendix F – Submittal Checklist**.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

SUBMITTAL PROCEDURES

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):

SUBMITTAL PROCEDURES

Distribution (to be completed by Contract Administrator)

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

END OF SECTION

SAFETY PROCEDURES

1. GENERAL

1.1 References

- .1 The Workplace Safety and Health Act, Province of Manitoba.

1.2 Requirements

- .1 Appoint a suitably qualified employee who has sole responsibility with regards to safety on Site on behalf of the Contractor. Advise the Contract Administrator in writing as to the identity of this individual.
- .2 Establish and maintain Safety and Health procedures for construction of the Works.
- .3 Comply with additional safety requirements as specified in the General Conditions and Supplemental Conditions.

1.3 Safety and Health Regulations

- .1 Contractor shall have certification from SAFE Work Manitoba as described in the Bidding Procedures.
- .2 Contractor shall provide a Safe Work Plan (SWP) as referenced in the Supplemental Conditions. SWPs shall include Lock-Out-Tag-Out (LOTO) procedures.
 - .1 The City is available to provide advice during the preparation of LOTO procedures and confined space entry procedures.
- .3 Keep a hard copy of the relevant construction occupational safety and health regulations on Site at all times. Post the policies and notices for the information of workers.
- .4 Ensure that workers are instructed and trained in safe and healthy working practices; take immediate action to correct any unsafe conditions and hold regular weekly safety (toolbox) meetings with all workers.
 - .1 Minutes of weekly safety (toolbox) meetings shall be submitted with weekly Progress Reports.
- .5 Establish Job Safety and Health Procedures and provide copies for the Contract Administrator's information.
- .6 Provide Safety Orientation for all Contractor Personnel.
 - .1 All Contractor Personnel must attend the Contractor's Safety Orientation before access to the Site is granted.
- .7 Ensure that the following essentials of the Workplace Hazardous Materials Information System are provided:
 - .1 Worker education on controlled products.

SAFETY PROCEDURES

.2 Workplace labelling and identification.

.3 Safety Data Sheets (SDS).

1.4 First Aid Facilities and Services

- .1 The Contractor shall provide first aid services at the Site, including their Subcontractors, until Total Performance. Provide qualified first aiders to man the first aid facilities.
- .2 Provide first aid coverage for the Site at all times, including periods outside of normal work hours (evenings, weekends, and holidays) as required to support the work of Subcontractors. Coordinate with others to establish required durations and levels of first aid to support regular and non-regular work hours.
- .3 Make all provisions and pay all installation, manpower, equipment, medical supplies, restocking, and other costs for the first aid facilities in order to provide ongoing service for the Site in accordance with the requirements of this Specification.
- .4 Locate the first aid facility in a convenient location within the Site. The Contractor shall provide and maintain unobstructed emergency vehicle access to the main door of the first aid facility, including appropriate signage as required.
- .5 Arrange and supply transportation for injured workers both on and off Site.
- .6 The Contract Administrator will review the Contractor's first aid facility, personnel, procedures, and safety and health program. The Contract Administrator is to have full access to the Work and the Contractor's first aid facilities and records at all times.

1.5 General Site Rules

- .1 Follow all posted traffic control signs. The maximum speed on Site for all vehicles is 40 km/hr except as otherwise posted.
- .2 Ensure that all workers comply with "NO SMOKING" regulations in effect in areas of the Site.
- .3 Wear hard hats and safety footwear on the Site at all times. Wear reflective vests as required by Site policy.
- .4 Wear eye protection where there is a risk of eye injury; this includes chipping, grinding, welding, drilling, sawing, concrete placing, etc.
- .5 Wear hearing protection device where required and ensure all workers have a valid hearing test.
- .6 Use scaffolding that complies with regulations.
- .7 Obtain a valid certificate of inspection for all cranes and boom trucks before coming on Site.
- .8 Immediately remove any worker found to be impaired.
- .9 Immediately report all hazardous situations to the Contract Administrator.

SAFETY PROCEDURES

- .10 Obtain and display at the Site SDS for all controlled products before the product is allowed on Site.

1.6 Submittals

- .1 Submit in writing to the Contract Administrator the identity of the Contractor representative responsible for safety on Site as described in 1.2.1.
- .2 Submit, by presentation to the Contract Administrator, the safety orientation for all Contractor's Personnel. This presentation must be made before commencement of the Work.
- .3 Submit to the Contract Administrator one (1) copy of any SDS as required. These sheets must be submitted before the controlled product is used on Site.
- .4 Submit to the Contract Administrator minutes of safety meetings, accident investigations, safety inspections, safety and health program, safety orientation records, hearing test records, copies of safe work procedures, and copies of training records as appropriate.

1.7 Confined Space Entry

- .1 Be aware that UV Reactors are considered confined spaces by the City as a result of access and possible hazards.
- .2 Follow applicable Safe Work Procedures for any Work requiring entry into confined spaces.

1.8 Scaffolding

- .1 Design and construct scaffolding in accordance with CSA S269.2.

1.9 Lockout Procedures

- .1 Address all regulatory requirements in areas of new construction where locking out of new equipment may be required.
- .2 When working within the existing plant, the Contractor shall perform equipment lockouts in accordance with the Contractor's approved lockout procedures as per item 1.3.2.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

QUALITY CONTROL

1. GENERAL

1.1 General Requirements

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

1.2 References

- .1 Within the text of the Specifications, reference may be made to the following standards and statutes:
 - .1 ACI American Concrete Institute
 - .2 AISC American Institute of Steel Construction
 - .3 ANSI American National Standards Institute
 - .4 ASTM American Society for Testing and Materials
 - .5 AWWA American Water Works Association
 - .6 CANI National Standard of Canada
 - .7 CEC Canadian Electric Code (published by CSA)
 - .8 CGA Canadian Gas Association
 - .9 CGSB Canadian Government Specification Board
 - .10 CISC Canadian Institute of Steel Construction
 - .11 CLA Canadian Lumberman's Association
 - .12 CPCA Canadian Printing Contractors Association
 - .13 CPCI Canadian Pre-stressed Concrete Institute
 - .14 CRCA Canadian Roofing Construction Association
 - .15 CSA Canadian Standards Association
 - .16 DIN Deutsches Institut Normung

QUALITY CONTROL

- | | | |
|-----|-------|--|
| .17 | EEMAC | Electrical and Electronic Manufacturer's Association of Canada |
| .18 | EIB | Electrical Inspection Branch |
| .19 | FMEC | Factory Mutual Engineering Corporation |
| .20 | IEEE | Institute of Electrical and Electronic Engineers |
| .21 | IPCEA | Insulated Power Cable Engineers Association |
| .22 | NAAMM | National Association of Architectural Metal Manufacturers |
| .23 | NACE | National Association of Corrosion Engineers |
| .24 | NBC | National Building Code |
| .25 | NEMA | National Electric Manufacturers Association |
| .26 | NFPA | National Fire Protection Association |
| .27 | ULC | Underwriters Laboratories of Canada |
- .2 Conform to the latest version of such standards available at the time of tendering, in whole or in part, as specified.
- .3 If there are questions as to whether any product or system is in conformance with applicable standards, the Contract Administrator reserves the right to have such products or systems tested to prove or disprove conformance with Contract Documents, or by the Contractor in the event of non-conformance.

1.3 Inspection

- .1 If the Work is designated for special tests, inspections, or approvals by the Contract Administrator, give notice of a minimum of five (5) Business Days requesting inspection.
- .2 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, have inspections or tests satisfactorily completed, and make good such Work.
- .3 The Contract Administrator will order part of the Work to be examined if the Work is suspected to be not in accordance with the Contract Documents. If, upon examination, such work is found not in accordance with the Contract Documents, correct such Work and pay cost of examination and correction. If such Work is found in accordance with the Contract Documents, the City shall pay cost of examination.

1.4 Independent Inspection Agencies

- .1 Independent inspection/testing agencies may be engaged by the City for the 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.

QUALITY CONTROL

- .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 Documents.
- .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.

1.5 Access to Work

- .1 Allow the 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 whenever it is in progress.
- .2 The City, the Contract Administrator, and other authorities having jurisdiction shall have access to the Work, off Site manufacturing, and fabrication plants. Do not cover or enclose systems prior to inspection.

1.6 Procedures

- .1 Notify appropriate agency and the Contract Administrator a minimum of forty-eight (48) hours in advance of requirement for tests, in order that attendance arrangements can be made.
- .2 Submit samples and/or materials required for testing, as specifically requested in the Specifications. Submit with reasonable promptness and in orderly sequence to not cause delays in Work.
- .3 Provide labour and facilities to obtain and handle samples and materials on Site. Provide sufficient space to store and cure test samples.

1.7 Rejected Work

- .1 Remove defective Work, whether the result of poor workmanship, use of defective products, or damage and whether incorporated in Work or not, which has been rejected by the Contract Administrator as failing to conform to the Contract Documents. Replace or re-execute in accordance with the Contract Documents.

1.8 Reports

- .1 Submit one (1) electronic copy of inspection and test reports to the Contract Administrator.
- .2 Provide copies to the Subcontractor of work being inspected or tested and to the manufacturer or fabricator of material being inspected or tested.
- .3 Each report shall include:
 - .1 Date of issue.

QUALITY CONTROL

- .2 Contract name and number.
 - .3 Name, address, and telephone number of inspection/testing agency.
 - .4 Name and signature of inspector and tester.
 - .5 Date of inspection or test.
 - .6 Identification of the Product and Specification Section covering inspected or tested Work.
 - .7 Location of the inspection or the location from which the tested product was derived.
 - .8 Type of inspection or test.
 - .9 Complete inspection or test data.
 - .10 Test results and an interpretation of test results.
 - .11 Ambient conditions at the time of sample taking and testing.
 - .12 The remarks and observations on compliance with the Contract Documents.
 - .13 Recommendations on retesting or other corrective action where necessary.
 - .14 Signature of a qualified and authorized representative of the testing agency.
 - .4 Submit reports within forty-eight (48) hours; notwithstanding, notify the Contract Administrator immediately if the test indicates improper conditions or procedures.
 - .5 Provide reports in accordance with Section 01 33 00 - Submittal Procedures.
- 2. PRODUCTS (NOT USED)**
- 3. EXECUTION (NOT USED)**

END OF SECTION

TEMPORARY FACILITIES

1. GENERAL

1.1 Scope of Work

- .1 The Contractor shall provide all temporary facilities for the proper completion of the Work, as required and as specified.
 - .1 Section Includes:
 - .1 Project identification.
 - .2 Temporary Facilities:
 - .1 Field offices and sheds.
 - .3 Equipment.
 - .4 Support facility installation.
 - .5 Security and protection.
 - .6 Operation, termination, and removal.

1.2 References

- .1 American National Standards Institute (ANSI):
 - .1 [A 117.1](#): Accessible and Usable Buildings and Facilities.
- .2 American Society for Testing and Materials (ASTM):
 - .1 [E84](#): Standard Test Method for Surface Burning Characteristics of Building Materials.
 - .2 [E136](#): Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 deg. C.
- .3 National Fire Protection Association (NFPA):
 - .1 [70](#): National Electrical Code.
 - .2 [241](#): Standard of Safeguarding Construction, Alteration, and Demolition Operations.
 - .3 [701](#): Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.

1.3 Use Charges

- .1 General: Costs for installation, removal, and use of temporary facilities shall be included in the Contract Price unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, City's construction forces, Contract Administrator, occupants of Project, testing agencies, and authorities having jurisdiction as applicable.

TEMPORARY FACILITIES

- .1 The Contractor shall provide access to appropriate City sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the Site of the Work, shall be properly secluded from public observation, and shall be maintained during the progress of the Work in suitable numbers and at such points and in such manner as may be required by pertinent health and safety regulations.
- .2 The Contractor shall maintain the City sanitary facilities on Site in a satisfactory and sanitary condition at all times and shall enforce their use. They shall rigorously prohibit the committing of nuisances on the Site of the Work, on the lands of the Owner, or on adjacent property.
- .2 Water and Sewer Service from Existing System: Water from City's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
- .3 Electric Power Service from Existing System: Electric power from City's existing system is available for use without metering and without payment of use charges; Contractor to confirm expected power requirements (e.g. amperage, voltage) with the City prior to use. Maximum available power for use by the Contractor will be 60 A at 575 V 3 phase. Transformation to lower voltages will be the responsibility of the Contractor.

1.4 Submittals

- .1 Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel. Submit the Site Plan to the Contract Administrator at least ten (10) Business Days prior to arriving on Site.

1.5 Quality Assurance:

- .1 Electric Service: Comply with NECA, NEMA, and cUL standards and regulations for temporary electric service. Install service to comply with the CEC.
- .2 Tests and Inspections: Arrange for Authorities Having Jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

1.6 Project Conditions

- .1 During adverse weather and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work may be properly done and satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, wood and building-paper shelters, or other suitable means.

2. PRODUCTS

2.1 Temporary Facilities

- .1 Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

TEMPORARY FACILITIES

- .2 The Contractor shall maintain a temporary field office near the Work for their own use during the period of construction at which readily accessible copies of all Contract Documents shall be kept. The office shall be located where it will not interfere with the progress of the Work.
- .3 Temporary Storage Buildings:
 - .1 The Contractor shall provide environmental control systems that meet the recommendations of Suppliers and manufacturers of the equipment and materials stored.
 - .4 The Contractor shall store combustible materials (paints, solvents, fuels) in a well ventilated and remote building meeting all applicable safety standards.

2.2 Office for Contract Administrator

- .1 Promptly after starting work at the Site, the Contractor shall provide and equip a suitable office for the exclusive use of the Contract Administrator, and the Contractor shall maintain this office thereafter until the completion of the work to be done under this Contract. This office shall be a separate building located where it will not interfere with the progress of the Work. An acceptable, suitably constructed and equipped trailer of adequate size and design for the purpose may be furnished as the Contract Administrator's office.
 - .1 The office trailer shall have a minimum width of 3.7 m (12 feet), and a length as required to obtain the square footage specified below and an insulated floor.
 - .2 The office and furniture shall be relatively new and in good condition.
 - .3 The equipment, supplies, and services furnished shall be acceptable to the Contract Administrator.
- .2 The Contractor shall furnish insurance coverage of adequate amount to replace not only the Contractor's equipment, but all property belonging to the Contract Administrator and the Contract Administrator's staff, at replacement cost.
- .3 The office shall be of suitable height and of ample size to accommodate the furniture and equipment listed below, without crowding (at least 70 sq. m. (200 sq. ft.) of floor area). It shall be weathertight and acceptably insulated and suitably ventilated; the floor shall be tight and of sufficient construction to withstand the loads imposed upon it.
 - .1 Each room will have a door, with lock and key, and a minimum of two (2) screened windows which can be both opened and locked shut.
 - .2 The office shall have two (2) exterior doors, with cylinder locks and keys.
 - .3 The exterior doors shall also be provided with a hasp, for which the Contract Administrator will furnish their own locks.
- .4 The Contractor shall furnish the following furniture, equipment, supplies, and services:
 - .1 One plan table or sloping plan shelf, about 0.9 m by 1.8 m (3 feet by 6 feet), with a reasonably smooth top, and one suitable swivel stool.
 - .2 Shelves, tables, and bookcases as recommended by the Contract Administrator.

TEMPORARY FACILITIES

2.3 Equipment

- .1 Fire Extinguishers: Portable, cUL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
- .2 HVAC Equipment: Unless City authorizes use of permanent HVAC system, provide vented, self-contained, electric unit heaters or liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
 - .1 Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - .2 Heating Units: Listed and labelled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.

3. EXECUTION

3.1 Installation, General

- .1 Locate facilities, including laydown area(s) as required, where they will serve the Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work. The proposed location of the facilities for the Contractor's consideration is the 30 m by 30 m area, directly southeast of the DBPS. The Contractor shall coordinate location of facilities with the Contract Administrator and the City.
- .2 Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 Temporary Utility Installation

- .1 General: Install temporary service or connect to existing service.
 - .1 Arrange with utility company, City, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- .2 Sanitary Facilities: Use of City's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to the City. At Substantial Performance, restore these facilities to condition existing before initial use.
- .3 Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
- .4 Electric Power Service: Connect to City's existing electric power service. Maintain equipment in a condition acceptable to City.
 - .1 Connect temporary service to City's existing power source, as directed by City.

TEMPORARY FACILITIES

- .5 Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
 - .1 Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.3 Support Facilities Installation

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 General: Comply with the following:
 - .1 Provide construction for temporary offices, shops, and sheds located within construction area or within 9 m (30 feet) of building lines that is non-combustible according to ASTM E136. Comply with NFPA 241.
 - .2 Maintain support facilities until Contract Administrator schedules Substantial Performance inspection. Remove from Site all such work before Substantial Performance. Personnel remaining after Substantial Performance will be permitted to use permanent facilities, under conditions acceptable to the City.
- .3 Maintain access to property including overhead clearances for use by emergency response vehicles.
- .4 Traffic Controls: Comply with requirements of Authorities Having Jurisdiction.
 - .1 Protect existing site improvements to remain including curbs, pavement, and utilities.
 - .2 Maintain access for fire-fighting equipment and access to fire hydrants.
 - .3 Unless described and approved under a Traffic Control Plan (TCP), conduct operations on the site so that the use of any plant roads by vehicles employed under this Contract will not restrict pedestrian and vehicular traffic thereon nor hinder the use of such facilities.
 - .4 All roads within the plant are used simultaneously by vehicles and pedestrians. The speed limit of 20 km/h applies throughout the plant, including the access roads and parking lots. Failure to comply with speed limit or to operate vehicles safely will result in possible removal of the staff from the Site.
- .5 Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.
 - .1 Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
 - .1 Provide temporary, directional signs for construction personnel and visitors.
 - .2 Maintain and touch up signs so they are legible at all times.
- .6 Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of Authorities Having

TEMPORARY FACILITIES

Jurisdiction. Comply with progress cleaning requirements in Section 01 14 14 - Control of Work.

- .7 Existing Stair Usage: Use of City's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to City. At Substantial Performance, restore stairs to condition existing before initial use.
 - .1 Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

3.4 Security and Protection Facilities Installation

- .1 Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at the Project Site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
- .2 Environmental Protection: Provide protection, operate temporary facilities, and conduct construction to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
 - .1 Use local recycling facilities appropriate for proper disposal of batteries and electronic components.
- .3 Barricades, Warning Signs, and Lights: Comply with requirements of Authorities Having Jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
- .4 Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from other construction operations and similar activities.
- .5 Temporary Partitions: Provide dustproof partitions as appropriate to limit dust and dirt migration and to separate areas occupied by City workers from fumes and noise.
 - .1 Provide dust tight screens or partitions to localize any dust generating activities, and for protection of workers, existing systems and buildings, and public.
 - .2 Maintain and relocate protection until such work is complete.
 - .3 Where fire-resistance-rated temporary partitions are indicated or are required by Authorities Having Jurisdiction, construct partitions according to the rated assemblies.
 - .4 Protect air-handling equipment.
 - .5 Provide walk-off mats at each entrance through temporary partition.
- .6 Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.
 - .1 Prohibit smoking in construction areas.

TEMPORARY FACILITIES

- .2 Supervise any welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of the Office of the fire commissioner.
- .3 Develop and supervise an overall fire-prevention and -protection program for personnel at Project Site. Submit to Contract Administrator ten (10) Business Days prior to mobilization to site. Review needs and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information related to the fire-prevention and -protection program as needed throughout the Work.

3.5 Cleaning During Construction

- .1 Contractor to maintain the grounds within their working limits and around any equipment or storage areas. This includes removal of waste material, cutting of grass, weed whacking around storage racks and material, snow plowing and snow shoveling.
- .2 The Contractor shall make arrangements for disposal of waste and debris.
- .3 The Contractor shall wet down exterior surfaces prior to sweeping to prevent blowing of dust and debris. At least weekly, the Contractor shall sweep all floors (basins, tunnels, platforms, walkways, roof surfaces), and pick up all debris and dispose of off Site.
- .4 The Contractor shall provide approved containers for collection and disposal of waste materials, debris, and rubbish. At least at weekly intervals, the Contractor shall dispose of such waste materials, debris, and rubbish off Site.
- .5 At least weekly, the Contractor shall brush sweep entry drive and roadways, and all other streets and walkways affected by the Work and where adjacent to the Work.

3.6 Office for Contract Administrator

- .1 Locate the Contract Administrator's Field office where directed by the City and the Contract Administrator.
- .2 Communication Services: The Contractor shall arrange and provide on Site cable Internet access including router/firewall for use during construction. The Contractor shall pay for all installation and basic monthly billing charges. The Contractor shall reinstate service outages resulting from construction activities within one Business Day.
- .3 Maintain all temporary buildings clean and free from nuisances so as to avoid danger to plant property or structures, and to prevent complaints from plant personnel, and prohibit interferences with the operation of the existing plant.
- .4 Provide and maintain services including power, heating, and ventilating.

3.7 Operation, Termination, and Removal

- .1 Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- .2 Maintenance: Maintain facilities in good operating condition until removal.

TEMPORARY FACILITIES

- .1 Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a twenty-four (24) hour basis where required to achieve indicated results and to avoid possibility of damage.
- .3 Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
- .4 Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - .1 Materials and facilities that constitute temporary facilities are property of Contractor.
 - .2 At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 1 Section "Closeout Procedures."

END OF SECTION

TEMPORARY BARRIERS AND ENCLOSURES

1. GENERAL

1.1 References

- .1 Canadian General Standards Board (CGSB):
 - .1 CGSB 1.59-(97), Alkyd Exterior Gloss Enamel.
 - .2 CAN/CGSB 1.189-(00), Exterior Alkyd Primer for Wood.
- .2 Canadian Standards Association (CSA International):
 - .1 CSA-O121-(M1978(R2003)), Douglas Fir Plywood.

1.2 Installation and Removal

- .1 Provide temporary controls in order to execute Work expeditiously.
- .2 Remove from Site all such work after use.

1.3 Dust Tight Screens

- .1 Provide dust tight screens or partitions to localize dust generating activities, and for protection of workers, existing systems and building, and public.
- .2 Maintain and relocate protection until such work is complete.

1.4 Access to Site

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

1.5 Fire Routes

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

1.6 Protection for Off-Site and Public Property

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

1.7 Protection of Building Finishes

- .1 Provide protection for existing building finishes and equipment during performance of Work.
- .2 Provide necessary screens, covers and hoardings.
- .3 Be responsible for damage incurred due to lack of or improper protection.

TEMPORARY BARRIERS AND ENCLOSURES

2. **PRODUCTS (NOT USED)**
3. **EXECUTION (NOT USED)**

END OF SECTION

COMMON PRODUCT REQUIREMENTS

1. GENERAL

1.1 References

- .1 Conform to reference standards, in whole or in part as specifically requested in the Contract Documents.
- .2 If there is a question as to whether products or systems are in conformance with applicable standards, the Contract Administrator reserves the right to have such products or systems tested to prove or disprove conformance.
- .3 Cost for such testing will be 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 used, damaged, or defective, and of the best quality for the purpose intended. If requested, furnish evidence as to type, source, and quality of products provided.
- .2 Defective products, whenever identified prior to completion of Work, will be rejected, regardless of previous inspections. Inspection does not relieve responsibility but is a precaution against oversight or error. Remove and replace defective products at Contractor's own expense and be responsible for delays and expenses caused by rejection.
- .3 Should disputes arise as to quality or fitness of products, decision rests strictly with the Contract Administrator based upon the requirements of the Contract Documents.
- .4 Unless otherwise indicated in the Specifications, maintain uniformity of manufacture for any particular or like item throughout the building.

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

COMMON PRODUCT REQUIREMENTS

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 See Section 01 66 10 - Delivery, Storage and Handling for storage, handling and protection requirements.

1.6 Transportation

- .1 See Section 01 66 10 - Delivery, Storage and Handling for transportation requirements.

1.7 Manufacturer's Instructions

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

1.8 Quality of Work

- .1 See Section 01 45 00 - Quality Control

1.9 Co-Ordination

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

1.10 Concealment

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

1.11 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 Work.

COMMON PRODUCT REQUIREMENTS

1.12 Fastenings

- .1 Provide metal fastenings and accessories in the 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.

1.13 Fastenings - Equipment

- .1 If additional fastenings are required, use the same fastenings as the existing ones or as specified by the manufacturer.

1.14 Protection of Existing Work

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

1.15 Existing Utilities

- .1 When breaking into or connecting to existing services or utilities, execute the Work at times directed by local governing authorities and or the Contract Administrator, with a minimum of disturbance to the Work, operational systems, and/or building occupants, pedestrian, and vehicular traffic.
- .2 Protect, relocate, or maintain existing active services. When services are encountered, cap off in a manner approved by the authority having jurisdiction. Stake and record the location of the capped service.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

EQUIPMENT INSTALLATION

1. GENERAL

1.1 Sequence of Work

- .1 A lifting plan for all piping and equipment lifts shall be developed by a Professional Engineer registered in Manitoba. The lifting plan shall include, at minimum, the approximate weight of the item to be lifted, lifting mechanism, and capacity of the proposed lifting equipment. The lifting plan is to be submitted to the Contract Administrator for review at least ten (10) Business Days prior to performing any lifts. All lifts are to be performed by qualified operators.
- .2 Temporary support shall be provided by the Contractor as required for unsupported piping and equipment.
- .3 A maximum of two (2) Reactors shall be taken out of service for retrofit at a time, limited to the Reactors within a single bank. Only one (1) bank of Reactors can be out of service at a time. While a Reactor is offline for mechanical modifications, all electrical, instrumentation, and control modifications shall proceed in parallel.
- .4 When the work on an individual Reactor is complete, put the Reactor back in service and complete Reactor commissioning and testing as specified in Section 01 91 31 - Commissioning Plan.
- .5 When a modified bank of Reactors is fully operational and commissioned with no deficiency, a subsequent bank of Reactors can be taken out of service for retrofit. This sequence shall continue until all six (6) Reactors and their associated electrical, instrumentation, and control systems are modified.
- .6 Any flowmeters that are removed to provide more clearance around the Reactors shall be re-installed and verified as functioning correctly using up- or downstream flowmeters prior to Reactor commissioning. Any flowmeter that is not removed shall be provided with temporary supports as per item 1.1.2 above.

1.2 Installation Assistance

- .1 Before commencing installation of the equipment, the Contractor shall arrange for the attendance of the Manufacturer's Representative to provide instructions in the methods, techniques, precautions, and any other information relevant to the successful installation of the equipment.
- .2 The Contractor shall inform the Contract Administrator, in writing, of the attendance at the Site of any Manufacturer's Representative for installation training at least ten (10) Business Days prior to arrival.
- .3 When the Manufacturer's Representative is satisfied that the Contractor is aware of all installation requirements, they shall so certify by completing Form 101 – Certificate of Readiness to Install, which is appended to this Section.
- .4 The completed form shall be delivered to the Contract Administrator prior to departure of the Manufacturer's Representative from the Site.

EQUIPMENT INSTALLATION

- .5 Installation of the equipment shall not commence until the Contract Administrator has advised that they have received the completed Form 101.
- .6 Separate copies of Form 101 shall be used for each major piece of equipment.

1.3 Installation

- .1 If necessary, or if so directed by the Contract Administrator during the course of installation, the Contractor shall contact the Manufacturer's Representative to receive clarification of installation procedures, direction, or any other additional information necessary to continue or complete the installation in an appropriate manner.
- .2 If it is found necessary, or if so directed by the Contract Administrator, the Contractor shall arrange for the Manufacturer's Representative to visit the Site to provide assistance during installation, all at the Contractor's cost.
- .3 Prior to completing installation, the Contractor shall inform the Manufacturer's Representative and arrange for the attendance at the Site of the Manufacturer's Representative to verify successful installation.
- .4 The Manufacturer's Representative shall conduct a detailed inspection of the installation including alignment, electrical connections, running clearances, workmanship and all other items as required to ensure successful operation of the equipment.
- .5 The Manufacturer's Representative shall identify any outstanding deficiencies in the installation.
 - .1 If deficiencies are found, they shall be rectified by the Contractor. The Manufacturer's Representative will be required to re-inspect the installation, at the Contractor's cost.
- .6 When the Manufacturer's Representative accepts the installation, they shall certify the installation by completing Form 102 – Certificate of Satisfactory Installation, attached to this Specification.
- .7 Deliver the completed Form 102 to the Contract Administrator prior to departure of the Manufacturer's Representative from the Site.
- .8 Tag the equipment with a 100 mm by 200 mm card stating "EQUIPMENT CHECKED. DO NOT RUN." stencilled in large black letters. Sign and date each card.
- .9 Provide separate copies of Form 102 for each piece of equipment.

1.4 Operation and Performance Verification

- .1 Equipment will be subjected to a Demonstration, Running Test, and Performance Test as described in Section 01 91 31 - Commissioning Plan after the installation has been verified and any identified deficiencies have been remedied.

2. PRODUCTS (NOT USED)

EQUIPMENT INSTALLATION

3. EXECUTION

3.1 General Requirements for UV Equipment

- .1 Develop a Safe Work Procedure (SWP) for confined space entry with assistance from the City. Submit to Contract Administrator for approval at least twenty (20) Business Days prior to performing any confined space entry .
 - .1 Ensure that the SWP is followed for all Reactors.
- .2 Contractor, City Service Engineers, and Manufacturer's Representative shall be engaged in the Lock-Out-Tag-Out (LOTO) procedures as outlined in the Safe Work Procedure.
- .3 All equipment and piping affected by the Work shall be cleaned and disinfected in accordance with Section 33 13 00 - Disinfection of Structures and Piping and approved by the Contract Administrator before being put back in service.
- .4 A maximum of two (2) Reactors shall be taken out of service for retrofit at a time. While the Reactor is offline for mechanical modifications, all electrical, instrumentation, and control modifications associated with that Reactor shall proceed in parallel.
 - .1 Following the Reactor modifications, the final tie-in to the WTP SCADA system shall take place.
 - .2 When the Work for an individual Reactor is complete, put the Reactor back in service and complete Reactor testing and commissioning. Contractor's inspection and Contract Administrator's inspection is required, and any deficiencies found must be addressed. When the modified Reactor is fully operational and commissioned with no deficiencies, the next Reactor can be taken out of service for retrofit. As per item 1.1.3, if two Reactors are out of service at the same time, they must be within the same bank.
 - .3 This sequence is continuous until all six (6) Reactors and their associated electrical, instrumentation, and control systems are modified.

3.2 Installation of UV Equipment

- .1 The provided requirements and sequence plan in no way relieve the Contractor's obligations under this Contract. All items below are required and the Contractor is responsible for determining means and methods of including these items in the Work and the associated SWP.
 - .1 The sequence plan, found below in Item 3.2.8, is to be altered and supplemented as necessary to meet the obligations of the Contract including isolation of the Work from the City's water distribution system.
 - .2 In preparation for retrofit work, the Reactor that is being modified must be shut down safely. To shut down a Reactor without allowing untreated water to enter the system, first close the associated flow control valve, as listed in **Table 1** immediately downstream of the Reactor.
 - .1 The Contractor shall confirm that the isolation valves have been fully exercised and are able to isolate flow prior to taking the nearby Reactor out of service.

EQUIPMENT INSTALLATION

- .3 Once the valve is closed, the Reactor can be shut down and electrically isolated.
 - .1 To electrically isolate the Reactor after shut-down, safely disconnect the main electrical supply to the Reactor.
 - .2 Allow five (5) minutes for the lamps to cool down and for energy to dissipate before proceeding with hydraulic isolation.
- .4 After shut-down, the Reactor that is being modified shall be hydraulically isolated. Isolate the Reactor by stopping flow to and from the bank by closing the rest of the associated isolation valves on the Reactor inlet and outlet. After the associated flow control valve is closed as mentioned in Item 3.2.1 above, each Reactor has four (4) or five (5) additional associated isolation valves to close; close the associated upstream flow valve, upstream header valve, and downstream header valve(s) as listed in **Table 1**.
- .5 Drain the Reactor before proceeding. To avoid drawing a vacuum on the system, open the air vent valve on the top of the Reactor before opening the drain valve. All drainage must be tied into the existing drainage system in the DBPS.
- .6 Confirm the approved lifting plan as per item 1.1.6 above, gasket sizes, and required procedure before proceeding.
- .7 Remove the spool pieces between the valves and the Reactors as required. Install blind flanges with gaskets as required to seal openings created by removed spool pieces. Provide temporary supports for piping as required, per item 1.1.2 above.
 - .1 Magnetic flow meters may also be removed to provide additional clearance around the Reactor if required.
 - .1 Any flow meters that are to be removed shall be re-installed and verified prior to Reactor commissioning as per item 1.1.6 above.
 - .2 Upon reinstallation of spool pieces, new gaskets are required. Ensure that receiving points on the pipes are free of rust to provide adequate mating.
- .8 The proposed sequence of taking UV Reactors off-line for retrofit is as follows:
 - .1 UVR-D300A (UVR-2100):
 - .1 Close associated isolation valves, draining water as required.
 - .2 Perform LOTO.
 - .3 Remove upstream and downstream spool pieces following the approved lift plan as per item 1.1.6 above.
 - .2 UVR-D400A (UVR-2200):
 - .1 Close associated isolation valves, draining water as required.
 - .2 Perform LOTO.

EQUIPMENT INSTALLATION

- .3 Remove upstream and downstream spool pieces following the approved lifting plan as per item 1.1.6 above.

- .3 UVR-D100A:
 - .1 Shut down pumps P-D001A and P-D002A to stop flow through the bank.
 - .2 Close associated isolation valves, draining water as required.
 - .3 Perform LOTO.
 - .4 Remove platform to provide access to Reactor and associated spool piece.
 - .5 Remove upstream spool piece following the approved lifting plan as per item 1.1.6 above.

- .4 UVR-D200A:
 - .1 Close associated isolation valves, draining water as required.
 - .2 Perform LOTO.
 - .3 Remove upstream spool piece following the approved lifting plan as per item 1.1.6 above.

- .5 UVR-D500A (UVR-2300):
 - .1 Close associated isolation valves, draining water as required.
 - .2 Perform LOTO.
 - .3 Remove upstream and downstream spool pieces following the approved lifting plan as per item 1.1.6 above.

- .6 UVR-D600A (UVR-2400):
 - .1 Close associated isolation valves, draining water as required.
 - .2 Perform LOTO.
 - .3 Remove upstream and downstream spool pieces following the approved lifting plan as per item 1.1.6 above.

- .9 Associated isolation valves and magnetic flow meters for each Reactor described in **Table 1** below.

EQUIPMENT INSTALLATION

Table 1: Reactor Isolation Valves and Flow Meters

Reactor	Downstream Flow Control Valve to Close	Upstream Flow Valve to Close	Upstream Header Valve to Close	Downstream Header Valve to Close	Flow Meter to Support
UVR-D100A*	FCV-D100A	FV-D100A	HV-D010A	FV-D021A	FT-F100A
UVR-D200A*	FCV-D200A	FV-D200A	HV-D010A	FV-D021A	FT-200A
UVR-D300A	FCV-D300A	FV-D300A	HV-D010C	HV-D020A, HV-D020C	FT-F300A
UVR-D400A	FCV-D400A	FV-D400A	HV-D010C	HV-D020A, HV-D020C	FT-400A
UVR-D500A	FCV-D500A	FV-D500A	HV-D010E	HV-D020D	FT-F500A
UVR-D600A	FCV-D600A	FV-D600A	HV-D010E	HV-D020D	FT-600A

*LOTO Valve FV-D021A to block flow to Branch I only during confined space entry into Bank 1 reactors.

EQUIPMENT INSTALLATION

**CERTIFICATE OF READINESS TO INSTALL
FORM 101**

I have familiarized the Contractor of the specific installation requirements related to the equipment listed below and am satisfied that they understand the required procedures.

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Authorized Signing Representative of the Manufacturer)

Date

I certify that I have received satisfactory installation instructions from the equipment Manufacturer/Supplier.

(Authorized Signing Representative of the Contractor)

Date

EQUIPMENT INSTALLATION

**CERTIFICATE OF SATISFACTORY INSTALLATION
FORM 102**

I have completed my check and inspection of the installation listed below and confirm that it is satisfactory and that defects have been remedied to my satisfaction except any as noted below:

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

REFERENCE SPECIFICATION: _____

OUTSTANDING DEFECTS: _____

_____ (Authorized Signing Representative of the Manufacturer)	_____ Date
_____ (Authorized Signing Representative of the Contractor)	_____ Date
_____ (Authorized Signing Representative of the Contract Administrator)	_____ Date

END OF SECTION

DELIVERY, STORAGE, AND HANDLING

1. GENERAL

1.1 General Requirements

- .1 This Section specifies the general requirements for the delivery, storage, handling, and protection for all items required in the construction of the Work. Specific requirements, if any, are specified with the related item.

1.2 Transportation and Delivery

- .1 Pay costs of transportation of products required in performance of the Work.
- .2 Transport and handle items in accordance with manufacturer's printed instructions.
- .3 Ten (10) Business days before delivery, notice shall be given to the Contract Administrator so that arrangements for receipt and inspection can be made. When the Contractor accepts the equipment delivery, they shall certify the delivery by completing Form 100 – Certificate of Equipment Delivery, attached to this Specification.
- .4 Schedule delivery to reduce long term on Site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the Site more than one (1) month prior to installation without written authorization from the Contract Administrator.
- .5 Ship equipment, material, and spare parts complete except where partial disassembly is required by transportation regulations or for protection of components.
- .6 The Contractor shall ensure that they are fully informed of precautions to be taken in the unloading of the equipment and subsequent storage including any required maintenance.
- .7 The Contractor shall be responsible for all equipment at the Site or any alternative storage location.
- .8 If off-Site storage of equipment is required, then the second move of the equipment to the Site will be at the Contractor's cost.
- .9 Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended. All spare parts shall be cross-referenced to their applicable the Specification Section.
- .10 Carefully pack and crate equipment for shipment. Protect polished and machined metal surfaces from corrosion and damage during shipment and installation. Specially pack electrical equipment to prevent damage by moisture. Cover equipment having exposed bearings and glands to exclude foreign matter. Carefully pack machines for shipment and protect electrical equipment from moisture damage. Protect bearings, seals, and glands from grit and dirt.
- .11 Identify each component with durable identifying labels or tags securely attached to each piece of equipment, crate, or container.
- .12 Finished surfaces of all exposed flanges shall be protected by fiberboard blank flanges strongly built and securely bolted thereto.

DELIVERY, STORAGE, AND HANDLING

- .13 Deliver spare parts at same time as pertaining equipment. Deliver spare parts to the Contract Administrator after completion of the Work.
 - .1 Deliver spare parts with a written itemized receipt of all parts, to be signed by the Contract Administrator.
- .14 Coordinate delivery with installation to ensure minimum holding time for items that are hazardous, flammable, easily damaged, or sensitive to deterioration.
- .15 Deliver products to the site in manufacturer's original sealed containers or other packing systems, complete with instructions for handling, storing, unpacking, protecting, and installing.
- .16 Assume responsibility for equipment material and spare parts just before unloading from carrier at the Site.
- .17 All items delivered to the Site shall be unloaded and placed in a manner which will not hamper the Contractor's normal construction operation or those of subcontractors, other contractors, or City staff and will not interfere with the flow of necessary traffic or impede access to equipment or areas required for use by operators.
- .18 Provide equipment and personnel to unload all items delivered to the Site.
- .19 Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e., City, other Contractors), perform inspection in the presence of the Contract Administrator. Notify Contract Administrator, verbally and in writing, of any problems.
- .20 Pay all demurrage charges if failed to promptly unload items.

1.3 Storage and Protection

- .1 Handle and store products and equipment to prevent damage, adulteration, deterioration, and soiling in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instruction shall be studied by the Contractor and reviewed with the Contract Administrator and the City. Instructions shall be carefully followed and a written record of this kept by the Contractor for each product and pieces of equipment.
 - .1 Remove and replace damaged products at own expense and to the satisfaction of the Contract Administrator.
- .2 Arrange storage of products and equipment to permit access for inspection. Periodically inspect to make sure products and equipment are undamaged and are maintained under specified conditions.
- .3 All mechanical and electrical equipment and instruments shall be covered with canvas and stored in a weathertight building to prevent damage. The building may be a temporary structure on the Site or elsewhere, but it shall be satisfactory to the Contract Administrator. Building shall be provided with adequate ventilation to prevent condensation. Maintain temperature and humidity within range required by manufacturer and to prevent condensation on the equipment being stored.

DELIVERY, STORAGE, AND HANDLING

- .4 If any equipment has been in storage for a significant period of time as defined by the Contract Administrator, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the storage period prior to acceptance of the equipment. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in a condition equal to that of equipment that has been shipped, installed, tested, and accepted in a minimum time period. As such, the manufacturer will guaranty the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.
2. **PRODUCTS (NOT USED)**
3. **EXECUTION (NOT USED)**

END OF SECTION

DELIVERY, STORAGE, AND HANDLING

**CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100**

We certify that the equipment listed below has been received and delivered into the care of the Contractor. The equipment has been found to be in satisfactory condition. No defects in the equipment were found.

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Authorized Signing Representative of the Contractor)

Date

(Authorized Signing Representative of the Manufacturer)

Date

(Authorized Signing Representative of the Contract Administrator)

Date

EXECUTION

1. GENERAL

1.1 Action and Informational 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 the 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 the Project.
 - .2 Location and description of affected Work.
 - .3 Statement on necessity for cutting or alteration.
 - .4 Description of proposed Work and products to be used.
 - .5 Alternatives to cutting and patching.
 - .6 Effect on the Work of the City or separate contractor.
 - .7 Written permission of the affected separate contractor.
 - .8 Date and time the Work will be executed.

1.2 Preparation

- .1 Inspect existing conditions, including elements subject to damage or movement during cutting and patching.
- .2 After uncovering, inspect conditions affecting performance of the Work.
- .3 Beginning of cutting or patching means acceptance of the existing conditions.
- .4 Provide supports to assure structural integrity of surroundings; provide devices and methods to protect other portions of Work from damage.
- .5 Exercise care where cutting holes in existing concrete elements so as not to damage existing reinforcing or conduit.

EXECUTION

- .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 be capable of detecting rebar and conduit in the full depth of the floor.
- .6 The Contractor shall exercise care where installing anchors into existing concrete elements so as not to damage existing reinforcing. All anchors shall be installed utilizing carbide tip drill bits. The existing reinforcing shall be located utilizing a reinforcing bar locator and marked out on the surface of the concrete. The drill holes shall be advanced to the required depth for installation of the anchors. Should reinforcement be encountered while drilling, terminate the hole and reposition to clear the reinforcement. Do not use core bits that can easily intercept and damage/cut the reinforcing during drilling. Patch and repair damages.

1.3 Execution

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

EXECUTION

- .11 Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- .12 Refinish surfaces to match adjacent finishes: Refinish continuous surfaces to nearest intersection. Refinish assemblies by refinishing entire unit.
- .13 Conceal pipes, ducts and wiring in floor, wall, and ceiling construction of finished areas except where indicated otherwise.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

CLEANING

1. GENERAL

1.1 Project Cleanliness

- .1 Maintain Work in tidy condition, free from accumulation of waste products and debris, other than that caused by the City or other Contractors.
- .2 Remove waste materials from the Site at weekly regularly scheduled times or dispose of it as directed by the Contract Administrator or the City.
- .3 Conduct cleaning and disposal operations to comply with local codes, ordinances, regulations, and anti-pollution laws. Do not burn or bury rubbish or waste materials on the Site. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains. Do not dispose of wastes into streams or waterways.
- .4 Provide on-Site containers for collection of waste materials and debris.
- .5 Provide and use marked separate bins for recycling.
- .6 Dispose of waste materials and debris at designated dumping areas off Site.
- .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 Business day.
- .9 Provide adequate ventilation during use of volatile or noxious substances.
- .10 Schedule cleaning operations so that resulting dust, debris, and other contaminants will not fall on wet, newly painted surfaces nor contaminate building systems.

2. PRODUCTS

2.1 Materials

- .1 Use only those cleaning materials which will not create hazards to property and persons or damage surfaces of material to be cleaned.
- .2 Use only cleaning materials recommended by the manufacturer of surface to be cleaned, and as recommended by cleaning material manufacturer.

3. EXECUTION

3.1 Cleaning During Construction

- .1 At all times maintain areas covered by the Contract and adjacent properties and public access roads free from accumulations of waste, debris, and rubbish caused by construction operations.
- .2 During execution of work, clean site and dispose of produced waste materials, debris, and rubbish to assure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish. Unneeded construction equipment shall be

CLEANING

removed, and all damage repaired, so that the public and property owners will be inconvenienced as little as possible.

- .3 Wet down dry materials and rubbish to lay dust and prevent blowing dust as applicable.
- .4 Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes structures, work done under this Contract, or elsewhere during the course of the Contractor's operations, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the Work, and the ditches, channels, drains, pipes, structures, and work, etc., shall, upon completion of the Work, be left in a clean and neat condition.
- .5 On or before the completion of the Work, the Contractor shall, unless otherwise especially directed or permitted in writing, return the Site to acceptable condition.
 - .1 The Contractor shall tear down and remove all temporary buildings and structures built by them.
 - .2 The Contractor shall remove all temporary works, tools, and machinery or other construction equipment furnished by them.
 - .3 The Contractor shall remove, acceptably disinfect, and cover all organic matter and material containing organic matter in, under, and around privies, houses, and other buildings used by them.
 - .4 The Contractor shall remove all rubbish from any grounds which they have occupied and shall leave the roads and all parts of the premises and adjacent property affected by their operations in a neat and satisfactory condition.
- .6 Provide on Site containers for collection and removal of waste materials, debris, and rubbish in accordance with applicable regulations.
- .7 When Substantial Performance has been achieved, remove surplus products, tools, construction machinery, and equipment not required for performance of the remaining Work.

3.2 Final Cleaning

- .1 Final cleaning shall be completed prior to issuance of Total Performance.
- .2 Remove waste products and debris other than that caused by others and leave Work Site clean and suitable for occupancy.
- .3 Prior to final review remove surplus products, tools, construction machinery, and equipment.
- .4 Remove waste products and debris other than that caused by the City or other Contractors.
- .5 Clean and polish glass, mirrors, hardware, wall tile, stainless steel, chrome, porcelain enamel, baked enamel, plastic laminate, and mechanical and electrical fixtures. Replace broken, scratched, or disfigured glass.
- .6 Remove stains, spots, marks, and dirt from decorative work, electrical and mechanical fixtures, furniture fitments, walls, and floors.
- .7 Clean lighting reflectors, lenses, and other lighting surfaces.

CLEANING

- .8 Clean off all piping and equipment.
- .9 Vacuum clean and dust building interiors, behind grilles, louvres, and screens.
- .10 Inspect finishes, fitments, and equipment and ensure specified workmanship and operation.
- .11 Exterior Work:
 - .1 Broom clean and wash exterior walks, steps, and surfaces (if disturbed) as applicable.
 - .2 Remove dirt and other disfiguration from exterior surfaces.
 - .3 Repair landscaping (if disturbed).
- .12 Restore and clean the existing equipment and building, if damaged as a result of this Work.
- .13 Clean and sweep areaways as applicable.
- .14 Sweep and wash clean paved areas.
- .15 Clean equipment and fixtures to sanitary condition; clean or replace filters of mechanical equipment.
- .16 Remove debris and surplus materials from accessible concealed spaces as applicable.

END OF SECTION

CLOSEOUT SUBMITTALS

1. GENERAL

1.1 Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Total Performance shall not be granted until review and acceptance of all Closeout Submittals is achieved.

1.2 Operating and Maintenance Manuals

- .1 Refer to Section 01 91 51 - Operating and Maintenance Manual.

1.3 As-Built Drawings

- .1 Possess a complete set of Drawings for the purpose of maintaining project as-built 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 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 the Work, submit as-built Drawings to the Contract Administrator for review.

1.4 Spare Parts

- .1 Provide spare parts as indicated in the individual Specification Sections.
- .2 Provide spare parts that are new, undamaged or defective, and of the same quality and manufacture as the products provided in Work.
- .3 Deliver to Site; place and store.
- .4 Submit inventory listing to the Contract Administrator. Include approved listings in operating and maintenance manual.

1.5 Maintenance Tools

- .1 Provide maintenance tools as indicated in the individual Specification Sections.
- .2 Provide maintenance tools that are new, undamaged, or defective.
- .3 Deliver to Site; place and store.

CLOSEOUT SUBMITTALS

- .4 Receive and catalogue items. Submit inventory listing to the Contract Administrator. Include approved listings in the operating and maintenance manual.

1.6 Other Submittals

- .1 Include test reports as specified in individual Specification Sections.
- .2 Satisfy additional requirements as specified in individual Specification Sections.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

TRAINING

1. GENERAL

1.1 Description

- .1 This Section contains requirements for training the City's staff, by persons retained by the Contractor specifically for the purpose of proper operation and maintenance of equipment supplied and installed under this Contract.
- .2 Training shall be performed by a Manufacturer's Representative. Contractor to work with the Manufacturer's Representative and the City to coordinate the operator training.
- .3 The Contractor shall submit the training proposal for review by the Contract Administrator and the City's Training Coordinator. The City's Training Coordinator has the authority to determine if the training plan is adequate based the submitted documents and requirements for training.
- .4 Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.
- .5 The training program shall:
 - .1 be designed to comprehensively train plant staff;
 - .2 be tailored for the specific audience in each course;
 - .3 contain both classroom and field training portions, organized in a format to most effectively train plant staff. The classroom portion should comprise no more than 40 percent of the training time and the field portion at least 60 percent of the training time, completed on the same day;
 - .4 include ample opportunities for participants to ask questions and have their questions answered;
 - .5 be based upon the Operation and Maintenance Manuals with complete consistency between the training and the Operation and Maintenance Manuals, including SOP (Safe Operating Procedures), SWP (Safe Work Procedures) and lock-out/tag-out procedures;
 - .6 ensure that each course accommodates plant staff shift schedules by providing multiple sessions covering the same content if necessary;
 - .7 Training to be scheduled and coordinated to not interfere with the operation and maintenance of the Deacon WTP and the RDS;
 - .8 ensure that all training sessions include demonstration of learning by the participants. Evaluation methods should reinforce learning, monitor progress, and provide feedback on progress. Assessment should be based on course objectives and implemented in accordance with Section 1.8; and
 - .9 ensure that all training courses are submitted to the Province of Manitoba to be evaluated for possibility of gaining continuing education credits for water treatment operators' certification.

TRAINING

1.2 Submittals

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit a training proposal complete with schedule, lesson plan, and name of trainer(s) to the Contract Administrator twenty (20) Business Days prior to anticipated date of beginning of training.
- .3 The training proposal will include for each course:
 - .1 course name;
 - .2 instructor(s), including the qualifications;
 - .3 overall training strategies;
 - .4 detailed course description, including the specific Project components addressed in the course;
 - .5 planned duration;
 - .6 recommended and minimum number of training sessions;
 - .7 specific participant group to be trained;
 - .8 recommended and maximum number of training participants within each training session;
 - .9 specific and measurable learning objectives that can be evaluated at the end of the session;
 - .10 format and implementation methodology; and
 - .11 participant evaluation methodology.
- .4 The training participants shall complete classroom and field training for a given unit process prior to commencing training in a separate process area.
- .5 The Contractor shall:
 - .1 not proceed with a training course until the corresponding training proposal and lesson plan has been reviewed and accepted by the Contractor Administrator and the City, and
 - .2 ensure that the portions of the Operations and Maintenance Manuals applicable to each training course have been reviewed and accepted by the Contractor Administrator and the City prior to the associated lesson plan being submitted.
- .6 The Contractor shall update each course lesson plan based upon the completed training and incorporate any changes made to the training. The revised course lesson plan shall be included with the training material.
- .7 Submit training materials at least three (3) weeks prior to commissioning as described in Part 1.10 of this Specification.

TRAINING

- .8 Submit edited training video within three (3) weeks of final training session.

1.3 Training Schedule

- .1 The Contractor shall prepare, provide, and update a schedule of all training activities.
- .2 The training schedule shall include:
 - .1 course names;
 - .2 course session dates and duration, and
 - .3 participant groups to be trained.
- .3 Integrate the training schedule with the Project Schedule.
- .4 The training schedule shall be coordinated with the Contract Administrator to ensure the planned training session dates include sufficient flexibility to allow for availability of the plant staff.
- .5 Each training session shall be a maximum duration of four (4) hours per day and limited to Business Days with following windows of time:
 - .1 8:00 a.m. to 12:00 p.m., with a 15 minute coffee break, and
 - .2 1:00 p.m. to 4:00 p.m., with a 15 minute coffee break.
- .6 Regularly update the training schedule based on the availability of the plant staff.

1.4 Trainees

- .1 Trainees: City personnel selected for operating and maintaining this facility.
- .2 The plant staff participants groups include:
 - .1 the operations group which consists of day and shift operators responsible for the operations of the UV System.
 - .2 the mechanical maintenance group consisting of mechanics, millwrights, plumbers, and labourers;
 - .3 the electrical maintenance group; and
 - .4 the instrumentation maintenance group and SCADA Control group.
- .3 In addition, the following City personnel may attend and observe the training:
 - .1 Water and Waste (W&W) supervisors;
 - .2 W&W operations engineers;
 - .3 W&W training coordinators; and

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- .4 the Project Manager and/or delegates of the Project Manager.
- .4 Repeat the training session(s) for each group to allow for training of all plant staff. The minimum number of sessions for each group and associated constraints are identified in Table 1, with additional requirements as follows:
 - .1 additional classroom sessions shall be provided in the event that the course content is not appropriate for the potential number of participants.

Table 1: Training Participants and Number of Sessions

Training Participant Groups	Approximate Number of Personnel	Minimum Number of Classroom Sessions	Minimum Number of Field Sessions
Operations Personnel	20	5	7
Mechanical Maintenance	10	2	3
Electrical Maintenance	5	2	2
Instrumentation Maintenance & SCADA	6	2	2

- .5 Trainees will be available for training during later stages of construction for purposes of familiarization with systems.

1.5 Classroom Requirements

- .1 Contractor shall:
 - .1 use appropriate learning resource materials, including slides and drawings, to aid in training clarity and effectiveness;
 - .2 make available applicable reference materials where it will be beneficial for the training participants to reference the material covered during the training. For example, paper copies of SOPs and SWPs should be provided, if beneficial to the training objectives;
 - .3 ensure all practical components are provided to ensure that training participants are able to see and hear the training. Provide projectors and screens as required, that are easily viewable and readable by all training participants; and
 - .4 be responsible for any temporary networking or other associated computer and audio requirements to implement the training sessions.
- .2 Contractor shall structure the training to provide an interactive environment that promotes active participation. The instructor shall use discussion, questions, and activities as appropriate during each session to provide engagement, enhance learning and to verify that the information presented is being understood.

1.6 Field Requirements

- .1 Implement the training using the constructed systems, unless otherwise approved by the Contract Administrator;

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- .2 Provide field training sessions in a manner that all training participants can see and hear all demonstrations provided;
- .3 Arrange for and require training participants to perform the demonstrated procedures, and
- .4 Ensure all training is in accordance with SWPs and SOPs and include training on their application and use.

1.7 Evaluation Requirements

- .1 As part of each classroom training session, the Contractor shall provide and execute a written training evaluation methodology, such as a quiz or test, to demonstrate each individual training participant's understanding of the learning objectives and course content.
 - .1 The test or quiz shall be submitted to the Contract Administrator and the City's Training Coordinator in advance of all training sessions for review and approval.
- .2 The Contractor shall record the results of all classroom training participant evaluations and include in the training records.
- .3 As part of each field training session, the Contractor shall provide and execute an evaluation method consisting of either written or practical demonstration components to test each training participant in their understanding of the learning objectives, course content, and ability to perform the tasks addressed by the course.
- .4 The Contractor shall ensure that the evaluation components are sufficiently detailed to affirm that a passing grade of the evaluation signifies that the training participant is qualified to operate and/or maintain the component of the system associated with the training course.

1.8 Instructions

- .1 Contractor to provide instruction on the following:
 - .1 overview of the process and any changes or modifications to the existing system;
 - .2 an overview of the SCADA interface and functionality;
 - .3 start-up, operation, and shutdown of equipment, components, and systems;
 - .4 control features, reasons for, results of, implications on associated systems of, adjustment of set points of control and safety devices;
 - .5 electrical equipment and systems;
 - .6 automation systems;
 - .7 safety systems; and
 - .8 instructions on servicing, maintenance, and adjustment of systems, equipment, and components.
- .2 The Contractor shall include the following in all training sessions, as applicable:

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- .1 all activities covered by a SWP;
 - .2 all activities covered by a SOP;
 - .3 all activities covered by a lock-out/tag-out;
 - .4 changing the modes of operation of the systems;
 - .5 operating and/or monitoring the system remotely (from SCADA or an HMI); and
 - .6 operation of the system during fault/trouble/alarm conditions.
- .3 For the operation personnel, in addition to the requirements of Section 1.8.2, include at a minimum:
 - .1 an overview of the Operations and Maintenance Manuals as they are applicable;
 - .2 the required equipment exercise procedures and intervals;
 - .3 the start-up, shutdown, and emergency procedures; and
 - .4 any routine inspection procedures.
 - .4 For the mechanical maintenance personnel, in addition to the requirements of Section 1.8.2, include at a minimum:
 - .1 an overview of the Operations and Maintenance Manuals as they are applicable;
 - .2 the start-up, shutdown, and emergency procedures, including system integration and interlocks, if any;
 - .3 any routine inspection and troubleshooting procedures of specific equipment trouble symptoms;
 - .4 routine inspection and troubleshooting procedures for the purposes of predictive maintenance;
 - .5 routine preventive maintenance, including applicable specific details on lubrication, maintenance of corrosion protection of the equipment, and ancillary components and the use of special tools;
 - .6 safety features and procedures related to the maintenance of the equipment, referencing and utilizing specific SWP;
 - .7 the required equipment exercise procedures and intervals; and
 - .8 disassembly and assembly of equipment, if applicable, for purposes such as routine inspection or maintenance of the equipment.
 - .5 For the electrical maintenance personnel, in addition to the requirements of Section 1.8.2, include at a minimum:

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- .1 an overview of the Operations and Maintenance Manuals as they are applicable;
 - .2 locations of all electrical equipment, as required;
 - .3 manual and automatic switching procedures, as they relate to electrical;
 - .4 routine preventative maintenance;
 - .5 identification and brief description of recommended predictive maintenance;
 - .6 any equipment and troubleshooting procedures,
 - .7 safety features and procedures related to the maintenance of the equipment, referencing and utilizing specific SWP;
 - .8 understanding of the arc flash mitigation systems, arc flash identification, and protective equipment selection;
 - .9 understanding and troubleshooting of electrical interlocks;
 - .10 the start-up, shutdown, occupancy operation, and emergency procedures, including system integration and interlocks, if any;
 - .11 black start procedures, if any; and
 - .12 the required equipment exercise procedures and intervals.
- .6 For the automation maintenance and SCADA Control personnel, in addition to the requirements of Section 1.8.2, include at a minimum:
- .1 an overview of the Operations and Maintenance Manuals as they are applicable;
 - .2 locations of all automation devices, including networking;
 - .3 overview of the configuration/reconfiguration of the PLC systems, including which component or PLC processes various functions;
 - .4 basic theory of the system, equipment and communication between the components;
 - .5 troubleshooting and identification of issues;
 - .6 identification of and general procedures for routine preventive maintenance;
 - .7 equipment inspection and troubleshooting procedures;
 - .8 safety features and procedures related to the maintenance of the equipment, referencing and utilizing specific SWP;
 - .9 overview of the configuration of the historian system, as applicable; and
 - .10 overview of the configuration of any HMI systems.

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1.9 Training Objectives

- .1 Training to be sufficiently detailed and of an appropriate duration of minimum three (3) hours to ensure the trainee:
 - .1 Can provide safe, reliable, cost-effective, and energy-efficient operation of systems in normal and emergency modes under all conditions.
 - .2 Can provide effective on-going inspection, measurements of system performance.
 - .3 Can apply proper preventive maintenance, diagnosis, and troubleshooting.
 - .4 Has the ability to update documentation.
 - .5 Can operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.
 - .6 Can restore the systems after an emergency event;
 - .7 Can place all components of the system in a safe, zero energy state.
- .2 As part of the training, one of each of the four (4) participant group training sessions indicated in **Table 1** is to be recorded on video for use by City for future operator training. Selected videographer must have experience producing technical demonstration videos. Recorded footage must be edited as appropriate to form a suitable training video and submitted to the Contract Administrator for review prior beginning the next training session.
 - .1 All participants must sign-off on being recorded prior to the start of recording.

1.10 Training Materials

- .1 Submit Training Materials to the Contract Administrator for review and approval at least three (3) weeks prior to commissioning.
 - .1 The training material shall be provided in electronic native, editable file format.
- .2 Instructors to be responsible for content and quality.
- .3 Training materials to include:
 - .1 course lesson plans, refer to 1.2.3;
 - .2 list of all course materials;
 - .3 As-Built Drawings;
 - .4 Operating manual;
 - .5 Maintenance manual;
 - .6 Management manual;

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- .7 Performance Testing Reports;
 - .8 classroom slide presentations in MS PowerPoint format;
 - .9 other audio/visual material;
 - .10 handouts;
 - .11 speaking notes (as applicable); and
 - .12 course training participant evaluation material with answer keys.
- .4 Training materials to be in a format that permits future training procedures to same degree of detail.

1.11 Responsibilities

- .1 Contractor is responsible for:
- .1 Scheduling and Implementation of all training activities.
 - .2 Coordination among instructors.
 - .3 Quality of training and training materials.
 - .4 Upon completion of training, provide written training records and applicable forms signed by instructors and witnessed by the Contract Administrator.
- .2 The Contract Administrator will evaluate training and materials.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Facilities for Training

- .1 Use City's designated facilities for specified training programs.
- .1 Classroom training sessions to be held in main boardroom at the WTP.
- .2 Facilities include installation site, which shall be used for hands-on training programs.
- .1 Hands-on training to be held in the Deacon Booster Pumping Station.
- .3 Coordinate use of City's facilities with City and Contract Administrator.

3.2 Training Records

- .1 The Contractor shall provide comprehensive training records indicating the specific training provided, along with the supporting documentation in accordance with the training program.

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- .2 The Contractor shall record all training participants for each training session on a training participant register.
- .3 For each session the training record shall include:
 - .1 training participant registers; and
 - .2 results of evaluations by individuals and summarized by course.
- .4 The Contractor shall submit all Training Records to the Contract Administrator.

3.3 Training Completion Forms and Payment

- .1 Training for the equipment shall be conducted before the operation period.
- .2 The Contract shall not be considered complete, for the purpose of issuing a Certificate of Total Performance, until the training has been provided and Forms 01 78 24-1 and 01 78 24-2 have been completed and signed.
- .3 Payment for this Work will be released only when the training has been completed to the Contract Administrator's satisfaction and the respective forms are signed.

3.4 Training Documentation

- .1 On completion of their training, the manufacturer's or supplier's representative shall submit in triplicate to the Contract Administrator a complete signed Form 01 78 24-1 demonstrating their training is complete.
- .2 If the Contract Administrator approves the training, the acceptance will be documented in a completed Form 01 78 24-2.
- .3 Differences between the equipment operating and maintenance manual and the manufacturers training session shall result in the training and/or operating and maintenance manual being corrected.

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**FORM 01 78 24-1
EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTRUCTION**

Owner - City of Winnipeg

Project - Deacon Booster Pumping Station Ultraviolet Disinfection System Upgrade

Contract No. 520-2022

AECOM No. 60640642

EQUIPMENT SPECIFICATION SECTION _____

EQUIPMENT DESCRIPTION _____

I _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name and model with Tag No.)

installed for the subject project (has) (have) been installed in a satisfactory manner, (has) (have) been satisfactorily tested, (is) (are) ready for operation, and that City assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit(s) on

Date: _____ Time: _____

CERTIFIED BY: _____ DATE: _____
(Signature of Instructor/Manufacturer's Representative)

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FORM 01 78 24-2
CITY'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

(I) (We) the undersigned, authorized representatives of the _____
and/or Plant Operating Personnel have received classroom and hands-on instruction on the operation,
lubrication, and maintenance of the subject equipment and (am) (are) prepared to assume normal
operational responsibility for the equipment:

_____ Date: _____

_____ Date: _____

_____ Date: _____

END OF SECTION

COMMISSIONING PLAN

1. GENERAL

1.1 Description

- .1 Provide a fully functional UV disinfection system and ensure that:
 - .1 Systems replaced or modified under this Project shall meet or exceed the functionality and performance of the existing systems prior to replacement.
 - .2 City personnel have been fully trained in aspects of installed systems.
 - .3 Documentation relating to installed equipment and systems has been completed.
- .2 The Contractor shall develop a Detailed Commissioning Plan and Commissioning Schedule using this Section as a Base Commissioning Plan.
- .3 Use this Specification section as a master planning document for Commissioning as it:
 - .1 Outlines organization, scheduling, allocation of resources, and documentation pertaining to implementation of Commissioning.
 - .2 Communicates responsibilities of team members involved in Commissioning including scheduling, documentation requirements, and verification procedures.
 - .3 Sets out deliverables relating to operation, maintenance, process and administration of Commissioning.
 - .4 Describes how the process of verification meets the design requirements of the completed Works .
 - .5 Sets out scope, standards, roles and responsibilities, expectations, deliverables and provides:
 - .1 An overview of Commissioning.
 - .2 A general description of elements that make up the Detailed Commissioning Plan.
 - .3 A process and methodology for successful Commissioning.
- .4 Ensure the system is functioning as described in Section 40 94 23 - Process Control Narrative.
- .5 The Contract Administrator shall witness and certify tests and reports of results.
- .6 Commissioning activities must be completed before issuance of Substantial Performance.

1.2 Definitions

- .1 Acceptance: for the purpose of this Specification Section, acceptance shall be defined as the formal turnover of a system to the City for their operation and maintenance. This shall occur after the successful end of Commissioning of each system through a formal acknowledgement

COMMISSIONING PLAN

- between the Contract Administrator, the City, and the Contractor. Success of the Commissioning period is determined by the Contract Administrator.
- .2 Base Commissioning Plan: General Commissioning requirements within this Section to be used in the development of a Detailed Commissioning Plan.
 - .3 Calculated Dose Approach: The Calculated Dose Approach relies on empirical equations to determine the applied UV dose from a Reactor with a given set of operating conditions. These equations are to be determined by the manufacturer (De Nora) and shall take into account factors such as UV intensity, UVT, and the reactor flow rate.
 - .4 Commissioning: for the purpose of this Specification Section, Commissioning shall be defined as the successful operation of components, equipment, systems, subsystems, or integrated systems in accordance with its design requirements for a period of ten (10) days, the last seven (7) of which shall be consecutive, unless otherwise specified.
 - .5 Commissioning Agent: Agent of the Contractor with experience in Commissioning, satisfactory to the Contract Administrator, responsible for the oversight and execution of Commissioning.
 - .6 Commissioning Report: the final Commissioning document as described in Item 3.16.
 - .7 Commissioning Schedule: Gantt chart showing planned dates for performing all activities related to commissioning of all upgraded systems. The Commissioning Schedule is to be developed by the Contractor and submitted to the Contract Administrator for review, as described in Item 3.1.
 - .8 Demonstration: a one-hour demonstration of the successful installation and operation of the equipment.
 - .9 Detailed Commissioning Plan: Commissioning Plan developed by Contractor from the Base Commissioning Plan to be submitted and reviewed by the Contract Administrator, as described in Item 3.2. Unless defined as "Base Commissioning Plan", all other instances of "Commissioning Plan" refer to the Detailed Commissioning Plan.
 - .10 Performance Test: a test in which the equipment is run continuously for seven (7) days (168 hours) or as specified for different equipment. Successful completion of the Performance Test is required for Form 104.
 - .11 Running Test: a test in which equipment is run continuously for a minimum of three (3) days (seventy-two (72) hours) or as specified for different equipment. During this period, as practicable, conditions shall be simulated which represent maximum or most severe, average, and minimum or least severe conditions. Successful completion of the Running Test is required for Form 103.
 - .12 Setpoint Approach: With the Setpoint Approach, the UV dose of a Reactor must exceed a given setpoint (or setpoints) to ensure the target UV dose is actually applied. During operation, the UV dose is measured directly, taking into account factors established during reactor validation that may affect the dose such as flow rate and UV intensity. During operation a single, conservative UV dose can be determined to satisfy all pathogen reduction requirements.

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- .13 System: for the purpose of this Specification section, a system shall be defined as the equipment, piping, controls, ancillary devices, electrical power, etc., which together perform a specific function at the facility. Each UV Reactor is a System, with its associated electrical and instrumentation being subsystems. The UV disinfection system as a whole is also a System that requires Commissioning, with associated electrical and the UV master being subsystems.
- .14 UV Reactor or Reactor: a UV unit that has a single feed water connection point and operates in parallel with other UV units and is independently controlled.

1.3 Pre-Commissioning Submissions

- .1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Commissioning Schedule to be submitted and accepted by the Contract Administer as per Item 3.1.
- .3 Detailed Commissioning Plan to be submitted and accepted by the Contract Administer as per Item 3.2.
- .4 Detailed Commissioning Plan to be refined and resubmitted as required during the construction phase as per Item 3.3.
- .5 Contractor shall not commence Commissioning until the reactor validation is complete and the reports have been reviewed and approved by the Contract Administrator and the City. Reactor validation will allow assessment of whether the UV Reactors are meeting a 2-log *Giardia* inactivation and 2-log *Cryptosporidium* inactivation for a given UV dose, UVT, and flow.

1.4 Composition, Roles, and Responsibilities of Commissioning Team

- .1 Commissioning Team to consist of the following members:
 - .1 Contract Administrator who is responsible for:
 - .1 Monitoring Commissioning activities.
 - .2 Witnessing and certifying reported results.
 - .3 Reviewing and approving Contractor submissions.
 - .4 Assisting in the resolution of issues resulting from all tests.
 - .5 Reviewing the final Commissioning Report.
 - .2 City personnel who are responsible for:
 - .1 Attending Commissioning activities to verify re-installed existing equipment, including but not limited to any removed flow meters, operates as per the original sequence of operations.
 - .2 Attending Commissioning activities to verify newly installed equipment operates as intended.

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- .3 Performing necessary testing as noted in Item 3.11.
- .3 Construction Team: Contractor, Subcontractors, suppliers, and support disciplines, who are responsible for construction/installation in accordance with Contract Documents, including:
 - .1 Integrating Commissioning activities into the Contractor's Project Schedule (Project Schedule).
 - .2 Test existing UV system controls, resolve errors, and confirm the UV operation is functional.
 - .3 Performing and documenting equipment installation as per Section 01 65 00 - Equipment Installation.
 - .4 Performing and documenting start-up including installation/start-up checklists.
- .4 Contractor's Commissioning Agent who is responsible for implementing specified Commissioning activities including:
 - .1 Planning/preparing checklists (installation/start-up checklists as required, product information) and test procedures.
 - .2 Determining operational training requirements.
 - .3 Developing a Detailed Commissioning Plan, updating information provided in the Base Commissioning Plan.
 - .4 Performing and documenting Performance Testing.
 - .5 Preparing and updating issues logs.
 - .6 Verifying, reviewing, and conducting training.
 - .7 Preparing final Commissioning Report.

1.5 Extent of Commissioning

- .1 Commission all systems per Manufacturer's requirements and this Section.
- .2 Testing of UV electrical panels must be completed before proceeding with Commissioning activities.
 - .1 Testing after the electrical modifications shall conform to CSA C22.2 No. 14, CSA C22.2 No. 286 and related CSA standards. CSA special inspections shall be coordinated by the Contractor after operation is confirmed.
- .3 A maximum of two (2) Reactors shall be taken out of service for retrofit at a time, limited to the Reactors within a single bank. Only one (1) bank of Reactor can be out of service at a time. While a Reactor bank is offline for mechanical modifications, all electrical, instrumentation, and control modifications shall proceed in parallel. When the Work for an individual Reactor bank is complete, the two Reactors shall be put back in service for complete Commissioning

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and testing of both Reactors. Final inspection is required, and any deficiencies found must be addressed. When a modified bank of Reactor is fully operational and commissioned with no deficiency, a subsequent bank can be taken out of service for retrofit. This sequence shall continue until all six (6) Reactors and their associated electrical, instrumentation, and control systems are modified.

- .1 Staging and coordination of the Work is required, which includes the UV Master system and SCADA.
- .4 Bring the existing flow lines back into service and confirm the operation conforms with Section 40 94 23 - Process Control Narrative.
 - .1 Upon start-up of a modified UV Reactor, downstream isolation valves must remain closed until the UV lamps have warmed up and effective treatment is established based off of validated UV doses.
 - .2 While re-introducing water to the UV Reactors, limit air entrance into the branch aqueducts using the vent valves upstream of each UV Reactor.

2. PRODUCTS

2.1 Equipment

- .1 Provide sufficient instrumentation to verify and commission the installed systems.

3. EXECUTION

3.1 Commissioning Schedule

- .1 Prepare a detailed Commissioning Schedule and submit to the Contract Administrator for review and approval at the same time as the Project Schedule. Include milestones, testing, documentation, training, and Commissioning activities of components, equipment, subsystems, systems, and integrated systems.
- .2 After approval, incorporate the Commissioning Schedule into the Project Schedule.
- .3 Contractor, Contractor's Commissioning Agent, and Contract Administrator will monitor progress of Commissioning against the approved Commissioning Schedule.

3.2 Development of Commissioning Plan

- .1 This Section is to be considered a Base Commissioning Plan for the UV systems, to be used by the Contractor in the development of a Detailed Commissioning Plan:
 - .1 Once the modifications specified in individual technical sections and Section 01 65 00 - Equipment Installation have been completed, each UV Reactor must be commissioned according to the requirements listed in this Section.
 - .2 The Contractor is responsible for submitting a Detailed Commissioning Plan for the Commissioning of the UV systems for the Contract Administrator's review. The Detailed Commissioning Plan and associated Commissioning Schedule is to be approved by the Contract Administrator at least twenty (20) Business days prior to the planned start of

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Commissioning. The plan shall comply with the requirements that have been established by the Contract Administrator.

- .3 The Detailed Commissioning Plan shall be drafted by the Contractor and reviewed by the Contract Administrator and shall incorporate the contents of the Base Commissioning Plan as specified in this Section. The Detailed Commissioning Plan shall include the following:
 - .1 A detailed schedule of Commissioning events to be incorporated into the Project Schedule, including but not limited to, the schedule for completion of testing of all component parts of the system. A preliminary schedule, including Commissioning events is provided for reference in Section 01 32 16 - Construction Progress Schedule.
 - .2 A sampling and analytical program for tests necessary to verify compliance with the performance specifications. The sampling and analytical program is to include, at minimum:
 - .1 Bacteriological testing as per Section 33 13 00 - Disinfection of Structures and Piping.
 - .2 Daily sampling and testing of treated water throughout the Performance and Running Tests as detailed in 3.14.
 - .3 Inform the Contract Administrator at least fifteen (15) Business Days in advance of conducting the tests and arrange for the attendance of the Manufacturer's Representative. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Contractor and the Contract Administrator.
 - .4 The Manufacturer's Representative shall conduct all necessary checks to the equipment and if necessary, advise the Contractor of any further checking, flushing, cleaning, or other work needed prior to confirming the equipment is ready to run.
 - .5 Contingency plans in the event of a process malfunction.
 - .6 Drawings and sketches as required to illustrate the planned sequence of events.
 - .7 List and details for all temporary equipment or component (additional spool pieces, etc.) required to facilitate Commissioning.
 - .8 List of all personnel who the Contractor plans to be in attendance for Commissioning and handover with information indicating their qualifications for this Work.
- .4 The Detailed Commissioning Plan to take into account:
 - .1 Approved Shop Drawings and product data.
 - .2 Approved changes to the Contract.
 - .3 Project Schedule.
 - .4 Contractor's, Subcontractor's, and suppliers' requirements.
 - .5 Project construction team's and Commissioning team's requirements.

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- .5 The Detailed Commissioning Plan to include:
 - .1 Commissioning Schedule.
 - .2 Installation/start-up check lists provided by manufacturers and suppliers.
 - .3 Manufacturer Performance Testing forms provided by manufacturers and suppliers.
 - .1 Forms to include testing parameters at full range of operating conditions to verify responses of equipment and systems.
- .6 Submit the completed Detailed Commissioning Plan to the Contract Administrator for review and acceptance. The Detailed Commissioning Plan shall be reviewed prior to its implementation. The Contract Administrator shall be the final arbiter.

3.3 Refinement of Commissioning Plan

- .1 During the construction phase, revise, refine, and update the Detailed Commissioning Plan to include approved design and construction changes.
 - .1 At each revision, indicate revision number and date.
- .2 Submit each revised Detailed Commissioning Plan to the Contract Administrator for review and acceptance.

3.4 Equipment

- .1 All process, electrical, control, and miscellaneous equipment related to the system shall be successfully installed and tested in accordance with Section 01 65 00, this Section, and any specific requirements noted in other Divisions. Form 103 shall be executed for each item.
- .2 Temporary equipment or components will be installed and tested as necessary to ensure that it functions reliably and consistently through the Commissioning period.

3.5 Controls

- .1 All controls which are the responsibility of this Contractor shall be installed and tested prior to Commissioning.
- .2 The Contract Administrator shall arrange for the simulation of the control sequences or shall allow for the operation of the system without the features included in the Work of others. Every effort shall be made to ensure that the Commissioning period provides for the full and comprehensive operation of the equipment under all anticipated normal and adverse operating conditions without interfering with the operation of the other UV systems.

3.6 Plant Utility Service

- .1 The City will provide power and other ancillary services as necessary to operate the plant through the Commissioning period. Provision of these services shall be limited to reasonable levels.

COMMISSIONING PLAN

3.7 Manpower

- .1 Supply all staff required during Commissioning as necessary to assist the City's staff in the operation of the plant.
- .2 Supply competent staff capable of maintaining, repairing, and adjusting the equipment and controls to achieve the intended design functions during the Commissioning period.
- .3 Ensure equipment Manufacturer's Representatives are available as necessary to certify adjustments in equipment, to guide in setting correct operating limits, and to generally provide input as required for the appropriate operation of the equipment.

3.8 Operating Descriptions

- .1 Operating descriptions shall be prepared by the Contract Administrator for the plant systems. Other information outlining the operating requirements shall also be available from the Contract Administrator. The Contractor will review these descriptions and will make themselves familiar with the requirements in order that they can undertake Commissioning in an appropriate manner.
 - .1 Operating descriptions shall be considered part of documentation for systems as listed in Item 3.16.2.

3.9 Design Parameters

- .1 Design parameters for the system to be commissioned shall be as defined in the Specifications and/or the operating descriptions.

3.10 Pre-Commissioning Activities

- .1 Conduct pre-start-up pressure, static, flushing, cleaning, and "bumping" testing during construction as specified in the individual sections. This testing to be witnessed and certified by the Contract Administrator and does not form part of Commissioning specifications. Include completed documentation with the Final Commissioning Report.
- .2 Perform prestart up inspections prior to commencing Commissioning. Utilise approved installation/start-up check lists if required. Rectify any deficiencies to the Contract Administrator's satisfaction. Include completed documentation with the Final Commissioning Report.

3.11 Tests to be Performed by City

- .1 City staff may conduct additional sampling for microbiological and/or chemical analysis at their own discretion to supplement testing required by the Contractor as part of this Work.

3.12 Commissioning of the Electrical System

- .1 Commissioning activities shall only proceed after electrical tests have been completed. Refer to Division 26 and Division 40 for additional requirements.
- .2 The Contractor shall provide Commissioning support to the Manufacturer for each UV Reactor system, and for the UV system as a whole.

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3.13 Commissioning of Instrumentation and Control

- .1 Commissioning activities shall only proceed after instrumentation and control tests have been completed. Refer to Division 26 and Division 40 for additional requirements and test forms.
- .2 A minimum written notice of two (2) weeks is required prior to commencing with process commissioning activities. In order to qualify for process commissioning the following activities must be completed:
 - .1 Instrument Calibrations;
 - .2 Initial Control Settings and adjustments have been made;
 - .3 All field devices have been set-u;
 - .4 Forms (i.e., misc. 100 forms; signed off where required) have been completed;
 - .5 PLC/SCADA IO and loop checks have been completed; and
 - .6 Proper mounting and connections have been made.
- .3 During Commissioning, demonstrate to the Contract Administrator proper calibration and correct operation of instruments and gauges.
- .4 Commissioning of the instrumentation and control system to include but not be limited to the following:
 - .1 Verify installation of components, wiring connections, and piping connections.
 - .2 Verify wiring continuity and pipe leak tests.
 - .3 Verify instrument calibrations and loop tests and provide a written report.
 - .1 The report shall include record of functional checks and any adjustments required for the instruments and control equipment under operational conditions.
 - .4 Coordinate instruments and control equipment supplier's service personnel as required for complete system testing.
 - .5 Coordinate and cooperate with the City, Contract Administrator, and other contractors to commission the Control System I/O points.
 - .6 Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.
 - .7 Ensure that the instrumentation and control equipment suppliers cooperate to complete the Work.
 - .8 Verify signal levels and wiring connections to all instrumentation and control equipment.

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3.14 Commissioning of UV Equipment

- .1 The DBPS shall have four (4) existing and/or fully commissioned UV Reactors available at all times for use in water treatment. A maximum of two (2) UV Reactors shall be out of service for retrofit or Commissioning at a time, limited to the UV Reactors within a single bank. Only one (1) bank of Reactors can be out of service at a time.
- .2 A Manufacturer's Representative shall conduct all necessary checks to the equipment prior to start-up as described in Section 01 65 00 - Equipment Installation.
- .3 Following the installation and calibration of the equipment, the Contractor shall perform a Demonstration, Running Test, and Performance Test on each UV Reactor bank. It will be the responsibility of the Contractor to communicate to arrange the times for testing and start-up activities. The Contractor must confirm that these times are acceptable to the Contract Administrator and the City.
 - .1 During the Demonstration, Running, and Performance tests, the Contractor shall operate equipment as required to meet the requirements from all Divisions of this Specification.
 - .2 If required, the Contractor shall supply any ancillary equipment or services required to complete the initial Demonstration, Running Test, and Performance Tests.
 - .3 Should the initial Demonstration, Running Test, or Performance Tests reveal any defects, then those defects shall be promptly rectified and the Demonstration, Running Tests, and/or Performance Tests shall be repeated to the satisfaction of the Contract Administrator.
 - .4 Additional costs incurred by the Contractor due to repeat Demonstration, Running Tests, and/or Performance Tests shall be borne by the Contractor.
- .4 On successful completion of the Demonstration and Running Test for a UV Reactor, Form 103 – Certificate of Equipment Satisfactory Running Test Performance (Form 103) (attached to this Specification) will be signed by the Manufacturer's Representative, the Contractor, and the Contract Administrator. Form 103 is required for each UV Reactor, which includes its associated electrical/control modifications by extension.
- .5 On successful completion of the Performance Test for an individual UV Reactor, Form 104 – Certificate of Equipment Satisfactory Performance Test Performance (Form 104) (attached to this Specification) will be signed by the Manufacturer's Representative, the Contractor, and the Contract Administrator. Form 104 is required for each UV Reactor, which includes its associated electrical/control modifications by extension.
- .6 Once all six (6) UV Reactors are fully commissioned, the UV control system shall be commissioned as a whole (Running Test and Performance Test only).
 - .1 On successful completion of the Final Running Test for the UV system as a whole, Form 103X will be signed by the Manufacturer's Representative, the Contractor, and the Contract Administrator. On successful completion of the Final Performance Test for the UV system as a whole, Form 104X will be signed by the Manufacturer's Representative, the Contractor, and the Contract Administrator. Forms 103X and 104X are required for the UV system as a whole.

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.7 Demonstration:

- .1 The Contractor shall notify the Contract Administrator of their readiness to demonstrate the operation of the equipment. The Contract Administrator shall attend.
- .2 With the assistance of the Manufacturer's Representative, the Contractor shall demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. will be checked and if appropriate, code certifications provided.
- .3 The equipment shall then be run for one (1) hour. Local controls shall be verified by cycling the equipment through several start-stop operations, modulating its output, or some combination. Operating parameters will be checked to ensure that they are within the specified or Manufacturer's Representative's recommended limits, whichever is more stringent. This step shall be repeated for each modified system.
- .4 On satisfactory completion of the one (1) hour demonstration, the equipment shall be stopped and critical parameters shall be rechecked.
- .5 Until the Reactor meets the specified UV dosage for adequate treatment, for Demonstration Testing, ensure that the UV Reactor remains isolated from other plant piping. All water used to fill the Reactor is to be drained using the drain valves present on a given reactor line.

.8 Running Test:

- .1 The Running Test shall be performed subsequent to modification and successful Demonstration of an individual UV Reactor bank.
- .2 The equipment shall be restarted and run continuously for a minimum of three (3) days (seventy-two (72) hours) or as specified. During this period, as practicable, conditions shall be simulated which represent maximum (or most severe), average, and minimum (or least severe) conditions. These conditions will be mutually agreed to by the Manufacturer's Representative, the Contractor, and the Contract Administrator on the basis of the information contained in the technical specifications, as well as the methods utilized to create the simulated conditions and the time periods allotted to each. This step shall be repeated for each modified UV Reactor bank.
- .3 Conduct daily sampling of treated water throughout the Running Test.
 - .1 Submit samples to an accredited laboratory for complete analysis.
 - .2 Parameters to be analysed include:
 - .1 General chemistry. At minimum, general chemistry shall include temperature, physical parameters (including colour, conductivity, hardness, alkalinity, langelier index, pH, turbidity and ultraviolet transmittance), anions, nutrients (including nitrates, ammonia, etc.), total organic carbon, dissolved organic carbon, and total metals (including aluminum, arsenic, mercury, lead, and boron, etc.)
 - .2 Total and fecal coliforms.

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- .4 The Running Test shall be completed as follows:
 - .1 To perform the Running Test, the Contractor with supervision by the Manufacturer's Representative, shall operate all controls and other devices to ensure they are functional and ready for Performance Testing.
 - .2 The purpose of the Running Test shall be to demonstrate the effectiveness of all system components and control features in all modes of control including:
 - .1 Automatic AND Manual START/STOP and flow control of UV Reactors by the SCADA Operator Interface Terminal (OIT) and UV Human Machine Interfaces (HMIs).
 - .2 Local control of all devices including mechanical cleaning system when local UV controller and/or HMI are not in service.
 - .3 Automatic shutoff and alarm for various failure modes for each UV Reactor and train for the entire UV System.
 - .4 Automatic testing of UV intensity sensors and verification of calculated dose.
 - .1 If the Running Test of the UVT analyzer fails (provides inaccurate readings), the Contractor shall repeat the testing with a different model UVT analyzer at their own cost.
 - .5 Verification of UV intensity/UVT set point control strategy based on UVT analyzer input.
 - .6 Log inactivation values (LIVs) achieved.
 - .7 Automatic switchover from normal power to emergency power, and emergency power to normal power, if this function has been disturbed by modifications.
 - .8 Operation of mechanical cleaning system and chemical cleaning system where applicable.
 - .9 Operation of all monitoring instruments.
 - .10 All control functions, both at local system and SCADA OIT(s).
 - .5 The Contractor shall submit results of the Running Test within twenty-four (24) hours to the Contract Administrator. Final documented and summarized results shall be submitted in a format acceptable to the Contract Administrator within five (5) Business days.
 - .1 Results shall include, at a minimum, Pass or Fail status of all tasks listed in Item 3.14.8.4 and commentary on the performance of each task.
 - .6 The Contractor, with assistance from the Manufacturer's Representative, shall complete the Running Test to the satisfaction of the Contract Administrator and the City prior to commencing the Performance Test.

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- .7 During a Running Test, until the Reactor meets the specified UV dosage for adequate treatment, coordinate with the Contract Administrator and City to ensure that the amount of water treated by the Reactor is kept below 1% of the total monthly production of the WTP. This requirement is to ensure conformance with item 4.8.2 of the City's operating license (**Appendix G**).
- .8 Confirm with the City in advance of every Running Test that upstream water treatment at the biologically activated carbon filters is performing optimally.
- .9 Performance Tests:
 - .1 Following completion of the Demonstration and Running Test on a UV Reactor bank, the Contractor in cooperation with the City's operating staff shall conduct the Performance Test with supervision assistance from the Manufacturer's Representative. The Manufacturer's Representative shall submit to the Contractor, the City, and the Contract Administrator a complete testing plan for the modified equipment.
 - .2 A Performance Test shall be restarted if a critical failure occurs. A critical failure shall be deemed as a failure which prohibits the process from functioning successfully or which creates a safety hazard.
 - .3 Performance Tests shall be as dictated in this Section, the technical specifications for each piece of equipment, and as reasonably required by the Contract Administrator to prove adherence to the requirements listed in the Specification.
 - .4 Conduct daily sampling of treated water throughout the Performance Testing.
 - .1 Submit samples to an accredited laboratory for complete analysis.
 - .2 Parameters to be analysed include:
 - .1 General chemistry. At minimum, general chemistry shall include temperature, physical parameters (including colour, conductivity, hardness, alkalinity, langelier index, pH, turbidity and ultraviolet transmittance), anions, nutrients (including nitrates, ammonia, etc.), total organic carbon, dissolved organic carbon, and total metals (including aluminum, arsenic, mercury, lead, and boron, etc.)
 - .2 Total and fecal coliforms.
 - .5 The Contractor shall submit the initial results of each Performance Test, as summarized in 3.14.9.14.1 within twenty-four (24) hours to the Contract Administrator. Final documented and summarized results shall be submitted in a format acceptable to the Contract Administrator within five (5) Business days.
 - .6 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 Tests and receipt of the test reports.
 - .7 To perform the Performance Test, the Contractor in cooperation with City's operating staff shall operate the system with supervision assistance from the Manufacturer's Representative over a seven (7) day test period and collect and summarize data to

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demonstrate that the system meets the Performance Test requirements for the parameters listed below.

- .8 In all cases, compliance with the requirements of this Specification shall be determined for each Business Day and, to successfully pass the test, the UV System must comply as follows:
 - .1 Equipment must meet minimum UV dose and treated water must meet log inactivation values at design flowrate and design UVT.
 - .1 2-log *Cryptosporidium* LIV using the Setpoint Approach, at both 25 MLD and 125 MLD, per reactor.
 - .2 2-log *Giardia* LIV using the Setpoint Approach, at both 25 MLD and 125 MLD, per reactor.
 - .2 Commissioning Requirements of Division 40 - Instrumentation and Controls and this Section.
- .9 The Manufacturer's Representative shall be responsible for confirming the UV intensity sensors are within the accuracy tolerances required for system operation and performance.
- .10 Should the Manufacturer's Representative be off-Site during the Performance Test, the Manufacturer's Representative is to provide full technical supervision (24/7) with telephone support and performance monitoring.
- .11 During the Performance Test, the City shall have the option of collecting samples for independent analyses to confirm measurements and analyses conducted by the Manufacturer's Representative and the Contractor. The Contract Administrator and the City shall have the option of witnessing all testing performed by the Manufacturer's Representative and the Contractor.
- .12 During a Performance Test, until the Reactor meets the specified UV dosage for adequate treatment, coordinate with the Contract Administrator and City to ensure that the amount of water treated by the Reactor is kept below 1% of the total monthly production of the WTP. This requirement is to ensure conformance with item 4.8.2 of the City's operating license.
- .13 Confirm with the City in advance of every Performance Test that upstream water treatment at the biologically activated carbon filters is performing optimally.
- .14 The Manufacturer's Representative and the Contractor shall provide the Performance Test Report within five (5) Business days of completion of the Performance Test.
 - .1 The Performance Test Report shall include the following as a minimum for each Reactor:
 - .1 Performance Test conditions and procedures.

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- .2 Performance Test Results for parameters as listed in **Table 1**, in the form of graphs and summary tables. Items #1-6 are to be acquired from the City for the duration of the Performance Test.

Table 1: Parameters for Performance of UV Disinfection

Item #	Parameter
General	
1	Feed Water Temperature (°C)
2	Feed Water Turbidity (NTU)
3	Feed Water UVT (percent)
4	Feed Water Flowrate (m ³ /d)
5	Feed Water Hardness (mg/L as CaCO ₃)
6	Feed Water Alkalinity (mg/L as CaCO ₃)
Disinfection	
7	Run time (hrs)
8	Total Production per Reactor (m ³)
9	Dose Required (mJ/cm ² , log-inactivation of <i>Giardia</i> and log-inactivation of <i>Cryptosporidium</i>)
10	Sensor Correction Factor
11	Calculated Dose (mJ/cm ² , log-inactivation of <i>Giardia</i> and log-inactivation of <i>Cryptosporidium</i>)
12	Validated Dose (mJ/cm ² , log-inactivation of <i>Giardia</i> and log-inactivation of <i>Cryptosporidium</i>)
13	Flowrate per Reactor (m ³ /d)
14	UV Dose Adequacy Determination (Validated Dose > Dose required)
15	percent of Volume in testing period that <i>Giardia and Cryptosporidium</i> Inactivation Exceeded 2-Logs
16	percent of Time in testing period that <i>Giardia and Cryptosporidium</i> Inactivation was Less than 2-Logs

- .3 Corrective actions taken.
- .4 Retesting results (if necessary).
- .5 Other pertinent information (if any).
- .6 Conclusions.
- .7 Recommendations for future actions.

3.15 Adjustment to Calculated Dose and Final Running and Performance Test

- .1 After the Demonstration, Running Test, and Performance Test have been successfully performed on each Reactor bank, the Contractor shall perform a Running Test and a Performance Test on the complete UV Disinfection System.

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- .1 It will be the responsibility of the Contractor to communicate to arrange the times for testing and start-up activities. The Contractor must confirm that these times are acceptable to the Contract Administrator and the City.
- .2 The Final Running Test and Final Performance Test shall conform to the same requirements as the individual Running Tests and Performance Tests, respectively. At this time, rather than use the Setpoint Approach, performance targets for the individual UV Reactors are to be as follows:
 - .1 2-log *Cryptosporidium* LIV using the Calculated Dose approach, at both 25 MLD and 125 MLD, per reactor.
 - .2 2-log *Giardia* LIV using the Calculated Dose approach, at both 25 MLD and 125 MLD, per reactor.
- .2 Substantial Performance shall not be awarded until Final Performance Testing is conducted.

3.16 Final Commissioning Report

- .1 Contractor to submit the completed Commissioning Report within a maximum of two (2) weeks of completion of the Commissioning. The final Commissioning Report to be reviewed and accepted by the Contract Administrator prior to granting Substantial Performance.
- .2 Final Commissioning Report to include:
 - .1 Start-up, pre- Commissioning activities, and documentation for systems and equipment.
 - .2 Description of Commissioning activities and documentation.
 - .3 Description of Commissioning of integrated systems and documentation.
 - .4 Completed installation checklists if required by manufacturer.
 - .5 Completed Running and Performance Test Report(s).
 - .6 Final settings of commissioned equipment.
 - .7 Training Plans.
- .3 Before the final Commissioning Report is accepted, individual reported results to be subject to verification by the Contract Administrator.

3.17 Training Plans

- .1 Refer to Section 01 78 24 -Training.

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**CERTIFICATE OF EQUIPMENT SATISFACTORY RUNNING TEST PERFORMANCE
FORM 103**

We certify that the equipment listed below has been operated and tested as per the Specifications using water and that the equipment meets its Running Testing criteria. No defects in the equipment were found. The equipment is therefore classed as “conforming”.

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Authorized Signing Representative of the Manufacturer) _____ Date

(Authorized Signing Representative of the Contractor) _____ Date

(Authorized Signing Representative of the Contract Administrator) _____ Date

Acknowledgement of Receipt of O&M Manuals.

(Authorized Signing Representative of the City) _____ Date

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**CERTIFICATE OF EQUIPMENT SATISFACTORY RUNNING TEST PERFORMANCE
FORM 103X**

We certify that the equipment listed below has been operated and tested as per the Specifications using water and that the equipment meets its Running Testing criteria. No defects in the equipment were found. The equipment is therefore classed as “conforming”.

PROJECT: _____

ITEM OF EQUIPMENT: Complete UV System, after update to Calculated Dose Approach

TAG NO: Complete UV System

REFERENCE SPECIFICATION: _____

(Authorized Signing Representative of the Manufacturer)

Date

(Authorized Signing Representative of the Contractor)

Date

(Authorized Signing Representative of the Contract Administrator)

Date

Acknowledgement of Receipt of O&M Manuals.

(Authorized Signing Representative of the City)

Date

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**CERTIFICATE OF SATISFACTORY PERFORMANCE TEST PERFORMANCE
FORM 104**

We certify that the equipment listed below has been operated and tested as per the Specifications using water and that the equipment meets its Performance Testing criteria. No defects in the equipment were found. The equipment is therefore classed as "conforming".

PROJECT: _____

SYSTEM DESCRIPTION: _____

TAG NO (S): _____

**REFERENCE
SPECIFICATION (S):** _____

(Authorized Signing Representative of the Manufacturer)

Date

(Authorized Signing Representative of the Contractor)

Date

(Authorized Signing Representative of the Contract Administrator)

Date

(Authorized Signing Representative of the City)

Date

COMMISSIONING PLAN

**CERTIFICATE OF SATISFACTORY PERFORMANCE TEST PERFORMANCE
FORM 104X**

We certify that the equipment listed below has been operated and tested as per the Specifications using water and that the equipment meets its Performance Testing criteria. No defects in the equipment were found. The equipment is therefore classed as "conforming".

PROJECT: _____

SYSTEM DESCRIPTION: Complete UV System, after update to Calculated Dose Approach

TAG NO (S): Complete UV System

**REFERENCE
SPECIFICATION (S):** _____

(Authorized Signing Representative of the Manufacturer) _____
Date

(Authorized Signing Representative of the Contractor) _____
Date

(Authorized Signing Representative of the Contract Administrator) _____
Date

(Authorized Signing Representative of the City) _____
Date

END OF SECTION

OPERATING AND MAINTENANCE MANUAL

1. GENERAL

1.1 Work Included

- .1 Furnish complete operations manuals and maintenance information as specified in this Section for installation check-out, operation, maintenance and lubrication requirements for each unit including mechanical, electrical and instrumentations systems.

1.2 General Requirements

- .1 Prepare operating and maintenance manuals using recommended information acquired from Manufacturer that describes the maintenance and operation of described products.
- .2 One (1) advance copy of the operating and maintenance manuals shall be submitted to the Contract Administrator for review and comments. After review and acceptance by the Contract Administrator, submit five (5) hard copies and one (1) electronic (PDF) copy of the final operating and maintenance manuals no later than four (4) weeks prior to commissioning of the Work.
- .3 Format of the operating and maintenance manuals 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.
 - .4 Standard letter size paper 216 mm x 279 mm (8.5 inch x 11 inch).
 - .5 Drawings, diagrams, and schematics to be professionally prepared, legible, and of equal quality as the originals.
 - .6 Provide electronic copies of all O&M Manuals in searchable PDF formats. The table of contents must be created using hyperlinks that link the headings in the table of contents to the headings in the O&M Manuals. Electronic copies must be acceptable to the Contract Administrator.
 - .1 Provide materials of equal clarity and quality as the originals.
 - .2 Provide drawings, diagrams, and Manufacturer's literature which are legible.
- .7 All instructions in the O&M Manuals are to be in simple language (English).
- .8 All measurements to be SI units.
- .9 Edit Manufacturers' standard documents to delete extraneous information not applicable to the equipment, assembly, subassembly, or material supplied. Cross out or remove and eliminate any extraneous material for models, options, or sizes not furnished.

OPERATING AND MAINTENANCE MANUAL

1.3 Contents and Organization

- .1 Arrange the O&M Manual to match the numbering system in the Specifications.
- .2 Provide the Manufacturers' standard O&M Manuals for the equipment or instrument supplied. If the Manufacturers' standard manuals do not contain all the required information, provide the missing information in supplementary documents and Drawings.
- .3 One (1) set of O&M manuals may be provided when more than one piece of similar equipment or instruments are supplied, such as different sizes of the same model and all similar pieces are covered in the same standard Manufacturer's O&M Manual.
- .4 When similar equipment or instruments are provided by the same Manufacturer but are not covered in the same standard Manufacturer's O&M Manual, their specific manuals may be included in the same electronic manual.
- .5 Provide a cover page as the first page of each manual, with the following information:
 - .1 Contract name and number.
 - .2 Equipment number, or if more than one piece of equipment is provided, equipment numbers for equipment or instruments covered by the manual. Include functional description of equipment after each number.
- .6 Provide a table of contents listing the contents of the manual and identifying where specific information can be located.
- .7 Include the specific information described below in the O&M Manuals:
 - .1 General Information:
 - .1 Functional title of the system, equipment, material, or instrument.
 - .2 Equipment or instrument tag number.
 - .3 Relevant Specification Section number and Drawing reference.
 - .4 Address and telephone number of the Manufacturers and the nearest Manufacturers' Representative.
 - .2 Equipment Data:
 - .1 Insert Specification Section and completed equipment and instrumentation data sheets for equipment supplied. Attach all Addenda, Change Orders, and Change Directives that refer to that specific item of equipment.
 - .3 Operation Information:
 - .1 Include the Manufacturers' recommended step-by-step procedures for starting and stopping under normal and emergency operation. Include all specified modes of operation including recommended operation after the assembly or equipment has been in long term storage.

OPERATING AND MAINTENANCE MANUAL

- .2 Provide control diagrams with data and information to explain operation and control of systems and specific equipment. Identify normal operating set points and alarm conditions.
- .3 Provide technical information on all alarms and monitoring devices provided with the equipment.
- .4 Provide a written control narrative for all equipment; describing as a minimum:
 - .1 Defaults.
 - .2 Standard operating procedures.
 - .3 Operator adjustable parameters, fixed parameters, and operating ranges.
 - .4 The programming of the PLC systems for individual processes or systems.
- .5 Provide final instrumentation set points including but not limited to:
 - .1 Units.
 - .2 Scale.
- .4 Technical Data:
 - .1 Insert Manufacturers' technical specification and data sheets.
 - .2 Insert Manufacturers' certified performance and calibration curves for the equipment and instruments.
- .5 Maintenance Information:
 - .1 Provide descriptions and schedules for Manufacturers' recommended routine preventative maintenance procedures including specific lubrication recommendations. Indicate service intervals as appropriate: daily; weekly; monthly; quarterly; semi-annually; annually; or after "X" hours of operation.
- .6 Maintenance Instructions:
 - .1 Provide requirements to set up and check out each system for use. Include all required and recommended step-by-step inspections, lubrications, adjustments, alignments, balancing and calibrations. Include protective device settings and warnings and cautions to prevent equipment damage and to insure personnel safety.
 - .2 Provide Manufacturers' description of routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation and to minimize corrective maintenance and repair.
 - .3 Provide Manufacturers' recommendations on procedures and instructions for correcting problems and making repairs.

OPERATING AND MAINTENANCE MANUAL

- .4 Provide step-by-step procedures to isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or requires replacement.
- .5 Provide step-by-step procedures and list special required tools and supplies for removal, replacement, disassembly and assembly of components, assemblies, subassemblies, accessories and attachments. Provide tolerances, dimensions, settings and adjustments required.
- .7 Assembly Drawings:
 - .1 Provide Drawings which completely document the equipment, assembly, subassembly or material for which the instruction is written. Provide the following Drawings as applicable: fabrication details, wiring and connection diagrams, electrical and piping schematics, block or logic diagrams, Shop Drawings, installation drawings, layout and dimension drawings, and electrical component fabrication drawings.
 - .2 Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items. When illustrations omit the part numbers and description, both the illustrations and separate listing shall show the index, reference, or key number which will cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies and subassemblies.
- .8 Record Drawings:
 - .1 Include sections for the record Drawings and as-built Drawings of all installations. Drafted record Drawings and as-built Drawings of size 432 x 279 mm (11 x 17") will be inserted by the Contract Administrator, based on the as-built Drawings marked up by the Contractor.
- .9 Testing and Commissioning Documentation:
 - .1 In accordance with Section 01 91 31 - Commissioning Plan and individual Specification Sections.
- .10 Bill of Materials:
 - .1 Provide a clear, legible copy of the bill of materials that was shipped with the equipment. The bill of materials should list all equipment, instruments, components, accessories, tools, and other items that were shipped with the equipment.
- .11 Electrical and Instrumentation and Control-Specific Information:
 - .1 Provide a copy of all wiring diagrams complete with wire coding, test sheets and programming information.
 - .2 Provide calibration sheets, instrument settings, type and accuracy of instruments used.

OPERATING AND MAINTENANCE MANUAL

- .3 Provide a copy of all configuration data and program listings available from the application software for all programmable instruments, devices, and systems.
 - .1 Copies of programming shall be provided in PDF format, and the program file for all programmable devices or systems. Additionally, provide a copy of all HMI and SCADA screens and pop-ups in PDF format.
- .4 Provide a tabulated list of all consumables utilized (fuses, lamps, calibration materials etc.) indicating where used, type, rating, and reorder details.

1.4 Field Changes

- .1 Following the acceptable installation and operation of an equipment item, modify and supplement the item's instructions and procedures to reflect any field changes or information requiring field data.

1.5 Warranties

- .1 Provide a separate Section labelled "Warranties" including:
 - .1 A list, in Specification Section order, of all warranties and guarantees required by the Contract Documents and all Manufacturers' standard warranties and guarantees received from equipment supplier. Include contact names and telephone numbers. Indicate the time frame of each warranty or guarantee on the list.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

COMMON WORK RESULTS FOR ELECTRICAL

1. GENERAL

1.1 Description

- .1 Comply with all laws, ordinances, rules, codes, standards, regulations, bulletins, by-laws, and orders of all Authorities Having Jurisdiction relating to this Work and enforced in the locality of jobsite. If otherwise specified herein the bare minimum of the code(s) and requirements shall first be met, and specified requirements shall be in addition to the code(s) and requirements.
 - .1 Supply and install all material, equipment, wiring and labour necessary for the installation of the systems detailed on the Drawings in accordance with the latest edition of the Canadian Electrical Code, Manitoba Electrical Code, and building codes. Where a conflict exists between the Contract documents and the applicable codes, the more stringent requirements shall apply.
 - .2 The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for delivery, erection, and installation of all equipment and apparatus required to be installed by the Contractor. All such equipment shall be removed by the Contractor upon completion of the project.
 - .3 All rigging and hoisting events shall be performed in accordance with the rigging/hoisting plan for the activity and by qualified persons.
- .2 This Section covers items common to sections of Division 26 Electrical. This Section supplements requirements of the General Conditions, Supplementary Conditions, and Division 01, which are a part of this Specification and shall apply to this Division.
 - .1 The intent of the Drawings and Specifications is to include all labour, products, and services necessary to complete the Work and to ensure that such items are tested and verified to be fully operational.
 - .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. Other Divisions most commonly requiring work and coordination by Division 26 (but not limited to) are 33, 40, and 46.
 - .3 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 proceeding with the Work.
 - .4 Responsibility to determine which Division provides various products and Work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of Specifications.

1.2 Codes and Standards

- .1 Canadian Standards Association (CSA):
 - .1 C22.1: Canadian Electrical Code Part I (CEC) as amended by provincial, territorial, or municipal authority having jurisdiction. References to CEC elsewhere in this document shall include reference to such amendments.

COMMON WORK RESULTS FOR ELECTRICAL

- .2 CSA CAN3-C235-83, Preferred Voltage Levels for AC Systems, 0 to 50,000 V.
- .2 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 IEEE SP1122, The Authoritative Dictionary of IEEE Standards Terms.
- .3 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
- .4 City of Winnipeg:
 - .1 Electrical Design Guide.
 - .2 Automation Design Guide.
- .5 Manitoba amendments to the Canadian Electrical Code (MEC).

1.3 Definitions

- .1 Electrical and electronic terms: unless otherwise specified or indicated, terms used in these Specifications and on Drawings are those defined by IEEE SP1122.
- .2 All terminologies, abbreviations, and acronyms used in this document are as listed in the various Standards, Codes, Rules, and Bulletins used herein.
- .3 Where the word “install” is used, unless specifically specified, is also meant to include the supply of the equipment.
- .4 Date Compliant means that the product accurately and correctly processes and stores date/time data (including, but not limited to, calculating, comparing, displaying, recording, and sequencing operations) including year, century, and leap year calculations.

1.4 Units of Measure

- .1 The Contract Documents have been prepared using the modified SI units of metric measurement. Whenever appropriate, available metric products shall be used unless otherwise specified herein.
- .2 Only metres (m) and millimetres (mm) are used. Generally, metres are used for measurements of 10 m or more, and millimetres for measurements less than 10 m.
- .3 Conversions:
 - .1 The following three (3) conversion methods were used in product and location dimensions:
 - .1 Hard Conversion: industry available products which are manufactured in metric measurements.
 - .2 Soft Conversion: products which are still manufactured in Imperial units and are converted in Specifications using arithmetic conversion factors.

COMMON WORK RESULTS FOR ELECTRICAL

- .3 Rationalized Conversion: dimensions which are soft converted and rounded off for ease of measurements.
- .2 In cases where measurements may be open for interpretation, dual dimensions have been incorporated until hard conversions can be used exclusively.
- .4 Symbols used to represent various electrical devices often occupy more space on the Drawing than the actual device does when installed. In such instances, do not scale locations of devices from electrical symbols. Install these devices with primary regard for usage of wall space, convenience of operation, and grouping of devices.

1.5 Design Requirements

- .1 Operating voltages: to CAN3-C235.
- .2 Provide all minor items and Work not shown or specified but which are reasonably necessary to complete the Work.
- .3 Motors, electric heating, control and distribution devices, and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.
 - .1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.
- .4 For vendor supplied packages, the Contractor will provide, install, and connect power and controls as required by the vendor. The Contractor's deliverables also include support, coordination, markups and other associated tasks as part of the work.
 - .1 The Contractor shall install all loose supplied electrical components/equipment by the vendor De Nora. The Contractor shall perform the installation and modifications per the De Nora drawings, and under De Nora's supervision and direction where required.
 - .2 It is the responsibility of the Contractor to check/confirm transformation, controls, and instrumentation is complete and fully functional allowing the distribution of power and control signals to equipment that comprise the package system and any of the required interconnections with systems or equipment by others.
 - .3 It is the responsibility of the Contractor to provide wire and miscellaneous shop supplies for the installation and modifications of the supplied components/equipment by others.
 - .4 It is the responsibility of the Contractor to communicate and capture red-lines with De Nora and for coordinating the onsite As-Built drawing set. Provide the final record drawings within each control panel at project completion.
 - .5 It is the responsibility of the Contractor to coordinate and provide a final CSA special inspection for each modified electrical control panel after completion of the Work. Provide the completed report to the Contract Administrator for their records.

1.6 Related Work

- .1 Supply and install electrical equipment as described and as shown on the Drawings.
- .2 Site Examination:

COMMON WORK RESULTS FOR ELECTRICAL

- .1 Immediately after award of Contract and prior to commencing the Work, verify location, arrangement, and point of attachment for service and service entrance equipment with supply authority and inspection departments. Failure to do so will render the Contractor responsible for any corrections necessary without additional compensation.

- .3 General:
 - .1 Provide all cabling (power, controls, and monitoring) required to make a complete and operational facility.
 - .1 It is the Contractor's responsibility to provide power and controls cabling to every equipment, device, and instrument installed under this Contract complete with all hardware components such as but not limited to breakers, terminal blocks, and relays.
 - .1 Install and terminate cables; Provide electrical connections and connect to all equipment including equipment supplied by other Divisions.
 - .2 Provide and/or extend raceway systems to allow complete installation for all cables.
 - .3 Provide electrical wiring, conduit, and other appurtenances required to provide power connections as required.
 - .4 Provide power connections to the various items of electrical equipment, motors, instrumentation, and control equipment.
 - .2 Provide additional electrical modifications such as breaker and control wiring adjustments, provision for future harmonic mitigation, surge protection etc. to accommodate modifications to the existing Reactors.
 - .3 Provide bonding as herein specified and indicated on the Drawings. All bonding shall comply with the Canadian Electrical Code, Manitoba Electrical Code, and local amendments to this code.
 - .4 The City shall retain demolished or removed equipment as desired. Provide demolished/removed equipment to the City as specified.
 - .5 Provide coordination, commissioning, and testing support for other Divisions.
 - .6 Correct any defects identified in commissioning.

1.7 Submittals

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures and this Specification.
- .2 Submit a detailed work plan for any scaffolding, rigging, hoisting, and other similar services. The work plan shall include the proposed work performed, construction sequence, specialized equipment, and methods/procedures for all testing.
- .3 Submit samples as required where specified in Division 26.
- .4 Shop Drawings:

COMMON WORK RESULTS FOR ELECTRICAL

- .1 Shop Drawings to be in accordance with Item 1.3 of Section 01 33 00 - Submittal Procedures.
- .2 Submit wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure coordinated installation.
 - .1 Identify on wiring diagrams circuit terminals and indicate internal wiring for each item of equipment and interconnection between each item of equipment.
- .5 Quality Control:
 - .1 Complete all necessary testing, detailed wiring continuity checks, wiring completion checks, installation integrity checks, functional equipment operation checks, and written system verification reports to provide a complete system that is ready for commissioning and start-up.
 - .1 Submit test and check results of installed electrical systems and instrumentation in accordance with the requirements found within Division 26 and Division 40.
 - .2 Provide commissioning and start-up of all systems included in the Scope of Work as per Section 01 91 31 - Commissioning Plan.
 - .3 Submit written certification of required values and settings as described in Item 3.17 of this Section.
 - .4 Submit records of inspections and certificate of acceptance from Authority Having Jurisdiction (AHJ) upon completion of Work to the Contract Administrator.
- .6 Manufacturer's Field Reports: submit to Contract Administrator Manufacturer's written report, within three (3) business days of review, verifying compliance of Work and electrical system and instrumentation testing, as described in Item 3.18 of this Section.
- .7 Provide documentary proof of the Date of Compliance as indicated in item 3.15 of this Section.

1.8 Quality Assurance

- .1 The Electrical Subcontractor shall be a firm normally engaged and fully competent in the type of Work described in this Section. The firm shall have been continuously and successfully engaged in this business for at least five (5) years.
- .2 Electrical work to be carried out by qualified, licensed journeyman electricians who hold valid license in accordance with Authorities Having Jurisdiction.
 - .1 Qualified journeyman electricians shall perform all power and control cabling installation and connections.
- .3 Instrumentation and control work to be carried out by qualified, licensed journeyman instrument mechanics who hold valid license in accordance with the Manitoba Trade Regulation.
 - .1 Journeyman familiar with the devices being installed shall perform all instrument hook-ups, calibrations, and checkouts. Refer to Division 40.

COMMON WORK RESULTS FOR ELECTRICAL

- .4 Standard of Workmanship:
 - .1 Execute all Work in a competent manner and to present an acceptable appearance when completed.
 - .2 Employ a competent supervisor and a sufficient number of licensed tradesmen to complete the Work in the required time.
 - .3 Arrange and install products to fit properly into designated building spaces.
 - .4 Unless otherwise specified or shown, install products in accordance with recommendations and ratings of Manufacturers.

1.9 Care, Operation, and System Start-up

- .1 See Section 26 08 00 - Commissioning of Electrical Systems.

1.10 Permits, Fees, and Inspection

- .1 Submit to the Electrical Inspection Department and Authority Having Jurisdiction (AHJ) the necessary number of Drawings and Specifications required for examination and approval prior to commencement of the Work.
 - .1 The Site falls under the jurisdiction of the RM of Springfield.
 - .2 AHJ for electrical permits is Manitoba Hydro.
 - .1 https://www.hydro.mb.ca/accounts_and_services/permits_and_inspections/
- .2 Pay associated fees.
- .3 Notify the Contract Administrator of changes required by Electrical Inspection Department and Supply Authority prior to making changes.
- .4 Notify the Contract Administrator a minimum of ten (10) Business Days prior to electrical inspections to allow the Contract Administrator to be present to witness inspections
- .5 Furnish a Certificate of Final Inspection and approvals from the Electrical Inspection Department and AHJ to the Contract Administrator.
- .6 At the time of issuance of any/all electrical Permit(s), provide a copy to the Contract Administrator.

2. PRODUCTS

2.1 Selected Products and Equivalents

- .1 Products and materials provided shall be new and free from all defects. Defective products or materials will be rejected, regardless of previous inspections. The Contractor shall be responsible to remove and replace defective products at their expense and shall be responsible for any resulting delays and associated expenses, which result from defective products being rejected. Related materials shall be of the same manufacturer throughout the project.

COMMON WORK RESULTS FOR ELECTRICAL

- .2 Products and materials referred to in the Specifications by trade names, manufacturer's name, and catalogue reference are those which shall be used as the basis for the Bid.
- .3 The design has been based on the use of the specified product.
- .4 Products provided, if not specified, shall be new, of a quality best suited to the purpose required and their use subject to approval by the Contract Administrator.

2.2 Quality of Products

- .1 All products provided to be CSA or cUL approved where applicable.
- .2 If products specified are not CSA or cUL approved, obtain approval of the relevant provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval at no additional cost to the Contract.

2.3 Materials and Equipment

- .1 Provide materials and equipment in accordance with Section 01 61 00 - Common Product Requirements.
- .2 Factory-assemble control panels and component assemblies as follows:
 - .1 Control panels associated with any electrical equipment are covered under this Section of Work unless otherwise noted.
 - .2 Conductors, including all types of wires, conductors, cables, which form an integral part of the electrical power system.
 - .3 Cables and bus support systems which are intended to enclose or support all forms of electrical conductors used for any purpose covered by this scope. This includes cable trays, raceways, and all forms of rigid, flexible, metallic, and non-metallic conduit, and including conduit for communication systems or others, which may be installed at a later date.
 - .4 Circuit breakers of all types and for all applications associated with electrical equipment, which receives its power supply from the main, auxiliary, or emergency (including battery) system.
 - .5 Grounding/bonding systems, as required by the MEC, or as otherwise specified in the Bid Documents.
 - .6 Control and instrumentation systems - electrical or electronic instrumentation systems, with auxiliary equipment and components, unless specified otherwise.
 - .7 Transformers of various types, dry, encapsulated etc., and for all applications, except control transformers supplied with Mechanical Equipment.
 - .8 Electronic data processing and transmission systems, including auxiliary equipment, interface, and components.

COMMON WORK RESULTS FOR ELECTRICAL

2.4 Electric Motors, Equipment and Controls

- .1 Verify installation and co-ordination responsibilities related to motors, equipment, and controls, as indicated.
- .2 Supply and install control wiring and conduit in accordance with Section 26 05 34 - Conduits, Conduit Fastenings and Conduit Fittings.

2.5 Warning Signs

- .1 Warning Signs: in accordance with requirements of AHJ, inspection authorities, and Contract Administrator.
- .2 Lamacoid 3 mm thick plastic engraving sheet, red face, white core, mechanically attached with self tapping screw, 20 mm text, minimum size 175 mm x 250 mm.

2.6 Wiring Terminations

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

2.7 Equipment Identification

- .1 Identify electrical equipment with nameplates as follows:
 - .1 Lamacoid 3 mm thick plastic lamacoid nameplates, white face, black lettering, mechanically attached with self tapping screws.
 - .2 Sizes as follows:

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 in English.

2.8 Wiring Identification

- .1 All conductors shall be identifiable by coloured insulation and permanent markers at every terminal and accessible points throughout its entire run.
- .2 Identify wiring with permanent indelible identifying markings, either numbered or coloured plastic tapes, on both ends of phase conductors of feeders, branch circuit wiring, and neutrals.

COMMON WORK RESULTS FOR ELECTRICAL

- .1 Wire tags to be heat shrink type with black letters on white background.
- .3 Maintain phase sequence and colour coding throughout.
- .4 Colour coding: to CSA C22.1.
- .5 Use colour coded wires in communication cables, matched throughout system.

2.9 Access Panels

- .1 Where electrical equipment, junction boxes, remote ballasts, or the like are concealed, access panels shall be supplied. Panels shall be of adequate size for servicing of the electrical Work and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate type and size of panels with the Contract Administrator.
- .2 In removable ceiling areas, provide markers on ceiling tile to locate equipment requiring access. Markers shall be of a type approved by the Contract Administrator.

2.10 Finishes

- .1 Touch-up all damaged painted finishes with matching lacquer, or, if required by the Contract Administrator, completely repaint damaged surface.

3. EXECUTION

3.1 Coordination with Other Divisions

- .1 Examine the Drawings and Specifications of all Divisions and become fully familiar with the Work. Before commencing Work notify the Contract Administrator if any conflict exists, and, if required, make any necessary adjustments.
- .2 Coordinate the Work to be performed under this Section of the Specification with all Divisions installing equipment to ensure that there are no conflicts.
- .3 Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to other Division's work.
- .4 Lay out the Work and equipment with due regard to architectural, structural, and mechanical features.
- .5 Do not cut structural members without prior approval from the Contract Administrator.
- .6 Examine previously constructed work and notify the Contract Administrator of any conditions which prejudice the proper completion of this Work.

3.2 Installation

- .1 Complete installation in accordance with CSA C22.1.

3.3 Grounding/Bonding

- .1 All circuits shall be installed with dedicated insulated ground wire.

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3.4 Dedicated Neutrals

- .1 Each circuit shall have its own dedicated neutral wire. Shared neutral for more than 1 circuit shall not be permitted.

3.5 Area Category and Classifications

- .1 The building areas have the following electrical categories and classifications as defined in the CEC/MEC:
 - .1 Areas and Rooms:
 - .1 Mezzanine and UV Reactor Area: General Location and Category 1 (Wet).
 - .2 Control Room/Office: General Location.
 - .2 All Others: Uncategorized, Unclassified.

3.6 Enclosures

- .1 The following are typical minimum requirements for various electrical equipment and installations.

Dry/General	CSA/NEMA 12
Motor Control Centre (MCC)	CSA/NEMA 1A (Gasketed) for Indoor
Wet Area – Non Corrosive (Category 1)	CSA/NEMA 4
Wet Area – Corrosive (Category 2)	CSA/NEMA 4X
Hazardous – Zone 0, Zone 1, Zone 2, etc.	Rated for hazardous location
Transformers, Metering Socket and CSTE, Service Entrance Disconnect Switch*	CSA/NEMA 3R

* Service Entrance Breaker, or breaker enclosures shall only be provided for indoor installations unless provided in a suitable climate-controlled enclosure.

3.7 Nameplates and Labels

- .1 Ensure Manufacturer's nameplates, CSA labels, and identification nameplates are visible and legible after equipment is installed.

3.8 Product Handling

- .1 Use all means necessary to protect the products of this Division before, during, and after installation and to protect products and installed Work of all other trades.
- .2 Immediately make good any damage by repair or replacement at no additional cost to the City and to the approval of the Contract Administrator.
- .3 Remove advertising labels from all electrical equipment. Do not remove identification or certification labels.
- .4 Remove dirt, rubbish, grease, etc. resulting from this Work from all surfaces, including the inside of all cabinets, equipment enclosures, panelboard tubs, etc.

COMMON WORK RESULTS FOR ELECTRICAL

- .5 The Contractor shall be responsible for the receipt, storage, care, and maintenance of all material/tools/equipment delivered to site.

3.9 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: 1800 mm to top
 - .2 Light switches: 1420 mm to top
 - .3 Wall receptacles: 900 mm to top
 - .4 Control panels: 1800 mm to top
 - .5 Emergency lights: 2400 mm (minimum)
 - .6 Emergency stop switches: 1500 mm to top
 - .7 Motor disconnect switches: 1800 mm to top

3.10 Conduit and Cable Installation

- .1 In accordance with Section 26 05 34 - Conduits, Conduit Fastenings, and Conduit Fittings.
- .2 Sleeves through concrete: schedule 40 steel pipe, sized for free passage of conduit, and protruding 50 mm.
- .3 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.
- .4 Install cables, conduits, and fittings embedded or plastered over, close to building structure so furring can be kept to minimum.
- .5 Do not mix wiring and/or cables from different panels within the same conduit runs or pull boxes. Provide equipment barriers where acceptable and where applicable.

3.11 Separation of Services

- .1 Maintain separation between electrical wiring system and building piping, ductwork, etc. so that wiring system is isolated (except at approved connections to such systems) to prevent galvanic corrosion.
- .2 In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is not permitted.

COMMON WORK RESULTS FOR ELECTRICAL

.3 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Contract Administrator and the ceiling installer, and approved clips or hangers are used.

.4 Classifications of Circuits:

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

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

.5 Separation of Circuits:

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

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

Segregation between circuits	Very Noisy	Noisy	Indifferent	Sensitive	Very Sensitive
Very Noisy	Thermal grouping as per CEC	150 mm	300 mm	300 mm	300 mm
Noisy	150 mm	Thermal grouping as per CEC	150 mm	150 mm	150 mm
Indifferent	300 mm	150 mm	Separation of circuit types.	100 mm	100 mm
Sensitive	300 mm	150 mm	100 mm	Touching	50 mm
Very Sensitive	300 mm	150 mm	100 mm	50 mm	Touching

COMMON WORK RESULTS FOR ELECTRICAL

3.12 Sealing of Wall and Floor Openings

- .1 All conduit and cable entries through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade shall be sealed to prevent passage of moisture, dust, gasses, flame, or to maintain pressurization.
- .2 Openings shall be sealed when all wiring entries shown on the Drawings have been completed.
- .3 Sealing material shall be fire resistant and shall not contain any compounds, which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations to be sealed.

3.13 Housekeeping Pads

- .1 All floor mounted electrical equipment installed by this Division shall be mounted on concrete housekeeping pads which, unless otherwise noted, shall be the responsibility of the Contractor.

3.14 Sleeves

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 Provide sleeves of either galvanized steel pipe or RPVC for protection of cables penetrating through metal studs or wall systems in pre-engineered steel building systems.
- .3 For walls, 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.
- .4 The space between the sleeve and the conduit shall be sealed with fire stop and caulked around the top and bottom with approved permanently resilient, non-flammable, and weatherproof silicone base compound and ensure that the seal is compatible with the floor and ceiling finishes.
- .5 Locate and position sleeves exactly prior to construction of walls, floors.
- .6 Failure to comply with the above requirements shall be remedied at the Contractors expense.

3.15 Non-Specific Date/Time Compliance

- .1 All equipment, hardware, software, and firmware (for the purposes of this clause, the "Product") delivered or deliverables resulting from any services provided are fully Date Compliant and the product will not adversely or materially affect the daily business operations as a result of a date related computer problem (for the purposes of this clause, the "Warranty").
- .2 Provide documentary proof of the Date of Compliance prior to Substantial Performance listing all equipment and certifying their compliance. Notwithstanding any other remedy available under this agreement or at law for breach of the warranty, any product that is not Date Compliant shall, within twenty-four (24) hours of receipt of notice of the breach, be repaired or replaced at the Contractor's sole cost and expense, including parts, labour, transportation, and insurance, so as to correct any failure to meet the warranty

COMMON WORK RESULTS FOR ELECTRICAL

3.16 Temporary Lighting and Power

- .1 Provide grounded extension cords and temporary lights as required for electrical Work.
- .2 If the City's operations will be affected by any power outage required for this Work, give adequate notice to the Contract Administrator and do not interrupt power until approval has been obtained.

3.17 Coordination of Protective Devices

- .1 Ensure circuit protective devices such as overcurrent trips, relays, and fuses are installed to required values and settings.
- .2 Upon completion, the Contractor shall certify, in writing, that the required values and settings are complete and that they accurately reflect values required under Contract.

3.18 Field Quality Control

- .1 Conduct following tests:
 - .1 Power generation and distribution system including phasing, voltage, grounding, and load balancing.
 - .2 Insulation resistance testing:
 - .1 Megger circuits, feeders, and equipment up to 350 V with a 500 V instrument.
 - .2 Megger 350-600 V circuits, feeders, and equipment with a 1000 V instrument.
 - .3 Check resistance to ground before energizing.
 - .4 Submit test results for the Contract Administrator's review.
- .2 Carry out tests in presence of the Contract Administrator.
- .3 Provide instruments, meters, equipment, and personnel required to conduct tests during and at conclusion of Project.
- .4 Manufacturer's Field Services:
 - .1 Obtain written report from Manufacturer verifying compliance of Work, in handling, installing, applying, protecting, and cleaning of product and submit Manufacturer's Field Reports as described in Section 01 33 00 - Submittal Procedures.
 - .2 Provide Manufacturer's field services consisting of product use recommendations and periodic Site visits for inspection of product installation in accordance with Manufacturer's instructions.
 - .3 Schedule Site visits, to review Work, as directed in Section 01 45 00 - Quality Control.

3.19 As-Built Drawings

- .1 In accordance with Section 01 78 00 - Closeout Submittals.

COMMON WORK RESULTS FOR ELECTRICAL

- .2 The Contractor shall keep one (1) complete set of white prints at the Site office, including all addenda, change orders, site instructions, clarifications, and revisions for the purpose of As-Built Drawings. As the Work on Site proceeds, the Contractor shall clearly record in Red all as-built conditions, which deviate from the original Contract Documents. As-Built Drawings to include circuiting of all devices, conduit and feeder runs (complete with conductor size and number) and locations of all electrical equipment.
- .3 Prior to Substantial Performance, the Contractor shall mark-up all As-Built information, including: Change Orders, Clarifications, Revisions, Site Instructions and Shop Drawings. Upon completion, the Contractor shall certify, in writing, that the As-Built Drawings are complete and that they accurately indicate all electrical services, including exposed as well as concealed items.
- .4 On completion of the Work, submit As-Built Drawings to Contract Administrator for review.

3.20 Operation and Maintenance Manuals

- .1 In accordance with Section 01 78 00 - Closeout Submittals.

END OF SECTION

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

1. GENERAL

1.1 Summary

- .1 This Section provides a comprehensive list of all conduit types that may be required for the Project and the applications where each type shall be used.
- .2 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.2 References

- .1 Canadian Standards Association (CSA):
 - .1 CSA B137.1 Polyethylene (PE) Pipe, Tubing, and Fittings for Cold Water Pressure Services.
 - .2 CSA C22.2 No. 18.1 Metallic Outlet Boxes.
 - .3 CSA C22.2 No. 18.2 Non-metallic Outlet Boxes.
 - .4 CSA C22.2 No. 18.3 Conduit, Tubing, and Cable Fittings.
 - .5 CSA C22.2 No. 18.4 Hardware for the Support of Conduit, Tubing, and Cable.
 - .6 CSA C22.2 No. 18.5 Positioning Devices.
 - .7 CSA C22.2 No. 45.1 Electrical Rigid Metal Conduit – Steel.
 - .8 CSA C22.2 No. 45.2 Electrical Rigid Metal Conduit — Aluminum, Red Brass, and Stainless Steel.
 - .9 CSA C22.2 No. 56, Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit.
 - .10 CSA C22.2 No. 83, Electrical Metallic Tubing (EMT).
 - .11 CSA C22.2 No. 227.3, Mechanical Protection Tubing (MPT) and fittings.

1.3 Submittals

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures and this Specification.
 - .1 Include certifications to applicable standards, and manufacturer specific installation requirements.

1.4 Coordination

- .1 Coordinate with other work including wire and cable, boxes and fittings, and panel work, as necessary to interface installation of conduit with other work.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .2 Coordinate installation of conduit in concrete as needed.
 - .1 Confirm size restrictions for concrete embedded conduit with Contract Administrator.
- .3 Coordinate installation of conduit in masonry as needed.
- .4 Coordinate installation of conduit which penetrates roof or requires waterproofing as needed.
 - .1 Provide necessary flashing and pitchpockets, making watertight joints where conduit passes through roof or waterproofing membranes.
- .5 Coordinate installation of conduit which penetrates fire rated walls, floors, or ceilings with firestopping work specified in Division 1. Ensure that integrity of the fire rated element is maintained.

1.5 Quality Assurance

- .1 Electrical equipment and materials shall be new and comply with the latest codes and standards. Unless otherwise called out in the Drawings, no used, re-built, refurbished and/or re-manufactured electrical equipment or materials shall be furnished on this project.
- .2 Coated type conduits shall be prepared/repared with cleaner, primer, and touch-up compound as per the manufacturer's requirements.
- .3 Installed conduit shall be free from dents, bruises, and other damage.

1.6 Conduit Identification

- .1 Colour code bands shall be placed at points where they enter walls, ceilings, or floors, and at 5-meter intervals.
- .2 Colours: 38 mm wide prime colour and 19 mm wide auxiliary colour.

Item	Prime	Auxiliary
Medium Voltage (> 750 V)	Orange	
347/600 V	Yellow	
208/120/240 V Power	Black	
UPS 208/120/240 V Power	Black	Green
Control Wiring (120 V)	Black	Orange
Fire Alarm	Red	
Low Voltage Communication/General	Blue	
Low Voltage Control (< 50 V)	Blue	Orange
Intrinsically Safe	Blue	White
Grounding	Green	
Fibre Optic Cable	Purple	

1.7 Delivery, Storage, and Handling

- .1 Storage: Whenever possible, store the conduit indoors to prevent possible discoloration, the accumulation of dirt, and to extend the life of the product. However, if conduit is stored

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

outdoors, it should be stored in such a way as to allow air circulation and water to drain-off and shall not be directly covered in plastic.

2. PRODUCTS

2.1 Conduits and Minimum requirements

- .1 Flexible metal Conduit.
 - .1 CSA C22.2 No. 56, aluminum liquid-tight flexible metal.
 - .2 Flexible Metal Conduit: spirally wound, interlocked zinc coated strip steel, minimum 10 mm diameter.
 - .3 Liquid-Tight Flexible Metal Conduit: continuous interlocked and double-wrapped steel, zinc coated inside and outside, coated with liquid-tight jacket of flexible PVC, minimum 12 mm diameter.
 - .4 Liquid-Tight Flexible Metal Conduit Fittings: cadmium plated, malleable iron fittings with compression type steel ferrule and neoprene gasket sealing rings.
- .2 Galvanized-Steel Rigid Conduit.
 - .1 CSA-C22.2 NO. 45.1 and ANSI C80.1, zinc coating steel.
- .3 Rigid Aluminum, Red Brass, or Stainless Steel metal Conduit.
 - .1 CSA C22.2 No. 45.2, with factory applied, closed-end thread protectors.

2.2 Conduit Fastenings

- .1 One-hole stainless steel straps to secure surface conduits 50 mm and smaller. Two-hole stainless steel straps for conduits larger than 50 mm.
- .2 Beam clamps to secure conduits to exposed steel work.
- .3 Channel type supports for two or more conduits at 1 m on centre.
- .4 Threaded stainless steel rods, 9 mm diameter, to support suspended channels.

2.3 Conduit Fittings

- .1 Fittings: to CSA C22.2 No. 18.3, No. 18.4, No. 18.5, and/or CSA C22.2 No. 45 manufactured for use with conduit specified. Coating: same as conduit.
- .2 Ensure factory "ells" where 90 degrees bends for 25 mm and larger conduits.
- .3 Miscellaneous Fittings: locknuts, bushings, reducers, chase nipples, 3-piece unions, split couplings, plugs, and expansion fittings specifically designed for their particular application.
- .4 Flexible Metal Conduit Fittings: threadless hinged clamp type.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

2.4 Fish Cord

- .1 Polypropylene.

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 Install conduit concealed, in walls, floors, ceilings, above suspended ceilings, and underground.
- .2 Except where otherwise required by Canadian Electrical Code (CEC/MEC), provide conduit of types specified and sizes indicated on Drawings or as specified.
- .3 Where sizes are not indicated, select proper sizes to suit intended use, fulfill wiring requirements, and comply with Canadian Electrical Code (CEC/MEC).
 - .1 Minimum conduit size for lighting and power circuits: 19 mm.
- .4 Water Treatment Plant – Conduit Types by Area:
 - .1 Office, lunchroom, and similar dry locations:
 - .1 Rigid Aluminum.
 - .2 General Locations/Areas and Category 1 (wet), and Heat Trace Systems:
 - .1 Rigid Aluminum threaded conduit.
 - .3 General Locations/Areas and dry:
 - .1 Rigid Galvanized Steel conduit.
 - .2 Rigid Aluminium conduit.
- .5 Use liquid tight flexible metal conduit for connection to motors/pumps, vibrating equipment, instrumentation, and luminaries.
- .6 Plug conduit ends to prevent entry of dirt and moisture.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .7 Seal conduit with duct seal compound or fibreglass where conduit leaves heated area and enters unheated area.
- .8 Field threads on rigid conduit must be of sufficient length to draw conduits up tight.
- .9 Install fish cord in empty conduits.
- .10 Remove and replace blocked conduit sections.
 - .1 Do not use liquids to clean out conduits.
- .11 Dry conduits out before installing wire.
- .12 Where conduit crosses building expansion joints, install expansion fitting approved by Authority Having Jurisdiction, complete with grounding jumper. Provide bend or offset in conduit adjacent to building expansion joint where conduit is installed above suspended ceilings.

3.3 Installation – Rigid Metal Conduit

- .1 Cut conduit straight, properly ream, cut threads and brush threads clean.
- .2 Fasten conduit terminations in sheet metal enclosures with two locknuts and terminate with bushing. Install locknuts inside and outside enclosure.
- .3 Conduit installed underground shall be painted with two (2) coats of corrosion inhibiting compound before backfilling.

3.4 Installation – Exposed/Surface and Semi-Concealed Conduit

- .1 Run conduits adjacent to or below existing cable tray systems. Use existing strut where available, add strut and threaded rod where existing strut is not available.
 - .1 Group conduits wherever possible on suspended or surface mounted unistrut channels.
- .2 Locate conduits behind infrared or gas fired heaters with 1.5 m clearance.
- .3 Install conduit to conserve headroom and cause minimum interference in spaces through which conduit passes.
- .4 Install conduit so as not to interfere with ceiling inserts, luminaires, or ventilation ducts or outlets.
- .5 Alter routing to avoid structural obstructions, keeping crossovers to a minimum.
- .6 Install exposed conduit and extensions from concealed conduit systems neatly, parallel with, or at right angles (perpendicular) to walls and structural members.
- .7 Run conduit for outlets on waterproof walls exposed. Set anchors for supporting conduit on waterproof wall in waterproof cement.
- .8 Run conduits in flanged portion of structural steel.

CONDUITS, CONDUIT FASTENINGS AND CONDUIT FITTINGS

- .9 Do not pass conduits through structural members except as indicated. Do not locate conduits less than 75 mm parallel to steam or hot water lines with minimum of 25 mm at crossovers.

END OF SECTION

CABLE TRAYS FOR ELECTRICAL SYSTEMS

1. GENERAL

1.1 Description

- .1 Provide a complete system of cable trays required to fully support all cable and conduit throughout the facility. System shall provide separate trays or barriers for 600 VAC systems, 120 VAC systems, and 24 VDC systems. System shall be complete with all supports and hangers as necessary for the installation.
 - .1 Where medium voltage (4.16 kV and 12.47 kV) power cables are either required or are existing, these tray systems shall be kept separate.
 - .2 Extend existing cable tray systems as required to support the installation.
- .2 Coordinate the location of the support channels so as not to interfere with other services.
- .3 Not all cable trays required are indicated on the Drawings. Provide additional trays and extensions to existing trays as required to fully support all cable and conduit throughout the facility.

1.2 References

- .1 Canadian Standards Association (CSA):
 - .1 CSA C22.1, Canadian Electrical Code (CEC), Part 1), Safety Standard for Electrical Installations.
 - .2 CSA C22.2 No. 126.1 - Metal Cable Tray Systems.
 - .3 CSA C22.2 No. 126.2 - Non-metallic Cable Tray Systems.
 - .4 CSA HA Series M - CSA Standards for Aluminum and Aluminum Alloys.
- .2 EEMAC F5-1-1977 – Cable trough system accessories.
- .3 Manitoba amendments to the Canadian Electrical Code (MEC).
- .4 NEMA VE 2 – Cable Tray Installation Guidelines.
- .5 NEMA RV 4 – Application and Installation Guidelines for Service-Entrance Cable.

1.3 Shop Drawings and Product Data

- .1 Submit Shop Drawings and Product data in accordance with 01 33 00 - Submittal Procedures and this Specification.
 - .1 Include in the Shop Drawing submission Manufacturer's descriptive literature for materials.
 - .2 For new cable tray only, prior to construction, submit design drawings and calculations indicating all tray loading has been reviewed by and bear the stamp of a Professional Engineer registered in the Province of Manitoba.

CABLE TRAYS FOR ELECTRICAL SYSTEMS

1.4 Coordination

- .1 For cable tray installation, coordinate pathways and installation of supports with structural work and mechanical ductwork.
- .2 Do not support cable tray from other division structural supports without permission from the Contract Administrator.
- .3 All trays are shown diagrammatically on the Drawings. Determine the exact location in the field. Install tray runs to prevent interference with process or service piping and ducting and to maintain clearance for tray access. Coordinate the exact location of tray supports and runs with the work of other Divisions.

2. PRODUCTS

2.1 Cable Tray

- .1 Use aluminum tray for new installation, and match existing tray for extensions unless indicated on the Drawings. Select the Class of tray based on the methods of cable tray support. Cable tray shall conform to CSA C22.2 No. 126.1 with 300 mm rung spacing, 150 mm side rails and width as required to prevent cable de-rating. The Contractor is responsible for increasing cable sizes due to de-rating factors from cable spacing.
- .2 Provide horizontal elbows, end plates, drop outs, vertical risers and drops, tees, wyes, expansion joints, reducers, and other fittings where required. Field fabricate only those fittings not available from Manufacturer. Radii on fitting: 600 mm minimum, unless otherwise required by the final design.
- .3 Provide stainless steel rod hanger clamps, rod hangers, wall mounting support brackets, and all necessary accessories for complete installation.
- .4 Provide barriers where different voltage systems or electrical systems are in the same tray, or as indicated.
 - .1 Provide barrier to separate 600 V power and control cables from analogue cables when these cables are installed in the same cable tray.
 - .2 Provide separate cable tray for medium voltage (4.16 kV and 12.47 kV) power cables.
 - .3 Provide fire barriers as required.
- .5 Cable tray covers shall be solid aluminum covers with a flange and complete with raised cover clips.
 - .1 Install cable tray cover where mechanical protection of cables is required and all external/outdoor installations. Where covers are required in only the vertical plane these shall be provided to a minimum height of 3 m above grade.
 - .2 Install covers on trays crossing under open stairways and grating, and for 2 m above floor penetrations.
- .6 Cable Spacers:

CABLE TRAYS FOR ELECTRICAL SYSTEMS

- .1 Recommend suitable space in accordance with manufacturers requirements if spacers are required.
- .2 Diameter of opening to be suitable for cable size.
- .3 Mounting hardware to be compatible with tray system.
- .4 Multi conductor cable feeders to be tied down with adequate tie raps.
- .7 Unless otherwise approved by the Contract Administrator, provide cable trays of the same manufacturer throughout the Work.
- .8 Acceptable cable tray manufacturers:
 - .1 B-Line Systems Inc.
 - .2 CANSTRUT Products Ltd.
 - .3 Unitray Systems Inc.
 - .4 Enduro Systems, Inc.
 - .5 Or approved equivalent.

2.2 Supports

- .1 Provide stainless steel rod hangers, nuts, fittings, rod hanger clamps and accessories as required. Material shall be Stainless Steel type AISI 304.
- .2 Suspend cable trays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than the maximum support spacing on centers as per the Span/Load Class requirements. Fasten hangers to channels securely mounted to the structure. Typical maximum support spacing have been provided Table below from CSA C22.2 No.126. Supports shall be provided as required for the Class, the installation means and methods employed, and all cable tray bends.

Class	Design Load	Maximum Design Support Spacing
A	37 kg/m (24.86 lb/ft)	3 m
C1	97 kg/m (65.18 lb/ft)	3 m
D1	67 kg/m (45 lb/ft)	6 m
E	112 kg/m (75.26 lb/ft)	6 m

- .3 Wall mounted support brackets: Provide aluminum channel strut supports mounted vertically in concrete wall complete with mounting brackets sized to suit cable tray width and loading. Use approved anchor bolts for fastening brackets.
- .4 Where supports cannot be installed due to lack of suitable structural members, the Contractor shall use longer lengths of cable tray and upgrade cable tray class accordingly to span between the available structural supports.
 - .1 This may require the cable tray classification to be adjusted (increased).

CABLE TRAYS FOR ELECTRICAL SYSTEMS

- .2 This may require Unistrut or other suitable structural means to span across the structural members (typically spanned and fastened between two or more purlins, or joists).
- .3 This may require Unistrut floor supports in areas where existing HVAC or other large equipment may impede a section of ceiling space. The floor supports shall not interfere with the rules of egress or required working space around equipment.

2.3 Expansion Joints

- .1 The table below has been provided as a minimum requirement for incorporation of expansion joints into the cable tray installation. Where the cable tray manufacturer has posted data indicating the expansion of their product may require additional gap, the more stringent shall apply.
- .2 Use expansion-joint splice plates to allow 50 mm free movement between adjacent trays when crossing a building expansion joint.
- .3 The table below provides the maximum spacing between expansion joints that allows for 250 mm (1") movement.
 - .1 Where a non-metallic tray is installed requiring 16 mm (5/8") movement, multiply maximum spacing between expansion joints by 0.625.

Application Type	Temp Differential* (°C)	Steel		Alum		Fiberglass	
		(m)	(ft)	(m)	(ft)	(m)	(ft)
Indoor Installation	14	156	512	79	260	203	667
	28	78	256	40	130	102	333
	42	52	171	27	87	68	222
	56	39	128	20	65	51	167
Outdoor Installation	70	31	102	16	52	41	133
	83	26	85	13	43	34	111
	97	22	73	11	37	29	95

* Temperature Differential is the difference in temperature between the hottest and coldest days of the year.

3. EXECUTION

3.1 Installation

- .1 Install all equipment in accordance with Manufacturer's recommendations.
- .2 Provide a cable tray system for three (3) or more cables when cable lengths exceed 3 m.
- .3 Cables in Cable Tray:
 - .1 Install cables individually.
 - .2 Lay cables into cable tray to provide a minimum of cable crossovers.
 - .3 Secure cables in cable tray at 6 m centres with nylon ties.

CABLE TRAYS FOR ELECTRICAL SYSTEMS

- .4 The air space between cables shall be 100% of the largest conductor diameter or unless otherwise specified. Provide a minimum of 20% space area in all cable tray systems.
- .4 Do not install tray routes and tray supports until the location of same has been reviewed by the Contract Administrator.
- .5 Suspend cable trays on rod hangers and hanger clamps or channels spaced as required by loading classification rating and not more than 3000 mm on centers. Fasten hangers to channels securely mounted to the structure.
- .6 Do not drill through wood ceiling trusses. Provide wood blocking on top of ceiling truss to anchor rod hangers and channels.
- .7 Install trays and raceways generally as indicated on Drawings. Coordinate this Work with the other trades to ensure adequate horizontal and vertical clearances.
- .8 Provide minimum vertical clearance above the trays as per the CEC or as indicated on the Drawings.
- .9 Provide minimum 600 mm horizontal clearance on one side of cable tray throughout.
- .10 Install tray systems in such a manner as to conserve headroom and minimize the use of free space through which they pass. Maintain a minimum 2100 mm clear headroom wherever possible.
- .11 Run trays parallel to building lines unless otherwise shown on the Drawings. Where two or more trays run the same route, make parallel and ensure offsets and bends are uniform.
- .12 When the ends on square strut channel type shelf brackets are below 2100 mm above finish floor (AFF) in a walking area, cut flush with tray. Permanently cap the end of square strut channels, etc. with plastic caps. Suitably protect sharp corners and edges of tray to prevent personal hazard.
- .13 Where hanger rods are used, use stainless steel and not be smaller than 12 mm in diameter.
- .14 Provide a green PVC-insulated bonding conductor of 4/0 AWG stranded tin plated copper on tray throughout the entire length of each tray run. Attach bonding conductor to tray at minimum every 15 m with approved ground wire clamps and anti-oxidizing compound, and at each isolated segments of tray. Bonding conductor insulation to be FT4 rated for indoors and FT1 rated for outdoors. For trays stacked vertically above each other (maximum of three trays in stack), provide a bonding conductor throughout the entire length of one tray with bonding jumpers at a minimum of every 15 m from that tray to the other tray(s) in the tray stack, and at each isolated segments of tray. Solidly connect each tray run to the electrical room ground bus.
- .15 Where a common tray is shown on Drawings, separate the cables for different voltage classes from each other by metal barriers as supplied by the tray manufacturer.
- .16 Check all trays for surface smoothness prior to installation and remove all burrs, ridges, etc. on tray surfaces facing cables.

CABLE TRAYS FOR ELECTRICAL SYSTEMS

.17 Warning Notices:

- .1 Provide yellow plates with black lettering.
 - .2 Install warning notices every 10 m on all cable trays in accordance with CSA C22.1.
- .18 Size cable trays as indicated on Drawings. If any discrepancies are found or changes in tray size are required, advise the Contract Administrator before installing the tray.
- .19 Fire stop tray penetrations at fire rated walls.

3.2 Cables in Cable Tray

- .1 Install cables individually.
- .2 Lay cables into cable tray. Use rollers when necessary to pull cables.
- .3 For horizontal cabling secure cables in tray at intervals not more than 1.5 m in accordance with CEC/MEC Rule 12-2202 5).
- .4 For vertical cabling provide support for cables in tray at intervals not exceeding those specified in CEC/MEC Table 21.
 - .1 Tie wraps are not permitted to support cables in vertical sections of cable tray, support must be provided in accordance with CEC/MEC Rule 12-120.
 - .2 Tie wraps may be used in horizontal sections of cable tray to maintain cable spacing.
- .5 Mark power and communication cables in accordance with colour coding outlined in Section 26 05 01 - Common Work Results for Electrical.

END OF SECTION

COMMISSIONING OF ELECTRICAL SYSTEMS

1. GENERAL

1.1 Scope of Work

- .1 Testing and commissioning are called for throughout the individual specifications. This does not relieve this trade from providing all testing and commissioning necessary to ensure that systems and equipment operate as required and that they interface with other systems and equipment as required.
- .2 Coordinate starting of electrical equipment and systems with testing, adjusting, and balancing, and demonstration and instruction of:
 - .1 Electrical equipment and systems specified in Division 26.
 - .2 Other electrical equipment and systems specified in other Divisions.
- .3 Where any equipment or system requires testing, adjusting or balancing prior to starting, ensure that such Work has been completed prior to starting of electrical equipment and systems.

1.2 Section Includes

- .1 Commissioning of all building electrical systems and component including:
 - .1 Testing and adjustment.
 - .2 Demonstrations and Instruction.
 - .3 Instructions of all procedures for City personnel.
 - .4 Updating as-built data.
 - .5 Co-ordination of Operation and Maintenance material.

1.3 Quality Assurance

- .1 Provide qualified trades persons, certified testing agencies, factory trained and approved by the Contract Administrator.
- .2 Submit the names of all personnel to be used during the commissioning activities for City Approval.

1.4 Commissioning

- .1 Further to Division 1 – Commissioning Plan, the purpose of the commissioning process is to fully test all building systems including architectural, mechanical, and electrical components and operating procedures by challenging these systems to realistic operation conditions.
- .2 The commissioning activities shall be co-ordinated by the Contractor.

COMMISSIONING OF ELECTRICAL SYSTEMS

- .3 Commissioning activities for the electrical systems must have available up to date As-Built Drawing information and accurate Operations and Maintenance Manuals. These documents shall be a major part of this activity.
- .4 Contractor shall be responsible to update all documentation with information and any changes duly noted during the commissioning exercise.
- .5 Contractor shall arrange for all outside suppliers, equipment manufacturers, test agencies and others as identified in the commissioning sections of this specification.

1.5 Submittals

- .1 A commissioning document shall be prepared by the Contractor prior to conducting these activities for use by the Contract Administrator.
- .2 The electrical Subcontractor shall be responsible for ensuring all activities are properly documented in this manual and co-ordinated through the Contractor.
- .3 As-built drawings and data books must be available two (2) weeks prior to commissioning for review and use by the Contract Administrator prior to the start of the commissioning activities.

1.6 Preparation

- .1 Provide test instruments required for all activities as defined in the commissioning documents.
- .2 Verify all systems are in compliance with the requirements of the commissioning documents prior to the pre-commissioning check out operation.
- .3 Confirm all scheduled activities have identified personnel available.
- .4 Where systems or equipment do not operate as required, make the necessary corrections or modifications, re-test and re-commission.

1.7 System Description

- .1 Perform all start-up operations, control adjustment, trouble shooting, servicing and maintenance of each item of equipment as defined in the commissioning documentation.
- .2 The City will provide list of personnel to receive instructions and will co-ordinate their attendance at agreed upon times.
- .3 Prepare and insert additional data in the operations and maintenance manuals and update as-built drawings when needed as additional data becomes apparent during the commissioning exercise.
- .4 Where instruction is specified in the commissioning manual, instruct personnel in all phases of operation and maintenance using operation and maintenance manuals as the basis of instruction.
 - .1 Conduct presentation on the City's premises. The City will provide space.

COMMISSIONING OF ELECTRICAL SYSTEMS

- .2 All presentations shall be video recorded in compliance with the training requirements of the Contract.

1.8 System Start-up

- .1 Instruct Contract Administrator and operating personnel in operation, care, and maintenance of systems, system equipment and components.
- .2 Arrange and pay for services of Manufacturer's factory service Engineer to supervise start-up of installation, check, adjust, balance, and calibrate components and instruct operating personnel.
- .3 Arrange and pay for services of an instrumentation technician to check, adjust, balance, and calibrate components and instruct operating personnel.
- .4 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 aspects of its care and operation.

1.9 Final Report

- .1 This trade shall assemble all testing data and commissioning reports and submit them to the Contract Administrator.
- .2 Each form shall bear signature of recorder, and that of the supervisor of reporting organizer.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 Energizing Electrical System

- .1 Prior to energizing the new electrical system:
 - .1 Verify supply authority voltage and phase rotation.
 - .2 Close and open all devices to ensure proper mechanical operation.
 - .3 Verify communication to the SCADA system is functional.

3.2 Starting Motors

- .1 Prior to starting motors:
 - .1 Confirm motor nameplate data with motor starter overloads.

3.3 Energizing Equipment

- .1 Prior to energizing equipment provided under other Sections and equipment provided by the Contract Administrator, confirm equipment nameplate with characteristics of power supply.

END OF SECTION

DISINFECTION OF STRUCTURES AND PIPING

1. GENERAL

1.1 Work Included

- .1 Disinfection of water retaining structures and piping.

1.2 Reference Standards

- .1 AWWA C651 Disinfecting Water Mains.
- .2 AWWA C652 Disinfection of Water Storage Facilities.
- .3 AWWA C653 Disinfection of Water Treatment Plants.

1.3 Coordination

- .1 Coordinate with other Divisions to ensure there are no conflicts in the Work.

1.4 Schedule of Items to be Disinfected

- .1 The Contractor shall disinfect all items which will be used for the conveyance or storage of potable water; these include but are not limited to the following structures and piping:
 - .1 UV Reactors.
 - .2 All pipework conveying treated water, including any exposed upstream or downstream piping.
- .2 The City is to be consulted for coordination of disinfection procedures.

1.5 Entry Into Existing Structures

- .1 Where work is undertaken within existing structures or piping used for the storage or conveyance of treated water, they shall be disinfected prior to being put back into service.

2. MATERIALS

2.1 Water

- .1 Water for disinfection shall be provided by the City. The water shall be free from all suspended and deleterious material. The water can be obtained from the water treatment plant after consultation with the City.

2.2 Calcium Hypochlorite

- .1 Calcium hypochlorite shall comply with AWWA B300.

2.3 Sodium Hypochlorite

- .1 Sodium hypochlorite shall comply with AWWA B300.

DISINFECTION OF STRUCTURES AND PIPING

3. EXECUTION

3.1 Applicable Standards

- .1 Except as otherwise specified, the work shall be undertaken in accordance with the following standards:
 - .1 AWWA C651 Disinfecting Water Mains.
 - .2 AWWA C652 Disinfection of Water Storage Facilities.
 - .3 AWWA C653 Disinfection of Water Treatment Plants.

3.2 Cleaning

- .1 The Reactors and pipework to be disinfected shall be thoroughly cleaned prior to disinfection.
- .2 All construction material not part of the permanent structure shall be removed.
- .3 The surfaces of walls, floor and roof of structures shall be cleaned using a high pressure jet, sweeping, scrubbing or equally effective means.
- .4 Pipes shall be flushed to remove all dirt prior to disinfection. If necessary, the pipe shall be cleaned by swabbing or other mechanical means as directed by the Engineer.

3.3 Disinfection of Piping

- .1 All equipment and piping affected by the work shall be cleaned and disinfected in accordance with Section 4.6 of AWWA C651-14 Disinfection of Water Mains and approved by the Contract Administrator before being put back in service.
- .2 In general, once pipe is cleaned, spray a 200-mg/L free chlorine solution on all surfaces.
- .3 After thirty (30) minutes, fill line and perform bacteriological sampling as described in Section 5.1 of AWWA C651-14 and Section 3.6 of this Specification.

3.4 Disposal of Chlorinated Water

- .1 After the disinfection process is complete, the heavily chlorinated water shall be drained and disposed of in an approved manner, and in accordance with Division 1.
- .2 Coordinate with the City regarding water disposal so as not to interfere with other waste streams.
- .3 Heavily chlorinated water shall not be discharged to local sewers without first obtaining the permission of local regulatory authorities.
- .4 If other disposal methods are impractical, dechlorinate the chlorinated water using methods outlined in AWWA C653.

DISINFECTION OF STRUCTURES AND PIPING

3.5 Filling of Piping and Structures

- .1 Immediately following the disposal of the heavily chlorinated water, the piping and structure shall be filled with potable water.
- .2 It is recommended that the potable water used for filling of the structures be sampled to ensure that no bacteriological contamination exists in the fill water prior to placement in the pipes or structures.

3.6 Bacteriological Testing

- .1 After the chlorination procedure is complete and the piping and structure has been filled with potable water, duplicate samples shall be taken at least thirty (30) minutes apart and shall be tested for coliforms in accordance with the Standard Methods for the Examination of Water and Wastewater. Two (2) consecutive negative tests are required in order for the bacteriological testing to pass.
- .2 Bacteriological testing is to be performed by an accredited laboratory that is able to perform the tests. Transportation and testing of all samples are at the Contractor's expense.

3.7 Disinfection

- .1 If the initial disinfection fails to produce satisfactory bacteriological samples, the pipes and reactors shall be disinfected again and the water resampled.
- .2 If check samples show the presence of coliform organisms, then the pipes and reactors shall be disinfected again until check samples confirm absence of coliform organisms.
- .3 All costs associated with the disinfection and testing shall be borne by the Contractor.

3.8 Placing Into Service

- .1 No piping, equipment, or structure that is required to be disinfected shall be placed into service until bacteriological samples indicate the absence of contamination.

3.9 Entry into Existing or Previously Disinfected Potable Watermains or Structures

- .1 Where work takes place within existing or previously disinfected potable water storage piping or equipment, the Contractor shall assure that the following measures are taken:
 - .1 All personnel shall wear clean, dirt-free protective overalls and disinfected, clean rubber footwear. Such footwear shall be reserved solely for use within the affected areas and shall not be worn in undisinfected areas. Such footwear shall be dipped in a Sodium hypochlorite solution tray before entering potable watermains or structures.
 - .2 All tools and equipment shall be clean, grease free and spray disinfected before use. Equipment which shows evidence of fuel, oil or grease leakage shall not be used.
 - .3 The immediate area surrounding the access point for the structures concerned shall be cleaned and spray disinfected prior to the start of work. All previously disinfected footwear, tools, or equipment removed outside this area of the affected structures shall be re-disinfected on return.

DISINFECTION OF STRUCTURES AND PIPING

- .4 Disinfection of footwear, tools, equipment and access areas shall be by spraying with a 200 mg/L concentrated chlorine/water solution.
- .5 Workers who show signs of illness shall not work within the affected structures or surrounding access area.

3.10 Costs

- .1 The Contractor shall bear the cost for chemicals, de-chlorination and disposal of water.

END OF SECTION

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

1. GENERAL

1.1 General Requirements

- .1 This Section defines the general requirements for the design, fabrication, supply, installation, programming, testing, and commissioning of instrumentation and control systems. This Section supplements the requirements of Division 1.

1.2 Definitions

- .1 Interpret specialized terms not explicitly defined herein in accordance with ISA S51.1, NEMA ICS 1, IEEE 100, and The Communications Standard Dictionary, by Martin H. Weik.
- .2 SCADA (Supervisory Control and Data Acquisition) – a term used to describe all components and sub-systems of the plant instrumentation, control, and information systems.
- .3 P&ID (Piping and Instrumentation Diagram) – a drawing typically used by both process and automation contractors.
- .4 PLC (Programmable Logic Controller) – a term describing the distributed process controllers that detect the status of field sensors and control the function of valves, pumps, and equipment.
- .5 OPC (OLE [Object Linking and Embedding] for Process Control) – a registered trademark for an inter-operable software communication standard.
- .6 FCE (Final control element) – a control device that can be electrical, electro-mechanical, or mechanical.
- .7 HMI (Human Machine Interface) – a custom field interface for operator use.
- .8 OIT (Operator Interface Terminal) – a computer workstation.
- .9 MCC (Motor Control Centre) – an equipment that controls motors and provides power to auxiliary systems.
- .10 MCP (Motor Control Panel) – an equipment that performs motor control.
- .11 ISD (Instrument Standard Details) – a drawing showing typical layouts, installation, materials, and other instructions.
- .12 ILD (Instrument Loop Diagrams) – detailed drawings showing typical interconnections for the specified instrumentation and control devices.
- .13 MCS (Motor Control Schematics) – they are detailed drawings showing typical interconnections of motor control equipment.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

1.3 References, Standards, and Codes

- .1 This Specification contains references to the following documents. They are a part of this Section as specified and modified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.
- .2 Where local laws, ordinances, rules, codes, standards, regulations, bulletins, by-laws, and orders from the Authorities Having Jurisdiction conflict with the requirements of this Section the most stringent shall apply.
 - .1 To provide further clarification on the requirements this section, the standards and requirements provided within this Division herein are in addition to providing the minimum work to local requirements.

Reference	Title
API RP550-86	Manual on Installation of Refinery Instruments and Control Systems, Part I - Process Instrumentation and Control Sections 1 Through 13
API-RP551-558	Manual on Installation of Refinery Instruments and Control Systems, Part I--Process Instrumentation and Control Sections 1 through 13
ASME BPVC-VIII-1, VII	Rules for Construction of Pressure Vessels
ASTM B68/B68M-11	Seamless Copper Tube
ASTM D883-89	Terms Relating to Plastics
CEC	Canadian Electrical Code
City of Winnipeg	Electrical Design Guide
City of Winnipeg	Automation Design Guide
IEEE 100	Dictionary of Electrical and Electronic Terms
ISA 7.0.01	Quality Standard for Instrument Air
ISA RP7.1-56	Pneumatic Control Circuit Pressure Test
ISA RP12.6	Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
ISA RP12.06.01	Recommended Practice for Wiring methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety
ISA 5.4	Instrument Loop Diagrams
ISA 51.1	Process Instrumentation Terminology
ISA S18.1	Annunciator Sequences and Specifications
ISA S51.1	Process Instrumentation Terminology
MBC	Manitoba Building Code
MEC	Manitoba amendments to the Electrical Code
NEMA 250	Enclosures for Industrial Controls and System
NEMA ICS 1	Industrial Control and Systems General Requirements
NEMA ICS 2	Industrial Control Devices, Controllers, and Assemblies

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

SAMA PMC 17-10-63	Bushings and Wells for Temperature Sensing Elements
UL 1012-89	Power Supplies
UL 94-80	Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

- .3 Comply with all laws, ordinances, rules, codes, standards, regulations, bulletins, by-laws, and orders of all Authorities Having Jurisdiction relating to this work and enforced in the locality of jobsite. If otherwise specified herein the bare minimum of the code(s) and requirements shall first be met, and specified requirements shall be in addition to the code(s) and requirements.
 - .1 Supply and install all material, equipment, wiring, and labour necessary for the installation of the systems detailed on the Drawings in accordance with the latest edition of the Canadian Electrical Code, Manitoba Electrical Code, and building codes. Where a discrepancy is found between the Contract documents and the Codes the more stringent shall apply.
 - .2 In accordance with Manitoba's Workplace Safety and Health Act W210 (WSH), which calls on other Safety Standards such as CSA Z432/Z434/Z460. These other standards are based on and/or further call upon other sub-standards. Equipment shall be assessed and Safety shall be designed to the requirements of the equipment, the use of it, and the process it is part of. When Safety is required it shall not only include the vender equipment but also the subsystem devices/equipment or process loop equipment it is a part of.

1.4 Permits, Fees, and Inspection

- .1 Submit to Electrical Inspection Department and Authority Having Jurisdiction (AHJ) necessary number of Drawings and Specifications for examination and approval prior to commencement of Work.
 - .1 The Site falls under the jurisdiction of the RM of Springfield.
 - .2 AHJ for electrical permits is Manitoba Hydro.
- .2 Pay associated fees.
- .3 Notify the Contract Administrator of changes requested by the AHJ prior to making changes.
- .4 Furnish a Certificate of Final Inspection and approvals from the AHJ to the Contract Administrator.
- .5 At the time of issuance of any/all electrical Permit(s), provide a copy to the Contract Administrator.

1.5 Work Included

- .1 Supply, install, commission, provide warranty, and fully document a complete instrumentation and control (I&C) system as shown on the Drawings and as specified herein. The instrumentation and control system contains vendor component subsystems specified in this and other sections of the Specification.

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- .2 Component subsystems of the instrumentation and control system will include, but are not limited to, the following:
 - .1 Primary elements and transmitters.
 - .2 Final control elements (FCE).
 - .3 Instrumentation and control field devices.
 - .4 Instrumentation and control junction boxes and marshalling panels.
 - .5 Instrumentation and network cabling.
 - .6 Instrumentation power supplies and UPS units.
 - .7 Conduit and cable tray.
 - .8 Vendor supplied packaged subsystems.
 - .9 Programmable Logic Controller (PLC) Control Panels.
 - .10 Human Machine Interface (HMI).
 - .11 Supervisory Control and Data Acquisition (SCADA) Hardware and Software.
- .3 The instrumentation and control system will contain vendor component subsystems which must be integrated with the plant PLC system, and/or SCADA.
- .4 Provide all labour, products, and services in necessary quality and quantities to meet the performance requirements for the Contract and provide a fully operational system.
 - .1 All instrumentation and control components supplied under other Sections of this Specification, to be connected to instrumentation and control components supplied under this Section of the Specification, comply with the requirements stated in the Contract Documents.
 - .2 Itemize all non-conformities noted above and forward them to the Contract Administrator. Any delays in construction resulting from the delivery to Site of non-conforming instrumentation and control components shall be borne by the Contractor.
 - .3 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Contract Administrator prior to installing any equipment of this type.
 - .4 Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.
- .5 Where packaged, stand-alone control systems are supplied under other Divisions of this Specification, provide cabling to connect to the required remote monitoring and/or control functions. Provide end-to-end commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other Divisions of this Specification.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

- .6 Codes, Rules, Permits & Fees:
 - .1 Give all required notices, submit drawings, obtain all permits, licenses, and certificates, and pay all fees required for this work.
 - .2 Comply with all laws, ordinances, rules, regulations, codes, and orders of all AHJ.
 - .3 Give all required notices, submit drawings, obtain all permits, licenses, and certificates, and pay all fees required for this work.
 - .4 When Substantial Completion has been certified, furnish a certificate of inspection and approvals from an inspection authority to the Contract Administrator in preparation for the Contract Administrator's Final Inspection as specified in Section 01 78 00 - Closeout Submittals.
 - .5 Coordinate with Section 26 05 01 - Common Work Results Electrical.

1.6 Quality Assurance

- .1 The instrumentation Subcontractor shall be a firm normally engaged and fully competent in the type of Work described in this Division. The firm shall have been continuously and successfully engaged in this business for at least five (5) years.
- .2 Electrical work to be carried out by qualified, licensed journeyman electricians who hold valid license in accordance with AHJ.
 - .1 Qualified journeyman electricians shall perform all power and control cabling installation and connections.
 - .2 The journeyman electricians shall provide this Work under direction of the licensed journeyman instrument mechanic to ensure coordination of the Work, and to ensure accommodation
 - .3 of any instrument specific installation requirements.
- .3 Instrumentation and control work to be carried out by qualified, licensed journeyman instrument mechanics who hold valid license in accordance with the Manitoba Trade Regulation.
 - .1 Journeyman familiar with the devices being installed shall perform all instrument hook-ups, calibrations, setups, programming, and checkouts.
- .4 Standards of Workmanship:
 - .1 Execute all work in a manner which will result in the complete installation presenting an acceptable appearance, to a level of quality defined this Specification.
 - .2 Employ a competent supervisor and a sufficient number of licensed tradesmen to complete the Work in the required time.
 - .3 Arrange and install products to fit properly into designated building spaces.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

- .4 Unless otherwise specified or shown, install products in accordance with the recommendations and ratings of the product manufacturers.

1.7 Drawings and Specifications

- .1 Supply and install all items and accessories specified by the Drawings and Specifications in the quality and quantity required. Perform all operations as designated by the Specification according to the methods prescribed, complete with all necessary labour and incidentals.
- .2 Treat any item or subject omitted from this Division's Specifications or Drawings, but which is mentioned or reasonably specified in other Divisions' Specifications or Drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.
- .3 Provide all minor items and work not shown or specified but which are reasonably necessary to complete the Works.
- .4 If discrepancies or omissions in the Drawings or Specifications are found, or if intent or meaning is not clear, request clarification from the Contract Administrator before proceeding with any work.
- .5 Intent of provided documentation is as follows:
 - .1 P&IDs – depict the general intent of the control systems and are to be used as the governing document for the scope of the Contract.
 - .2 Process Control Narratives – when these are included, they provide a written explanation of the control philosophy for process equipment as depicted on the P&IDs.
 - .3 Instrument Index – an index of the instrument and control devices shown on the P&ID diagrams. The index lists the relevant support documentation for supply and installation of the listed devices.
 - .4 Input/Output Index – an index of the SCADA I/O points shown on the P&IDs.
 - .5 Instrument Specification Sheets – detailed specifications and attributes for the supply of instrumentation devices.
 - .6 Instrument Standard Details (ISD) – provide a reference for typical layouts, installation, materials and other instructions for the provision and installation of components in various applications.
 - .7 Location Drawings – Instrumentation devices may be shown on the process and electrical drawings in plan and/or section views to aid in the location of instrumentation devices and other control system components. Refer to other Divisions for exact location of equipment and in-line devices.
 - .8 Instrument Loop Diagrams (ILDs) – detailed drawings showing typical interconnections for the specified instrumentation and control devices. The Contractor is to reproduce an ILD for each device and record all relevant as-built information on each sheet for submission at the completion of the work. Modify the Drawings if necessary and fill in all

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

terminal and wiring numbers, etc. from the relevant Shop Drawings as they become available.

- .9 Motor Control Schematics (MCS) – when these are included, they are detailed drawings showing typical interconnections of motor control equipment. The Contractor is to reproduce a MCS for each motor and record all relevant as-built information on each sheet for submission at the completion of the work. Modify the Drawings if necessary and fill in all terminal and wiring numbers, etc. from the relevant Shop Drawings as they become available.
- .10 Division 40 Specifications – lists qualifications, quality of materials and workmanship, and supplementary information.

1.8 Submittals

- .1 Provide submittals as indicated in the individual Specifications and in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Submit programming and configuration information as information only submittals. Minimum software documentation includes detailed operating description, flow charts, screen dumps or other information that describes the functionality of the program.
- .3 Submit test sheet examples e.g., Loop Check Report and Network/Segment Checkout Forms with proposed Commissioning Plan.

1.9 Shop Drawings

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

1.10 Product Information

- .1 Process Stop: this pushbutton shall be the colour black (alternatively, this can be an HMI pushbutton) and follow the normal process narrative for shutdown.

1.11 Operations and Maintenance Manuals

- .1 Provide operating and maintenance manuals in accordance with Section 01 33 00 - Submittal Procedures and Section 01 91 51 - Operating and Maintenance Manual.

1.12 Record Drawings

- .1 Provide As-built Drawings in accordance with Section 01 33 00 - Submittal Procedures and Section 01 78 00 - Closeout Submittals.

1.13 Site

- .1 Classification of Plant Areas:
 - .1 Refer to Division 26.
 - .2 All electrical and control installations and wiring in these areas shall comply with applicable sections of the CEC/MEC.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

2. PRODUCTS

2.1 General

- .1 Refer to the requirements of Division 1.
- .2 Product Finishes:
 - .1 Products are to be finished to the Manufacturers' standard unless otherwise specified. Where special finishes are specified, refer to other Divisions for details on quality and workmanship of the finishes.
- .3 Use of Products During Construction:
 - .1 Any equipment used for temporary or construction purposes is to be approved by the Contract Administrator. Clean and restore to "as new" condition all equipment prior to the time of Substantial Performance.

2.2 Quality of Products

- .1 All products provided to be CSA or cUL approved where applicable.
- .2 If products specified are not CSA or cUL approved, obtain approval of the relevant provincial regulatory authority. Pay all applicable charges levied and make all modifications required for approval.

2.3 Instrumentation

- .1 Use instruments suitable for the environmental conditions in which they are to be installed.
- .2 Where instruments are installed in locations where injurious conditions may be expected to occur, make provisions to protect the instruments to ensure their proper and reliable operation.
- .3 Provide power surge protectors and devices to protect instruments, equipment, and lines from being functionally impaired or damaged by power surges or environmental conditions such as moisture.
- .4 Provide factory calibration test sheets for all devices being supplied.

2.4 Identification

- .1 Refer to Division 1 and Division 26 for general identification requirements. Provide laminated nameplates with white lettering on black background. Identify with the loop tag number (where applicable) and the device name, function, and instrument range or setpoint value on the nameplate.
- .2 Where it is not possible to attach a laminated nameplate to a field instrument component, provide the component with a stainless steel metal tag firmly wired to the device and identified with the loop tag number.
- .3 Identify all wires where they terminate at the marshalling panels, junction boxes and field devices with a machine printed heat shrink sleeve.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

- .4 Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature of service.
- .5 Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.
- .6 Identify all exposed control cables and conduits at all pull box locations, where the conduits enter or leave a room, and 13 m on centre throughout the room. This shall apply to cables and conduits above removable ceilings. Use Thomas & Betts TY-RAP 5532-M labels conduit identification and stainless steel tags or acceptable alternate in accordance with B7 for the cables.
- .7 For direct current wiring, use black for positive and white for negative.
- .8 For thermistor wiring to motors, use red and blue coloured insulated wire.

3. EXECUTION

3.1 Site Examination

- .1 Refer to the requirements specified in the Bidding Procedures.

3.2 Coordination with Other Divisions

- .1 Examine the Drawings and Specifications of all Divisions and become fully familiar with the Work. Before commencing work notify the Contract Administrator if any conflict exists, and if required, make any necessary adjustments.
- .2 Coordinate the work to be performed under this Section of the Specification with all Divisions installing equipment to ensure that there are no conflicts.
- .3 Install anchors, bolts, pipe sleeves, hanger inserts, etc. required in ample time to prevent delays to other Division's work.
- .4 Do not cut structural members without prior approval from the Contract Administrator.
- .5 Examine previously constructed work and notify the Contract Administrator of any conditions which prejudice the proper completion of this Work.

3.3 Product Handling

- .1 All instrumentation and control components supplied for this project under this Section of the Specification comply with the requirements stated in the instrument Specification Sheets.
- .2 All instrumentation and control components supplied under other Sections of this Specification, to be connected to instrumentation and control components supplied under this Section of the Specification, comply with the requirements stated in the Contract Documents.
- .3 Use all means necessary to protect the products included in this Division before, during and after installation, and to protect products and installed work of all other trades.
- .4 Any damage to the products and/or installed work shall be repaired or replaced. Return all damaged equipment to the factory for total corrective repairs. If deemed necessary by the

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

Contract Administrator, the damaged equipment shall be replaced with new product. The Contractor shall bear any costs due to construction delays resulting from the delay in delivery of acceptable equipment.

- .5 Remove advertising labels from all products installed that have such labels attached. Identification or CSA labels are not to be removed.
- .6 Remove dirt, rubbish, grease, etc. resulting from work performed.
- .7 List any non-conformities and submit them to the Contract Administrator. Any delays in construction resulting from the delivery to Site of non-conforming instrumentation and control components shall be borne by the Contractor.
- .8 The Contractor's responsibility shall also include receiving, uncrating, examining for shortages or damage, assembling, field fitting, installing, mounting, wiring and testing of vendor supplied component subsystems.
 - .1 All instrumentation, primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building. Maintain the space temperature above 10°C and the space relative humidity below 50%.
 - .2 Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Contract Administrator prior to installing any equipment of this type.
- .9 Perform a preliminary examination upon delivery to ensure that:
 - .1 All damage is noted and reported to the Contract Administrator prior to accepting or rejecting delivery.

3.4 Separation of Services

- .1 Maintain separation between the electrical wiring system, building piping, ductwork, and the instrumentation cables so that each system is isolated to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.
- .2 Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings are not to be used for the support of wiring.
- .3 Classifications of Circuits:
 - .1 The circuit categorization shall of first priority follow Canadian Electrical Code with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility:

Very Noisy	High voltage circuits and their associated grounding
	High current (>200 A) LV circuits
	Harmonic-rich LV circuits
	DC circuits: un-suppressed or above 50 V
Noisy	Low current class two (2) circuits
	Medium power pulsed or radio frequency circuits

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

Indifferent	ELV digital status circuits
	Intrinsically safe circuits
	Telecommunications circuits
	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits)
	Any other emergency, shutdown, or high integrity circuit (e.g. toxic gas alarm)
Sensitive	Analogue signal circuits
	Data communication circuits
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors)

.4 Separation of Circuits:

- .1 This Section relates to the running of cables carrying differing types of circuit in close proximity to one another and to other services. Sensitive circuits shall normally be run in overall shielded cable. Very sensitive circuits shall normally be run in individually twisted pair shielded cable.
- .2 For cables sharing the same support/containment system, the following shall provide guidance to minimize extraneous interference.

Segregation between circuits	Very Noisy	Noisy	Indifferent	Sensitive	Very Sensitive
Very Noisy	Thermal grouping as per CE Code	150 mm	300 mm	300 mm	300 mm
Noisy	150 mm	Thermal grouping as per CE Code	150 mm	150 mm	150 mm
Indifferent	300 mm	150 mm	Separation of circuit types	100 mm	100 mm
Sensitive	300 mm	150 mm	100 mm	Touching	50 mm
Very Sensitive	300 mm	150 mm	100 mm	50 mm	Touching

3.5 Wire and Cable

- .1 Refer to other Specifications in Division 26 and Division 40.

3.6 Equipment Connections

- .1 Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible do not make the connections. Report the condition immediately to the Contract Administrator.
- .2 All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. The requirements for instruments and controls may vary with different manufacturer devices and equipment.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

- .1 Installation considerations, calibration/setup/programming, and operation may vary between manufacturers. The Contractor is responsible for evaluating the use of the product or device and accommodating the control system design accordingly to ensure the system and plant operate as intended.
- .2 Control circuits may vary. Verify all control circuits with the suppliers of the equipment and make any corrections to the control wiring diagrams that may be required.
- .3 Provide power disconnect terminals in the marshalling panels for all devices and PLC/DCS/SCADA input/outputs sourced from the panel.

3.7 Wiring to Equipment Supplied by Others

- .1 Install, wire, and commission equipment supplied by other Divisions, that may also have external or field mount control devices.

3.8 Access Panels

- .1 Provide access panels where instrumentation and control system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners. Coordinate the type and size of access panels with the Contract Administrator.
- .2 In removable ceiling areas, provide markers on the ceiling tile to locate equipment requiring access. Use a 25 mm diameter blue circle painted on the access panel to indicate that it is for instrumentation and control system access.

3.9 Instrument Mounting Stands

- .1 Supply and install instrumentation mounting stands as required. Either floor or wall mount the stand as applicable for each application. Fabricate the mounting stands from aluminium or galvanized steel.
- .2 Supply and install protective drip shield for stand-mounted instrumentation equipment if needed. The drip shield is to extend 50 mm at the top and sides from the front face of the equipment. Fabricate the drip shield from aluminium.

3.10 Sealing of Wall and Floor Openings

- .1 Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.
- .2 Seal openings after all wiring entries have been completed.
- .3 Provide fire resistant sealing material free from any compounds which will chemically affect the wiring jacket or insulating material seal for all cable penetrations through fire separations. Acceptable materials are Nelson Blocks, Canstrut "Fire Stop", Electrovert "Multi-Cable Transit" or, Dow Corning RTV Silicone Foam or approved equal in accordance with B7.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

3.11 Sleeves

- .1 Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- .2 For wall, partitions, and ceilings make the ends flush with the finish on both sides. For floors, extend the ends 100 mm above finished floor level.
- .3 Fill the space between the sleeve and the conduit with fire stop material and caulked around the top and bottom with permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.
- .4 Locate sleeves in their final position prior to construction of the walls and floors.

3.12 Connections to Mechanical, Electrical, and Existing Systems

- .1 Refer to Division 26 for the required tie-in procedures.

3.13 Tagging Standards for Devices and Wiring

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

3.14 Calibration

- .1 Calibrations and instrument setup shall be performed prior to testing of the instrumentation and control loops.
- .2 Instruments to be factory pre-calibrated and the calibration verified in-place after installation. Provide a printed record of the factory and as-constructed calibration parameters for "smart" devices.
 - .1 Prior to calibration, completely program all "smart" transmitters including entries of the appropriate range and tag number. Provide a printed record of smart device serial numbers against their assigned tag number.
 - .2 Instruments shall be set up and calibrated by qualified instrument technician working in accordance with procedures set out by the instrument manufacturer.
 - .3 Calibrate all instruments to a minimum accuracy of 0.5% of the full range or better, or to the manufacturer's stated accuracy of the instrument whenever an accuracy of 0.5% is not achievable.

3.15 Testing of Instrumentation Loops

- .1 After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable. Provide notice to the Contract Administrator when the loops are going to be tested so that the tests may be witnessed by the Contract Administrator.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

- .2 Confirm instrument calibrations are complete, PLC or SCADA IO checks are complete, and the scaled ranges for the instruments have been inputted into the PLC/SCADA or signal conditioning equipment prior to loop checks. Each loop check is intended to test the instrument calibration and the scaled value in the controller under real applications to verify the calibrations, instrument settings, loop stability, and readouts. Document the tests performed, and the results of the loop checks for each of the instruments and their values.
 - .1 Calibrate online analyzers with reference standards or lab prepared samples.
- .3 Check the operation of final control elements such as solenoid valves, actuators, etc. by manual control before checking with automatic control.
- .4 Perform tests and record results on test data forms which are included in this Section. Develop additional and/or more detailed test forms as necessary to suit more complex instrumentation. Where the provided test forms are insufficient for the complexity of the test/instrument/equipment, create a similar sheet as required.
 - .1 Upon completion of testing, sign, and date all test reports. Submit the test reports to the Contract Administrator with commissioning deliverables prior to Substantial Performance.
- .5 Verify the status of all points connected or accessible to the PLC and SCADA level where applicable.
 - .1 Check and simulate all alarms and shutdown functions.
- .6 Coordinate and cooperate with the City, Contract Administrator, and other contractors to verify the Control System I/O.

3.16 Commissioning

- .1 Commissioning shall be in accordance with Section 01 91 31 - Commissioning Plan.
 - .1 Use the test forms provided in this Section.

3.17 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.

3.18 Training

- .1 Provide multiple training sessions in accordance with Section 01 78 24 - Training in the proper operation and maintenance of all control devices, final control elements, control valves, operator interface devices, SCADA computers, and ancillary components and instruments described under this division of the specifications.

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

3.19 Test Forms

<u>Form No.</u>	<u>Title</u>
ITR	Instrument Test Report
LPCHK	Instrument Loop Check Sheet

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

LOOP CHECK REPORT

- CHECKED OUT OK
- NOT APPLICABLE
- FURTHER ACTION REQUIRED

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

REMARKS:

READY FOR START-UP

DATE: _____

Installed by: _____

Checked by: _____

INSTRUMENTATION AND CONTROL – GENERAL REQUIREMENTS

INSTRUMENT TEST REPORT

SYSTEM: _____

SERVICE: _____ TAG NO. _____

LOCATION: _____

MAKE: _____ MODEL: _____

SERIAL NO.: _____ CSA: _____

ELEMENT: _____ RANGE: _____

DESIGN SETTING/RANGE: _____ CONTACT TO: _____ ON: _____

SIGNAL IN: _____ OUT: _____ ASSOCIATED INSTRUMENT: _____

INSTRUMENT CONDITION: _____ CONFORM TO SPEC: _____

PROJECT NO.: _____ DATA SHEET: _____

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

TESTED BY: _____ CHECKED BY: _____

DATE: _____ DATE: _____

END OF SECTION

COMMUNICATION SERVICES CABLING

1. GENERAL

1.1 Summary

- .1 Installation services to mount and connect all networking and communications equipment provided as part of this Section. The Contractor is responsible for provision of fibre optic patch cords to complete the assigned paths used for equipment communication.
- .2 Testing services to validate communications between all networking and communications equipment provided as part of this Section.

1.2 Product Data

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures and Division 40.

1.3 Standards

- .1 The publications referred to hereinafter form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of referenced publications in effect at the time of the bid shall govern. In case of conflict between the requirements of this Section and the listed references, the requirements of this Section shall prevail.
- .2 JIS C 5961 - Test methods for connectors for optical fiber cord.
- .3 JIS C 5962 - General rules for connectors for optical fiber cord.
- .4 JIS C 5970 - FO1 type connectors for optical fiber cables.
- .5 JIS C 6820 - General rules of optical fibers.
- .6 TIA/EIA-455-Series - Fiber Optic Cable Tensile Loading and Bending Test.
- .7 TIA/EIA-455-25 - Compressive Loading Resistance of Fiber Optic Cables.
- .8 TIA/EIA-455-33 - Compound Flow (Drip) Test for Filled Fiber Optic Cable.
- .9 TIA/EIA-455-41 - FOTP-86 Fiber Optic Cable Jacket Shrinkage.
- .10 TIA/EIA-455-81 - Fiber Optic Cable Cyclic Flexing Test.
- .11 TIA/EIA-455-86 - Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components.
- .12 TIA/EIA-455-104 - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class IA Graded-Index Multimode Optical Fibers.
- .13 TIA/EIA-455-181 - Standard Test Procedures for Optical Fibers, Cables, Connecting and Terminating Devices, and other Fiber Optic Components (FOTPs).

COMMUNICATION SERVICES CABLING

- .14 TIA/EIA-455-492AAAA-A - Repeated Impact testing of Fiber Optic Cables and Cable Assemblies.
- .15 TIA/EIA-598-A - Optical Fiber Cable Color Coding.
- .16 TIA/EIA-568-C - Optical Fiber Cable Testing Standard.
- .17 UL 1277 - Electrical Power and Control Tray Cables with Optional Optical Fiber Members.
- .18 UL 1666 - Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
- .19 UL 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical Fiber Cables.
- .20 City of Winnipeg - Electrical Design Guide.
- .21 City of Winnipeg - Automation Design Guide.

1.4 Submittals

- .1 Submit product data in accordance with Section 01 33 00 - Submittal Procedures and Division 40.
- .2 All wire and cable shall be cUL or CSA approved and conform to CEC and IEC standards.
- .3 Submissions shall include manufacturers catalog and product literature, installation guidelines, and fibre optic patch panels.
- .4 Shop Drawings:
 - .1 Shop Drawings to be in accordance with Item 1.3 of Section 01 33 00 - Submittal Procedures.
 - .2 Provide termination drawings with complete list of materials and nameplate engraving list. Provide Interconnection wiring diagrams for the complete system showing every fibre in each cable.
- .5 Include network installer qualifications:
 - .1 All installation, termination, and testing of equipment specified herein is to be performed by a qualified, skilled technician who is regularly engaged in such work and is equipped with the necessary tools to perform such work.
 - .2 Provide proof of technical certificate and applicable training of skilled technician to perform such work.

COMMUNICATION SERVICES CABLING

2. PRODUCTS

2.1 Fibre Optic Cables and Accessories

- .1 Supply and install multimode, OM3, 50/125 micron fibre optic cable in areas as shown on the system architecture Drawing.
- .2 Supply and install one fibre optic patch panel in each control panel where fibre optic cable is terminated. Fibre optic cables shall be spliced at fibre optic patch panels only.
- .3 Mechanical splicing is not permitted, only fusion splicing shall be used.
- .4 Provide and install fibre patch cords in each area where fibre optic cable is terminated.
- .5 Label all fibre optic patch panels, jacks, and fibre optic cabling at each end.
- .6 Provide new fibre optic to ethernet switches. Design standard: Siemens RuggedCom equipment or approved equal in accordance with B7.

3. EXECUTION

3.1 Installation

- .1 Install new fibre optic cabling to replace existing serial cabling between the master PLC and the local PLC control panels.
 - .1 The fibre optic cable shall be installed in a fibre optic ring topography.
 - .2 Within each UV PLC control panel, a combination fibre optic to ethernet switch shall be installed. Cat6 cabling shall connect each switch to the local PLC and peripherals. A Cat6 cable shall be installed from the Master UV Panel to Network Cabinet located in the DBPS Control Room (office).
- .2 Fibre optic cables shall be installed in conduit. Conduit systems shall maintain adequate bend radius (i.e., use of long sweep elbows) as required by the cable size and type, and manufacturers recommendations.
- .3 Supply, install, and test a complete fibre optic system as per Specification and Drawings.
- .4 Terminate fibre optic cables on fibre optic patch panels and at both ends with appropriate end connectors and fibre optic patch panels, unless otherwise specified. All fibres shall be terminated in the patch panels.
- .5 Fibre optic cabling between communications rooms to be installed as individual links. No splices or intermediate connections points are allowed. Follow manufacture guidelines and recommendations when installing fibre optical cables.
- .6 Label all fibre optical cables with a high-quality material and adhesive type label and as the following example: 02A-F001, where 02A indicates area number, F indicates fibre cable and sequential number of fibre strands.

COMMUNICATION SERVICES CABLING

- .7 Provide a minimum of 5 m (16.4 ft) of slack (service loop) cable in each communications room, before termination for future additions, moves and changes.
- .8 Ground and testing of communications equipment to be done in accordance with industry standards testing guidelines, and as per local electrical safety code.

3.2 Testing

- .1 Submit all fibre optic cable sample test sheets and all test results. Test forms shall clearly label the test type, the test location, test date, wavelength, index of refraction, cable identification, fibre type, fibre number, fibre colour, and the result or the value of the tested parameter.
- .2 Along with the test forms, the following documents shall be submitted:
 - .1 Manufacturer's data on testing equipment used on this project.
 - .2 Details (such as manufacturer, model number, serial number, and calibration expiration date) of test equipment being used. Must be current within six (6) months of test date.
 - .3 All OTDR traces and end-to-end attenuation testing (attenuation and length) results shall be supplied on printed hard copy and submitted electronically.
 - .4 A completed warranty registration and acceptance by the cable manufacturer.
 - .5 Testing shall be in accordance with TIA -526-14-C. TIA -568, TIA-455-78-B for Multimode 50/125 µm.
 - .6 Test cable for continuity to include cable, connectors, splices (if applicable) and adapters on each strand.
 - .7 Cable links must be tested for 100% of the installed cable. Any failing links must be diagnosed and corrected, followed with a new test to verify that the corrected link meets the manufacturer and standards performance requirements.

3.3 Identification

- .1 Identify all cables.
- .2 Identify each fibre with wire tags using a machine printed heat shrink wire marker, similar to PANDUIT LS4H or approved equal in accordance with B7.

3.4 Operation and Maintenance Instructions

- .1 Submit operation and maintenance (O&M) instructions as specified in Section 01 91 51.
- .2 Include recommended spare parts list.

END OF SECTION

INSTRUMENTATION SPECIFICATION SHEETS

1. GENERAL

1.1 References - General

- .1 The Work includes the provision of instrument specification sheets for all instruments supplied for this project.
- .2 Refer to Section 40 05 00 - Instrumentation and Control – General Requirements for additional general instrumentation and control requirements related to this Section.

1.2 References

- .1 Canadian standards Association:
 - .1 CSA C22.1, Canadian Electrical Code.
 - .2 CSA C22.2 No. 14, Industrial Control Equipment.
- .2 International Society of Automation (ISA):
 - .1 ISA 20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
- .3 National Electrical Manufacturers Association (NEMA):
 - .1 NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - .2 NEMA ICS 6, Industrial Control and Systems: Enclosures.
- .4 Underwriters Laboratories:
 - .1 UL 508A, Industrial Control Panels.

1.3 Instrument Specification Sheets

- .1 Provide data sheets to itemize detailed as-built information regarding the Specification of instruments included as part of this Work for each instrument supplied. The data sheets already included in this Section list specific minimum requirements for particular applications.
- .2 Use forms in accordance with the ISA 20 as a template for the preparation of the specification sheets.

2. PRODUCTS (NOT USED)

INSTRUMENTATION SPECIFICATION SHEETS

INSTRUMENT SPECIFICATION NUMBER: I-101

DEVICE: De Nora Vendor Supply

3. EXECUTION

3.1 De Nora Vendor Supply

.1 Summary:

- .1 The De Nora vendor supply is the Work associated with upgrading each of the six (6) UV Reactors, associated UV reactor PLC Panel to the M580 platform, and associated programming. Programming will involve the new PLC/HMIs for each UV reactor, exchanging memory maps, and updating and prioritizing Alarm states.

.2 Submittals and Shop Drawings:

- .1 Refer to Section 40 05 00 - Instrumentation and Control – General.
- .2 Provide all instrumentation calibration sheets complete with the desired range and accuracy. Specifically provide for the existing UVT instruments.

.3 Work Included:

- .1 At no point in the conversion/upgrade shall the SCADA system lose communication with the UV reactors unless approved by the City.
- .2 Provide project management for the coordination of the Work with others.
- .3 Upgrade of six (6) Sentinel 48 – 9x20 kW UV Reactors and their associated controls as indicated in Section 46 66 23 - Closed Vessel Medium Pressure Ultraviolet Treatment Equipment.
- .4 Clean, and adjust instrument settings as required for all sensor wells and UV duty sensors to accommodate current filtered water at 90% UVT.
- .5 Provide design Drawings, PLC/HMI/SCADA programming, based on the Schneider M580 ePAC PLC system.
 - .1 Upgrade reactor control program to current standard with standard validation.
 - .2 Include the Action Spectra Correction Factor (ASCF) program, sensor calibration, and calculations of the ASCF.
 - .3 Perform CFD Modeling of validation vs. installed piping configuration to show non-significant impact on performance.
 - .4 Include provisions for all updates to current De Nora UV standards with sensor calibration and calculation of the ASCF.
 - .5 Provide SCADA Interface Document minimizing changes to the extent possible.

INSTRUMENTATION SPECIFICATION SHEETS

- .6 Include Schneider/Modicon development software as required. Transfer all licenses to the City, provide all passwords.
- .6 Upgrade PLC and HMI hardware for each of the six (6) UV Reactors, plus one (1) UV Master control enclosure.
 - .1 Remove existing obsolete PLC system hardware and replace with a new Schneider M580 series PLC system.
 - .2 Upgrade DC Drive boards.
 - .3 Remove existing HMIs and replace with new hardware based on the Schneider Electric Magelis product. HMI screen size shall be equal to the existing and updated to modern display and industry best practices. The icons and textual descriptions shall be of sufficient size for ease of use, descriptive, and intuitive.
 - .4 Provide PLC IO provision to each UV reactor control panel to allow for future active harmonic filter (AHF) control.
 - .5 Properly dispose of all PLC's and other equipment removed from service. Refer to further instructions under Division 1.
 - .1 Should the City wish to retain any of the old PLC hardware, provide to the City instead.
 - .6 Recertify the control cabinets or provide CSA special inspections.
- .7 Provide additional Operations and Maintenance information including:
 - .1 Drawing changes.
 - .2 HMI/OIT screens.
 - .3 SCADA ID.
 - .4 PDF and digital copies of all programming and files.
- .4 Drawings:
 - .1 Calgon Carbon to design and update Contract Drawings to incorporate new PLC hardware. Drawings to include (at minimum):
 - .1 Control panel assembly.
 - .2 Sub panel.
 - .3 PLC configuration.
 - .4 I/O Schematic.
 - .5 Drawing Index.
 - .6 Updated Fuse Chart.

INSTRUMENTATION SPECIFICATION SHEETS

**INSTRUMENT
SPECIFICATION NUMBER:** I-102

DEVICE: Manco Control System Inc UV Master Vendor

3.2 Manco Control Systems Inc Vendor Supply

.1 Summary:

- .1 The UV Vendor supply is the Work associated with transitioning support to De Nora for each of the six (6) UV Reactors PLC controllers, and associated programming. Programming will involve the coordination of memory maps, network updates, SCADA updates, as well as programming required to integrate into the Wonderware SCADA level to allow operation of the UV system without the need for a UV master supervisory controller. Upgrade the UV master PLC system to a M580 platform.
- .2 For Information: The City's SCADA software version is Wonderware 2017, which will be upgraded in 2022 as part of the PLC/SCADA upgrade project 805-2019 (w-761).

.2 Submittals and Shop Drawings:

- .1 Refer to Section 40 05 00 - Instrumentation and Control – General.
- .2 Submit the approach and methodology for upgrade of the UV Master panel. Clarify the upgrade option that will be utilized (see below options in Item .3), and proposed coordination of the work.
- .3 Submissions shall include updated drawings prior to commencing the work and an updated final as-constructed set at project close-outs which shall also be included within the control panel.

.3 Work Included:

- .1 At no point in the conversion/upgrade shall the SCADA system lose communication with the UV reactors unless approved by the City.
- .2 Ensure the M580 backbone for the UV Master is prepped and ready by the time the fibre and internet inter-connections between UV panels and the SCADA have been completed. As the upgrades progress the former Modbus Plus network will be reduced, and eventually removed altogether (with the Quantum controllers).
 - .1 The network will consist of Ring Topography.
 - .2 The network will require managed fibre-ethernet switches, utilizing the Modbus TCP/IP protocol.
 - .3 It is desirable to retain the existing UV Master control cabinet to house all new components as required as part of the upgrade efforts. The upgrade will require staging and coordination as the Modbus Plus is taken offline and transitioned to Modbus TCP/IP.
 - .1 All temporary components shall be cleaned up, seals replaced, penetrations sealed etc., after completion of the upgrade.

INSTRUMENTATION SPECIFICATION SHEETS

- .2 Space adjacent to the UV Master control cabinet for a temporary or permanent enclosure is available if required.
- .3 The back of the enclosure door can be used as transitional space.
- .4 If the enclosure door cannot be closed during the upgrade provide a temporary plastic or fabric droop-cloth to reduce dust ingress into the enclosure.
- .4 Option 1 – If upgrading the UV Master to M580 prior to the upgrading all six (6) UV systems ensure the appropriate gateway or X80 proxy module is utilized. Once all UV systems have been upgraded, remove the Modbus Plus gateway/module.
- .5 Option 2 – Upgrading the UV Master to the M580 after upgrading all six (6) UV systems.
- .6 Option 3 – Upgrade the UV Master and all six (6) UV systems as the work progresses.
- .3 Upgrade PLC and network hardware for (1) UV Master control enclosure.
 - .1 Remove existing obsolete PLC system hardware and replace with a new Schneider M580 series PLC system.
 - .2 Remove and replace the Modbus Plus network with a managed fibre-ethernet switch.
 - .3 Properly dispose of all PLC's and other equipment removed from service. Refer to further instructions under Division 1.
 - .1 Should the City wish to retain any of the old PLC hardware, provide to the City instead.
 - .4 Include Schneider/Modicon development software as required. Transfer all licenses to the City, provide all passwords.
 - .5 A preliminary list of hardware has been provided to assist with estimating the level of effort:

<u>QTY</u>	<u>PN</u>	<u>DESC</u>
2	BMEXBP0400	4 SLOT ETHERNET RACK
2	BMEXBP1200	12 SLOT ETHERNET RACK
4	BMXCPS4002	Redundant High Power supply AC 110/220 VAC
2	BMEH584040	M580 HSBY CPU L4 WITH RIO
2	BMENOC0301	M580 ETH COMM CARD
2	490NAC0100	M580 Redundant link RJ45 SFP
2	BMECRA31210	M580 CRA REMOTE IO ADAPTER
2	BMXAMI0810	8 CH AI MODULE 4..20MA
2	BMXAMO0410	4 CH AO MODULE 4..20MA
7	BMXDAI1614	16 CH DI 120VAC ISOLATED
2	BMXDRC0805	8 CH RELAY FORM C
2	BMXFTB2010	TERMINAL BLOCK SCREW
2	BMXFTB2800	TERMINAL BLOCK
9	BMXFTB4000	TERMINAL BLOCK

INSTRUMENTATION SPECIFICATION SHEETS

1	990CHQUAX80060	Evolution PLC-I/O Chassis 140XBP00600 to BM*XBP - without backplate
2	990ADQUAX80112	Evolution I/O-adapter 140ACI/AVI03000 to BMXAMI0800/0810 2 ft
2	990ADQUAX80122	Evolution I/O-adapter 140ACO02000 to BMXAMO0410 2 ft
7	990ADQUAX80110	Evolution I/O-adapter 140DAI54/74000 to BMXDAI1614/1615 2 ft
2	990ADQUAX80134	Evolution I/O-adapter 140DRC83000 to BMXDRC0805 2 ft

SOFTWARE

1	CEXSPUCZXSPMZZ	CONTROL EXPERT XL SINGLE LIC
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- .6 Recertify the control cabinets or provide CSA special inspections.
- .4 Programming and Commissioning.
 - .1 Calibrate the existing UVT instruments to the ranges as required by De Nora (quantity of two (2)).
 - .1 Provide appropriate training to City employees for the care, maintenance, and calibration of the existing UVT instruments. Reference Section 01 78 24.
 - .2 Prepare and coordinate memory maps, update network addresses, and perform setup changes with others for the transitioning from Modbus Plus to Modbus TCP/IP.
 - .3 As each of the six (6) UV systems are upgraded confirm operation of the existing SCADA screens and repair/update as required.
 - .4 A review of the UV system alarms from the six (6) upgraded UV systems, and the UV master will be required.
 - .1 Review all alarms, their priority, and ensure that when these priority/status alarms are passed to the SCADA system that these descriptions are clear, meaningful, and appropriate. Confirm application objects in the SCADA platform are modified to generate appropriate alarms and event statuses.
 - .2 Update the SCADA screens to show when the UV lamp wiper assemblies are operated in manual.
 - .3 Provide and confirm all local UV alarms are passed to the SCADA. Ensure these alarms are meaningful with the appropriate equipment tag for reference.
 - .4 The existing system experiences intermittent issues where the system transfers the UV valves to manual without notification to the SCADA. This situation is undesirable and needs to be rectified in the reprogramming of the Master UV PLC.
 - .5 The current UV system experiences sudden shut-down of UV reactors, or mystery alarms. Monitor the system and correct PLC logic issues to ensure stable use of the UV systems.

END OF SECTION

PROCESS CONTROL NARRATIVE

1. GENERAL

1.1 Process Description

- .1 This Section is provided for reference only to describe the general operation of the ultraviolet (UV) disinfection system installed within the Deacon Booster Pumping Station (DBPS). For further details on the functionality of the City's existing water treatment system, refer to **Appendix E**. The UV disinfection system consists of a suction header, five (5) pumps, an intermediate header, three (3) banks of two (2) reactors each totalling six (6) UV reactors, and a discharge header divided into the Branch I and Branch II Aqueducts.
- .2 This document is intended to provide an overview of the functions and features of the UV Disinfection System after modifications/upgrades under this Contract are complete. Standard Operating Procedures and component Operating and Maintenance manuals for specific and detailed procedures are to be submitted by the Contractor as per Section 01 91 51.
- .3 Upon completion of validation testing as per Section 01 91 31, the contractor shall submit a revised Process Control Narrative, using this Section as a template, documenting validated operating conditions.
- .4 The existing UV Disinfection System includes the following:
 - .1 Six (6) Calgon Sentinel UV reactor systems with power panels, control panels, and operator interface system.
 - .2 Five (5) hydraulically operated pump discharge control valves.
 - .3 Six (6) magnetic flow meters.
 - .4 Six (6) electrically operated control valves.
 - .5 Mechanical HVAC systems.

2. PRODUCTS

2.1 Process Equipment Numbering

- .1 The process equipment numbering has been provided below for ease of identification:
 - .1 Pumps are designated P-D001A, P-D002A, P-D003A, P-D004A, and P-D005A.
 - .1 Pump suction isolation valves are designated HV-D001A, HV-D002A, HV-D003A, HV-D004A, and HV-D005A.
 - .2 Pump discharge valves are designated FV-D001B, FV-D002B, FV-D003B, FV-D004B, and FV-D005B.
 - .3 Pump discharge isolation valves are designated HV-D001C, HV-D002C, HV-D003C, HV-D004C, and HV-D005C.

PROCESS CONTROL NARRATIVE

- .2 Isolation valves on the intermediate header are designated HV-D010A, HV-D010B, HV-D010C, HV-D010D, and HV-D010E.
- .3 UV reactors on Bank 1 are designated UVR-D100A and UVR-D200A; UV reactors on Bank 2 are designated UVR-D300A and UVR-D400A; and UV reactors on Bank 3 are designated UVR-D500A and UVR-D600A.
 - .1 For Bank 1:
 - .1 The inlet isolation valves are designated FV-D100A and FV-D200A.
 - .2 The magnetic flow meters are designated FT-F100A and FT-200A.
 - .3 The outlet flow control valves are designated FCV-D100A and FCV-D200A.
 - .2 For Bank 2:
 - .1 The inlet isolation valves are designated FV-D300A and FV-D400A.
 - .2 The magnetic flow meters are designated FT-F300A and FT-400A.
 - .3 The outlet flow control valves are designated FCV-D300A and FCV-D400A.
 - .3 For Bank 3:
 - .1 The inlet isolation valves are designated FV-D500A and FV-D600A.
 - .2 The magnetic flow meters are designated FT-F500A and FT-600A.
 - .3 The outlet flow control valves are designated FCV-D500A and FCV-D600A.
- .4 Isolation valves on the discharge header are designated HV-D020A, HV-D020B, HV-D020C and HV-D020D.
- .5 The magnetic flow meter on the discharge line is designated FT-D021A.
- .6 Flow valves on the discharge lines are designated FV-D021A for Branch I and FV-D022A for Branch II.
- .7 Isolation valves on the lines going from Branch I and Branch II back to the water treatment plant (WTP) are designated HV-D021A and HV-D022B.

3. EXECUTION

3.1 General

- .1 The filtered water treatment capacity of each reactor after upgrades is approximately 125 ML/d. The UV reactors are to be validated as part of the Work to establish the treatment capacity and control algorithms to be used. It should be noted that the UV reactors are capable of treating flows both above and below the validated flow range but the treatment effectiveness outside of the validated range is not certified and therefore should be avoided during normal operation.

PROCESS CONTROL NARRATIVE

- .2 The DBPS currently operates two independent systems; the Branch I and Branch II Aqueducts. Branch I delivers water primarily to the McPhillips reservoir and Branch II delivers water primarily to the Hurst reservoir. An interconnecting pipe joins the two branch aqueducts near the MacLean reservoir allowing MacLean to be fed from either branch aqueducts. The interconnection also allows cross feeding from one branch to the other to facilitate maintenance activities.
- .3 Flow through the branch aqueducts is manually set by adjusting reservoir inlet valve positions at McPhillips, Hurst, and MacLean reservoirs. Valve FV_D021A(DHV-1) at the DBPS is also manually adjusted in conjunction with the McPhillips inlet valve to maintain normal water levels in the Tache surge tower. The discharge flow rate, and the difference between it and the sum of the UV reactor flow rates are displayed on the SCADA workstation at Deacon for reference to the Branch I, and Branch II flow rates, respectively.
- .4 Filtered water from the WTP plant is pumped from the clearwells to the three (3) UV reactor banks with five available pumps that draw from the suction header.
- .5 The six (6) UV reactors are each equipped with individual control and power panels, isolation valves, flow control valves, and magnetic flow meters. Each UV reactor operates independently and has an automatic dose-paced control system, fully capable of allowing lamps to maintain a target UV dose based on flow rate, lamp intensity, and water quality conditions. The dose-pacing control strategy resides in each of the individual reactor PLCs.
- .6 The delivered dose must be greater than or equal to the validated dose for the target pathogen and target log inactivation level. Validated operating conditions for the Calculated Dose Approach are as follows:
 - .1 The operating UVT must be equal to or greater than the minimum UVT evaluated during validation testing.
 - .2 The operating flow rate must not exceed the flow rate evaluated during validation testing.
- .7 The UV system is monitored and controlled from a computer workstation (OIT). The Supervisory Control and Data Acquisition (SCADA) system provides full access to control and monitor the UV reactors remotely.
- .8 The UV Master PLC communicates with the individual reactor PLC's, Station PLC, D21 PLC, and SCADA and then performs all interlocking and control functions to operate the UV system. The main function of the UV Master PLC is to provide supervisory control of the UV system by deciding how many reactors need to be online for each branch and to maintain flow split to each operating UV reactor within set operating limits. This PLC also coordinates UV system operation with other pump station operations and provides safety interlocking with the booster pumps, and station flood alarm shutdown.
- .9 An important goal of the UV control system is to provide 100% treatment of the flow passing through the station. To facilitate this goal, the reactor flow control valves are normally closed whenever a reactor is offline. When a reactor is requested to start, the flow control valve remains closed until the UV lamps have warmed up and effective treatment is confirmed. Similarly, when a reactor is requested to stop, the flow control valve will first close, and then the reactor is turned off.

PROCESS CONTROL NARRATIVE

- .10 The UV system control sequencer for each branch has duty start/stop flow setpoints and time delay settings to control the starting and stopping of reactors in response to the branch flow rate. When the reactors are online, the flow split to each reactor is governed by flow control valves, which are throttled as required to prevent flows in excess of the validated capacity of the reactor; otherwise, the flow control valves will remain 100% open.

3.2 Combined Branch Operating Scenario (Normal Operating Mode)

- .1 For water demands up to 400 ML/d, it is anticipated that the combined header configuration, where combinations of Branch I and II pumps can be used to simultaneously deliver flow to both Branches, will normally be employed. This configuration also provides flexibility in terms of optimizing the number of UV reactors used to treat flows.
- .2 The flexibility provided by the common header is significant since optimal energy consumption and UV lamp usage is achieved when flow is maximized through individual reactors and, therefore, when the minimum number of reactors is used to treat a given flow rate.
- .3 For example, at a total flow of 300 ML/d evenly split between Branches I and II, two reactors would be required to treat flow for each Branch or four reactors altogether. Assuming a treatment capacity of more than 100 ML/d per reactor, with a combined header it would be possible to use three reactors to treat the same total flow. Also, since there are only two reactors on the Branch I side of the Deacon BPS, the separate header configuration provides limited redundancy in terms of UV treatment.
- .4 At higher flow rates, it may be necessary to throttle flow down Branch I with the discharge header valve FV_D021A (previously known as DHV-1) located inside the DBPS. This allows a greater driving head to be placed on Branch II while controlling the head on Branch I and preventing overflows from the Taché and Branch I surge towers.

3.3 Reactor Control

- .1 Each UV reactor may be controlled locally or remotely based on a local/remote selection at the local control panels.
- .2 When local control is selected, the reactor will not respond to supervisory signals from the UV Master PLC and automatic sequencer control of the respective branch is inhibited.
- .3 When remote control is selected, the reactor will respond to control signals from either the UV Master PLC or operator commands from the SCADA OIT.
- .4 The reactors each have a fully automatic dose control mode and two forms of manual controls that are primarily for maintenance activities.

3.4 Power Failure

- .1 Power failure at the pump station will result in immediate shut down of all pumps and UV reactors. The control system will remain active on UPS power and the emergency generator will start to provide power for life safety and essential services. Pumps and UV reactors are currently only supported by the standby generator, and shall auto-reset upon restoration of power if selected.

PROCESS CONTROL NARRATIVE

- .2 All electrically operated valves will remain in their last positions and the pump discharge control valves will open if they were closed prior to the power failure. These actions effectively return the station to gravity flow mode and to allow any surging or reverse flows to stabilize.
- .3 If the power failure duration is more than a few minutes or if the weather indicates that numerous power failures are likely, the operator should consider stopping the branch flows until the power has stabilized. This will minimize the quantity of untreated water being sent to the city reservoirs and reduce undue stress and cycling on the equipment.
- .4 Upon restoration of power, the UV reactors may be restarted manually or automatically based on the "Auto Restart Reactors after Power Failure" selection in the SCADA system.
- .5 If the auto restart function has been enabled, alarms related specifically to the power failure will automatically reset, the branch sequencer controls will switch back to automatic control, and reactors will be restarted in sequence following a time delay. The delay timer ensures that power is stable and that reactors have cooled down sufficiently to enable restart. It should be noted that in some instances, alarms such as "Loss of Phase" may occur requiring manual reset before the automatic restart of reactors will begin.
- .6 If the auto restart function is turned off, both branch sequencer controls will switch to hand control and alarms will be initiated for "Reactor XXXX flowing without treatment". The operator will be required to take some immediate action, either restarting the reactors or shutting down the branch flows.
- .7 Pump alarms specifically related to the power failure will be reset automatically but the pumps will not restart automatically.

3.5 Process Shut-Down

- .1 The control system is equipped with a Process Shut Down feature for each branch of the UV system. In a shutdown event for the branch aqueduct, the Process Shut Down feature initiates immediate shut down of the reactors, pumps, and flow control valves for the affected branch.
- .2 It should be noted that use of the Process Shut down function may result in air being introduced into the affected branch aqueduct. Follow up of such an event should include inspection of all related equipment and piping according to established protocols. Refilling of the branch aqueduct may also be necessary to displace any air that enters the system.

3.6 Station Flood Alarm Shut Down

- .1 The booster pump station is equipped with a critical alarm called "Station Flood" which is initiated by a High-High water level in the south-east floor sump. Activation of this alarm will cause an immediate shut down of all UV reactors, booster pumps, and all remote-controlled valves related to station isolation.
- .2 It should be noted that occurrence of the station flood alarm may result in air being introduced into the branch aqueducts. Follow up of such an event should include inspection of all related equipment and piping according to established protocols. Refilling of the branch aqueducts may also be necessary to displace any air that enters the system.

END OF SECTION

GENERAL PROCESS PROVISIONS

1. GENERAL

1.1 Requirements

- .1 Modify the existing ultraviolet (UV) disinfection system and provide a fully tested and operational system to meet requirements described herein and in complete accordance with applicable regulations and standards.
- .2 This Section is to be read in accordance with Division 1 sections and in conjunction with the following process, electrical, control and instrumentation specifications and drawings:
 - .1 Section 26 05 01 - Common Work Results for Electrical.
 - .2 Section 26 05 36 - Cable Trays for Electrical Systems.
 - .3 Section 40 05 00 - Instrumentation and Control – General Requirements.
 - .4 Section 40 70 00 - Instrumentation Specification Sheets.
 - .5 Section 46 66 23 - Closed-Vessel Medium-Pressure UV Treatment Equipment.
- .3 Contract Documents and Drawings of this Division are diagrammatic and approximately to scale unless detailed otherwise. They establish scope, material, and installation quality and are not detailed installation instructions.
- .4 Follow Manufacturer's recommended installation details and procedures for the UV disinfection system.
- .5 Where new equipment or electrical panels are required to be installed, install in locations shown on the Drawings with minimum interference with other services or free space. Remove and replace improperly installed equipment to the satisfaction of the Contract Administrators at no extra cost.
- .6 Install equipment to provide access and ease of maintenance.
- .7 Connect to equipment specified in other Sections. Adjust and make corrections as required.
- .8 Contractor shall supply and reinstall the required identification, labeling, or signage for any damaged labels on pipes, valves, and pieces of equipment.
- .9 Contractor shall arrange for all power requirements for the modified system to be met and coordinate necessary revisions to electrical distribution system.

1.2 Discrepancies and Omissions

- .1 These Specifications shall be considered as an integral part of the Drawings, which accompany them, and neither the Drawings nor Specifications shall be used alone. Any items or subject omitted from one but which is mentioned and/or indicated in the other shall be considered as properly and sufficiently specified and shall therefore be provided.

GENERAL PROCESS PROVISIONS

1.3 Transportation and Hoisting

- .1 Assume responsibility for transportation, hoisting, warehousing, and demurrage for all materials to be furnished and installed under this Division.

1.4 Definitions and Interpretations

- .1 Where working pressure or pressure ratings are specified or shown on the Drawings for valves, piping, fittings, equipment, etc., these items shall be suitable for operating at specified pressures and corresponding temperature unless noted otherwise.

1.5 Shop Drawings

- .1 Provide Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures.
- .2 For specific requirements for Shop Drawings for various pieces of equipment, refer to the relevant specific Sections describing the equipment.

1.6 Coordination

- .1 Coordinate the connection of the services of other Divisions to the equipment and material supplied under this Division.

1.7 Cutting and Patching

- .1 Patch building where damaged from equipment installation, improperly located holes etc. Use matching materials as specified in the respective Section.

1.8 Equipment Protection and Clean-Up

- .1 Protect equipment and materials in storage on Site during and after installation until final acceptance. Leave factory covers in place. Take special precautions to prevent entry of foreign material into working parts of piping.
- .2 Protect equipment with polyethylene covers and crates.
- .3 Thoroughly clean both existing and new piping and equipment of dirt, cuttings, and other foreign substances.
- .4 All areas in contact with treated water shall be disinfected in accordance with Section 33 13 00 and approved by the Contract Administrator.
- .5 Ensure that existing equipment is carefully dismantled and not damaged or lost. Do not reuse existing materials and equipment unless specifically indicated.

1.9 Temporary Usage

- .1 Usage by the City of any process device, apparatus, machinery, or equipment prior to substantial performance being issued is not to be construed as acceptance.

GENERAL PROCESS PROVISIONS

1.10 Acceptable Products and Manufacturers

- .1 All equipment and related coatings, lubricants, etc., in contact with treated water shall be NSF/ANSI 61 approved.

1.11 Abbreviations

- .1 ABMA - American Bearing Manufacturers Association.
- .2 AISI - American Iron and Steel Institute.
- .3 ANSI - American National Standards Institute.
- .4 API - American Petroleum Institute.
- .5 ASME - American Society of Mechanical Consultants.
- .6 ASTM - ASTM International (formerly American Society for Testing and Materials).
- .7 AWS - American Welding Society.
- .8 AWWA - American Water Works Association.
- .9 CGA - Canadian Gas Association.
- .10 CGSB - Canadian General Standards Board.
- .11 CISPI - Cast Iron Soil Pipe Institute.
- .12 CPC - Canadian Plumbing Code.
- .13 CSA - Canadian Standards Association.
- .14 EJMA - Expansion Joint Manufacturer's Association.
- .15 MSS - Manufacturers Standardization Society of the Valve and Fittings Industry.
- .16 NACE - NACE International (formerly National Association of Corrosion Consultants).
- .17 NSF - NSF International (formerly National Sanitation Foundation).
- .18 SSPC - Society for Protective Coatings.

2. PRODUCTS

2.1 Spare Parts

- .1 Spare parts are to be supplied by the Contractor as required in the various Specification sections. The lists in these sections are intended to include all parts which normally would be required within a single year for normal preventative maintenance and where fabrication requirements for special parts would delay delivery and could keep an item of equipment out of service for an extended period.

GENERAL PROCESS PROVISIONS

- .2 In addition, the Contractor shall consult with the Manufacturer to provide a list of all spare parts, not including lubricants, which would normally be required through the first five (5) years of operation. Provide prices for each part, guaranteed for six (6) months.
- .3 The Contractor shall be responsible to replenish the spare parts used in the initial year of operation at the end of the Warranty period for the related item(s) of equipment.

2.2 Flanges and Pipe Threads

- .1 Provide flanges on steel equipment and appurtenances that conform in dimension and drilling to ANSI B16.5, Class 150 unless otherwise specified.
- .2 Provide pipe threads that conform in dimension and limits of size to ANSI B1.1, coarse thread series, Class 2 fit.
- .3 Provide flange assembly bolts that are heavy pattern, hexagonal head, carbon steel machine bolts with heavy pattern, hot pressed, hexagonal nuts conforming to ANSI B18.2.1 and B18.2.2. Provide threads that conform to Unified Thread Standards (UTS), Standard Coarse Thread Series (UNC), Class 2A and 2B, ANSI B1.1.

3. EXECUTION (NOT USED)

END OF SECTION

CLOSED VESSEL MEDIUM PRESSURE ULTRAVIOLET TREATMENT EQUIPMENT

1. GENERAL

1.1 Work Included

- .1 This Section specifies the mechanical work necessary to modify the existing Ultraviolet (UV) Disinfection System for the City of Winnipeg (City) Deacon Booster Pumping Station (DBPS). The City has pre-purchased Shop Drawings from De Nora for the reactor upgrades (see **Appendix A** for De Nora's shop drawings).
- .2 De Nora will complete the scope of work as follows (see **Appendix B** for De Nora's proposal).
 - .1 Computational fluid dynamics (CFD) modeling of the existing piping to confirm the modified UV system installed in the existing piping will provide the required disinfection as specified in this document.
 - .2 Submission of a validation report for the system which has been completed in accordance with the latest version of the United States Environmental Protection Agency (USEPA) UV Disinfection Guidance Manual (UVDGM) considering the polychromatic bias issues (e.g. action spectra correction factor – ASCF). The validation report shall be submitted to the Contract Administrator at least twenty (20) Business Days prior to starting Commissioning.
 - .3 Supply and delivery of parts for use within the UV Reactors, including but not limited to the following:
 - .1 Fifty-four (54) replacement sensor wells and UV duty sensors to accommodate 90% UV transmittance (UVT) as compared to the original design of 75% UVT.
 - .2 Eighteen (18) replacement wiper plate assemblies, including a 32 mm (1.25") drive screw and sleeve with each new wiper plate.
 - .3 Eighteen (18) replacement top baffles to accommodate 90% UVT as compared to the original design of 75% UVT.
 - .4 Any parts required for modification to the existing Calgon reactors to accommodate any changes to the revised wiper system, UV sensor wells, and UV sensors.
 - .4 Inspection, commissioning assistance, and testing supervision of the mechanical, electrical and instrumentation and control modifications to the existing UV disinfection system located at the DBPS as indicated and in compliance with Contract Documents.
 - .5 Onsite performance testing, equipment start-up, training of the City's staff, and follow-up testing services as required.
- .3 Submission of Operating and Maintenance (O&M) manuals. De Nora shall be responsible for installation of all components and materials within the reactors, for supervision and assistance to the contractor as required, and for programming/commissioning of each UV system after the UV panels have been upgraded.
- .4 The Contractor shall be responsible for assisting De Nora with the installation of all components and materials external to the reactors, all work exterior to the UV Reactors and

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UV Reactor panels, including isolation of the reactors, preparing the piping and Reactor interior work, disinfection of piping and equipment, all additional electrical work, and instrumentation integrations. Components and materials will be provided to the contractor from De Nora, shop materials will be required to be provided by the contractor. Refer to the De Nora drawings for further information.

- .5 The Contractor shall be responsible for overseeing De Nora's CFD modeling, validation testing, equipment modification, start-up, commissioning and training.
- .6 The Contractor shall be responsible for performance warranty and equipment warranty and guarantee as specified in these Contract Documents.
- .7 The work included in this Section shall be reviewed in conjunction with Divisions 01, 26, 33, and 40.

1.2 Definitions

- .1 ASCF: Action spectra correction factor.
- .2 CFD: Computational fluid dynamics.
- .3 DBPS: Deacon Booster Pump Station.
- .4 DVGW: Deutscher Verein des Gas - und Wasserfaches (German Technical and Scientific Association for Gas and Water).
- .5 Filtered Water: Water produced by the Winnipeg Drinking Water Treatment Plant (WTP).
- .6 LIV: Log Inactivation Value.
- .7 NSF: National Sanitation Foundation.
- .8 SWP: Safe Work Procedure.
- .9 USEPA: United States Environmental Protection Agency.
- .10 UV: Ultraviolet Radiation.
- .11 UV Dosage: the total radiant energy incident from all directions onto an infinitesimally small sphere of area dA for a given exposure time. UV dose is calculated by the following equation:

$$D = I * t$$

where D = UV dose ($mW.s/cm^2$ or mJ/cm^2)

I = Intensity or irradiance (mW/cm^2)

t = exposure time (s)

- .12 UV Reactor or Reactor: A UV unit that has a single feed water connection point and operates in parallel with other UV units and is independently controlled. Each reactor is fully isolatable from other reactors.

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.13 UV Transmittance (UVT): the transmittance of ultraviolet light at a wavelength of 254 nm through the water across a path length of one centimeter (cm). UV transmittance is calculated from UV absorbance (A) at 254 nm by the following equation: $UVT \text{ (percent)} = 100 \times 10^{-A}$.

.14 UVDGM: UV Disinfection Guidance Manual.

1.3 Assistance and Submittals Required after Award

.1 Arrange for a technically qualified Manufacturer's Representative to attend a site visit at the DBPS to inspect the existing UV system, electrical, instrumentation and control equipment and piping assembly prior to starting the design and manufacturing.

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

.3 Product Data:

.1 Provide Manufacturer's printed product literature and datasheets for the modified UV disinfection system, and include product characteristics, performance criteria, physical size, finish, and limitations.

.4 Shop Drawings:

.1 Indicate following items:

.1 Shop Drawings showing the modifications to the existing system including general arrangements and layouts, overall dimensions, connection and mounting details, cross-sections, make and model numbers, and a complete materials list indicating the new components. Include Specifications, catalogue cuts, and descriptive literature. Include control panel drawings, power supply drawings, electrical and control schematics and diagrams. Provide information for all modified components:

.1 Provide certified maximum input power for each lamp including ballast (either one or one-half ballast per lamp).

.2 Variable output electronic ballasts.

.3 UV intensity detection systems.

.4 Power distribution centers.

.5 Automatic mechanical cleaning system.

.2 Installation instructions for the replaced parts indicating assembly and mounting requirements, alignment and assembly tolerances, and points of connection for ancillary services.

.3 Calibration and range requirements for the existing UVT analyzers.

.4 Ballasts shall be installed to De Nora's Technical Specification.

.5 Spare parts list. Include as a minimum sleeves, ballasts, and replacement parts for cleaning/wiper system, with prices current at the time of submission of the Tender.

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- .6 Operating characteristics of all electrical and control equipment; operating voltage and amperage tolerances; ancillary electrical services required.
- .7 A full field wiring schematic, if applicable.

1.4 Quality Control Submittals

- .1 The Contractor shall provide the following items for the entire UV disinfection system prior to the issuance of the Certificate of Total Performance:
 - .1 Operating and Maintenance Manuals as specified in Section 01 91 51 - Operating and Maintenance Manual.
 - .2 UV Equipment Validation reports/certificates.
 - .3 Executed warranties.
 - .4 Manufacturer's Certificate of Proper Installation.
 - .5 Data summary from testing and start-up period.
 - .6 List of all original equipment by model and part number (detailed bill of materials). List manufacturer names, addresses, and phone numbers.
 - .7 Training documents and training completed as specified in Section 01 78 24.
 - .8 Updated process control narrative and SCADA screens.

1.5 Spare Parts

- .1 The Contractor Shall provide the following spare parts:
 - .1 Two (2) sets of expendable materials such as gaskets, and seals for each reactor.
 - .2 Two (2) sets of new and unused special tools required for installation, operation, and maintenance.
 - .3 One (1) set of jigs, fixtures, clamps, lifting beams, hooks, and other instruments required to facilitate the removal, disassembly, re assembly, and installation of each item of equipment within the system.
 - .4 One (1) complete set of UV intensity sensors for each UV reactor.
 - .5 Three (3) DVGW certified reference sensors.
 - .6 Six (6) complete set of wiper assemblies, including all accessories.
 - .7 NSF cleaning solution (if required) for two (2) years including any resupply to take into account shelf life.
 - .8 Sufficient reagents/chemicals, calibration sets, and spare parts for individual equipment items or instruments for two (2) years of operation.

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- .9 Manufacturer recommended spare parts listed in **Table 1** for two (2) years of operation.

Table 1: Manufacturer Recommended Spare Parts

Part No.	Description
350331	Seal, motor mount o-ring
350342	Seal, o-ring for quartz sleeve
S301121	QTZ, END PLUG, 48" AOP/CHEVRON SENTINEL
S301122	LAMP SPACER, 48" SN, AOP/CHEVRON
S301638	UV sensor assembly (0-500 W/m ²)
153735	SENSOR, MAG PROX 12 mm X 1 DC OUT N.O.
S300807	Wiper drive nut
S300861	Wiper element assembly
450625	Cuvette, quartz, 10X10 (450623/450656)
153480	Transformer, ballast 20 kW
153481	Transformer, sat core used with 153480
350222	Fan assembly for power cabinet
350346	SEAL, ORNG EPDM-NSF 6.98"ID X .21"W
1007278	Sanitary clamp - Sensor Well
1007447	Gasket, sanitary 2"

- .2 All spare parts shall be suitably marked and packaged in protective cartons. All spare parts shall be of same type and quality as the equipment provided for the UV Disinfection System upgrade.
- .3 The Contract Administrator is to be notified of both delivery and receipt of these spare parts, and a tracking log of items are to be maintained electronically and on-site. Coordinate with the City and the Contract Administrator for a storage location for the spare parts.

1.6 Delivery, Storage and Handling

- .1 Deliver materials to site in original factory packaging, labelled with Manufacturer's name and address.

2. PRODUCTS

2.1 General

- .1 The modification to the UV disinfection system shall include retrofitting the six (6) existing Calgon Sentinel 48 – 9 x 20 kW UV reactors, located in the City of Winnipeg Drinking Water Treatment Plant - DBPS. The Work includes but are not limited to the following:
- .1 Completion of CFD modeling to confirm that the hydraulic conditions of the existing piping do not interfere with the UV dose delivery of the system, with any concerns discovered conveyed immediately as to be addressed as quickly as possible.
- .2 The work to the UV disinfection system and its subsystems shall form a complete and fully functional system, complete with all necessary components, accessories and appurtenances including but not limited to modifications/upgrades and adjustments required to UV intensity sensors, sensor wells, wipers, and wiper plates, UVT analyzers,

CLOSED VESSEL MEDIUM PRESSURE ULTRAVIOLET TREATMENT EQUIPMENT

and all required control and electrical system components as specified in Division 26 and 40.

- .3 Modifications to the existing UV disinfection systems shall include minimum UV equipment and monitoring and control requirements per the latest version of the UVDGM. The Manufacturer is to provide a detailed approach and description on how their current validation results of their proposed modified system has taken into account the polychromatic bias issues (e.g. action spectra correction factor – ASCF).
- .2 The items to be furnished shall be the Manufacturer's standard model unless otherwise indicated or requested in these Contract Documents. All items shall be new, unused, and shall be the Manufacturer's most current product line at the time of product submittal.
- .3 All products that will be in contact with potable water shall have NSF 61 certification.
 - .1 Electrical material and equipment shall have Canadian listing. The complete electrical assembly shall meet all requirements of the Canadian Electrical Code (CEC) with amendments by the Manitoba Electrical Code (MEC), the National Electrical Manufacturers Association (NEMA), the National Fire Protection Association (NFPA), and all applicable local and provincial requirements.
- .4 All supplied components shall comply with AWWA standards, unless specified otherwise.
- .5 All terminal point connections shall be ANSI standard flanges and meet the pressure requirements listed in clause 2.7.

2.2 Acceptable Manufacturers

- .1 De Nora UV Technologies LLC (formerly Calgon Carbon Corporation UV Technologies LLC) or approved equal in accordance with B7.

2.3 Feed Water Quality Conditions

- .1 Background data regarding upstream filtered water quality will be collected by the City in accordance with their regular testing regimen. The Contractor shall be responsible for collecting water samples and undertaking any required water testing that is necessary to determine the suitability of their proposed modification to the existing UV disinfection system for the duty points and performance specifications stipulated by these specifications.

2.4 Performance Requirements

- .1 UV Disinfection:
 - .1 UV disinfection log inactivation requirements shall be met while meeting the design criteria specified herein (**Table 2**).

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Table 2: UV Disinfection Design Criteria

Design Parameter	Value	Unit
Maximum design flow (per reactor)	125	ML/d
Number of reactors	6	-
Minimum flow (accommodated by three duty reactors)	184	ML/d
Average flow (accommodated by three duty reactors)	232	ML/d
Maximum projected flow (accommodated by four duty reactors)	374	ML/d
Minimum UVT	90	%
Temperature	1.75 – 23	°C
pH	7.4 - 8.0	
Challenge microorganism for validation	MS2 bacteriophage	--
Dose monitoring strategy	Calculated dose approach	--
Disinfection requirement	2-log inactivation of Cryptosporidium oocysts and Giardia Lamblia cysts	--
Maximum pressure	35 - 70	m head

.2 Cleaning of Quartz Sleeves:

- .1 Operation of the UV reactors shall be unaffected, and performance of the reactor shall be unchanged during mechanical cleaning of quartz sleeves.

2.5 Service Conditions

- .1 All equipment will be installed in the DBPS. The building is heated and ventilated.

2.6 Arrangement and Layout of UV Disinfection System

- .1 Refer to the process mechanical drawing, 1-0601D-M0001, for UV reactor layout. Actuated isolating butterfly valves are located upstream and downstream of each reactor. A magnetic flow meter is located upstream of each reactor between the actuated valve and the reactor. The spool piece between the flow meter and the reactor on the inlet side and between the valve and the reactor on the outlet side of each reactor can be removed for the modification Work. The Contractor shall conduct a Site visit to confirm if available space upstream and downstream of each reactor is enough to complete the modification Work without removing the flow meters.

2.7 UV Reactor Intensity Sensors

- .1 The modified UV intensity sensors shall provide continuous performance verification over the water UV transmittance, lamp life and quartz fouling.
- .2 One UV intensity sensor shall be installed for each lamp in all UV reactors.
- .3 The UV intensity sensors shall be provided in compliance with the latest revision of UVDGM.

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- .4 The UV intensity sensors shall be comprised of a stainless steel probe body, SiC sensor with UV-C filter, type UVC 3 and window.
- .5 The UV intensity sensor spectral response shall be in the 210 – 275 nm range as required by the manufacturer to meet operational and performance targets.
- .6 The UV intensity sensors shall be unaffected by static, electromagnetic fields or shortwave radio emissions.
- .7 The UV intensity sensors shall be housed inside the reactor and contained within protective quartz sleeves.
- .8 The UV intensity sensors shall be removable from the UV reactor without draining the reactor or removing the sensor sleeve.
- .9 DVGW certified reference sensors shall be provided to obtain UV sensor reference readings.
- .10 The same as the existing system, the modified system shall incorporate a method of performing checks and recalibration of UV sensors without requiring the reactor to be taken off-line or decreasing the treatment capacity.

2.8 Instrumentation & Controls

- .1 Refer to Division 40 - Instrumentation and Controls for requirements.

3. EXECUTION

3.1 General

- .1 Following the installation and calibration of the equipment, the Contractor shall perform a demonstration, running test and performance test on the UV Disinfection System in accordance with Section 01 91 31 - Commissioning Plan. It will be the responsibility of the Contractor to communicate and arrange the times for testing and start-up activities. The Contractor must confirm that these times are acceptable to the Contract Administrator and the City.

END OF SECTION