

SUMMARY OF WORK

1. GENERAL

1.1 Description

- .1 Work of this Supply Contract comprises of the supply of low pressure high output ultraviolet (UV) disinfection equipment complete with all electrical and control appurtenances. Work also includes start-up, commissioning, training, performance testing and O&M manuals.
- .2 The Work includes, but is not limited to the following elements:
 - .1 Supply of a low pressure high output UV disinfection system, including a new system control panel, ballast cabinets, lamp wiping, lifting system, etc.
 - .2 Delivery of equipment including spare parts to the Construction Contractor.
 - .3 Provision of storage and maintenance requirements to the Construction Contractor for uninstalled and spare equipment.
 - .4 Start-up, commissioning, performance testing, warranties and O&M manuals.
 - .5 Provision of latest software and firmware version available at the time of warranty expiration.
 - .6 Detailed information of bank position in and out of the channel to facilitate channel cover design.
- .3 Equipment to be installed under a separate contract, with installation guidance from the UV equipment Supplier.
- .4 Coordinate delivery, storage requirements, installation, training, start-up and commissioning with the Construction Contractor.
- .5 All products or materials that are deemed no longer supported or the product is no longer produced at the expiration of the warranty period, shall not be acceptable and will be replaced with the subsequent product. The City shall be notified of these products prior to delivery.

1.2 Work Sequence

- .1 Co-ordinate Progress Schedule with the City and Contract Administrator during construction to minimize disruption and maintain disinfection.
- .2 Proposed stages include:
 - .1 Award of Contact.
 - .2 Review and approval of Shop Drawings.
 - .3 Review and approval of O&M manual and training content.
 - .4 Delivery to Site.

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.5 Equipment Installation (two subsequent low-flow seasons i.e., approximately mid-November to mid-March). This is to minimize impact when UV equipment is bypassed during construction.

.6 Start-up, commissioning, and training during two different installation periods.

1.3 Work Coordination

.1 Co-ordinate work with General Contractor in regard to equipment delivery, long-term storage, installation, start-up, commissioning and training.

1.4 City of Winnipeg Personnel Occupancy

.1 The City personnel will work around Site during the entire construction period for execution of normal operations.

.2 Co-operate with the City personnel in scheduling operations to minimize conflict and maintain the UV disinfection in the system at all times.

.3 Assist the City with operational strategies for when the City is operating the new UV system alongside the existing UV system to preserve disinfection capability.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

SUBMITTALS

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 according to the Schedule of Submittals to not cause delay in Work. Failure to submit in the scheduled 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 Provide a copy of all the Specification Sections in the RFP package with any applicable addenda with each paragraph check marked to indicate Specification compliance or cross marked to indicate non-compliance. Requested deviations and clarifications from the specified requirements shall be provided with the Shop Drawings.
- .3 Do not proceed with Work affected by the submittal until reviewed by the Contract Administrator.
- .4 Present Shop Drawings, product data, and samples in only in SI Metric units. Dual units are acceptable.
 - .1 Where items or information is not produced in SI Metric units, convert units to SI Metric.
- .5 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.
- .6 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.
- .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 filed by Division.

1.2 Submittals Procedures

- .1 Details regarding submittals can be found in the individual Specification Sections.
- .2 Direct submittals to the Contract Administrator.

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- .3 Hardcopy Submittals: Submit hard copies only where specifically required under individual Specifications Sections.
- .4 Electronic Submittals: Submittals made in electronic format shall be as follows:
 - .1 Each submittal shall be electronic file in a searchable 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, 279.4 mm by 431.8 mm or ISO A1 (594 mm by 841 mm). 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 Shop Drawings requiring an engineering seal shall be updated at the UV project closeout and assigned a City of Winnipeg Water and Waste drawing number, sheet number, revision number and drawing size. Water and Waste will provide a template title block for incorporation into the Shop Drawings.
- .5 Schedule of Submittals:
 - .1 Prepare a table listing all anticipated submittals required to complete the Work.
 - .2 For each Specification Section show, at a minimum, the following:
 - .1 Specification Section.
 - .2 Total number of submittals for each Specification Section.
 - .3 Identify each submittal by its submittal number in accordance with a numbering and tracking system.
 - .4 Identify each submittal by its name or title.
 - .5 Identify the estimated date of submission to the Contract Administrator.
 - .6 State the revision number and status for each submittal.

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- .3 On a monthly basis, submit an updated schedule of submittals to the Contract Administrator if changes have occurred.
- .6 Transmittal of Submittal:
 - .1 Stamp each submittal with uniform approval stamp before submitting to Contract Administrator.
 - .1 Stamp to include project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with Contract.
 - .2 Contract Administrator will not review submittals that do not bear Contractor's approval stamp and will return them without action.
 - .3 Contract Administrator will not review submittals received directly from a Subcontractor and will return them without action.
 - .4 Complete, sign, and transmit with each submittal package, one (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 Include Contractor's written response to each of Contract Administrator's review comments with resubmission of submittals stamped "Exceptions Noted, Resubmit".
- .7 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.

SUBMITTALS

- .4 Index with labeled tab dividers in orderly manner.
- .8 Timeliness:
 - .1 Schedule and submit submittals in accordance with schedule of submittals and requirements of individual Specification Sections.
 - .2 Submit Shop Drawings and samples a minimum of two (2) months ahead of scheduled delivery date for associated equipment and material and in an orderly sequence so as to cause no delay in the Work.
- .9 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 no later than ten (10) Business Days after receipt, unless otherwise specified.
 - .3 Contractor shall make all submittal corrections and resubmit to the Contract Administrator within ten (10) Business Days after receipt of mark-ups.
 - .4 Resubmittals will be subject to the same review time.
 - .5 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.
- .10 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.
- .11 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.

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- .5 Submittals missing professional engineer's seal and signature, where it is required.
- .4 The submittal will be deemed incomplete if unusual high number of errors are identified on the submittal, making it difficult to proceed with the review.
- .12 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 2020-01-31) 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 All equipment to be installed at the Site shall require Shop Drawings, which shall be submitted to the Contract Administrator.
- .3 Sales bulletins and other general publications are not acceptable as submittals for review except where necessary to provide supplemental technical data.
- .4 Adjustments made on Shop Drawings by the Contract Administrator shall not change the Contract Price.
- .5 All Shop Drawings shall include details as follows:
 - .1 Indicate dimensions, operating weights, materials, methods of construction, and attachment of support wiring, diagrams, connections, recommended installation details, explanatory notes, and other information necessary for completion of Work. Larger and heavy items that need to be removed and replaced for maintenance shall have their weight identified and indicated.
 - .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.
 - .4 Indicate all quantities and type of fluids required for equipment operation and maintenance.
 - .5 A three-dimensional drawing of the system and the system opening to show that there is adequate clearance in the planned installation location and to ensure that there are no points of interference. Provide the drawing at key points of the movement procedure, including wiring to show there are no interferences,
 - .6 Placement and installation of all equipment shall be subject to the approval of the City.

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- .6 Electrical and instrumentation and control system Shop Drawings shall 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 permanently 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.
 - .2 Wiring diagrams shall mark conductor identification, field terminals, changes, etc.
 - .3 Detailed listing of all nameplates.
 - .4 Identification in accordance with the City of Winnipeg Water & Waste Identification Standard (Appendix A).
 - .5 Network architecture showing all components of the network supplied by the Supplier. Tables showing data maps for communications with Plant PLC. Tables showing data map for communications with Plant HMI. Control schematics with plant PCS interconnect details. Interconnection diagrams shall show all electrical and network connections between equipment, panel, terminal junction.
 - .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 notes and installation-specific information on each sheet. Update the ILDs as necessary and fill in all terminal and wiring number from 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 shall reproduce a MCS for each motor and record all relevant notes and installation-specific information on each sheet. Update the MCS as necessary and fill in all terminal and wiring numbers from 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 Highlight 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. Sales literature, or custom-made sheets, or sales declarations shall not be included. Only manufacturer issued technical literature shall be accepted.

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- .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 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 by NFPA 820, 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 wire or 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, and other components/devices may produce sufficient heat within the enclosure, and as requested by the Contract Administrator.
- .7 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.
- .8 Submit Shop Drawings stamped and signed by professional engineer registered or licensed in the Province of Manitoba as required in the Specifications. The following components require sealed Shop Drawings:
 - .1 Metal fabrications.
 - .2 Control Panels.
 - .3 Instrument Loop Wiring Diagrams.
- .9 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

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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.
- .10 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 searchable PDF copy.
- .11 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.
 - .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.
- .12 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.
- .13 Make changes in Shop Drawings, which the Contract Administrator shall require, consistent with Contract. When re-submitting, notify the Contract Administrator in writing of any revisions other than those requested by the Contract Administrator.
- .14 The mark-up and comments on submittals and O&M package shall be incorporated within two months of receipt from the Contract Administrator regardless of the status of the returned submittal. Supplier shall submit long-term storage requirements for equipment that is received by the Construction Contractor and stored prior to installation.
- .15 Supplier shall provide a list of maintenance requirements for uninstalled equipment to be performed and documented by the Construction Contractor. The list shall be submitted one (1) month prior to the delivery of the equipment.

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- .16 Construction Contractor shall submit records of the maintenance schedules to the Contract Administrator on a monthly basis.

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 plan 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 entitles the Contractor to extra payment or an extension of time.
- .3 Other Considerations:
 - .1 Fabrication, erection, installation, and commissioning may require modifications to equipment and 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.
 - .2 Number RFI's consecutively in one sequence in order submitted, in a numbering system established by the Contract Administrator.
 - .3 Submit one (1) distinct subject per RFI request. The unrelated items shall not be combined 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 provide:
 - .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.

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- .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 the RFI 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 a change to the Contract and the Contractor intends to submit a change request. Failure to give such written notice of ten (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.

1.7 Miscellaneous Submittals

- .1 Prepare and submit required Contract Documents.
- .2 Copies: Submit one (1) electronic copy to Contract Administrator. Method of electronic submission shall 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.

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- .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 shall be 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 and in accordance with Specification Sections 01 65 00 and 01 91 31.
- .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 be signed and sealed by a Professional Engineer registered in the Province of Manitoba.

1.8 Supplements

- .1 The supplements listed below, following "End of Section", are part of this Specification:
 - .1 Request for Information (RFI), RFI No.0.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

SUBMITTALS

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):

SUBMITTALS

Distribution (to be completed by Contract Administrator)

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

[Click here to enter text.](#)

COMMON PRODUCT REQUIREMENTS

1. GENERAL

1.1 Standards

- .1 Within text of each Specification Section, references are made to reference standards.
- .2 Conform to these reference standards, in whole or in part as specifically requested in the Specifications.
- .3 If there is question as to whether products or systems are in conformance with applicable standards, the Contract Administrator reserves the right to have such products or systems tested to prove or disprove conformance.
- .4 Cost for such testing shall be borne by the City in event of conformance with Construction Contract Documents or by the Construction Contractor in event of non-conformance.
- .5 Conform to latest date of issue of referenced standards in effect on date of submission of Bids.

1.2 Quality Assurance

- .1 Products, materials, equipment and articles incorporated in the Work shall be new, not 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, shall be rejected, regardless of previous inspections. Inspection shall not relieve responsibility but is a precaution against oversight or error. Supplier shall remove and replace defective products at his own expense and shall 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 Construction Contract Documents.
- .4 Unless otherwise indicated in the Specifications, maintain uniformity of manufacture for any particular or like item.
- .5 Permanent labels, trademarks and nameplates on products shall not be acceptable in prominent locations, except where required for operating instructions, or when located in mechanical or electrical rooms.
- .6 The Contractor shall be responsible for development of a quality plan to ensure all tasks are performed to the necessary requirements and manufacturers specifications. The quality plan shall include such things as Inspection and Test Plan (ITP) to ensure that all steps are performed in the appropriate order and in-line with the construction schedule. All tasks should be listed and identified by the Contract Administrator, certain tasks will have either witness points, hold points attached to them to ensure inspections are held prior to proceeding the next chronological task in the construction sequence. The Contractor shall be responsible for quality control (QC) of all construction tasks, drawing redlines and any other QC measured deemed necessary by the Contract Administrator to ensure as little rework is required which will assist in meeting the construction schedule.

COMMON PRODUCT REQUIREMENTS

1.3 Availability

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

1.4 Storage, Handling and Protection

- .1 The Supplier shall provide the Construction Contractor with full instructions in writing of all preservation requirements, procedures and precautions for long-term storage and protection of the equipment. A copy of all instructions shall be provided to the Contract Administrator.
- .2 The Construction Contractor shall be responsible for off-site storage of the equipment, appurtenances, and materials and for protection against weather, loss, damage, or theft until equipment installation.
- .3 The storage location shall be inspected and approved by the Contract Administrator and/or the City.
- .4 The Construction Contractor shall:
 - .1 Handle and store products in a manner to prevent damage, adulteration, deterioration and soiling and in accordance with Supplier's instructions.
 - .2 Store packaged or bundled products in original and undamaged condition with Manufacturer's seal and labels intact. Items shall not be removed from packaging or bundling until provided to the Construction Contractor.
 - .3 Store products subject to damage from weather in above zero weatherproof enclosures.
 - .4 Store materials on flat, solid supports and keep clear of ground. Slope to shed moisture.
 - .5 Remove and replace damaged products at own expense and to the satisfaction of the Contract Administrator.
 - .6 Touch-up damaged factory finished surfaces to Contract Administrator's satisfaction. Use touch-up materials to match original. Do not paint over nameplates.
- .5 The Construction Contractor shall adhere to Supplier's long-term storage and maintenance instructions.
- .6 Preservation requirements and procedures as per Supplier's recommendation shall be followed and documented by the Construction Contractor. Construction Contractor shall keep records of the maintenance schedules (lubrication, coatings, etc.) frequently and submit the records to the Contract Administrator on a monthly basis.

COMMON PRODUCT REQUIREMENTS

1.5 Transportation

- .1 Pay costs of transportation of products required in performance of Work. Goods shall be delivered DDP (Delivery Duty Paid) destination, freight prepaid to Winnipeg, MB.
- .2 The Construction Contractor shall be responsible for receiving, off-loading, and placing into storage all equipment at the Site.

1.6 Supplier's Instructions

- .1 Unless otherwise indicated in the Specifications, install or erect products in accordance with the Supplier's instructions. Do not rely on labels or enclosures provided with products. Obtain written instructions directly from Supplier.
- .2 Notify the Contract Administrator in writing, of conflicts between the Specifications and the Supplier's instructions, so that the Contract Administrator will establish 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 Construction Contract Price or Construction Contract Time.

1.7 Quality of Work

- .1 Ensure Quality of Work is of the highest standard, executed by workers experienced and skilled in respective duties for which they are employed. Immediately notify the Contract Administrator if required Work is such as to make it impractical to produce required results.
- .2 The Supplier and Contractor shall not employ anyone unskilled in their required duties for Work. 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.

1.8 Location of Fixtures

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

1.9 Fastenings

- .1 Space anchors within individual load limit or shear capacity and ensure they provide positive permanent anchorage. Wooden, or any other organic material, plugs are not acceptable.
- .2 Keep exposed fastenings to a minimum, space evenly and install neatly.
- .3 Fastenings which cause spalling or cracking of material to which anchorage is made shall not be acceptable.

COMMON PRODUCT REQUIREMENTS

- .4 Use fastenings of standard commercial sizes and patterns with material and finish suitable for service.
- .5 Use heavy hexagon heads, semi-finished unless otherwise specified. Use 304 stainless steel unless specified otherwise.
- .6 Bolts may not project more than one diameter beyond nuts.
- .7 Use soft-gasket lock-type washers at attachments prone to vibration. Use resilient washers with stainless steel.
- .8 Prevent electrolytic action between dissimilar metals and materials.
- .9 Use plain type washers on equipment, sheet metal and soft gasket lock type washers where vibrations occur. Use resilient washers with stainless steel.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

EQUIPMENT INSTALLATION

1. GENERAL

1.1 Description

- .1 This Section describes requirements for all equipment supplied under this Contract relating to factory inspections, equipment delivery, equipment installation training, equipment installation, commissioning, equipment performance testing, and process performance tests.
- .2 At least thirty (30) days prior to commencing equipment operation and performance testing, the Supplier shall assist the Construction Contractor to prepare and submit a detailed start-up plan to indicate the schedule and sequence of equipment installation checks and tests required for the Contract Administrator's review and inputs. No testing Work shall commence until this plan has been discussed and reviewed by all parties involved and accepted by the Contract Administrator.

1.2 Definitions

- .1 Supplier's Representative: A Supplier's Representative is a trained person empowered by the Supplier to provide:
 - .1 Witnessing of delivery.
 - .2 Installation and process training.
 - .3 Witnessing of equipment installation.
 - .4 Assistance in commissioning and equipment performance testing.
 - .5 Assistance in commissioning and process performance testing.
 - .6 Training to the City's staff.

1.3 Expertise and Responsibility

- .1 The Contract Administrator recognizes the expertise of the Supplier.
- .2 Should the Contract Administrator issue an Addendum, Field Order, Change Order, or Instruction to change the Work which would, in the opinion of the Construction Contractor, compromise the success or safety of the Work, then it shall be incumbent on the Construction Contractor to notify in writing the Contract Administrator to this effect within two (2) days.

1.4 Inspection at Factory

- .1 The City or the Contract Administrator may, before or after selection of equipment has been made, inspect or have an authorized representative inspect the manufacturing, assembling, and testing facilities at the Supplier's or Subcontractor equipment factory, to satisfy themselves of the capability of the Supplier or Subcontractor equipment to supply the specified equipment.
- .2 The City and/or the Contract Administrator may inspect or have an authorized inspector inspect the equipment factory or the process of manufacture or testing of the equipment at the Supplier's or Subcontractor equipment factory at any reasonable time. The City and/or

EQUIPMENT INSTALLATION

the Contract Administrator or the inspector may notify the Supplier or Subcontractor at any time of unsatisfactory materials, workmanship, or processes.

- .3 The Supplier shall provide every reasonable facility, access, and cooperation to assist the City and the Contract Administrator or an authorized inspector in carrying out inspection or testing at the equipment factory or facility.
- .4 Inspection or testing carried out by the City or the Contract Administrator or an authorized inspector shall not relieve the Supplier of the responsibility for supplying equipment in accordance with the Contract and good engineering practice.

1.5 Equipment Delivery

- .1 Delivery shall be coordinated with and made to the Construction Contractor. Written acceptance of receipt, at delivery, by the Construction Contractor shall constitute "Delivery to Site" under this Contract. The shipping lists of materials shall be carefully checked by the Supplier's Representative in the presence of the Contract Administrator and the Construction Contractor. When the Construction Contractor accepts the equipment delivery, they shall certify the delivery by completing Form 100 – Certificate of Equipment Delivery, attached to this Specification.
- .2 The Supplier shall provide a schedule within fifteen (15) calendar days after notification of acceptance of Shop Drawings. No delivery to the Site of the Work shall occur until Reviewed Shop Drawings are received by the Supplier.
- .3 The schedule shall allow for:
 - .1 Two (2) weeks for the Contract Administrator to review and comment on the Supplier's Shop Drawings for the equipment to be supplied. Additional time for Shop Drawings corrections and resubmittals shall be accommodated in the schedule.
- .4 The Supplier shall be entitled to an extension of the quoted delivery period on account of:
 - .1 Delay attributable to Acts of God or other matters, which were not the fault of the Supplier and over which it had no control, provided that the Supplier took all possible action to reduce delays and notified the City promptly of the occurrence of such delays.
- .5 Ten (10) days before delivery, notice shall be given to the Contract Administrator so that arrangements for receipt and for inspection can be made. The shipping lists of materials shall be carefully checked by the Supplier in the presence of the Contract Administrator and the Construction Contractor.
- .6 The Supplier shall clearly mark each item to be shipped and identify and reference it to the packing lists and to bills of materials on the Shop Drawings. The lists will be used by the Supplier, the Construction Contractor, and the Contract Administrator to check the contents of each delivery. No shipments shall be off-loaded until itemized packing lists have been received by the parties mentioned herein.
- .7 The Supplier shall adequately pack and crate each component to provide protection during transport, handling, and storage. Equipment suitable for outside storage will be stored to the satisfaction of the Supplier and the Contract Administrator. The Supplier shall identify each component with durable labels or tags securely attached to each piece of equipment, crate, or container. All crates shall be clearly labelled with 5 cm red font as "Indoor Storage" or "Outdoor Storage" on a minimum of four (4) faces of the crate.

EQUIPMENT INSTALLATION

- .8 The Supplier shall protect polished and machined metal surfaces from corrosion and damage during shipment and storage and shall carefully pack and crate the equipment for shipment. The Supplier shall protect threaded connections with threaded plugs or caps and shall protect open plain end pipes with caps.
- .9 The Supplier shall pack electrical equipment and control panels to prevent scratching, access by dirt, moisture, or dust, or damage to insulation and shall cover equipment having exposed bearings and glands to exclude foreign matter. All openings in the equipment shall be covered before shipment. Sufficient lifting hooks shall be supplied for handling all crates and boxes and heavy pieces.
- .10 The equipment is to be stored off-site for an extended period for installations over two subsequent low-flow seasons. The Construction Contractor shall provide temperature controlled, humidity controlled and secure local storage in Winnipeg, MB in a location to be inspected and approved by the City, between equipment delivery and installations according to Section 01 61 00.
- .11 The Supplier shall provide any special packaging and protective coatings, lubricants, etc., which the Supplier deems necessary to protect the equipment during the protracted storage and prior to equipment performance testing.
- .12 The Supplier shall be responsible for providing the Construction Contractor with full instructions in writing of all precautions to be observed in connection with the storing and protection of the equipment.
- .13 The Construction Contractor shall keep records of the maintenance schedules and submit to the Contract Administrator on a monthly basis.
- .14 The Construction Contractor shall notify the Contract Administrator of any damages and loss occurred to the stored equipment during the storage period. Any damaged crate shall be fully inspected by the City and the Supplier. The Construction Contractor shall be responsible for the repair and replacement of the damaged and lost good.
- .15 The Construction Contractor shall be responsible for removing any protective coatings prior to installation and equipment performance testing in accordance with the Supplier's written instructions.
- .16 The Supplier's Representative shall be at the delivery Site to witness the off-loading, moving and placement of the equipment and to examine the equipment for damage and loss, and to inspect the Construction Contractor's storage facilities for the equipment supplied for compliance with the Supplier's recommendations. The Supplier shall maintain an inventory of all equipment supplied and delivered to the Construction Contractor.
- .17 The Construction Contractor shall be responsible for receiving, off-loading, and placing into storage all equipment at the Site and/or the off-Site storage location.

1.6 Installation Assistance

- .1 The equipment will be installed by the Construction Contractor in the UV channels at separate time periods so that the existing UV system can be maintained. The Supplier's Representative shall participate in each installation period. It is currently anticipated that equipment installation will occur over two low-flow seasons (i.e., mid-November to mid-March) in consecutive years.

EQUIPMENT INSTALLATION

- .2 Unless otherwise specifically stated in the Specifications, the Supplier shall provide, a factory-trained Representative who, in conjunction with the Contract Administrator or their agent, shall give instructions regarding the installation of the equipment as well as cable and hydraulic hose management for all the UV banks.
- .3 Before commencing installation of the equipment, the Construction Contractor shall arrange for the attendance of the Supplier's Representative who shall provide instructions in the methods, techniques, precautions, and any other information relevant to the successful installation of the equipment.
- .4 The Construction Contractor shall inform the Contract Administrator, in writing, of the attendance at the Site of any Supplier's Representative for installation training at least fourteen (14) days prior to arrival.
- .5 Before commencing the second installation period, the Supplier's Representative shall be at the storage site to inspect the stored equipment for damage and loss. The Supplier's Representative shall identify any outstanding deficiencies and shall provide a copy of the inspection report to the Contract Administrator. The deficiencies shall be rectified by the Construction Contractor and the Supplier's Representative shall re-inspect the equipment.
- .6 When the Supplier's Representative is satisfied that the Construction Contractor is aware of all installation requirements, they shall so certify by completing Form 101 – Certificate of Readiness to Install, attached to this Specification.
- .7 The completed form shall be delivered to the Contract Administrator prior to departure of the Supplier's Representative from the Site.
- .8 Installation of the equipment shall not commence until the Contract Administrator has advised that he has received the completed Form 101 and the Supplier Representative is at site ready to participate in each installation period.
- .9 Separate copies of Form 101 shall be used for different equipment and for each installation period.

1.7 Installation

- .1 If necessary, or if so directed by the Contract Administrator during the course of installation, the Construction Contractor shall contact the Supplier's Representative to receive clarification of installation procedures, direction and any other additional information necessary to continue and complete the installation in an appropriate manner.
- .2 The Construction Contractor shall arrange for the Supplier's Representative to visit the Site to provide assistance and instruction during all of the separate installation periods, and including items such as all aspects of cable installation and movement and cable management from the individual UV banks to the ballast cabinets, hydraulic hose, all at the Construction Contractor's cost. For clarity, the Supplier's Representative is not required to witness the entirety of the installation.
- .3 Prior to completing each period of installation, the Construction Contractor shall inform the Supplier's Representative and arrange for the attendance at the Site of the Supplier's Representative to verify successful installation.

EQUIPMENT INSTALLATION

- .4 The Supplier's Representative shall conduct a detailed inspection of the installation for each period of installation including alignment, electrical connections, belt tensions, rotation direction, running clearances, lubrication, workmanship and all other items as required to ensure successful operation of the equipment.
- .5 The Supplier's Representative shall identify any outstanding deficiencies in the installation.
- .6 The deficiencies shall be rectified by the Construction Contractor and the Supplier's Representative shall be required to re-inspect the installation, at the Construction Contractor's cost.
- .7 When the Supplier's Representative accepts the installation, they shall certify the installation by completing Form 102 – Certificate of Satisfactory Installation, attached to this Specification.
- .8 Separate copies of Form 102 shall be used for each channel installation.
- .9 Deliver the completed Form 102 to the Contract Administrator prior to departure of the Supplier's Representative from the Site.
- .10 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.

1.8 Operation and Performance Verification

- .1 Equipment shall be subjected to a demonstration, Running Test, and Performance Test after the installation has been verified and any identified deficiencies have been remedied.
- .2 During the demonstration, Running Test, and Performance Test, the Construction Contractor shall operate equipment as required by Section 01 91 31 to complete the Performance Verification.
- .3 Inform the Contract Administrator at least fifteen (15) days in advance of conducting the tests and arrange for the attendance of the Supplier's Representative. The tests may be concurrent with the inspection of satisfactory installation if mutually agreed by the Construction Contractor and the Contract Administrator.
- .4 The Supplier's Representative shall conduct all necessary checks to the equipment and if necessary, advise the Construction Contractor of any further checking, flushing, cleaning, or other work needed prior to confirming the equipment is ready to run.
- .5 Demonstration, Running Test and Performance Test shall be performed according to Section 01 91 31.
- .6 In the event that the new UV channel equipment has not been fully commissioned to operate remotely from the HMI in the control room, but it is satisfactorily commissioned, at the option of the City, to be operated at the Supplier's local HMI and there are high flows that would require the new channel, then commissioning for remote operation would be deferred until high flows subside while the channel is used for service.

EQUIPMENT INSTALLATION

1.9 Supplements

.1 The supplements listed below, following “End of Section”, are part of this Specification:

- .1 Form 100 – Certificate of Equipment Delivery.
- .2 Form 101 – Certificate of Readiness to Install.
- .3 Form 102 – Certificate of Satisfactory Installation.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

EQUIPMENT INSTALLATION

**CERTIFICATE OF EQUIPMENT DELIVERY
FORM 100**

We certify that the equipment listed below has been received and delivered into the care of the Construction 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 Construction Contractor)

Date

(Authorized Signing Representative of the Supplier)

Date

(Authorized Signing Representative of the Contract Administrator)

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 Supplier)

Date

(Authorized Signing Representative of the Construction Contractor)

Date

(Authorized Signing Representative of the Contract Administrator)

Date

CLOSEOUT SUBMITTALS

1. GENERAL

1.1 Submittals

- .1 Submittals shall be in accordance with Section 01 33 00.
- .2 Prepare instructions and data using personnel experienced in the maintenance and operation of described products.
- .3 A copy will be returned after final inspection with the Contract Administrator's comments.
- .4 Revise the content of the documents as required prior to final submittal.
- .5 All mark-ups identified from previous reviews shall be implemented for final O&M manuals.
- .6 Four (4) weeks prior to Substantial Performance of the Work, submit to the Contract Administrator six (6) final paper copies of the Operating and Maintenance (O&M) Manuals and one (1) searchable electronic copy (PDF) on USB drive in S.I. Units.
- .7 Ensure spare parts, maintenance materials and special tools provided are new, undamaged or defective, and of the same quality and manufacture as the products provided in Work.
- .8 Furnish evidence, if requested, for type, source and quality of the products provided.

1.2 Format

- .1 Organize data as an instructional manual.
- .2 Binders shall be vinyl, hard covered, 3 'D' ring, loose leaf with spine and face pockets. The maximum width of each binder shall not exceed 125 mm; where there is more data than will fit in a binder of 125 mm maximum width, the number of binders shall be as required.
- .3 When multiple binders are used, correlate the data into related consistent groupings. Identify contents of each binder on the spine.
- .4 Covers shall be used to identify each binder with type or printed title "Operation and Maintenance Manual"; list date, title of project, the City, Construction Contractor and Contract Administrator, and identify subject matter of contents.
- .5 Arrange content by systems, under Section numbers and sequence of Table of Contents.
- .6 Provide tabbed fly leaf for each separate product and system, with typed description of product and major component parts of equipment.
- .7 The text shall be Manufacturer's printed data.
- .8 Drawings shall be provided with reinforced punched binder tab. Bind in with text, fold larger drawings to size of text pages.
- .9 Provide 1:1 scaled CAD files in dwg format on a USB drive.

CLOSEOUT SUBMITTALS

- .10 Provide one (1) electronic copy (on USB drive) of the entire manual. The electronic copy shall have a linked Table of Contents to each section and shall be word searchable.
- .11 PDF files shall be set to open "Bookmarks and Page" view and contain internal book marking from index page to major sections of document.

1.3 Contents - Each Volume

- .1 Table of Contents: provide title of project:
 - .1 Date of submission; names.
 - .2 Addresses and telephone numbers of the Contract Administrator, Contractor and Sub-Contractor with the names of responsible parties.
 - .3 Schedule of products and systems, indexed to content of volume.
- .2 For each product and system:
 - .1 List names, addresses and telephone numbers of subcontractors and suppliers, including local source of supplies and replacement parts.
 - .3 Product Data: mark each sheet to identify specific products and component parts, and data applicable to installation; delete inapplicable information.
 - .4 Drawings: supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Drawings larger than 210 mm x 300 mm (A4) shall be contained in plastic pouch. Provide a separate panel for each drawing.
 - .5 Typewritten Text: as required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating Manufacturer's instructions.
 - .6 Training: refer to Section 01 79 00.

1.4 As-Builts and Samples

- .1 Maintain, in addition to the requirements in the General Conditions, at Site for Contract Administrator one (1) record copy of:
 - .1 Contract Drawings.
 - .2 Specifications.
 - .3 Addenda.
 - .4 Change Orders and other modifications to Contract.
 - .5 Reviewed Shop Drawings, product data, and samples.
 - .6 Field test records.
 - .7 Inspection certificates.

CLOSEOUT SUBMITTALS

- .8 Manufacturer's certificates.
- .2 Store record documents and samples in the field office apart from documents used for construction. Provide files, racks, and secure storage.
- .3 Label record documents and file in accordance with Section number listings in the List of Contents of this Project Manual. Label each document "PROJECT RECORD" in neat, large, printed letters.
- .4 Maintain record documents in clean, dry and legible condition. Do not use record documents for construction purposes.
- .5 Keep record documents and samples available for inspection by the Contract Administrator.
- .6 The Contractor shall keep one (1) completed set of automation documents at the Site during the work, including all addenda, change orders, Site Instructions, clarifications, and revisions for the purpose of As-Built documents. This includes, but is not limited to the following:
 - .1 IO Lists (Hardwired and communicated):
 - .1 Including panel/equipment source and destination, signal tag, signal type, signal description, signal range, signal states (for discrete signals), signal scaled range (for analog signals), and notes.
 - .2 Instrument Lists:
 - .1 Including instrument tag, instrument description, instrument type, instrument range, and instrument voltage.
 - .3 IP Address Lists:
 - .1 IP Addresses shall be assigned by the City once requested from Contractor. To request IP Addresses, submit a complete list of devices for the project that require IP Addresses.
 - .4 Functional Requirements Specifications.
 - .5 Automation Equipment List.
 - .6 PLC Module List.

1.5 Recording Actual Site Conditions

- .1 Record information on set of Issued for Construction drawings.
- .2 Mark-ups shall be identified with separate colours for each major system.
- .3 Record information concurrently with the construction progress. Do not conceal Work until required information is recorded.
- .4 Contract Drawings and Shop Drawings: mark each item to record actual construction, including:

CLOSEOUT SUBMITTALS

- .1 Measured depths of elements of foundation in relation to finish first floor datum.
- .2 Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
- .3 Measured locations of internal utilities and appurtenances, referenced to visible and accessible features of construction.
- .4 Field changes of dimension and detail.
- .5 Changes made by change orders.
- .6 Details not on original Contract Drawings.
- .7 References to related Shop Drawings and modifications.
- .5 Specifications: mark each item to record actual construction, including:
 - .1 Manufacturer, trade name, and catalogue number of each product actually installed particularly optional items and substitute items.
 - .2 Changes made by Addenda and change orders.
- .6 Other Documents: maintain Manufacturer's certifications, inspection certifications, and field test records as required by individual Specifications Sections.
- .7 Provide digital photos for Site records.

1.6 Equipment and Systems

- .1 For each item of equipment and each system:
 - .1 Include the description of the unit or system, and component parts. Give function, normal operation characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and commercial number of replaceable parts.
- .2 Provide copy of reviewed submittals.
- .3 Panel board circuit directories: provide electrical service characteristics, controls, and communications.
- .4 Include installed colour coded wiring diagrams.
- .5 Operating Procedures: include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.
- .6 Maintenance Requirements: include preventative and corrective maintenance routine, procedures and guide for troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

CLOSEOUT SUBMITTALS

- .7 For any equipment requiring measurement to be taken, the baseline values of all measurements shall be provided.
- .8 Provide a maintenance and lubrication schedule, and a list of lubricants and quantities required.
- .9 Include Manufacturer's printed O&M instructions.
- .10 Include the sequence of operation by the controls Manufacturer.
- .11 Provide original Manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- .12 Provide a list of original Manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.
- .13 Additional requirements: as specified in individual Specification Sections.

1.7 Materials and Finishes

- .1 Building Products, Applied Materials, and Finishes: include product data, with catalogue number, size, composition, and colour and texture designations. Provide information for re-ordering custom manufactured products.
- .2 Instructions for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .3 Moisture-Protection and Weather-Exposed Products: include the Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- .4 Additional Requirements: as specified in individual Specifications Sections.

1.8 Spare Parts

- .1 Provide spare parts, in quantities specified in individual Specification Sections.
- .2 Provide items of the same manufacture and quality as items in the Work.
- .3 Deliver to Site, place and store.
- .4 Receive and catalogue items. Submit inventory listing to the Contract Administrator. Include approved listings in O&M Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.9 Maintenance Materials

- .1 Provide maintenance and extra materials, in quantities specified in the individual Specification Sections.
- .2 Provide items of the same manufacture and quality as items in the Work.

CLOSEOUT SUBMITTALS

- .3 Deliver to Site, place and store.
- .4 Receive and catalogue items. Submit inventory listing to the Contract Administrator. Include approved listings in the O&M Manual.
- .5 Obtain receipt for delivered products and submit prior to final payment.

1.10 Special Tools

- .1 Provide special tools, in quantities specified in individual Specification Section.
- .2 Provide items with tags identifying their associated function and equipment.
- .3 Deliver to Site, place and store.
- .4 Receive and catalogue items. Submit inventory listing to the Contract Administrator. Include approved listings in the O&M Manual.

1.11 Storage, Handling and Protection

- .1 Store spare parts, maintenance materials, and special tools in manner to prevent damage or deterioration and in accordance with the Manufacturer's preservation instruction.
- .2 Store in original and undamaged condition with Manufacturer's seal and labels intact.
- .3 Store components subject to damage from weather in weatherproof enclosures.
- .4 Store paints and freezable materials in a heated and ventilated room.
- .5 Remove and replace damaged products at own expense and to satisfaction of Contract Administrator.

1.12 Warranties and Bonds

- .1 Develop a warranty management plan to contain information relevant to Warranties. Warranty management plan to include required actions and documents to assure that the Contract Administrator receives warranties to which it is entitled.
- .2 Provide the plan in narrative form and contain sufficient detail to make it suitable for use by future maintenance and repair personnel.
- .3 Submit warranty management plan, thirty (30) days before planned pre-warranty conference, to Contract Administrator approval.
- .4 Submit warranty information made available during the construction phase, to the Contract Administrator for approval prior to each monthly pay estimate.
- .5 Assemble approved information in binder and submit upon acceptance of work. Organize the binder as follows:
 - .1 Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing.

CLOSEOUT SUBMITTALS

- .2 List Subcontractor, Supplier, and Manufacturer, with name, address, and telephone number of responsible principals.
- .3 Obtain warranties and bonds, executed in duplicate by Subcontractors, Suppliers, and Manufacturers, within ten (10) days after completion of the applicable item of Work.
- .4 Verify that documents are in proper form, contain full information, and are notarized.
- .5 Co-execute submittals when required.
- .6 Retain warranties and bonds until time specified for submittal.
- .6 Conduct a joint ten (10) month warranty inspection, measured from the time of acceptance by the Contract Administrator. The inspection shall be attended by the Contract Administrator, Contractor, and Manufacturer representative.
- .7 Include information contained in the warranty management plan as follows:
 - .1 Roles and responsibilities of personnel associated with the warranty process, including points of contact and telephone numbers within the organizations of Construction Contractors, Subcontractors, Manufacturers or Suppliers involved.
 - .2 Provide a list for each warranted equipment, item, feature of construction or system indicating:
 - .1 Name of item.
 - .2 Model and serial numbers.
 - .3 Location where installed.
 - .4 Name and phone numbers of Manufacturers or Suppliers.
 - .5 Names, addresses and telephone numbers of sources of spare parts.
 - .6 Warranties and terms of warranty: include one (1) year overall warranty of construction after Substantial Performance for all the units functioning. Indicate items that have extended warranties and show separate warranty expiration dates.
 - .7 Cross-reference to warranty certificates as applicable.
 - .8 Starting point and duration of the warranty period.
 - .9 Summary of maintenance procedures required to continue warranty in force.
 - .10 Cross-Reference to specific pertinent O&M Manuals.
 - .11 Organization, names and phone numbers of persons to call for warranty service.
 - .12 Typical response time and repair time expected for various warranted equipment.
- .3 Procedure and status of tagging equipment covered by extended warranties.

CLOSEOUT SUBMITTALS

- .4 Post copies of instructions near selected pieces of equipment where operation is critical for warranty and/or safety reasons.
- .8 Respond in a timely manner to oral or written notification of required construction warranty repair work.
- .9 Written verification will follow oral instructions. Failure to respond will be cause for the City to proceed with action against the Construction Contractor.

1.13 Warranty Tags

- .1 Tag, at time of installation, each warranted item. Provide durable, oil and water-resistant tag approved by the Contract Administrator.
- .2 Attach tags with a durable plastic tie.
- .3 Leave the date of acceptance until project is accepted for occupancy.
- .4 Indicate the following information on the tag:
 - .1 Type of product/material.
 - .2 Model number.
 - .3 Serial number.
 - .4 Construction Contract number.
 - .5 Warranty period.
 - .6 Inspector's signature.
 - .7 Construction Contractor.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

OPERATION AND MAINTENANCE DATA

1. GENERAL

1.1 Description

- .1 This Section includes detailed information for the preparation, submission, and Contract Administrator's review of operations and maintenance (O&M) data as required by individual Specification Sections.

1.2 Definitions

- .1 Preliminary Data: Initial and subsequent submissions for Contract Administrator's review.
- .2 Final Data: Contract Administrator-accepted data, submitted as specified herein.
- .3 Maintenance Operation: As used on Maintenance Summary Form is defined to mean any routine operation required to ensure satisfactory performance and longevity of equipment. Examples of typical maintenance operations include but are not limited to lubrication, belt tensioning, adjustment of pump packing glands, and routine adjustments.
- .4 Instructional Manual: An organized compilation of operating and maintenance data including detailed technical information, documents and records describing operation and maintenance of individual systems, subsystems and components as specified in individual sections of this Specification.

1.3 Sequencing and Scheduling

- .1 Equipment and System Data:
 - .1 Preliminary Data:
 - .1 Do not submit until Shop Drawing for equipment or system has been reviewed and returned stamped "NO EXCEPTIONS TAKEN" or "EXCEPTIONS NOTED" by Contract Administrator. Refer to 01 33 00 for submittals approval procedure.
 - .2 Submit the data a minimum of ten (10) Business Days prior to shipment date.
 - .2 Final Data:
 - .1 Submit Instructional Manual not less than 30 days prior to equipment or system field Functional Testing.
 - .2 Submit Compilation Formatted and Electronic Media Formatted data prior to Substantial Performance of Project. All errors and omissions shall be corrected.

1.4 Data Format

- .1 Preliminary Manual Format:
 - .1 Binder: Commercial quality, permanent, three-ring binders with durable plastic cover.
 - .1 Three-hole punch data for binding and composition; arrange printing so that punched holes do not obliterate data.

OPERATION AND MAINTENANCE DATA

- .2 Size: 8-1/2 inches by 11 inches, minimum.
- .3 Cover: Identify manual with typed or printed title "OPERATION AND MAINTENANCE DATA, VOLUME NO._OF____", and list:
 - .1 Project title.
 - .2 Contractor's name, address, and telephone number.
 - .3 If entire volume covers equipment or system provided by one supplier include the following:
 - .1 Identity of general subject matter covered in manual.
 - .2 Identity of equipment number and Specification Section.
- .4 Provide each volume with title page and typed table of contents with consecutive page numbers. Place contents of entire set, identified by volume number, in each binder.
- .5 Table of contents neatly typewritten, arranged in a systematic order:
 - .1 Include list of each product, indexed to content of each volume.
 - .2 Designate system or equipment for which it is intended.
 - .3 Identify each product by its product name and other identifying numbers or symbols as set forth in Contract Documents.
- .6 Section Dividers:
 - .1 Heavy, 80-pound cover weight, tabbed with numbered plastic index tabs.
 - .2 Fly-Leaf:
 - .1 For each separate product, or each piece of operating equipment, with typed description of product and major component parts of equipment.
 - .2 List with each product:
 - .1 Name, address, and telephone number of Subcontractor, supplier, installer, and maintenance contractor, as appropriate.
 - .2 Identify area of responsibility of each.
 - .3 Provide local source of supply for parts and replacement.
 - .3 Identity of separate structure as applicable.
 - .4 Maintenance Summary (Format in accordance with paragraph 1.6.).
- .7 Assemble and bind material in same order as specified in the Contract Documents.
- .8 Material shall be suitable for reproduction, with quality equal to original.

OPERATION AND MAINTENANCE DATA

- .2 Final Instructional Manual Format:
 - .1 Compile all Contract Administrator-accepted preliminary O&M data into a hard-copy, hard-bound set as detailed in Clause 1.4.1 above and in electronic media format as described in Clause 1.4.3.
- .3 Electronic Media Format:
 - .1 Portable Document Format (PDF):
 - .1 After all preliminary data has been found to be acceptable to Contract Administrator, upload electronic copies of O&M data to the City's DMS (Aconex) in PDF format and in native file format as applicable.
 - .2 Files to be exact duplicates of Contract Administrator-accepted preliminary data. Arrange by Specification number and name.
 - .3 Files to be fully functional and viewable in most recent version of Adobe Acrobat.
 - .4 PDF files to be indexed and searchable.
 - .5 USB drive tag: Identify with typed or printed title "OPERATION AND MAINTENANCE DATA, VOLUME NO. ____ OF ____" and list:
 - .1 Project title.
 - .2 Contractor's name, address, and telephone number.
 - .3 Identity of equipment number and Specification section.

1.5 Submittals

- .1 Informational:
 - .1 Data Outline: Submit an electronic copy of a detailed outline of proposed organization and contents of final data prior to preparation of preliminary data.
 - .2 Preliminary Data:
 - .1 Submit three (3) hard copies for Contract Administrator's review.
 - .2 If data meets conditions of the Contract:
 - .1 One (1) copy will be returned to Contractor.
 - .2 One (1) copy will be forwarded to The City.
 - .3 One (1) copy will be retained in Contract Administrator's file.
 - .3 If data does not meet conditions of the Contract:
 - .1 Two (2) copies will be returned to Contractor with Contract Administrator's comments (on separate document) for revision.

OPERATION AND MAINTENANCE DATA

- .2 One (1) copy with comments will be retained in Contract Administrator's file.
- .3 Resubmit three (3) copies revised in accordance with Contract Administrator's comments.
- .3 Final Data: Submit four (4) hard copies and two (2) USB drive copies in format(s) specified herein.

1.6 Data For Systems, Subsystem and Components

- .1 Content For Each Unit (or Common Units) and System unless otherwise specified:
 - .1 Product Data:
 - .1 Include only those sheets that are pertinent to specific product.
 - .2 Clearly annotate each sheet to:
 - .1 Identify specific product(s) or part(s) installed.
 - .2 Identify data applicable to installation.
 - .3 Delete references to inapplicable information.
 - .3 Function, normal operating characteristics, and limiting conditions.
 - .4 Serial Numbers.
 - .5 Performance curves, engineering data, nameplate data, and tests reports for all pumps.
 - .6 Motor and pump vibration readings.
 - .7 Final power measurements from field testing.
 - .8 Complete nomenclature and commercial number of replaceable parts.
 - .9 All baseline numbers of all equipment from final installation shall be included for predictive maintenances.
 - .10 Original Manufacturer's parts list, illustrations, detailed assembly drawings showing each part with part numbers and sequentially numbered parts list, and diagrams required for maintenance.
 - .11 Spare parts ordering instructions.
 - .12 Where applicable, identify installed spares and other provisions for future work (e.g., reserved panel space, unused components, wiring, terminals).
 - .2 Safety Data Sheets (SDSs) for all chemicals needed in operation and maintenance.
 - .3 As-installed, color-coded piping diagrams.
 - .4 Charts of valve tag numbers, with the location and function of each valve.

OPERATION AND MAINTENANCE DATA

- .5 Drawings: Supplement product data with Drawings as necessary to clearly illustrate:
 - .1 Format:
 - .1 Provide reinforced, punched, binder tab; bind in with text.
 - .2 Reduced to 8-1/2 inches by 11 inches, or 11 inches by 17 inches folded to 8-1/2 inches by 11 inches.
 - .3 Where reduction is impractical, fold and place in 8-1/2-inch by 11-inch envelopes bound in text.
 - .4 Identify Specification section and product on Drawings and envelopes.
 - .2 Relations of component parts of equipment and systems.
 - .3 Control and flow diagrams.
 - .4 Coordinate drawings with Project record documents to assure correct illustration of completed installation.
- .6 Instructions and Procedures: Within text, as required to supplement product data.
 - .1 Format:
 - .1 Organize in consistent format under separate heading for each different procedure.
 - .2 Provide logical sequence of instructions for each procedure.
 - .3 Provide information sheet for the City's personnel, including:
 - .1 Proper procedures in event of failure.
 - .2 Instances that might affect validity of guarantee or Bond.
 - .2 Installation Instructions: Including alignment, adjusting, calibrating, and checking.
 - .3 Operating Procedures:
 - .1 Start-up, break-in, routine, and normal operating instructions.
 - .2 Test procedures and results of factory tests where specified.
 - .3 Regulation, control, stopping, and emergency instructions.
 - .4 Description of operation sequence by control Manufacturer.
 - .5 Shutdown instructions for both short and extended duration.
 - .6 Summer and winter operating instructions, as applicable.
 - .7 Safety precautions.

OPERATION AND MAINTENANCE DATA

- .8 Special operating instructions.
- .4 Maintenance and Overhaul Procedures:
 - .1 Routine and preventative maintenance.
 - .2 Guide to troubleshooting.
 - .3 Disassembly, removal, repair, reinstallation, and re-assembly.
- .7 Guarantee, Bond, and Service Agreement: In accordance with Section 01 78 00, Closeout Submittals.
- .2 Content for Each Electric and Electronic Item and System:
 - .1 Description of Unit and Component Parts:
 - .1 Function, normal operating characteristics, and limiting conditions.
 - .2 Performance curves, engineering data, nameplate data, and tests.
 - .3 Complete nomenclature and commercial number of replaceable parts.
 - .4 Interconnection wiring diagrams, including control and lighting systems.
 - .2 Circuit Directories of Panelboards:
 - .1 Electrical service.
 - .2 Controls.
 - .3 Communications.
 - .3 List of electrical relay settings, and control and alarm contact settings.
 - .4 Electrical interconnection wiring diagram, including control, panel, and lighting systems.
 - .5 As-installed control diagrams by control Manufacturer.
 - .6 ISA S20 data sheets for all instruments.
 - .7 Operating Procedures:
 - .1 Routine and normal operating instructions.
 - .2 Sequences required.
 - .3 Safety precautions
 - .4 Special operating instructions.
 - .8 Maintenance Procedures:
 - .1 Routine maintenance.

OPERATION AND MAINTENANCE DATA

- .2 Guide to troubleshooting.
- .3 Adjustment and checking.
- .4 List of relay settings, control and alarm contact settings.
- .9 Manufacturer's printed operating and maintenance instructions.
- .10 List of original Manufacturer's spare parts, Manufacturer's current prices, and recommended quantities to be maintained in storage.
- .3 Content for Programmable Devices/Components/Sub-systems:
 - .1 The following requirements are minimum requirements applicable to programmable equipment such as VFDs, ASDs, microprocessor-based devices, PLCs, Human-Machine-Interfaces, computers, and other programmable devices. Additional requirements may be specified elsewhere.
 - .2 As-Constructed version of Shop Drawings.
 - .3 Functional description.
 - .4 Wiring details.
 - .5 Configuration Records; record of switch settings, program listings and parameter settings, after commissioning.
 - .6 IO Lists (Hardwired and communicated):
 - .1 Including panel/equipment source and destination, signal tag, signal type, signal description, signal range, signal states (for discrete signals), signal scaled range (for analog signals), and notes.
 - .7 Instrument Lists.
 - .1 Including instrument tag, instrument description, instrument type, instrument range and calibrated range, and instrument voltage.
 - .8 IP Address Lists.
 - .9 PLC Module List.
 - .10 Instrument Calibration Sheets.
 - .11 Maintenance manuals.
 - .12 User guides, technical reference, and programming manuals.
 - .13 USB drive copies of:
 - .1 Manuals.
 - .2 Settings, databases and templates. Include both native format of files and ASCII-exported version.

OPERATION AND MAINTENANCE DATA

- .3 Application programs.
- .14 Cable and software for use on The City's notebook computer for revising/downloading the settings and software.
- .4 Maintenance Summary:
 - .1 Compile individual Maintenance Summary for each equipment item, respective unit and system, and for components and sub-units.
 - .2 Format:
 - .1 Use Maintenance Summary Form bound with this section or electronic facsimile of such.
 - .2 Each Maintenance Summary shall take as many pages as required.
 - .3 Use only 8-1/2-inch by 11-inch size paper.
 - .4 Complete using electronic printing. Hand-written and hand-printed entries shall not be accepted.
 - .3 Include detailed lubrication instructions and diagrams showing points to be greased and oiled; recommend type, grade, and temperature range of lubricants and frequency of lubrication. Include total volume of oil required for draining purposes in the event of equipment removal.
 - .4 Provide Safety Data Sheets (SDS) for all lubricants and cleaners required for operation.
 - .5 Include list of spare parts provided for each equipment item, unit number, and quantities included.

1.7 Control Narrative

- .1 Provide a Control Narrative for the system including;
 - .1 List of functions monitored, controlled, and alarmed by Supplier. The Control Narrative shall include all failure conditions including individual PLC failures, instrumentation failures, network connection failures, and master control failures and responses to each situation.
 - .2 Equipment shall be controlled in REMOTE-MANUAL (operator controlled through selection of equipment to start/stop) and REMOTE-AUTO (equipment operates automatically based on process feedback) modes of operation through the PCS system.
 - .3 The narrative is to be written so that the text conforms to the following headings: Process Description, Equipment, Control Modes, I/O Points, Normal Operation, Fault Response and Interlocks, Program Variables, Virtual Points, Alarms, PLC Data Exchange (Memory Map) and Hardwired Control Logic.
 - .4 Identify all register locations in UV system controller software to be accessed for monitoring purposes by the PCS system, and those registers from which the UV PLC will read control settings required for the operation of the system. This document shall be approved by the Contract Administrator prior to commencement of programming.

OPERATION AND MAINTENANCE DATA

1.8 Data For Materials and Finishes

- .1 Content for Architectural Products, Applied Materials, and Finishes:
 - .1 Manufacturer's data, giving information on products:
 - .1 Catalog number, size, and composition.
 - .2 Color and texture designations.
 - .3 Information required for reordering special-manufactured products.
 - .2 Instructions for Care and Maintenance:
 - .1 Manufacturer's recommendation for types of cleaning agents and methods.
 - .2 Cautions against cleaning agents and methods that are detrimental to product.
 - .3 Recommended schedule for cleaning and maintenance.
- .2 Content for Moisture Protection and Weather Exposed Products:
 - .1 Manufacturer's data, giving full information on products:
 - .1 Applicable standards.
 - .2 Chemical composition.
 - .3 Details of installation.
 - .2 Instructions for inspection, maintenance, and repair.

1.9 Supplements

- .1 The supplements listed below, following "End of Section", are part of this Specification:
 - .1 Forms: Maintenance Summary Form.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

OPERATION AND MAINTENANCE DATA

MAINTENANCE SUMMARY FORM

PROJECT: _____ CONTRACT NO.: _____

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. MODEL _____

4. SERIAL NUMBER _____

5. EQUIPMENT/TAG NUMBER(S) _____

6. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 45 KG) _____

7. NAMEPLATE DATA (hp, voltage, speed, etc.) _____

8. MANUFACTURER' S LOCAL REPRESENTATIVE _____

a. Name _____ Telephone No. _____

b. Address _____

9. MAINTENANCE REQUIREMENTS

MAINTENANCE OPERATION COMMENTS	FREQUENCY	LUBRICANT (IF APPLICABLE)
List briefly each maintenance operation required and refer to specific information in manufacturer's standard maintenance manual, if applicable. (Reference to manufacturer's catalog or sales literature is not acceptable.)	List required frequency of each maintenance operation	Refer by symbol to lubricant required.

OPERATION AND MAINTENANCE DATA

10. LUBRICANT LIST

REFERENCE SYMBOL	[SHELL]	[STANDARD OIL]	[GULF]	[ARCO]
List symbols used in No. 9. above.	List equivalent lubricants, as distributed by each manufacturer for the specific use recommended.			

11. RECOMMENDED SPARE PARTS FOR THE CITY'S INVENTORY.

PART NO.	DESCRIPTION	UNIT	QUANTITY	UNIT COST

Note: Identify parts provided by this Contract with two asterisks.

DEMONSTRATION AND TRAINING

1. GENERAL

1.1 Description

- .1 This Section contains requirements for training City staff, by persons retained by the Contractor specifically for the purpose of proper operation and maintenance of all equipment supplied and installed under this Contract.
- .2 The Installation Contractor will develop the overall training plans for Unit Processes and Facility Areas with input from the Supply Contractor, vendors, and the City. The Supply Contractor shall be responsible for providing qualified training instructors and field lesson plans as detailed in the Specifications and as described herein.
- .3 Arrange for Supplier’s Representatives to supply detailed classroom and hands-on training to the City’s operations personnel, maintenance personnel, and select on-call personnel on operation and maintenance of specified product (system, subsystem, and component) and as required in applicable Specifications.
 - .1 Be tailored for the specific audience in each course.
 - .2 Ensure that each course accommodates plant staff shift schedules by providing multiple sessions covering the same content if necessary.
 - .3 Arrange for and require plant staff to perform the demonstrated procedures and provide an evaluation of the Participants.
- .4 The City shall require training for at least three (3) shifts for each specified training session focused to each Mechanical Maintenance and Electrical and Instrumentation staff, two (2) for Automation and Industrial Controls Group (AICG) and at least five (5) shifts for Operations . See Table 1. Allow at least the minimum specified number of hours or days of training for each City staff shift for each specified product (system, subsystem, and component).

Table 1 : Training Requirements

Training Participant Groups	Approximate Number of Personnel	Minimum Number of Sessions	Constraints
Operations Personnel	40	5	Crew and shift schedules
Maintenance Personnel			
Mechanical Maintenance	20	3	
Electrical and Instrumentation Maintenance	20	3	
Automation and Industrial Controls Group	10	2	

DEMONSTRATION AND TRAINING

- .5 To facilitate scheduling of the City personnel, the City may elect to divide sessions into operation-specific topics and maintenance-specific topics as applicable, to allow operations/on-call staff and maintenance staff to attend separately. The Contractor shall coordinate with the Contract Administrator and the City. Training to be scheduled and coordinated to not interfere with the operation and maintenance of the existing NEWPCC facility.
- .6 Training will be scheduled at least four (4) weeks in advance of the respective training sessions.
- .7 Furnish trained, articulate personnel to coordinate and expedite training, to be present during training coordination meetings with the City and familiar with Operation and Maintenance manual information specified in Section 01 78 23, Operation and Maintenance Data.
- .8 Training sessions shall be conducted by qualified Supplier's Representatives, with a minimum of two (2) years' experience. Supplier's Representatives shall be familiar with the specified equipment as well as with facility operation and maintenance requirements.
- .9 The Contract Administrator has the authority to determine if the training is sufficient based on the lesson plan submitted by the Contractor.
- .10 Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.
- .11 Training Staging:
 - .1 Due to the staging of the construction and the partial completion of the UV system, we may need more stages of training. For example after the first low flow period we will have at least one channel on the new system and two channels on the old system. The operators will need training on this stand alone channel from the OIT and know any necessary information to do with interaction between the two. Depending on construction the PCS may or may not be available until after the channel is needed for operations in the spring, once the PCS is operational there will be training required as well. There will be training required after the second low flow when there are all three channels available for the duty / standby operation at the OIT and at the PCS.
 - .2 The field training for maintenance will not need to be done more than once. But the classroom and field training for the entire system will need to be done at the end.

1.2 Submittals

- .1 Submit the following information to the Contract Administrator thirty (30) days prior to the first training session. The material will be returned as either "NO EXCEPTIONS TAKEN", "EXCEPTIONS NOTED" or "EXCEPTIONS NOTED - RESUBMIT".
 - .1 Lesson plan and supplemental training manuals, handouts, visual aids and other reference material required for each training session.
 - .2 Submit proposed lesson plan not less than twenty-one (21) days prior to scheduled training and revise as necessary for acceptance.
 - .3 Lesson Plan: When training of the City personnel is specified, prepare for each required course, a lesson plan containing but not limited to the following information:

DEMONSTRATION AND TRAINING

- .1 Title and objectives.
 - .2 Recommended types of attendees (e.g., managers, engineers, operators, maintenance).
 - .3 Course description and outline of course content.
 - .4 Format (e.g., lecture, self-study, demonstration, hands-on).
 - .5 Instruction materials and equipment requirements, including supplemental training manuals, handouts, visual aids and other reference material required for each training session.
 - .6 Resumes of instructors providing the training.
- .4 Training Schedule:
- .1 Submit not less than twenty-one (21) calendar days prior to start of equipment installation and revise as necessary for acceptance.
 - .2 List specified equipment and systems that require training services and show:
 - .1 Respective Supplier.
 - .2 Estimated dates for installation completion.
 - .1 Training schedule to include:
 - .1 Course name;
 - .2 Course Lesson Plan submittal dates;
 - .3 Planned session dates and durations; and
 - .4 Planned Training Participant Groups.
 - .3 Adjust schedule to ensure training of appropriate personnel as deemed necessary by the City, and to allow full participation by Supplier's Representatives. Adjust schedule for interruptions in operability of equipment.
 - .4 Individual sessions shall not exceed four (4) hours. A break should be incorporated into sessions that exceed two (2) hours. Training session anticipated to exceed four (4) hours can be assigned to multiple-sessions; however, no more than one (1) - 3-hour and one (1) - 4-hour sessions (seven (7) hours total) may be delivered to the same participants in a single day. Two (2) successive 4-hour sessions may be delivered to alternating shifts of attendees in a single day (i.e., one group of attendees in the morning, and a second group of attendees in the afternoon). Training sessions requiring more than seven (7) hours may be delivered on separate days.
 - .5 Classes shall not be scheduled concurrently.

DEMONSTRATION AND TRAINING

1.3 Location and Training Facilities

- .1 The City shall provide the classroom training facilities.
- .2 Field training sessions shall take place at the equipment location.

1.4 Format and Content

- .1 The training program shall:
 - .1 Be focused on field and hands-on training, organized in a format to most effectively train plant staff operating the system.
 - .2 Include classroom training that comprise no more than 20 percent of the training time and the field training of at least 80 percent of the training time, with both training completed within the same two weeks.
 - .3 The classroom training shall be completed within the same two weeks as the field training.
 - .4 Ensure training covers all aspects of the unit needed by operations or maintenance staff (such as operating the system locally, operating the system remotely, operating the system during fault or upset, returning the system to normal operating condition, etc.)
 - .5 Ensure training covers all aspects of the Process Control System (PCS) including screens and graphics, screen navigation, pre-configured and custom trending, pop-up dialog boxes, alarm management, remote/local and manual/automatic operating modes, and any programmed sequences.
- .2 The training sessions shall be comprised of both classroom training and field training. As a minimum, they shall cover the following topics for each item of equipment or system:
 - .1 Training shall cover:
 - .1 Familiarization.
 - .2 Safety.
 - .3 Operation.
 - .4 Troubleshooting.
 - .5 Preventative and predictive maintenance.
 - .6 Corrective maintenance.
 - .7 Parts.
 - .8 Local representation.
 - .2 Classroom Training:

DEMONSTRATION AND TRAINING

- .1 As a minimum, classroom equipment/system training shall be completed prior to Running Test and shall include:
 - .1 The specific equipment location in the plant and operational overview. Use slides and drawings to aid discussion.
 - .2 Purpose and function of the equipment/system.
 - .3 The operating theory of the equipment/system.
 - .4 Start-up, shutdown, normal operation and emergency operating procedures, including system integration and electrical interlocks, if any.
 - .5 Safety items, standard operation procedures (SOPs), and safe work procedures (SWPs) related to operation of the equipment.
 - .6 Routine and preventative and predictive maintenance.
 - .7 Disassembly and assembly of equipment if applicable.
 - .8 Normal and major repair procedures.
 - .9 Inspection and troubleshooting procedures including the use applicable test instruments and the “pass” and “no pass” test instrument readings.
 - .10 Calibration procedures.
- .2 The Contractor shall integrate a PCS Demonstration System into any classroom training course where:
 - .1 The content includes equipment monitoring and control via the HMI.
 - .2 The content includes alarming and alarm response.
 - .3 The content includes coordination of maintenance events and states to PCS/HMI status indications.
 - .4 The use of the PCS Demonstration System would clarify and aid in the training of the Training Participants.
 - .1 Where use of the PCS Demonstration System is included in a training course, the Contractor shall:
 - .2 Provide the PCS Demonstration System in accordance with the Specifications.
 - .3 Make certain that the PCS Demonstration System in no way impacts the actual operating PCS or in any other way expose the PCS to any risk of inadvertent operation.
 - .4 Provide a second projector and screen to display the HMI Operator Workstation to all participants.

DEMONSTRATION AND TRAINING

.3 Field Training:

.1 As a minimum, field equipment training for operations personnel shall include:

- .1 Identification of equipment: location of primary element; location of instrument readout; discussion on purpose, basic operation, and information interpretation.
- .2 Discussion and demonstration of standard operating procedures, safe work procedure, and daily visual inspection of system operations.
- .3 Discussion and demonstration of the preventative maintenance activities, and predictive maintenance activities where applicable.
- .4 Discussion and demonstration of start-up and shutdown procedures.
- .5 Demonstration of routine disassembly and assembly of equipment.
- .6 Identification and review of safety items and demonstration of safety procedures.
- .7 Review of Contractor prepared Operation and Maintenance Manuals.
- .8 Demonstration of operating parameter adjustment for optimized equipment and system operation.

1.5 Training Deliverables

- .1 Contractor shall provide all material used in the training to the City;
- .2 Contractor shall provide shareable content object reference model (SCORM) of Training Materials to be used for future City training;
- .3 SCORM is a collection of standards and specifications for web-based electronic educational technology (also called e-learning). By using software like Adobe Captivate, Storyline etc. to create training modules which incorporate slide content information, edited videos, etc. and contain module quizzes to test employees' knowledge in a single e-learning pack package for upload to a learning management system.
- .4 SCORM courses should include presentation slides from classroom training, embedded and edited videos and an end of module quiz including a minimum of 5 questions specific to the learning objectives. Each course should be customized for the specific training participants.
- .5 Training Videos may be embedded in the SCORM and shall meet the requirements of Section 1.8.

1.6 Participant Evaluation Requirements

- .1 As part of each field training session, Design Builder 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.

DEMONSTRATION AND TRAINING

1.7 Training Material

- .1 The Training Material shall be provided in electronic native, editable file format.
- .2 The Training Material shall be organized by course, with all material used and collected from Participant Groups during training systematically arranged in a consistent manner.

1.8 Training Videos

- .1 Contractor shall provide videos to augment the SCORM (the “**Training Videos**”). When Training Videos are embedded in the SCORM, Contractor shall:
 - .1 provide a minimum of one set of videos for each classroom training course;
 - .2 select sessions to record to provide the most comprehensive and highest quality of video training; and
 - .3 replace or amend videos as required in the event that the training content for a course is amended after recording a training session.
- .2 Training Videos shall:
 - .1 be in a SCORM-compatible format;
 - .2 have high definition audio (48 kHz, 16 bit) or better;
 - .3 be separated and organized by course and into clips/segments on each topic, with each clip/segment limited to approximately 15 minutes;
 - .4 be recorded with sufficient technical skill and recording quality to clearly illustrate the subject matter; and
 - .5 be structured to provide a logical sequence of learning.

1.9 Training Completion Forms

- .1 Form T1, attached to this Specification, shall be signed by the trainer, the Contract Administrator, and by a City Staff representative for each City shift when classroom training has been completed. One (1) form is to be used for each item of equipment and each system for which training has been provided. Once all classroom training sessions have been completed, Form T1 is to be submitted to the Contract Administrator.
- .2 Form T2, attached to this Specification, shall be signed by the trainer, the Contract Administrator, and by a City Staff representative for each City shift when field training has been completed. One (1) form shall be used for each item of equipment and each system for which training has been provided. Once all field training sessions have been completed, Form T2 shall be submitted to the Contract Administrator.
- .3 The supply of adequate training, including completion of Forms T1 and T2 shall be a required prerequisite for handover of equipment, Unit Processes and Facility Areas as appropriate to the City.

DEMONSTRATION AND TRAINING

1.10 Supplement

.1 Supplements listed below, following “End of Section,” is a part of this Specification:

.1 Form T1 Certificate of Satisfactory Classroom Training.

.2 Form T2 Certificate of Satisfactory Field Training.

2. PRODUCTS (NOT USED)

3. EXECUTION (NOT USED)

END OF SECTION

DEMONSTRATION AND TRAINING

**CERTIFICATE OF SATISFACTORY TRAINING
FORM T1**

We certify that the initial training for the equipment listed below has been provided as per the Specifications.

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Trainer)

Date

(City Staff Representative)

Date

(Contract Administrator)

Date

DEMONSTRATION AND TRAINING

**CERTIFICATE OF SATISFACTORY TRAINING
FORM T2**

We certify that the final training for the equipment listed below has been provided as per the Specifications.

PROJECT: _____

ITEM OF EQUIPMENT: _____

TAG NO: _____

**REFERENCE
SPECIFICATION:** _____

(Trainer)

Date

(City Staff Representative)

Date

(Contract Administrator)

Date

COMMISSIONING PLAN

1. GENERAL

1.1 Description

- .1 Provide a complete and fully functional system ensuring that:
 - .1 City personnel have been fully trained in aspects of installed systems as per Section 01 79 00.
 - .2 Documentation relating to installed equipment and systems has been completed as per Section 01 65 00.
- .2 The Supplier shall cooperate with Construction Contractor in all commissioning activities pertaining to the supplied equipment.
- .3 The Supplier shall cooperate with Construction Contractor to develop a Detailed Commissioning Plan and Commissioning Schedule using this Section as a Base Commissioning Plan.
- .4 Use this 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.
- .5 The Contract Administrator shall witness and certify tests and reports of results.
- .6 Commissioning activities shall 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. This shall occur after the successful end of Commissioning of each system through a formal acknowledgement between the Contract

COMMISSIONING PLAN

- 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 Bumping:
 - .1 Used to Commission mechanical systems and associated equipment.
 - .2 Used to Commission, test, and tune instrumentation and process loops.
 - .4 Process systems:
 - .1 UV disinfection equipment.
 - .5 Low voltage below 750 V:
 - .1 Low voltage equipment.
 - .6 Instrumentation and control systems:
 - .1 PLC automation system.
 - .2 Instrumentation.
 - .3 Communication with the Process Control System.
 - .7 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 and without major alarms, shutdowns, etc. for a period of ten (10) days, the last seven (7) of which shall be consecutive, unless otherwise specified.
 - .8 Commissioning Agent: Agent of the Contractor with experience in Commissioning, satisfactory to the Contract Administrator, responsible for the oversight and execution of Commissioning.
 - .9 Commissioning Report: the final Commissioning document as described in Clause 3.14.
 - .10 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 Clause 3.1.
 - .11 Demonstration: a one-hour demonstration of the successful installation and operation of the equipment.
 - .12 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 Clause 3.2. Unless defined as "Base Commissioning Plan", all other instances of "Commissioning Plan" refer to the Detailed Commissioning Plan.

COMMISSIONING PLAN

- .13 There will need to be three distinct commissioning plans in place, with one for each channel. Then there need to be an additional commissioning required once all three channels are brought online. The software program and the PCS program will need to be staged as the I/O for the equipment is brought online. Supplier to participate in development of all plans.
- .14 **Running Test:** a test in which equipment is run continuously for a minimum of seven (7) days for each installation period. During the test 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. In the event that the conditions cannot be simulated by modifying plant operations, the I/O signals may be manipulated to simulate the conditions to verify necessary response by the UV system.
- .15 **Performance Test:** a test in which the equipment is run continuously for thirty (30) days after the complete UV system has been installed. 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 Performance Test is required for Form 104.
- .16 **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.

1.3 Submittals

- .1 Provide submittals in accordance with Section 01 33 00.
- .2 Commissioning Schedule to be submitted and accepted by the Contract Administrator as per Clause 3.1.
- .3 Detailed Commissioning Plan to be submitted and accepted by the Contract Administrator as per Clause 3.2.
- .4 Detailed Commissioning Plan to be refined and resubmitted as required during the construction phase as per Clause 3.3.

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:

COMMISSIONING PLAN

- .1 Attending Commissioning activities to verify re-installed existing equipment operates as per the original sequence of operations.
- .2 Attending Commissioning activities to verify newly installed equipment operates as intended.
- .3 Performing necessary testing as noted in Clause 3.11.
- .3 Construction Team: Contractor, Subcontractors, suppliers, and support disciplines, who are responsible for construction and/or installation in accordance with Contract Documents, including:
 - .1 Testing.
 - .2 Mechanical testing, adjusting and balancing (TAB).
 - .3 Integrating Commissioning activities into the Contractor's Project Schedule.
 - .4 Performing and documenting equipment installation as per Section 01 65 00.
 - .5 Performing and documenting start-up including installation and start-up checklists.
- .4 Contractor's Commissioning Agent who shall be responsible for implementing specified Commissioning activities including:
 - .1 Planning and 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 Running Test and 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 Testing of 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.

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- .2 Process systems:
 - .1 UV disinfection equipment.

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 disinfection systems, to be used by the Contractor in the development of a Detailed Commissioning Plan.
- .2 The Detailed Commissioning Plan and associated Commissioning Schedule shall be approved by the Contract Administrator 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.
- .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 sampling and analytical program for tests necessary to verify compliance with the performance specifications.
 - .2 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.
 - .3 The Manufacturer's Representative shall conduct all necessary checks to the equipment and advise the Contractor of any further checking, flushing, cleaning, or other work needed prior to confirming the equipment is ready to run.
 - .4 Contingency plans in the event of a process malfunction.

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- .5 Drawings and sketches as required to illustrate the planned sequence of events.
- .6 List and details for all temporary equipment or component (additional spool pieces, etc.) required to facilitate Commissioning.
- .7 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 shall 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.
- .5 The Detailed Commissioning Plan shall include:
 - .1 Commissioning Schedule.
 - .2 Installation and 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 piece of major equipment for each installation period. Form 104 shall be executed for each piece of major equipment.

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- .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.
- .3 In the event that achieving adverse operating condition was deemed impractical by the City operation, the I/O signals may be manipulated to achieve the necessary reaction of the system.

3.6 Plant Utility Service

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

3.7 Manpower

- .1 Supply all staff required during Commissioning as necessary to assist the City's staff in the operation of the facility.
- .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 Supplier'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 facility systems. Other information outlining the operating requirements shall also be available from the Contract Administrator. The Contractor will review these descriptions and shall 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 Clause 3.14.2.

3.9 Design Parameters

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

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3.10 Pre-Commissioning Activities

- .1 Conduct pre-start-up pressure, static, flushing, cleaning, "bumping" testing, and loop validation during construction as specified in the individual sections. This testing shall 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 and start-up check lists if required. Rectify any deficiencies to the Contract Administrator's satisfaction. Include completed documentation with the Final Commissioning Report.
- .3 Pre-commissioning activities shall include, at minimum:
 - .1 Process systems:
 - .1 "Bump" each item of equipment in its "stand-alone" mode.
 - .2 Complete pre-start-up checks and complete relevant documentation.
 - .3 After equipment has been started, test related systems in conjunction with control systems on a system-by-system basis.

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 Instrumentation and Control

- .1 Commissioning activities shall only proceed after instrumentation and control tests have been completed.
- .2 A minimum written notice of two (2) weeks shall be required prior to commencing with process commissioning activities. To qualify for process commissioning the following activities shall be completed:
 - .1 Instrument calibrations;
 - .2 Initial Control Settings and adjustments have been made;
 - .3 All field devices have been set-up;
 - .4 Forms (i.e., 100 forms) 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.

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- .4 Commissioning of the instrumentation and control system shall 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 to the Contract Administrator.
 - .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 as per Section 01 79 00.
 - .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.

3.13 Start-Up and Commissioning of Process Equipment

- .1 A Supplier's Representative shall conduct all necessary checks to the equipment prior to start-up as described in Section 01 65 00.
- .2 Following the installation and calibration of the equipment, the Contractor shall perform a Demonstration, Running Testing, and Performance Testing of the full system. It will be the responsibility of the Contractor to arrange the times for testing and start-up activities. The Contractor shall confirm that these times are acceptable to the Contract Administrator and the City.
 - .1 During the Demonstration, Running, and Performance testing, 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 Testing, and Performance Testing.
 - .3 Should the initial Demonstration, Running Testing, or Performance Testing reveal any defects, then those defects shall be documented and promptly rectified and the Demonstration, Running Testing, and/or Performance Testing shall be repeated to the satisfaction of the Contract Administrator. Even if this shall require repeating of all commission procedures from the beginning, it will be at the sole discretion of the Contract Administrator.

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- .4 Additional costs incurred by the Contractor due to repeat Demonstration, Running Testing, and/or Performance Testing shall be borne by the Contractor.
- .3 On successful completion of the Demonstration and Running Testing, Form 103 – Certificate of Equipment Satisfactory Running Test Performance (attached to this Specification) will be signed by the Supplier's Representative, the Contractor, and the Contract Administrator. Form 103 is required for each channel and each piece of major equipment, which includes its associated electrical/control modifications by extension and for each installation period.
- .4 On successful completion of the Performance Testing, Form 104 – Certificate of Equipment Satisfactory Performance Test Performance (attached to this Specification) will be signed by the Supplier's Representative, the Contractor, and the Contract Administrator. Form 104 is required for each piece of equipment, which includes its associated electrical/control modifications by extension. For clarity, Performance Testing will not begin until all UV equipment is installed.
- .5 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 Supplier's Representative on site, the Contractor shall demonstrate that the equipment is properly installed. Alignment, piping connections, electrical connections, etc. shall 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 shall be checked to ensure that they are within the specified or Supplier'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.
- .6 Running Test:
 - .1 The Running Test shall be performed subsequent to successful Demonstration of equipment.
 - .2 After cleaning, completely test each UV bank to verify that equipment can perform its specified function in satisfactory manner without mechanical or electrical defects, or operational difficulties.
 - .3 The equipment shall run continuously for a minimum of seven (7) days. During this period conditions shall be simulated which represent maximum (or most severe), average, and minimum (or least severe) flow and UVT conditions. These conditions shall be mutually agreed to by the Supplier's Representative, the Contractor, and the Contract Administrator on the basis of the information contained in the technical specifications, and the methods utilized to create the simulated conditions and the time periods allotted to each.

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- .4 The Running Test shall be repeated for each piece of major equipment and each period of installation.
- .5 The Contractor shall conduct daily *E.coli* sampling throughout the Running Test:
 - .1 Contractor shall collect and send final effluent samples to an accredited laboratory for analysis of *E.coli*, UV transmittance (%UVT) and total suspended solids (TSS) concentrations at their own cost.
 - .2 The grab samples shall be collected for each day that the UV system is discharging effluent to the outfall (one (1) sample set per day).
 - .3 Each set of samples shall include the following analyses:
 - .1 The most probable number (MPN) Fecal Coliform count per 100 mL in the UV disinfection channel influent (upstream) and effluent (downstream).
 - .2 The %UVT at a wavelength of 254 nanometers of the UV disinfection channel influent.
 - .3 The TSS concentration in the UV disinfection channel influent.
 - .4 Collect adequate sample such that the City may split the sample and perform its own testing, at its discretion.
 - .5 Running Test shall demonstrate that the UV system meets the *E.coli* limits.
 - .6 The criterion for a Running Test pass shall be *E.coli* count of less than 200 MPN/100 ml for all effluent UV samples based on a 7-day Geometric Mean over the 7 day period.
- .6 The Running Test shall be completed as follows:
 - .1 To perform the Running Test, the Contractor, with on-site supervision by the Manufacturer's Representative, shall operate all controls and other devices to ensure they are functional.
 - .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.
 - .1 Local control of all devices when local controllers and/or HMI are not in service.
 - .2 Automatic shutoff and alarm for various failure modes. This shall include air monitoring, process monitoring, and shutdown sequences operating as intended for both life safety and process safety.
 - .3 Automatic switchover from normal power to emergency power, and emergency power to normal power, if this function has been disturbed by modifications.
 - .4 Operation of mechanical cleaning system and chemical cleaning system where applicable.

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- .5 Operation of all monitoring instruments.
- .6 All control functions, at local system, HMI, and SCADA OIT(s).
- .7 At the time of the tests, make final adjustments necessary to place equipment in satisfactory working order to prepare for Start-up.
- .8 Test and calibrate equipment and accessories specified herein in accordance with Supplier's printed instructions over full operating range of equipment.
- .9 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. Results shall include, at a minimum:
 - .1 Pass or Fail status of all tasks and commentary on the performance of each task.
 - .2 The headloss through each UV channel at peak flow.
 - .3 The average power draw of the UV system.
 - .4 The peak power draw of the UV system.
- .10 The Contractor, with assistance from the Manufacturer's Representative, shall complete each Running Test to the satisfaction of the Contract Administrator and the City prior to commencing the Performance Test.
- .7 Performance Tests:
 - .1 Following completion of the Demonstrations and Running Tests, the Contractor in cooperation with the City's operating staff shall conduct the Performance Test with on-site supervision assistance from the Supplier's Representative. The Supplier's Representative shall submit to the Contractor, the City, and the Contract Administrator a complete testing plan.
 - .2 Performance Tests shall be conducted subsequent to the Running Test.
 - .3 To perform the Performance Test, the Contractor in cooperation with City's operating staff shall operate the complete system with on-site supervision assistance from the Manufacturer's Representative continuously for a minimum of thirty (30) days and collect and summarize data to demonstrate that the system meets the requirements specified in Section 46 66 56.
 - .4 During the thirty (30) day period, conditions shall be simulated by plant operations which represent maximum (or most severe), average, and minimum (or least severe) flow and UVT conditions. These conditions shall be mutually agreed to by the Supplier's Representative, the Contractor, and the Contract Administrator on the basis of the information contained in the technical specifications, and the methods utilized to create the simulated conditions and the time periods allotted to each.
 - .5 The Performance Test shall be completed for the entire UV system.

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- .6 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.
- .7 The UV system shall be run in automatic mode and respond to varying flow, UV transmittance, and UV intensity signals.
- .8 At the completion of the Performance Test, confirm all instruments remain within calibration tolerances. If out of calibration, take necessary actions to rectify the instruments and recalibrate.
- .9 The Construction Contractor shall supply all water, UV feed, chemicals, temporary power, heating, and/or any other ancillary equipment or services required to complete the initial demonstration, running test and performance tests.
- .10 Should the initial demonstrations, Running Tests or the Performance Test reveal any defects, then those defects shall be promptly rectified and the demonstration, Running Tests and/or the Performance Test shall be repeated to the satisfaction of the Contract Administrator. Additional costs incurred by the Construction Contractor, or the Contract Administrator, due to repeat demonstration, running tests, and/or performance tests shall be the responsibility of the Construction Contractor.
- .11 Contractor shall collect and send final effluent samples for each newly equipped channel to an accredited laboratory at their own cost for analysis of *E. coli*, %UVT and TSS concentrations.
- .12 Samples shall be collected daily for the entirety of the thirty (30) day Performance Test.
- .13 Each set of samples shall include the following analyses:
 - .1 The most probable number (MPN) Fecal Coliform count per 100 mL in the UV disinfection channel influent (upstream) and effluent (downstream).
 - .2 The %UVT at a wavelength of 254 nanometers of the UV disinfection channel influent.
 - .3 The TSS concentration in the UV disinfection channel influent.
- .14 Performance Test shall demonstrate that the UV system meets monthly *E.coli* limits.
- .15 The criterion for a Performance Test pass shall be *E.coli* count of less than 200 MPN/100 ml for all effluent UV samples based on a 30-day Geometric Mean.
- .16 If, in the opinion of the Contract Administrator, the system does not meet the requirements specified in Section 46 66 56, Supplier shall make all necessary adjustments, at no cost to the City, and assist the Contractor in carrying out Performance Test again.
- .17 The Contractor shall submit the initial results of each Performance 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.

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- .18 The Contract Administrator reserves the right to request additional testing at no additional cost. No equipment shall be accepted and handed over to the City prior to the satisfactory completion of the Performance Test and receipt of the test reports.
- .19 In all cases, compliance with the requirements of this Specification shall be determined for each day of the testing period.
- .20 The Supplier's Representative shall be responsible for confirming instruments are within the accuracy tolerances required for system operation and performance.
- .21 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.
- .22 At the end of the Performance Test, confirm that the equipment is still within calibration. If calibration exceeds the manufactures acceptable requirements, address the issue and extend performance testing by 7 days.
- .23 The Supplier'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:
 - .1 Performance Test conditions and procedures.
 - .2 Corrective actions taken.
 - .3 Retesting results (if necessary).
 - .4 Other pertinent information (if any).
 - .5 Conclusions.
 - .6 Recommendations for future actions.

3.14 Final Commissioning Report

- .1 Contractor to submit the completed Commissioning Report within a maximum of two (2) weeks of completion of Commissioning. The final Commissioning Report is to be reviewed and accepted by the Contract Administrator prior to granting Substantial Performance.
- .2 Final Commissioning Report shall 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.

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- .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.

3.15 Training Plans

- .1 Refer to Section 01 79 00 - Demonstration and Training.

3.16 Supplements

- .1 The supplements listed below, following “End of Section”, are part of this Specification:
 - .1 Form 103 – Certificate of Equipment Satisfactory Running Test Performance.
 - .2 Form 104 – Certificate of Equipment Satisfactory Performance Test Performance.

END OF SECTION

COMMISSIONING PLAN

**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 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 Supplier)

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

COMMISSIONING PLAN

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

We certify that the equipment listed below has been operated and tested as per the Specifications 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 Supplier) _____ Date

(Authorized Signing Representative of the Contractor) _____ Date

(Authorized Signing Representative of the Contract Administrator) _____ Date

(Authorized Signing Representative of the City) _____ Date

LOW PRESSURE HIGH OUTPUT UV DISINFECTION EQUIPMENT

1. GENERAL

1.1 Description

- .1 The work of this Section includes all design, fabrication of pre-assembled packages, factory acceptance testing, freight, labour, materials, tools, supervision of installation, on-Site testing, commissioning, training, and equipment necessary to furnish and test the open channel, gravity flow, low pressure high output ultraviolet (UV) disinfection system, complete and operational with all control equipment and accessories as specified herein. This system will be capable of disinfecting effluent to meet the water quality standards listed in this section.
- .2 All equipment and ancillary items provided as part of this equipment Specification shall be new, field tested and proven effective for the intended service, and shall meet the requirements specified in this Section. All equipment and ancillary items installed shall be suitable for a wet and corrosive environment.
- .3 The UV system shall use inclined lamps.
- .4 New lamp banks shall be designed to fit into the existing channels without requiring expanding channels (i.e., increasing depth, increasing width, increasing length) or additional channels. The existing UV system includes 3 channels with dimensions as shown in the Drawings. For clarity, placing grout within the channels to ensure sealing of the lamp banks is acceptable.
- .5 The UV system shall utilize measured flow, UV intensity, and UV transmittance to dose-pace and minimize power consumption.
- .6 The UV system shall utilize the existing modulating weir gates to maintain acceptable water levels in the UV channels and shall not require increasing the hydraulic profile upstream of the UV system.
- .7 Under no circumstances shall the installation of any of the UV equipment, control cabinets, conduits and cable raceways block or interfere with the safe operation or safe access of any existing equipment.
- .8 Supplier's Representative shall certify proper installation of the UV system and cables and shall assist the Contractor and PCS System Integrator perform Startup, Commissioning, Running and Performance Testing of the installed UV disinfection system.
- .9 The UV disinfection system shall pass Running and Performance Tests requirement of producing an effluent with less than of 200 *E.coli*/100 ml, based on a 30-day Geometric Mean.
- .10 Supplier shall coordinate with the Contractor and PCS System Integrator to interface the UV system controls with the plant Process Control System (PCS). Supplier shall provide all hardware, software, and firmware, including development of drivers if required, to interface with the PCS. Supplier to turn-over software programming and PLC control logic once finalized and approved to allow City to reinstall.
- .11 Supplier shall fully support the commissioning of the PCS system.

LOW PRESSURE HIGH OUTPUT UV DISINFECTION EQUIPMENT

- .12 All cabling, conduit and electrical work shall comply with the CSA electrical code. Any violations shall be corrected to satisfaction of the Contract Administrator at the cost of the Contractor.
- .13 A separate common hardwire alarm shall be provided for each of UV system P1, P2 and P3 station alarms. The common P1, P2 and P3 station alarms shall be individually wired out to the PCS system in addition to individual alarms via communications. The common P1, P2 and P3 station alarms shall only be displayed by PCS when communications is not operational.
- .14 The supplier controls shall be configured so that they can operate in conjunction with the staged construction. The final program will be capable to operate the UV equipment for all three channels; however, until all of equipment is installed the I/O will not be available and the program needs to run whatever equipment has been installed in channels and are in-service seamlessly.
- .15 The Contractor and supplier shall reassign alarm priorities in the OIT and PCS based on operational requirements at no additional cost. A separate common hardwire alarm shall be provided for each of UV system P1, P2 and P3 station alarms. The common P1, P2 and P3 station alarms shall be individually wired out to the PCS system in addition to individual alarms via communications. The common P1, P2 and P3 station alarms shall only be displayed by PCS when communications is not operational.
- .16 There are 4 levels of alarms in the plant operations which are designated as P1, P2, P3 and P4. Priority 1 (P1) – High Priority / Emergency. The alarm indicates a condition that required manual or automatic functions to avoid unacceptable operating conditions or product. P1 are strictly for operational staff that require an immediate response. Also, indicates a callout when unmanned. Priority 2 (P2) – Medium Priority. The alarm indicates a condition that requires manual or automatic functions to avoid unacceptable operating conditions or product. The alarm requires attention, but on its own, does not require a require an immediate response or callout when unmanned. Priority 3 (P3) – Low Priority. The alarm indicates a condition that may result in off-quality product or may lead to more severe consequences. Priority 4 (P4) – Abnormal Condition. This priority indicates an abnormal condition that does not require immediate attention. In general, Local, Manual, or Not Remote mode alarms will be in this category. A critical alarm in the UV system, as designated by the Supplier, is not necessarily classified as a priority 1 (P1) alarm. Alarm levels need to be a submittal for approval.
- .17 Provide all UV disinfection system components specified in this Section from a single manufacturer.
- .18 All electrical components and instruments shall be in compliance with or be approved by either CSA or cUL for the given installation environment as noted in Contract Documents. All electrical components and instruments installed shall be suitable for a wet and corrosive environment.
- .19 The design of the UV disinfection system shall be based on near-term and long-term UVT and flow parameters as summarized in Table 46 66 56-1 at the end of this Specification. It is anticipated that the UV system will operate in the near-term conditions for approximately the first ten (10) years.
- .20 The UV disinfection system shall be capable of disinfection of secondary effluent, produced by a high purity oxygen system followed by secondary clarification, to meet the effluent quality standards specified in this Section in the near-term. For greater clarity, there is no effluent

LOW PRESSURE HIGH OUTPUT UV DISINFECTION EQUIPMENT

filtration on this plant. In the long-term, it is anticipated that the existing secondary treatment will be upgraded to a biological nutrient removal process followed by secondary clarification.

- .21 The UV disinfection system shall be tested at both near-term and long-term conditions. UVT at near-term conditions is highly variable and may represent long-term conditions at various times throughout the year. Flow conditions will be simulated by reducing the number of channels in service, as needed, to test the remaining channels in service.

1.2 Standards

- .1 Unless otherwise specified, references to documents shall mean the latest published edition of the referenced document in effect at the project bid date.
- .2 The City of Winnipeg Water & Waste Department Identification Standard Rev04.
- .3 The City of Winnipeg Water & Waste Department Wastewater Treatment Facilities Automation Design Guide Rev03.
- .4 The City of Winnipeg Water & Waste Department Electrical Design Guide Rev05.
- .5 American Institute of Steel Construction (AISC).
- .6 American National Standards Institute (ANSI).
- .7 American Society for Testing and Materials (ASTM):
 - .1 ASTM A380: Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
 - .2 ASTM A480: General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- .8 American Water Works Association (AWWA):
 - .1 Standard Methods for the Examination of Water and Wastewater.
- .9 American Welding Society (AWS):
 - .1 AWS D1.1: Structural Welding Code – Steel.
- .10 International Electrical Code (IEC).
- .11 Institute of Electrical and Electronics Engineers (IEEE):
 - .1 Standard 519: Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems.
- .12 International Ultraviolet Association (IUVA):
 - .1 Uniform Protocol for Wastewater UV Validation Applications.
- .13 National Electrical Code (NEC).

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- .14 National Electrical Manufacturers Association (NEMA):
 - .1 ICS 1: Industrial Control and Systems General Requirements.
- .15 National Institute of Standards and Technology (NIST).
- .16 National Water Research Institute (NWRI):
 - .1 Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse.
- .17 Physikalisch Technische bunddesanstalt (PTB):
 - .1 UV sensor calibration and certification.
- .18 Underwriters Laboratory Inc. (UL).
- .19 United States Environmental Protection Agency (USEPA):
 - .1 Ultraviolet Disinfection Guidance Manual for the Final Long-Term Phase 2 Enhanced Surface Water Treatment Rule.
- .20 In the event that there is a conflict between standard the Contract Administrator will determine which standard to be followed on a case by case basis. Typically the more onerous standard will apply. The Supplier shall be responsible for submitting a RFI for determination of any such conflicts between standards.

1.3 Submittals

- .1 Submit the following Shop Drawings in accordance with Section 01 33 00 and the following:
 - .1 Catalog cuts and equipment data sheets showing the Supplier's complete descriptive information and product literature. Include complete parts list.
 - .2 Equipment make and model and part number, material of construction, weight of product, electrical requirements, and all electrical and mechanical components.
 - .3 Equipment dimensions, and layout requirements, including the height, width and length of the channels. Indicate the maximum lamp cable length and maximum hydraulic hose length (if applicable).
 - .4 Data sheets and dimension Drawings, including cross sectional details of each UV reactor and ancillary equipment, showing major components and materials of construction.
 - .5 3D model of the UV system within the existing UV building, including UV lamp banks (showing clearance for bank raising), ballast cabinets, system control panel, hydraulic system centre (if applicable), and all other panels required. Include cable routing/cable management systems between all ballast cabinets and lamp banks and hydraulic hose routing/management (if applicable). Supplier shall assist the Engineer in locating ballast cabinets and designing a cable management system to achieve a UV system that is safely and readily accessible for operation and maintenance and does not prevent access and movement of goods within the existing UV building. Supplier shall assist the Engineer

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in the design of removable channel covers to facilitate lamp bank raising and replacement of channel covers to permit maintenance on the raised lamp bank.

- .6 For UV system panels, including the system control panel, ballast cabinets, hydraulic system panel (if applicable), and any other control panel:
 - .1 Front elevations, with and without door.
 - .2 Elementary detailed wiring connection diagrams, cable interconnection diagrams and control panel schematics. Connections and devices shall be labelled with equipment and wire tags.
 - .3 Catalog sheets for all devices within the control panels.
 - .4 Use NEMA device designations and symbols for electric diagrams. Contents of elementary connection diagrams shall be in accordance with NEMA ICS 1.
 - .5 Supplier's standardized elementary diagrams shall not be acceptable unless applicable portions of the diagram have been clearly identified and non-applicable portions are deleted or crossed out.
- .7 Drawings indicating all structural connections, clearances to structures and indicate loads transferred through structural connections to these structures.
- .8 Complete assembly, breakdown, foundation, and installation Drawings, detailed Specifications and data covering materials used and accessories forming a part of the equipment furnished.
- .9 Drawings indicating minimum separation required between UV Banks and clearance around banks, ballast cabinets, and other system equipment to facilitate general maintenance and removal and replacement of components.
- .10 Electrical single line diagram showing all power requirements.
- .11 Performance curves showing headloss across UV channel at specified flow rates.
 - .1 Indicate headloss on the y-axis and flow on the x-axis.
 - .2 Provide data on how headloss curve was generated including:
 - .1 Number of banks in the channel.
 - .2 Size of lamp banks.
- .12 Catalogue data on ancillary electrical components.
- .13 ASTM UL certification for each electrical and control equipment.
- .14 List of the supplied special tool(s) and spare parts required for installation and maintenance. Special tools not listed and are required for maintenance, that are identified prior to the expiration of the warranty period, shall also be supplied at the cost of the Supplier.

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- .15 Factory Acceptance Tests: Submit a detailed test plan with complete instrumentation configuration diagram. Following the testing, provide test results including performance data with unit serial numbers indicated, original test log, data sheets and sample calculations.
- .16 Instrumentation and control Shop Drawings including:
 - .1 All control system components, panels, and instrumentation supplied with this package.
 - .2 Data tables detailing all available system status and control variables for communication with the plant PCS. The data tables should include status of all lamps, ballasts, power supplies, lamp banks, UV Transmittance, UV intensity, effective dose, setpoints, and alarms etc. Provide all the alarm points and categorically list them as critical, major and minor.
 - .3 Provide data indicating range and required settings of indicators, instruments, timers and other related devices.
 - .4 Two (2) USBs with a copy of the final as-built programmed software on each USB.
 - .5 Supplier's required installation and testing instruction.
- .2 Submit the following energy information for the UV system:
 - .1 Average and peak power draw.
 - .2 Power vs. Flow chart from minimum flow to peak hour flow for both near-term and long-term conditions, based on the minimum UVT specified in Table 46 66 56-1. Both curves shall be on the same chart:
 - .1 Power in kW on y-axis.
 - .2 Flow in ML/d on x-axis.
 - .3 Provide a summary report of the anticipated operating conditions across the minimum to maximum flow range in 25 ML/d increments for the following attributes for both near-term and long-term conditions, based on the minimum UVT specified in Table 46 66 56-1:
 - .1 Maximum available dose at each flow increment, assuming all lamps in service.
 - .2 Number of UV banks and lamps in service at each flow increment to meet the specified dose in Table 46 66 56-1.
 - .4 Submit the following additional information:
 - .1 A copy of this Specification Section with any applicable addenda and all referenced Specification Sections with each paragraph check marked to indicate Specification compliance or marked to indicate requested deviations and clarifications from the specified requirements shall be provided with the detailed Shop Drawing.

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- .1 If deviations and clarifications from the Specifications are indicated; and, therefore requested by the Supplier, provide a detailed written justification for each deviation and clarification.
- .2 Failure to include a copy of the marked-up Specification Sections and or the detailed justifications for any requested deviation or clarification may result in disqualification of bid.
- .2 A letter of understanding stating that the UV disinfection system conforms with the requirements specified in this Section and any exceptions shall be clearly listed and explained in the letter. This letter shall accompany Shop Drawing submittal, otherwise Shop Drawings will not be reviewed.
- .3 Hydraulic calculations for the outlet control weirs demonstrating compliance with the required hydraulic characteristics.
- .4 Independent bioassay validation and reduction equivalent dose (RED) calculations demonstrating compliance with the specified dose requirements based on the design fouling and lamp aging factors, and effluent permit limits listed herein.
 - .1 Supplier shall have an independent firm perform all required bioassay evaluations for the proposed UV disinfection system in accordance with NWR1 or IUVA.
 - .2 The bioassay results shall demonstrate that the proposed UV system design and number of lamps will deliver the specified RED and meet the disinfection performance specified herein.
 - .3 Use MS2 bacteriophage for bioassay evaluation. Other surrogate organisms will not be accepted.
 - .4 UV lamp end-of-lamp-life (EOLL) factor shall be 0.50. A higher EOLL factor may be used if third party validation can be provided for the proposed lamp in similar operating conditions; however, an EOLL factor greater than 0.90% will not be accepted.
 - .5 Quartz sleeve fouling factor (QSFF) shall be 0.80, based on clean sleeves. A higher QSFF may be used if third party validation can be provided for the proposed system in similar secondary effluent conditions; however, a QSFF greater than 0.96 will not be accepted.
- .5 Chemical cleaning requirements for UV lamps.
- .6 Letters, signed by an officer of the Supplier, guaranteeing the items in Clause 1.6.
- .7 Warranties for overall system and system components.
- .8 Heat rejected to the surroundings by any proprietary packaged electrical and controls equipment, including thermal load distribution.
- .9 Operation and maintenance instructions, installation and assembly instructions, parts lists, and theory of operation, in accordance with Section 01 78 23.

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- .10 Templates and certified layout and setting plans showing all tolerances, anchor bolts, and other required components needed for proper installation.
 - .11 Recommended spare parts other than those specified.
 - .12 Supplier's requirements for short- (up to 6 months) and long-term (up to 18 months) storage of the UV disinfection system and its components prior to installation.
 - .13 Supplier's product data and specifications for shop painting.
 - .14 Qualifications of service/start-up personnel.
 - .15 Shop and field inspection reports.
 - .16 Training materials for operations and maintenance staff in accordance with Section 01 79 00.
- .5 Sales bulletins or other general publications are not acceptable as submittals for review. Submit only to provide supplemental technical data.
- .3 The Contract Administrator will provide all requested information with regards to the existing weir gates for functional, operational and control concerns. The Supplier / Contractor must advise the Contract Administrator in writing, four months prior to start of construction, if the existing weir gates are compatible or not and have the required features needed to interact with the Supplier's control system to meet all requirements stated within the specification. Failure to advise the Contract Administrator in writing will be taken as acceptance of the existing weir gates as is.

1.4 Quality Assurance

- .1 The Supplier shall be regularly engaged in the design, manufacture and servicing of UV systems for municipal wastewater disinfection. Supplier to submit evidence of a proven track record with at least twenty (20) operating UV installations at municipal wastewater treatment plants over a design flow of 400 MLD.
- .2 The Supplier shall provide documentation of previous experience with municipal UV disinfection systems in wastewater applications with variable output electronic drivers and automatic cleaning systems.
- .3 Perform the Work required by and in accordance with applicable federal, provincial, and local codes; arrange for all permits, inspections and tests required by these codes. Provide systems and items of equipment that conform to applicable safety standards including those for safety of personnel.
- .4 One vendor shall provide equipment and appurtenances, regardless of Supplier, and shall be responsible for the satisfactory operation of the system. Substitutions on functions specified shall not be acceptable.
- .5 Provide components to Supplier's standard for service intended unless otherwise required in these Specifications.

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- .6 Equipment shall be the product of one Supplier. Provide equipment of Supplier's latest and proven design. Lamps shall be standard cataloged products.
- .7 Specifications direct attention to certain required features of the equipment but shall not purport to cover all details entering into its design, construction and installation; supply and install equipment so that systems shall be complete and ready for operation.
- .8 All products and materials that are deemed "no longer supported" or "no longer produced" by the expiration of the warranty period, shall not be acceptable and shall be replaced with the subsequent product replacement at the expense of the Supplier.

1.5 Supplier's Services

- .1 Services of Supplier's Representative stated in Sections 01 65 00, 01 79 00, 01 91 31, and as specified herein.
- .2 Provide services of factory-trained service personnel, specifically trained on type of equipment specified.
 - .1 Submit qualifications of service personnel for review.
 - .2 Person-day requirements listed exclusive of travel time and shall not relieve Contractor of obligation to provide sufficient service to place equipment in a satisfactory operation.
 - .3 Installation: Sufficient time to assist in location of anchorage, setting, leveling, alignment, field erection, etc.; coordination of outlet control weirs, electrical, miscellaneous utility connections, but shall not be less than 3 person-days.
 - .4 Start-Up: Sufficient time for Running Test, Start-up, and Commissioning but shall not be less than 7 person-days.
 - .5 Performance Testing: Sufficient time for Performance Testing in accordance with Section 01 91 31 but shall not be less than 10 person-days.
 - .6 Training: Sufficient time for classroom and/or field operation and maintenance instruction in accordance with Section 01 79 00.
 - .7 Credit to the City unused service person-days specified above at the Supplier's published field service rate plus any costs of travel.
- .3 The minimum days specified above shall not relieve the Supplier of responsibility of providing sufficient service to place components and systems in satisfactory operation as determined by the Contract Administrator. Provide, in addition to time periods specified above, time and material used to correct defective equipment due to fault by the Supplier at no additional cost to City.
- .4 8-hour days specified are exclusive of travel time.
- .5 Turn on no form of energy to any part of systems prior to receipt by City of certified statement of approval of installation from Contractor containing his Supplier's authorization to energize system. Only Supplier Representative shall energize the system for purpose of Functional Completion Testing.

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- .6 Prior to shipment to Site the Supplier shall perform a test of each lamp bank and ballast and have test reports submitted and approved by the Contract Administrator.

1.6 Guarantees

- .1 The Supplier shall guarantee that the UV system shall perform in accordance with the Specifications when operated at the design conditions specified in Table 46 66 56-1.
- .2 The Supplier shall guarantee that the UV system will meet the dose listed in Table 46 66 56-1 at the peak hour flow and minimum UV transmittance specified at specified EOLL factor and QSFF.
- .3 The Supplier shall guarantee the peak power draw (i.e., power consumption at peak hour flow, minimum UV transmittance, and design dose). Power factor shall not be less than as specified herein, or as specified by the Supplier, whichever is greater.
- .4 The Supplier shall guarantee the average power draw (i.e., power consumption at average day flow, average UV transmittance and design dose). Power factor shall not be less than as specified herein, or as specified by the Supplier, whichever is greater.

1.7 Warranty

- .1 The UV lamps shall be warranted for a minimum of 15,000 hours when operated in automatic mode, prorated after 9,000 hours. If a lamp fails under normal operation before reaching 9,000 hours of system operation, the Equipment supplier shall replace the lamp at no cost to the City.
- .2 The ballasts shall be warranted for ten (10) years, prorated after four (4) years.
- .3 UV Intensity sensors shall be warranted for five (5) years, prorated after one (1) year.
- .4 All other equipment, wiring and components shall be warranted for twelve (12) months from the Substantial Performance for all units functioning.

2. PRODUCTS

2.1 General

- .1 Provide a UV disinfection system complete with UV Banks and integral lifting mechanism, System Control Center, Power Distribution Centers, and Water Level Controller(s) as shown on the contract drawings and as herein specified.
- .2 The UV disinfection system shall be a low pressure high output lamps design with inclined lamp orientation within the open flow channel. Horizontal lamp orientation shall not be accepted.
- .3 The UV disinfection system shall produce an effluent conforming to the discharge permit of 200 *E.coli*/100 ml, based on a 30 day Geometric Mean. Refer to Section 01 91 31 for Running and Performance Test.
- .4 The UV disinfection system shall be provided by one of the following listed vendors:

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- .1 Model SignaUV manufactured by Trojan Technologies.
- .2 Or approved equivalent.
- .5 The UV system shall be able to continue providing disinfection while replacing UV lamps, quartz sleeves, ballasts and while performing maintenance on any components of the lamp bank. Shutdown of individual lamp banks to perform these activities is acceptable.
- .6 The required design criteria are listed in Table 46 66 56-1 at the end of this Specification.

2.2 Equipment

- .1 General:
 - .1 Provide all materials and equipment new and free from any defects.
 - .2 Units must fit in the channels provided without modification (i.e., increasing depth, increasing width, increasing length) and have a fully functional lifting mechanism.
 - .3 Where two or more units of the same type of material or equipment are required, provide products of a single manufacturer.
 - .4 Equipment shall fit in the existing channels with no modifications to the existing concrete required (i.e., no increasing depth, increasing width, or increasing length). Pouring wall infills or benching to allow a proper seal for the new lamp banks is acceptable. Refer to Appendix D for As-built Drawings of the existing channels.
 - .5 All lamp bank metal components in contact with effluent and above the effluent and/or exposed to UV light, including the anchoring hardware shall be Type 316L stainless steel. The UV lamp bank support rack shall be Type 316L stainless steel and shall be mounted above the effluent in the channel allowing adjustment to the precise height of the channel. Threading of stainless steel fasteners shall be done using an approved non-galling application.
 - .6 All metal components not in contact with plant effluent and/or UV light shall be Type 304L stainless steel.
 - .7 All wiring exposed to UV light shall be Teflon or polyurethane coated. All wires connecting the lamps to the ballasts shall be capable of withstanding direct exposure to the effluent and direct UV light.
 - .8 All designs of the cable and hydraulic hose management shall be subject to the approval of the Contract Administrator. All costs due to rejections and changes shall be at the Supplier's expense.
- .2 UV Lamps:
 - .1 The lamp array configuration shall be in a staggered inclined arrangement.
 - .2 Lamps shall be high intensity low pressure amalgam design.

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- .3 The lamps shall be capable of withstanding an average of no less than four (4) ON/OFF cycles per day without reducing lamp life, warranty or causing any damage to the lamp.
 - .4 The lamp filament shall be significantly rugged to withstand shock and vibration.
 - .5 Electrical connections shall be at one end of the lamp and have four (4) pins, dielectrically tested for 2,500 volts. Lamps shall be rated to produce zero levels of ozone.
 - .6 Each lamp plug shall be accessible from the top of the UV bank to facilitate lamp removal without moving the UV banks or any other components.
 - .7 Lamps shall be operated by electronic ballasts with variable output capabilities ranging from 30% to 100% of nominal power. The lamp assembly shall incorporate active filament heating to maintain a minimum lamp efficiency of 35% across varying water temperatures and between the minimum and maximum stated lamp power levels.
 - .8 Each lamp plug shall have a light emitting diode (LED) visual indicator that indicates ON/OFF status for each lamp.
 - .9 An integral safety interlock in the lamp plug shall prevent removal of energized lamps.
 - .10 The lamp plug shall be rated IP67 or NEMA 6P.
 - .11 UV lamps shall be capable of operating a minimum of 15,000 hours when operated in automatic mode, and ON/OFF cycles are limited to an average of no less than four (4) per day and maximum ON/OFF cycles are limited to twenty (20) per day.
 - .12 The system shall be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the effluent. Both lamp electrodes shall operate at the same temperature and be cooled by the effluent. Systems designed whereby the lamps are inserted through a metallic bulkhead or which otherwise prevent continuous cooling of the lamp electrodes by the effluent shall not be permitted.
- .3 Lamp Banks:
- .1 Each UV bank will consist of UV lamps, quartz sleeves, UV intensity sensor and an automatic chemical/mechanical cleaning system mounted in a Type 316 stainless steel frame.
 - .2 Each lamp will be enclosed in its individual quartz sleeve, one end of which will be closed, and the other end sealed by a lamp end seal.
 - .3 The closed end of the quartz sleeve will be held in place by a retaining O-ring. The quartz sleeve shall not come in contact with any steel in the frame. Quartz sleeve shall be 99.9% silicon dioxide with a minimum of 87% transmission of UV radiation at a wavelength of 253.7 nm.
 - .4 Each UV bank shall contain a pre-formed Type 316 stainless steel wall on each side to prevent possible short-circuiting at the side walls of the reactor.
 - .5 Each UV bank shall contain two (2) light locks at the top of the bank to prevent short circuiting over the top of the lamps and maximize disinfection efficiency.

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- .6 Each UV bank shall be rated IP67 or NEMA 6P for temporary submergence.
 - .7 Lamps shall be replaceable without draining the channel.
 - .8 Lamp banks shall have integral lifting lugs to facilitate equipment installation and removal.
 - .9 Automatic interlock protection shall be incorporated into each bank such that when the bank is not seated in place, power to the lamps in that bank will automatically shut off, an alarm will be triggered, and automatic wiping operations for that bank will be disabled.
- .4 Lamp Wipers:
- .1 Each lamp bank shall be equipped with an automatic wiping system with selectable wiping frequency and number of strokes per wiping cycle.
 - .2 Lamp wipers shall use a combination of mechanical and chemical methods to clean the quartz sleeve.
 - .3 Wipers shall be designed such that they provide effective and uniform cleaning, long service life, low replacement and maintenance costs and compensation for wear over the life of the wiper.
 - .4 Wipers shall be fabricated of UV resistant material and accommodates any irregularities in the quartz sleeves and precludes binding during operation.
 - .5 The wipers shall be replaceable without having to disassemble the wiper drive system, remove the quartz sleeves, or disassemble the lamp bank structure.
 - .6 The wipers shall travel the entire length of the quartz sleeves.
 - .7 Wiping system shall be PLC controlled and provide a fully automatic, unattended operation. Each lamp bank shall be equipped with an automatic wiping system with selectable wiping frequency.
 - .8 UV system shall be designed to allow chemical cleaning solution replacement while the UV bank and lamps are in place in the channel and operational. Shutdown of the individual lamp bank to allow replacement of the chemical cleaning solution is acceptable.
 - .9 Provide sufficient chemical for startup and testing and for the first 18 months of operation, after acceptance.
 - .10 Repeated binding of the wipers on the entire system more than 2 times per year during warranty shall require a thorough investigation. The Supplier's Representative shall determine the root cause and supply a modified design that addresses the issues at no cost to the City.
 - .11 Wiper materials shall be resistant to high-intensity radiation, high temperatures, and chlorine at concentrations up to 10.0 mg/L.
- .5 Hydraulic System Center:

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- .1 If Supplier requires a hydraulic system center for lamp bank lifting or wiper actuation, Supplier shall provide all necessary equipment to provide a complete system including food-grade hydraulic oil.
- .2 The hydraulic system center shall be floor mounted, in a NEMA 4X Type 304L stainless steel enclosure.
- .3 The hydraulic system center shall contain a hydraulic pump complete with integral 4-way valve and fluid.
- .4 The hydraulic system center shall monitor the hydraulic system and shall communicate with the system control center.
- .5 The hydraulic system center shall include the following:
 - .1 Main disconnect switch.
 - .2 Wipe/Lifter selector switch.
 - .3 Raise/Lower selector switch.
 - .4 Lifter individual bank control selector switch.
 - .5 Main hydraulic system center wiper control selector switch.
 - .6 Individual wiper group control selector switches.
 - .7 Manual Raise/Lower switches for each wiper group and lifter.
- .6 Supplier shall provide the hydraulic hoses, connectors and isolation valves required to connect the hydraulic pump to the wipers and lifters. Provide hoses of a suitable material and pressure rating for the application. Installation will be by the Contractor.
- .6 Water Level Control:
 - .1 The City intends on using modulating weir gates for water level control across the UV banks. Supplier is not required to provide the downstream level control device. The Supplier shall indicate all requirements for the level control devices and actuators including, but not limited to:
 - .1 Height and width.
 - .2 Deflection limits if more than stringent than required by AWWA C561 and AWWA C542.
 - .3 Maximum seating and unseating heads.
 - .4 Maximum torque for actuator.
 - .5 Speed requirements, accuracy and allowable dead band for gate actuation.
 - .6 Minimum and maximum number of actuations per hour.

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- .2 Supplier's system control panel shall modulate the weir gates using hard wired 4-20 mA and discrete control signals to maintain appropriate water levels in the channels for UV system operation.
- .7 Channel Isolation Gates:
 - .1 The City intends on installing slide gates on the upstream end of the existing UV channels to isolate the channel for maintenance. Supplier is not required to provide the slide gate and actuator. Supplier shall indicate all requirements for the slide gate actuator including control philosophy, and any switches, interlocks, etc. that are required.
- .8 UV Bank Lifting Mechanism:
 - .1 Supplier shall include a lifting mechanism, integral to each UV bank, to raise the UV bank from the channel for easier access and maintenance. Ancillary equipment to assist with lifting of the UV bank shall not be acceptable.

2.3 Electrical and Controls

- .1 General:
 - .1 The electrical supply to the UV system is 480 Volts, 3 phase, 4 wire + ground, 60 HZ with power as required by the Supplier. All control voltage is required by the UV system shall be provided by Supplier by appropriate control transformer(s).
 - .2 The electrical supply to the hydraulic system center, be 480 Volts, 3 phase, 3 wire + ground, with power as required by the Supplier.
 - .3 A single connection to each Control and Power Panel (PDC) shall supply all components of a PDC, its UV bank and related components.
 - .4 Control Components: Operate at 24 VDC. The input power to the control systems shall be at 120 VAC UPS and normal power. Redundant power supplies shall be internal to the unit.
 - .5 Supplier shall incur any costs resulting from harmonics limits not being in accordance with IEEE 519 as amended from time to time by more recently published editions.
 - .6 Supplier shall indicate any other electrical requirement such as disconnect for each panel, selector switches, pilot lights, control relays, control transformers, etc.
 - .7 UV panels components shall be factory installed and prewired. Field wiring shall be limited to external connection of the components.
 - .8 Supplier shall provide all cabling between lamps and drivers.
 - .9 All applicable electrical components shall be CSA or cUL certified.
 - .10 The control system for each module shall have a non-volatile memory capable of retaining stored data relative to all conditions including UV intensities, alarm conditions, elapsed operating hours and power settings, and the number of on-off cycles for each lamp.

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- .11 Each UV lamp module shall be protected by a class B Ground Fault Circuit Interrupter (GFCI) or other approved system as per CEC.
 - .12 The components shall be arranged in the enclosure such that failure of any component requires the removal of the failed component only.
 - .13 Provide wiring length to accommodate all options for final placement of components. The Supplier shall provide the maximum theoretical length of cabling allowed between the lamps and the panels.
- .2 Wiring Identification:
- .1 Identify both cables and wiring using heat shrink labels with mechanically printed black letters on white background. Label both ends of all conductors. Cables shall follow the City Identification Standard (Appendix A) with equipment tag based labelling.
 - .2 All stranded wiring shall be terminated using ferrules or wire connectors to all external devices and all terminations inside all cabinets.
- .3 Electronic Ballasts:
- .1 Ballasts shall be of electronic design and specifically designed for the proposed lamps.
 - .2 Lamp ballasts shall be housed in a NEMA 4X rated Type 304L stainless steel enclosure (ballast cabinet) located external to the channel, but within the UV process room, and shall be equipped with a suitable filtered air conditioning system, provided by the Supplier, to maintain internal enclosure temperatures below 40°C. The Disinfection Building is heated and ventilated to maintain a minimum ambient air temperature of 10°C in the winter under normal circumstances and maximum air temperature no greater than 35°C in the summer. The temperature in the building can be less than 10°C and the UV system should be designed so as not to be adversely affected by lower temperatures. Ventilation design of the building calls for overall maximum of 35°C, account for locally higher temperature values if heat releasing cabinets are closely spaced.
 - .3 Each lamp bank shall be powered from the bank's dedicated ballasts located in the ballast cabinet. The Supplier shall supply all cabling, complete with pre-terminations and connectors, between lamps and ballasts. The Contractor shall be responsible for supplying the conduits and cable trays. Each electronic ballast within a ballast cabinet shall operate a maximum of two (2) lamps. The power factor shall not be less than 98% leading or lagging.
 - .4 Ballasts shall be capable of automatically varying power input and UV output levels, at least between 60 and 100% nominal power.
 - .5 Ballasts shall comply with the CEC and cUL requirements, specifically IEEE 519 and the IEC 6100-3-2.
 - .6 Supplier shall provide a theoretical electrical systems harmonic study for the electrical distribution system. The goal of the study is to determine requirement for the UV system to comply with harmonic distortion levels in accordance with IEEE 519. Supplier shall provide necessary components to meet the harmonic distortion levels specified. Supplier shall be responsible for obtaining all data necessary to carry out the study such as feeder

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cable sizes, feeder length, motor data, switchgear data, and loads. The point of common coupling for the harmonic analysis will be the motor control center serving the UV equipment. Submit a report with the following:

- .1 Explanation of method used to perform the study. For reference, the breaker feeding the bus connection for UV equipment is 2500 amp and upstream transformer is expected to be 2500 kVA with 5.75% impedance.
 - .2 Study results with specific recommendations on filters and/or other measures that shall be implemented to meet the distortion limits.
 - .3 Calculations and/or computer printouts used to arrive at the recommendations.
 - .4 Submit the report to Contract Administrator for review before or with the UV system Shop Drawings.
 - .7 All internal components shall be sealed from the environment. All ballast cabinets shall be CSA or cUL approved.
 - .8 The power distribution shall be through environmentally sealed receptacles on the ballast cabinets to allow for local connection of lamp banks. Data concentration shall be through integrated circuit boards located inside the ballast cabinets. One (1) circuit breaker shall be provided for each lamp bank and shall be located inside the ballast cabinet.
- .4 Water Level Controllers:
- .1 Supplier shall supply ultrasonic sensors/transmitters for each UV channel to allow level control. Sensors/transmitters shall continuously monitor channel water level with a 4-20 mA output suitable for connection to the UV system control center.
 - .2 Supplier shall supply ultrasonic sensors/transmitters for each UV channel to monitor the water level within a set operating range. Provide an alarm to warn the City's staff early if the water level is beginning to depart from the normal operating range. Sensors/transmitters shall continuously monitor channel water level with a 4-20 mA output suitable for connection to the UV system control center.
 - .3 Supplier shall supply one (1) low level switch for each UV channel. Float switches shall not be permitted.
 - .4 During all modes of system operation (MANUAL, AUTOMATIC AND REMOTE), the water level sensor shall ensure that lamps extinguish automatically if the water level in the channel drops below an acceptable level.
 - .5 Low water level set points to be determined during installation. System power shall turn off in the event of low water level. System shall generate a warning in the event of high water level.
- .5 UV Intensity Sensors:
- .1 Supplier shall provide one (1) UV intensity sensor for each bank.

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- .2 Sensors shall be designed to provide UV intensity data for dose monitoring and control functions. Provide smoothing algorithm to attenuate temporary spikes in the signal. Use the intensity data as part of the dose pacing program.
 - .3 The sensors shall only measure the germicidal portion (253.7 nm) of the light emitted by the lamps. Accuracy shall be a minimum of plus or minus 1% and have a 30 second maximum response time.
 - .4 The sensors shall be factory calibrated to US NIST or PTB. The sensor shall be digitally calibrated to ensure calibration accuracy.
 - .5 To ensure continuous disinfection, the sensor shall be accessible without shutting down the entire UV system, lifting a bank or removing lamps.
 - .6 Sensors shall be automatically cleaned by the UV system.
 - .7 Sensors in redundant channels, including of different sensor type, shall be installed with separate power and communication circuits to prevent all single-point failures impacting redundant channels.
- .6 UV Transmittance (UVT) Sensor:
- .1 Supplier shall provide one (1) UVT sensor for the complete system.
 - .2 The UVT sensors shall be provided to automatically and continuously track the UV transmission of the UV influent at the 254 nm wavelength. Locate the UVT sensors in the common feed channel.
 - .3 The UVT sensors shall measure transmittances from 25 to 100%.
 - .4 Pumping shall not be required for operation of the UVT sensors.
 - .5 The UVT sensors shall provide a 4-20 mA signal to the system control panel for use in dose-pacing.
 - .6 The UVT sensors shall be automatically self-cleaning.
- .7 Dose-Pacing:
- .1 UV system shall utilize a dose-pacing system to minimize power consumption by the lamps.
 - .2 The dose-pacing system shall modulate the lamp UV output in relationship to a 4-20 mA DC flow signal, UV intensity signal, and UVT signal.
 - .3 The dose-pacing system shall automatically adjust the number of the lamps in service and output of the lamps, by bank, to reduce energy consumption while continuing to deliver the design UV dose.
 - .4 If the flow signal is lost, the dose-pacing program shall default to use the maximum recorded flow.

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- .5 Supplier shall indicate the default setting for UV intensity if the UV intensity signal is lost.
 - .6 If the UVT signal is lost, the dose-pacing program shall default to use the minimum recorded UVT.
 - .7 The dose-pacing system shall allow the operator to vary the design dose setting, whether the flow, UV intensity or UVT signals are lost or not.
 - .8 Logic and time delays shall be provided to regulate UV bank ON/OFF cycling when operating in automatic mode.
 - .9 Sensors in redundant channels, including of different sensor type, shall be installed with separate power and communication circuits to prevent all single-point failures impacting redundant channels.
- .8 System Control Center:
- .1 Supplier shall provide the system control center, which houses the PLC controller. The system control center cabinet shall be NEMA 4X Type 304L stainless steel and mounted on a housekeeping pad within the UV process room. The system control center shall be connected to an internal UPS. There shall be a redundant PLC and communications module within the system control center.
 - .2 Provide a complete main and hot standby PLC control system for the UV system control including racks, power supplies, controller(s), communications, and input/output modules. Lightning and surge protective devices shall be incorporated into all electrical power and control panels.
 - .1 The control panel shall comply with CSA C22.1 and have a CSA or cUL inspection sticker.
 - .2 The operator interface display (HMI) screen shall be menu driven with automatic fault message windows appearing upon alarm conditions.
 - .3 The system control center display shall be capable of displaying and trending key process variables for user-adjustable time periods.
 - .4 The system control center shall be capable of receiving the following signals, at minimum:
 - .1 External Signals:
 - .1 Weir gate position (each channel).
 - .2 Flow signal input.
 - .3 Upstream channel isolation gate.
 - .2 Internal Signals:
 - .1 Lamp bank not sealed.
 - .2 System control center operating on UPS.

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- .3 UPS failure condition.
 - .4 Channel high water level (each channel).
 - .5 Channel low water level (each channel).
 - .6 UVT signal input.
 - .7 UV intensity signal input.
 - .8 Channel water level discrete input signal (each channel).
 - .9 Channel water level continuous analog signal input (each channel)
- .5 The system control center shall be capable of sending to PCS the following system status points, at a minimum:
- .1 Alarms, as indicated below.
 - .2 Effluent weir gate position (each channel).
 - .3 UV transmittance.
 - .4 UV intensity.
 - .5 Dose.
 - .6 Lamp power output.
- .6 Alarms shall be provided to indicate to the City's staff that maintenance attention is required or to indicate an extreme alarm condition in which the disinfection performance may be jeopardized. The alarms shall include:
- .1 Lamp failure.
 - .2 Multiple lamp failure.
 - .3 Low UV intensity.
 - .4 UV intensity sensor fault.
 - .5 Low UV transmittance.
 - .6 UV transmittance monitor fault.
 - .7 Flow signal fault.
 - .8 Low water level.
 - .9 Low level shutdown.
 - .10 High water level.

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- .11 Channel water level transmitter fault.
 - .12 Weir gate position fault.
 - .13 Weir gate failure to move.
 - .14 Actuator high torque.
 - .15 Wiper failure.
 - .16 Wiper position fault.
 - .17 Wiper jammed.
 - .18 High temperature in ballast cabinet.
 - .19 Ballast cabinet air conditioner failure.
 - .20 Ballast cabinet fan failure.
 - .21 Equipment shutdown due to high temperature in ballast cabinet.
 - .22 Lamp bank communication failure alarm.
- .7 The main and hot standby PLC shall provide seamless transition without any process interruptions if the main PLC fails.
 - .8 Communication with the PCS shall be optimized such that seamless and responsive interfacing of the UV system equipment shall occur on the PCS. Reorganize the UV system PLC logic if required to enable responsive interfacing. Maximum delay allowed for updating PCS system via routine or request shall be 500 mgs.
 - .9 The 100 most recent alarms shall be recorded in an alarm history register and displayed when prompted at the OIT.
 - .10 Bank status shall be capable of being placed either in MANUAL, OFF, or AUTO mode.
 - .11 Elapsed time of each bank shall be recorded and displayed on the display screen when prompted.
 - .12 I/O modules shall be provided to remotely indicate status and alarms for bank status (one (1) for each UV bank supplied).
 - .13 The system control center shall be interfaced with the plant PCS using Modbus TCP to allow remote monitoring and operation of the UV system.
 - .14 The following data, at a minimum, shall be transmitted from the UV system control center to the plant PCS:
 - .1 UV system total flow.
 - .2 Design dose.

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- .3 UV intensity.
- .4 UV transmittance.
- .15 The PCS HMI screens to replicate the OIT HMI screens. Coordinate with the Systems Integrator to provide full replication of the OIT on the plant HMI. Provide a means for operators to select either the local OIT or the plant HMI as the active system.

2.4 Spare Parts

- .1 Supply following spare parts, identical and interchangeable with similar parts installed in Work:
 - .1 Spare UV lamps in a quantity to replace 110% of one lamp bank, or 100 lamps, whichever is greater.
 - .2 Five percent (5%) spare parts for each of the following:
 - .1 Quartz sleeves.
 - .2 Mechanical wiper rings.
 - .3 Ballasts.
 - .4 All electrical connectors.
 - .5 All seals.
 - .6 Mounting parts.
 - .7 All other parts that should be replaced at the same time as a lamp or sleeve replacement.
 - .3 Provide one (2) UV intensity sensor.
 - .4 One handheld UVT monitor
 - .5 Provide any other Supplier's recommended spare parts necessary to maintain each piece of equipment for a period of one (1) year.
 - .6 Provide ten pairs of personnel goggles for protection against UV energy between 200 and 400 nm wavelength.
 - .7 Cleaning chemical for eighteen (18) months of operation following acceptance. Quantity of chemical shall be determined based on usage rate during Commissioning.
 - .8 One (1) spare PLC I/O module of each type used.
 - .9 One (1) spare PLC power supply of each type used.
 - .10 One (1) spare hydraulic pump for the hydraulic system center (if applicable).

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- .11 One (1) spare power unit for electrically driven wiping and bank raising systems (if applicable).
- .12 One (1) spare ultrasonic level sensor/transmitter.
- .13 One (1) spare low water level switch.
- .2 Pack spare parts in suitable protective containers bearing labels clearly designating contents, and pieces of equipment for which they are intended.
- .3 Deliver spare parts at same time as equipment to which they pertain. Provide instructions to Contractor on how to properly store and safeguard such spare parts until completion of the Work, and then deliver to City.
- .4 Provide all special tools (i.e., those not normally in a mechanic's toolbox) required to maintain the UV system.
 - .1 Deliver tools in a metallic tool chest, with labelling identifying the tools are for maintenance of the UV system.
 - .2 Provide inventory list of special tools. Affix the list to the inside top of the tool chest.

3. EXECUTION

3.1 IP Addresses

- .1 IP Addresses shall be provided to the Contractor for all network devices after project award. The Contractor will be required to sign a Non-disclosure Agreement and confidentiality agreement in relation to the IP Addresses.

3.2 Factory Acceptance Testing

- .1 Source quality control and performance tests specified herein shall be performed by the Supplier and shall be witnessed and certified by the City and/or Contract Administrator personnel. Certification costs to perform such factory acceptance testing shall be covered by the Supplier.
- .2 Supplier shall notify the Contractor and the Contract Administrator of factory acceptance testing a minimum of four (4) weeks prior to the anticipated start date to allow time to schedule witnessing of the factory test. The supplier shall be responsible for the travel, room and board cost of factory test witnessing for two (2) personnel.
- .3 Certify all tests performed in factory by Supplier and submit documented test results to the Contract Administrator for review and approval prior to shipment.
- .4 Factory test the UV control system including but not limited to:
 - .1 Panel inspection and factory acceptance testing shall be performed in the presence of, and to the satisfaction of, the Contract Administrator, and shall include all devices necessary to simulate actual operating conditions.

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- .2 Specific test function for the application code must address all control and monitoring strategies and adequately demonstrate, either through the use of software or hardware I/O simulation, and all functionality aspects, as a minimum.
- .3 Configure and connect the system control panel and HMI in an accurate simulation of the final stand-alone and networked configurations. Install all application programs, establish communication, temporarily wire digital inputs to test switches and digital outputs to indicating lights, analogue inputs to 4-20 mA generators and analogue outputs to panel meters to demonstrate functionality of all hardware and software. Exercise the hardware (such as I/O, communications, panel mounted instruments) to demonstrate/monitor operation of all connected equipment and wiring and to fully demonstrate the process control actions and responses to manually entered process condition changes.
- .4 All basic functions shall be demonstrated, including I/O processing, alarm conditioning, communications, as well as the specific functions listed herein. These tests may run concurrently with the demonstration of hardware and software functions. The test procedures shall also include at least a four (4) hour period for discretionary tests to be conducted by the City.
 - .1 Verification of the hot standby PLC system.
 - .2 Verification of control signals.
 - .3 Establish preliminary set points to test control system.
 - .4 Verification of control system response to set points.
 - .5 Verification of control system response to changes in variations of test parameters.
 - .6 Conduct simulated variation in flow to a UV channel to similar weir gate position confirming regulated water level in UV channel is consistently met.
 - .7 Verification of alarms and safe operation in out-of-spec conditions.
- .5 Necessary corrections as indicated by the tests, or as directed by the Contract Administrator shall be made. Shipment of equipment to Site shall be contingent upon the Contract Administrator's approval.

3.3 Installation

- .1 Provide equipment installation supervision according to Section 01 65 00.
- .2 Supplier's Representative shall certify proper installation and provide associated documentation used for certification according to Section 01 65 00.

3.4 Demonstration and Running Test

- .1 Conform with the requirements of Section 01 91 31.

3.5 Start-Up and Commissioning

- .1 Conform with the requirements of Section 01 91 31.

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3.6 Performance Testing

- .1 Conform with the requirements of Section 01 91 31.

3.7 Training

- .1 Provide the services of a qualified technical Supplier's Representative for personnel training as specified in accordance with Section 01 79 00.

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Table 46 66 56-1: UV Disinfection System Design Criteria

Description	Criteria
Near-term Parameters:	
- Minimum Flow (ML/d)	117
- Design Average Flow (ML/d)	195
- Design Max Day Flow (ML/d)	380
- Minimum UV Transmittance (%)	40
- Average UV Transmittance (%)	50
Long-term Parameters:	
- Minimum Flow (ML/d)	155
- Design Average Flow (ML/d)	263
- Design Max Day Flow (ML/d)	705
- Minimum UV Transmittance (%)	50
- Average UV Transmittance (%)	60
Monthly Geometric Mean <i>E. Coli</i> Permit Limit (MPN/100 mL)	200
Total Suspended Solids Permit Limit (mg/L)	25
Minimum Design UV Dose (mJ/cm ²) (MS2-phage)	29.7 at peak flow
Minimum Design UV Dose (mJ/cm ²) (T1 organism)	23.7 at peak flow
End of Lamp Life Factor (unless other, third party validated, factor used)	0.5
Fouling Factor (unless other, third party validated, factor used)	0.8
Maximum headloss through each channel at long-term Max Day Flow (mm)	400
Maximum headloss over each modulating weir gate at long-term Max Day Flow (mm)	800
Number of Channels	3
Channel Width at UV banks (metre) (Existing channels to be used)	2.38
Channel Length (metre) (Existing channels to be used)	12.92
Maximum Channel Operating Water Depth (metre)	3.1

END OF SECTION