

## SECTION 11463

### ULTRAVIOLET DISINFECTION EQUIPMENT

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. Scope:
1. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a low pressure, high intensity ultraviolet lamp (UV) disinfection system complete and operational.
  2. Included, but not limited to, are the following components for each unit:
    - a. Horizontal, UV disinfection modules, including low pressure, high output (LPHO) lamps.
    - b. Quartz sleeves.
    - c. UV intensity monitoring system.
    - d. Automatic dose-pacing energy conservation system.
    - e. Automatic cleaning system consisting of mechanical wipers.
    - f. Electrical Power Distribution Centers and interconnecting power and data cables to modules.
    - g. System control center.
    - h. Accessories.
- B. Coordination:
1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, UV reactors Work.
  2. Notify other contractors in advance of the installation of the UV disinfection system to provide them with sufficient time for the installation of items included in their contracts that must be installed with, or before, the UV disinfection system Work.
- C. Related Sections:
1. Section 03300, Cast-in-Place Concrete.
  2. Section 03600, Grout.
  3. Section 05051, Anchor Bolts, Toggle Bolts, and Concrete Inserts.
  4. Section 05532, Aluminum Grating and Checker Plate.
  5. Division 13, Applicable Sections on Instrumentation and Control.
  6. Division 16, Electrical.

##### 1.2 REFERENCES

- A. Standards referenced in this Section are listed below:
1. American Institute of Steel Construction, Inc. (AISC).
  2. American National Standard Institute, (ANSI).

3. American Society of Mechanical Engineers, (ASME).
4. American Society for Testing and Materials, (ASTM).
5. American Welding Society, (AWS).
6. Institute of Electrical and Electronics Engineers, (IEEE).
7. The Instrumentation, Systems and Automation Society, (ISA).
8. Joint Industrial Council, (JIC).
9. National Electrical Code, (NEC).
10. National Electrical Manufacturers' Association, (NEMA).
11. National Fire Protection Association, (NFPA).
12. National Institute of Standards and Technology, (NIST).
13. Underwriters Laboratories, (UL).
14. U.S. Department of Labor, Occupational Safety and Health Administration, (OSHA).

### 1.3 QUALITY ASSURANCE

#### A. Supplier's Qualifications:

1. Supplier shall have a minimum of five years producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

#### B. Component Supply and Compatibility:

1. Obtain all equipment included in this Section regardless of the component manufacturer from a single ultraviolet disinfection equipment Supplier.
2. The ultraviolet disinfection equipment Supplier shall review and approve or shall prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the ultraviolet disinfection equipment Supplier.

#### C. Source Quality Control:

1. Demonstrate that the dose specified in the Performance Requirements is being met or exceeded in an effluent at 50 degrees Fahrenheit at the Service Conditions listed in Paragraph 2.1. The UV equipment Supplier shall submit a bioassay evaluation for the proposed reactor. This bioassay shall have been validated by an independent third party and have followed protocols described in the US EPA Design Manual – Municipal Wastewater Disinfection (EPA/625/1-86/021), without exception. The manufacturer's bioassay report must demonstrate that the proposed UV system design and number of lamps shall deliver the specified dose.

D. Definitions:

1. Lamp Life: The lamp life is the number of hours it takes for the lamp output to be reduced from 100% to 60%, as compared to the initial lamp output.
2. UV Transmittance (UVT): UVT is defined as the transmittance of ultraviolet light at a wavelength of 254 nanometers through the water across a pathlength of one centimeter.
3. UV Intensity: UV intensity is defined as the intensity of UV energy and shall be defined as the total radiant power incident from all directions onto an infinitesimally small sphere of cross-sectional area  $dA$ , divided by  $dA$ . The units of intensity are milli-Watts per square centimeter ( $mW/cm^2$ ).
4. Fouling/Aging Factor: The fouling/aging factor is a design safety factor that accounts for the relative UV lamp output within the reactor in comparison to the conditions of clean, new lamps. A design safety factor of 80% shall be utilized for UV system design to account for lamp aging and wear, lamp fouling, and cleaning efficiency by an automatic cleaning apparatus.

#### 1.4 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Manufacturer's literature, data sheets, fabrication, assembly and mounting drawings showing materials, weight and significant dimensions in sufficient detail to demonstrate compliance with specified requirements.
2. Include the following manufacturer's data:
  - a. UV dose.
  - b. UV lamp intensity.
  - c. UV lamp output.
  - d. Retention time of effluent within the system.
  - e. Maximum headloss caused by each UV module.
  - f. Documentation on cleaning and maintenance requirements of the equipment and appurtenances.
  - g. Certificate from the lamp manufacturer certifying the type of ballast required for the particular lamp supplied for the system.
  - h. Independent certification of fouling factor and lamp aging factor must be submitted if values other than the specified default values are being proposed.
3. Bioassay Evaluation: Submit bioassay evaluation as specified in Paragraph 1.3 C of this Section.
4. Complete Installation Data in compliance with Section 01620, Installation of Equipment, including setting drawings, templates and instructions for the installation of anchor bolts and other anchorages.
5. Complete written instructions on handling and storage of equipment in compliance with Section 01651, Transportation and Handling of Products, and Section 01661, Storage and Protection of Products.
6. Furnish a list of additional recommended spare parts for an operating period of one year. Describe each part, the quantity recommended and current unit price.
7. Controls:

- a. Submit Shop Drawings as specified below.
- b. Panel Wiring Diagrams: Drawings shall include the following information:
  - 1) Name of panel.
  - 2) Wiring sizes and types.
  - 3) Terminal strip numbers.
  - 4) Color coding.
  - 5) Functional name and manufacturer's designation for items to which wiring is to be connected.
- c. Point to Point Field Wiring Diagrams:
  - 1) Color coding.
  - 2) Wiring sizes, types and numbers.
  - 3) Designation of conduits in which wiring is to be run.
  - 4) Panel terminal strip numbers.
  - 5) Location, functional name and manufacturer's designation of items to which wiring is to be connected.
- d. Panel Layout Drawings: Provide the following information:
  - 1) Front, rear, end and plan views to scale.
  - 2) Dimensions.
  - 3) Location, tag number, functional name and manufacturer's designation of items mounted in and on panels.
  - 4) Product information on all panel components.
  - 5) Location of anchoring flanges and holes.
  - 6) Location of external wiring connections.
  - 7) Nameplate location and legend including text, letter size and colors to be used.
  - 8) Subpanel layouts.
- e. Mounting details for all items.
- f. Process connection details for all process connections.
- g. Product Information: Submit the following information for each item of equipment or material:
  - 1) Manufacturer's product name and model number.
  - 2) Tag number, if applicable.
  - 3) Functional name.
  - 4) Dimensions.
  - 5) Detailed product catalog information.
  - 6) Detailed wiring information including identification of all interconnections and points of connection.
7. Electrical service requirements including all field wiring interconnections and wire sizes for the UV equipment and appurtenances.
8. Maximum separation distance between the panels and modules.

## B. Shop Tests

1. A schedule of the date of shop testing.
2. A description of the factory test procedures and equipment.
3. Copies of all test results.

- C. Field Quality Control:
  - 1. Submit a written report giving the results of the required field tests.
  - 2. Submit Supplier's Installation Certification Form as specified in Section 01732, Installation.
  
- D. Instruction of Operations and Maintenance Personnel:
  - 1. Comply with the requirements of Section 01821, Instruction of Operations and Maintenance Personnel.
  
- E. Operation and Maintenance Data:
  - 1. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
  - 2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01781, Operations and Maintenance Data.
  
- F. Warranty: Submit warranty details on all components including, but not limited to:
  - 1. UV lamps.
  - 2. Ballasts.
  - 3. Sleeves.
  - 4. Sensors.
  - 5. Wiper rings.

## 1.5 DELIVERY, STORAGE AND HANDLING

- A. Packing, Shipping, Handling and Unloading:
  - 1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
  
- B. Storage and Protection:
  - 1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
  
- C. Acceptance at Site:
  - 1. All boxes, crates and packages shall be inspected by Contractor upon delivery to the Site. Contractor shall notify Engineer, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

## PART 2 - PRODUCTS

### 2.1 Design Conditions

A. Performance Requirements:

1. The UV reactor system provided shall be an open channel, horizontal, low-pressure, high-output system. The UV system shall be designed for complete immersion of the UV lamps.
2. The UV reactor effluent shall not contain more than 1000 fecal coliform/100ml, as dictated by the discharge permit and based on a 30 day Geometric Mean. The grab samples shall be obtained using the Microbiology Sampling Techniques in *Standard Methods for the Examination of Water and Wastewater, 19<sup>th</sup> Edition*.
3. The UV dose produced by the system shall not be less than 22,000 microwatts-sec/cm<sup>2</sup> at peak flow, in effluent with a UV Transmission of 65% after reductions for quartz sleeve absorption, sleeve fouling and at the end of lamp life (EOLL). The basis for evaluating the UV dose delivered by the UV system shall be the manufacturer's bioassay as carried out by an independent third party. Bioassay validation methodology shall follow protocols described in the *US EPA Design Manual – Municipal Wastewater Disinfection (EPA/625/1-86/021)*, without exception.
4. The UV Dose shall be adjusted using an end of lamp life factor of 0.5 to compensate for lamp output reduction over the time period corresponding to the manufacturer's lamp warranty. The use of a higher lamp aging factor shall be considered only upon review and approval of independent third party verified data that has been collected and analysed in accordance with protocols described in *NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003)*.
5. The UV Dose shall be adjusted using a quartz sleeve fouling factor of 0.8 when sizing the UV system in order to compensate for attenuation of the minimum dose due to sleeve fouling during operation. The use of a higher quartz sleeve fouling factor shall be considered only upon review and approval of independently verified data that has been collected and analysed in accordance with protocols described in *NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003)*.
6. The actual retention time of the effluent within the system determined by hydraulic analysis shall not be less than 0.9 times the theoretical retention time, but no more than 1.0 times the theoretical retention time.
7. The theoretical retention time shall not be less than 6 seconds at the peak design flowrate.
8. The flow characteristics through the system shall closely simulate ideal plug flow conditions under the full operating flow range.
9. The total headloss through the UV system with two UV banks shall not exceed 30 inches at peak flow rate as calculated using a headloss formula agreed to by the Engineer. This headloss shall also be validated by field testing after start-up.
10. The system will be capable of sustaining disinfection during lamp, sleeve, and ballast replacement and while cleaning the lamp sleeves.

- B. The UV equipment shall be suitable for the following design conditions:
1. Peak Flow: 6.0 mgd.
  2. Average Flow: 2.0 mgd.
  3. Future Peak Flow: 16.5 mgd.
  4. Total Suspended Solids: 5 mg/l on a 30 day average.
  5. Carbonaceous Biochemical Oxygen Demand (CBOD<sub>5</sub>): 10 mg/l on a 30 day average; 15 mg/l on a 7 day average.
  6. Ultraviolet Transmittance @ 253.7 nm:
    - a. Peak Flow: 65 percent minimum.
    - b. Average Flow: 65 percent minimum.
  7. Annual Effluent Temperature Range: 33 to 85 degrees F.
  8. Effluent Standards to be achieved: Fecal coliforms less than 1000 per 100 ml at peak flow for any 30 day geometric mean of daily samples at an ultraviolet dose less than or equal to that which shall be produced by the proposed system.

## 2.2 DETAILS OF CONSTRUCTION

- A. Acceptable Model and Manufacturer:
1. Trojan UV 3000 Plus as manufactured by Trojan Technologies.
  2. Or equal.
- B. Materials of Construction:
1. All welded metal components in contact with effluent shall be of Type 316L stainless steel.
  2. All wiring exposed to UV light shall be Teflon coated.
  3. All wiring connecting ballasts to the lamps shall be enclosed inside the UV module frame and not exposed to the effluent.
  4. All materials exposed to UV light shall be of Type 304 or Type 316 stainless steel, anodized aluminum, Type 214 quartz, or Teflon.
  5. The ballast enclosure shall be of anodized aluminum.
  6. Provide all fasteners, anchors and hardware necessary for installation of UV equipment.
- C. General: Provide a horizontal lamp UV disinfection system complete with UV lamp modules, power distribution centers, data control center, UV detection systems, module cleaning systems, eye shields and accessories as specified herein.
1. The UV system shall be installed in an open channel within the area having dimensions as shown on the Drawings.
  2. The UV system supplied shall be arranged as follows:
    - a. Number of Channels: 1.
    - b. Number of Banks per Channel: 2.
    - c. Number of UV Modules per Banks: 3 (expandable to 8 for future expansion).
    - d. Number of Lamps in each UV Lamp Module: 8.
    - e. Total Number of UV Lamps: 48 (expandable to 128 for future expansion).

3. The lamp array configuration shall be horizontal, uniform in arrangement, with all lamps parallel to each other and to the flow. The lamps shall be spaced in vertical rows with 4-inch centerline spacing, which shall ensure effective disinfection and low system headloss.
4. The effluent water level depth in each UV channel shall be maintained between 35 and 30 inches at each operating UV module.
5. The UV lamps, including both electrodes and the full lamp length, shall be designed for complete immersion.
6. The UV system in its entirety shall be designed for outdoor installation.

D. UV Module:

1. Each horizontal UV module shall consist of a Type 316L stainless steel frame holding the electronic ballast enclosure and the UV lamps.
2. Each lamp shall be enclosed in an individual quartz sleeve, one end of which shall be closed and the other end shall be sealed with a lamp end seal. A retaining O-ring shall hold the closed end of the quartz sleeve in place. No portion of the quartz sleeve may come in contact with any part of the metal frame assembly. Lamp ends shall not protrude past the UV Module stainless steel frame.
3. Each module shall be completely field serviceable while located in the channel and shall be fitted with individual water resistant UL rated multi-pin connectors for both power and data. The connectors shall allow each module to be readily disconnected and physically removed from the channel if required without disturbing other modules or the proper operation of the balance of the UV disinfection system. Each power connection shall be provided with a cover to protect the terminals during periods when the cables are not connected. All connectors shall be fully field serviceable.
4. Ultraviolet lamps, electronic controls and individual electronic lamp controllers shall be arranged so that they may be easily tested in place.
5. An electronic ballast enclosure shall be located at the top of the UV module and shall house both the electronic ballasts. Lamp wires shall terminate in the electronic ballast enclosure. The UV Manufacturer shall be responsible for manufacturing and testing all lamp to ballast connections.
6. Each UV Module will be connected to a receptacle on the Power Distribution Center.
7. At the point of exit from the UV Module frame the multi-conductor cable will pass through a waterproof strain relief.

- E. UV Lamps:
1. Lamps shall be of the low pressure, high intensity amalgam design and shall be preheated to promote longevity. Lamp amperages shall not exceed 500 milliamps.
  2. Each lamp shall produce UV light with at least 90 percent of the UV emission at 253.7 nanometer wave length.
  3. Lamps used in the system shall be of a generic type and not customized in any way that would prevent their replacement by lamps from another manufacturer.
  4. The filament of the lamps shall be the clamped design, significantly rugged to withstand shock and vibration.
  5. The electrical connections of the UV lamps at one end shall have four pins, dielectrically tested for 2,500 volts.
  6. Electronic ballasts operating the lamps shall have variable output settings.
  7. The UV lamp shall not produce ozone.
  8. The lamp base shall be of a durable construction resistant to UV.
  9. The lamp design shall prevent electrical arcing between electrical connections in moist conditions.
  10. The UV lamps shall be warranted for a minimum of 12,000 hours of actual operating time with the lamps operating in automatic mode with less than 4 on/off cycles per day. The warranty shall be pro-rated after 9,000 hours of actual use. Ballasts shall be warranted for 5 years, prorated after 1 year.
- F. Lamp End Seal and Lamp Holder:
1. A knurled surface sleeve nut shall seal the open end of the lamp sleeve by threading onto a steel sleeve cup and compressing the sleeve O-ring. The sleeve nut shall not require tools for removal.
  2. Each lamp shall be held in place and isolated from the module frame and other lamps in the module by a two-seal, molded lamp holder. The double seal shall be set against the inside of the quartz sleeve to act in series with the external O-ring and prevent moisture from entering the lamp module frame and the electrical connections to other lamps in the event of a lamp fracture.
  3. The lamp sleeve shall be prevented from touching the steel sleeve cup by a UV resistant PVC molded stop contained in the lamp holder.
- G. Electronic Lamp Controllers (ELC's):
1. Each module shall include one Electronic Lamp Controller (ballast) for each pair of UV lamps. The ELC shall be designed for use with the specified UV lamps.
  2. Each ELC shall be identical to the ballast used in the validation of the system with respect to type, construction, power modulation, and noise and heat generation characteristics.
  3. The ELC shall comply with the following requirements:
    - a. The ballast shall be specifically designed to power two UV germicidal low pressure high output lamps with a UVC output of not less than 52 watts.

- b. With two lamps operated, the ballast draw shall not exceed 250 watts per lamp at an operating voltage of 230V.
  - 4. The ELC shall include automatic protection from thermal overload. The ELC shall be capable of automatic reset.
  - 5. The ELCs shall include standard non-proprietary plug in connections for ease of troubleshooting and replacement of individual ballasts. Designs which require removal of multiple ballasts for service or where ballasts are hardwired shall not be acceptable.
- H. UV Lamp Quartz Sleeves:
- 1. Provide Type 214 clear fused quartz circular tubing domed at one end to enclose the UV lamps. UV lamp sleeves shall have a nominal wall thickness of 1.5 mm and not be subject to solarization over the length of their life.
  - 2. Each sleeve provided shall be identical to the sleeves used in reactor validation with respect to the material of construction, dimensions, and rated UV transmittance.
- I. UV Module Support Rack:
- 1. Provide a support rack for the UV modules mounted above the effluent in the channel. The support rack shall have the adjustment capability to place it at the precise height of the channel and be fabricated of minimum of Type 304 stainless steel.
- J. Baffles:
- 1. Each UV lamp bank shall be equipped with flow dispersion baffles mounted to the channel wall to facilitate channel widening needed to accommodate future flows.
- K. Effluent Level Control:
- 1. The automatic level controlling gate shall be constructed of Type 304 stainless steel and other non-corroding materials. The gate shall be located at the end of the UV channel and shall regulate the channel water level with minimal fluctuations to ensure the channel water level remains above the minimum water level needed for lamp submergence. The gate shall operate by means of galvanized steel counterweights.
- L. Low Water Sensor:
- 1. One (1) low water sensors shall be provided by the manufacturer to detect when the water level falls below the accepted level, under all modes of operation, and automatically extinguish the lamps.
  - 2. The low water level sensor shall be powered by the Power Distribution Center (PDC).

M. Electrical:

1. The UV system power shall be supplied by two separate Power Distribution Centers (PDCs). Each center shall be dedicated to one UV bank. The power supply to each PDC shall be 277/480 volt, 3-phase, 4 wire (plus ground), 18.5 kVA. A 12 Volt DC electrical supply for the water level sensor shall be provided by the PDC.
2. A separate 480 volt, 3 phase, 3 wire (plus ground), 2.5 kVA connection shall be supplied for the Hydraulic System Center (HSC).
3. Each module shall be completely field serviceable while located in the channel and shall be fitted with water resistant UL rated multi-pin connectors for power and data.
4. Power factor shall not be less than 98% leading or lagging.
5. Power cabling and conduit between lamps and ballasts shall be provided by the Manufacturer. Terminations between lamps and ballasts shall be performed by Manufacturer.
6. UV system electrical panels as supplied do not include electrical disconnects. Each electrical power supply shall be supplied with a separate disconnect under Division 16.
7. Each module shall be protected by a 15A fuse and relay interlock.
8. Ballasts shall have individual fusing for over current protection.
9. When disconnecting a module, the high voltage power circuit shall be broken first due to the FBLM pin of the relay interlock circuit and the high voltage component of the receptacle shall be eliminated.
10. Module enclosure design and grounding shall provide protection against any dangerous high potential on the equipment.

N. Power Distribution Center (PDC):

1. Provide one separate sealed PDC per bank of lamps for a total of 2 PDCs.
2. Each wall/floor mounted PDC shall be NEMA 4X and shall be conveniently located as shown on the Drawings. PDC/SCC construction shall conform to the requirements of Section 13430, Control Panels and Enclosures.
3. Power shall enter the PDCs from environmentally sealed receptacles on the PDCs, allowing for local connection of UV modules, and terminate in a load center.
4. Data concentration shall be provided by integrated circuit boards located within the PDC.
5. The PDC enclosure shall be fabricated of Type 304 stainless steel and all internal components shall be sealed from the environment.
6. All PDCs shall be UL approved or equivalent with a rating of Type 4X.
7. Each PDC shall have a main incoming circuit breaker.
8. The number 1 PDC shall provide 480V 3 phase power for the UV Hydraulic System Center.

O. Control and Instrumentation:

1. System Control Center (SCC):

- a. The SCC shall include a Microprocessor-based controller with a menu-based operating screen for monitoring and operating the UV system's controls and functions.
- c. Bank status shall be placed in Manual, Off or Auto mode through the SCC, which shall also record the elapsed time of each bank and display the time on the operating screen when prompted.
- b. The SCC shall include alarms for both maintenance conditions and conditions where disinfection may be reduced. Upon alarm activation, an automatic fault message shall appear on the operating screen. The previous 100 alarms shall be recorded and displayed at request on the operating screen. The alarms include, but are not limited to:
  - 1) Lamp failure.
  - 2) Multiple lamp failure.
  - 3) Ballast failure.
  - 4) Low UV intensity.
  - 5) Module communication alarm.
  - 6) Lamp runtime hours exceeded.
  - 7) Wiper jam.
  - 8) Low water level.
- c. Status of the system and any alarms shall be able to be remotely obtained through digital I/O modules.
- d. The operator interface side of the System Controller shall be provided with a sun shield if in direct sunlight.
2. The controller in the SCC shall provide a connection for Manufacturer's service technicians to perform diagnostics and for data to be transferred to the manufacturer. The controller shall have an Ethernet connection to the plant monitoring and control system.

P. UV Intensity Monitoring:

1. The UV channel shall have a minimum of one (1) submersible, factory-calibrated, ultraviolet intensity sensor which continuously monitors and responds to the germicidal portion of light generated by each bank of UV lamps.
2. The sensor shall not utilize a filter, reflector prism, or separate quartz sleeve.
3. The sensor shall not degrade after prolonged exposure to UV light or effluent.
4. The UV intensity measured by the selected UV sensor shall be shown on the operating display.

Q. Dose-Pacing:

1. A dose-pacing system shall be supplied to turn the UV lamps on and off in response to variations in plant flow using a 4-20 mA signal received from the Plant SCADA PLC panel. The dose-pacing system shall provide the designed UV dose in response to changing flow and effluent quality fluctuations.
2. The UV system design shall allow the operator an option to operate the UV system in either manual or automatic modes.

3. The UV system shall be capable of automatically adjusting the lamp power level from 60 to 100 percent in the UV panels.

R. Cleaning System:

1. Mechanical Wipers:

- a. Each high output module shall be equipped with mechanical wipers containing a chemical cleaning agent. The mechanical wipers shall be capable of being operated in either manual or automatic mode, either locally or remotely. The wiping system shall be fully operational while UV lamps are completely submerged and fully energized. The cleaning wipers shall be automatically initiated with the option for a manual override. Cleaning cycle intervals shall be field adjustable within the range of once per day to once per week. Each module shall be provided with an independent cleaning system which is actuated by an AC motor housed in the module, along with all required monitoring and control components so that each module's cleaning system is independent, only requiring an initiate cycle command from the main controller.
- b. Wipers shall be fabricated of UV resistant material and installed in a manner which accommodates any irregularities associated with the quartz sleeves and precludes any binding during operation.
- c. The wipers shall be replaceable without having to dismantle the wiper drive system or disassemble the module structure.
- e. The wiper system shall be mechanically driven with a single drive assembly. The drive shall incorporate a centrally located means of supporting and aligning the wipers properly throughout the travel.
- f. The wipers shall travel the full length of the UV lamp sleeves. Designs in which the wipers only travel part way along the sleeves shall not be considered acceptable.
- g. The system shall be supplied with all solutions necessary for equipment testing and start-up.

2. Hydraulic System Center (HSC):

- a. The HSC shall be fabricated of Type 304 stainless steel and contain all components necessary for the operation of the automatic UV cleaning system, including a hydraulic pump complete with integral 4-way valve and fluid.
- b. The HSC shall be powered by 480V, 3 phase.

S. Photometer:

1. For manual sampling of the effluent, a single-beam UV photometer with 100% transmittance control adjustment shall be provided. The range shall be 0-100% transmittance with a wavelength accuracy monitoring  $\pm 0.16$  half-band width.

- T. Protector Caps:
1. Protector caps shall provide a replacement seal for UV module plugs and PDC receptacles. The caps shall be used whenever UV modules are removed from the channel for extended time periods.

## 2.3 SPARE PARTS AND SAFETY EQUIPMENT

- A. Furnish and deliver the following spare parts and safety equipment, separately packaged and labeled by quantity, item description and part number:
1. Four (4) additional UV Lamps.
  2. Four (4) additional Quartz Sleeves.
  3. Acticlean Gel (1L).
  4. Four (4) Electronic Ballasts.
  5. One (1) Operators Kit including Face Shields for protection against UV energy between 200-400 nanometers wave length and gloves.
  6. Two (2) UV area warning signs.
- B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the Owner at the conclusion of the Project.
- C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. The Contractor shall construct the disinfection channels for the Ultraviolet Disinfection system as shown on the Drawings and as recommended by the UV manufacturer.
- B. Equipment shall be installed in accordance with the manufacturer's shop drawings and written installation instructions.
- C. Electrical Connections and Wiring:
1. The UV manufacturer shall furnish power cabling between the UV modules and the PDC/HSC. All other interconnecting lines shall be provided by Contractor. Electrical Contractor shall provide all conduit for vendor cables up to wireway along UV modules. The incoming power supply, conduit, and field terminations shall be the responsibility of the Electrical Contractor.
  2. Equipment shall be delivered to site requiring minimal on-site labor for installation. Systems requiring extensive on-site wiring of the modules, and

systems with more than one power and one data connection per module shall not be allowed.

### 3.2 FIELD QUALITY CONTROL

- A. All equipment will be given running tests by Contractor at the job Site following installation of the equipment and controls. Should the tests indicate any malfunction, Contractor shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the Engineer, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.
  - 1. Start-up and Field Testing:
    - a. Comply with the requirements of Section 01751, Starting and Placing Equipment in Operation, and Section 01752, Field Tests of Equipment.
    - b. Field test and calibrate equipment to demonstrate to the Owner's representative that all equipment shall satisfactorily operate.
    - c. The field testing shall include at least 8 hours of UV disinfection to verify that the Performance Requirements of Paragraph 2.1.B are met. Owner shall complete lab analysis for fecal coliform testing.
- B. A factory trained representative of the Supplier shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of three visits to the Site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation, to complete field tests, and supervise initial operations. The third visit shall be to instruct the Owner's personnel in the proper care, operation, and maintenance of the equipment in accordance with Section 01821. Supplier's representative shall test operate the system in the presence of the Engineer and verify that the equipment conforms to the requirements.
- C. Supplier's Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the Owner.

### 3.3 ONLINE TRAINING

- A. Provide online training per Section 01821 for all equipment included in this section.

++ END OF SECTION +