# **EXAMPLE 500,000 GPD WASTEWATER VERTICAL**

100% REDUNDANCY CONCRETE OPEN CHANNEL

# **SECTION 11**

**VERTICAL ULTRAVIOLET DISINFECTION SYSTEM**

1. GENERAL
   1. SCOPE OF WORK
2. Furnish, install, test and put into operation an open channel, gravity flow low-pressure, high output, self-cleaning, vertically oriented ultraviolet (UV) light system (SYSTEM) with redundancy for the disinfection of wastewater, complete, in place as shown on the Drawings and as specified herein.
3. The EQUIPMENT SUPPLIER shall furnish all components of the SYSTEM as specified herein, including:
   * + 1. Two (2) Vertically Oriented UV Modules
       2. One (1) Power Distribution Center (PDC)
       3. One (1) System Control Center (SCC)
       4. One (1) Level Control Weir
       5. One (1) Air Compressor for automatic cleaning system
       6. One (1) Set of spares, safety equipment and lifting bracket
       7. One (1) Hoist
4. The EQUIPMENT SUPPLIER shall provide the following services to ensure the safe and efficient operation of the SYSTEM:
   * + 1. SYSTEM commissioning and installation inspection
       2. SYSTEM startup
       3. Operator training
5. The CONTRACTOR shall furnish all labor, materials, equipment and appurtenances required to install, test and place into satisfactory operation the SYSTEM furnished by the EQUIPMENT SUPPLIER, including, but not limited to:
   * + 1. Mechanical installation of SYSTEM components, stainless steel anchor bolts, air piping, air piping supports, fittings, valves and appurtenances.
       2. Electrical installation of SYSTEM components, Power Distribution Center, MCC breakers, transformers (unless specified), raceways, fittings, conduits and cable trays, wires and cables (unless specified), panel boards, grounding systems, power factor correction capacitors and surge protection.
   1. QUALITY ASSURANCE
      1. All SYSTEM components shall be supplied to the CONTRACTOR by a single EQUIPMENT SUPPLIER.
      2. The EQUIPMENT SUPPLIER shall have at least five (5) years experience in furnishing UV systems of similar design to the equipment specified herein. As part of their submittal package, the EQUIPMENT SUPPLIER shall submit following documentation:
         1. Evidence that UV systems of similar design have been in successful operation for at least two (2) years in at least five (5) separate installations. Provide location of installation, contact person name and phone number, capacity of generation system and year installed.
         2. Evidence that they are an authorized manufactuer, distributor, owner of the technology and that the system being provided does not infringe upon any patents or other’s ownership rights.
      3. The SYSTEM shall be designed, fabricated, assembled and tested prior to shipment. The system shown on the Drawings is the WMV-40-HOS-2 system as manufactured by UVSYSCO, NY USA. If a system other than the WMV-40-HOS-2 is accepted, the CONTRACTOR shall prepare and submit to the Engineer for approval detailed drawings and equipment list showing all necessary changes and embodying all special features of the system to be furnished. The submittal shall address changes to all disciplines, including structural, mechanical, instrumentation and control and electrical. Such changes, if approved, shall be at no additional cost to the OWNER. The CONTRACTOR shall assume the cost of, and responsibility for, satisfactorily accomplishing all the necessary changes for installation of the alternate system as approved by the ENGINEER.
      4. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
         1. American Society for Testing Materials (ASTM)
         2. National Electric Code (NEC)
         3. National Electrical Manufacturer’s Association (NEMA)
         4. Occupational Safety and Health Association (OSHA)
         5. “Municipal Wastewater Disinfection” US EPA Design Manual, EPA/625/1-86/021
         6. American Welders Society (AWS)
         7. Underwriter’s Laboratories (UL)
      5. Manufacturer’s Representative
         1. The services of a full-time employee of the EQUIPMENT SUPPLIER shall be provided on the project site as the EQUIPMENT SUPPLIER representative. The representative shall have complete knowledge of the SYSTEM including proper installation, operation and maintenance.
         2. The EQUIPMENT SUPPLIER’S representative shall inspect the installation and supervise any required modifications, additions, or other changes required to allow the EQUIPMENT SUPPLIER to certify that the complete installation is appropriate and is expected to operate as expected.
         3. The EQUIPMENT SUPPLIER’S representative shall instruct the OWNER and ENGINEER’S personnel on the operation and maintenance of the SYSTEM. The instruction shall include classroom training on UV Technology and the specific installation, and field training on proper operation and maintenance procedures, along with complete demonstration of the same.
         4. The EQUIPMENT SUPPLIER’S representative shall provide minimum services in accordance with the following table:

Purpose No. of Days

Startup and Functional Testing 1 1/2

Operator Training 1/2

* + - 1. The number of days indicated above shall be provided on an 8-hour day on-site basis.
  1. SUBMITTALS
     1. The EQUIPMENT SUPPLIER shall submit, in accordance with section 01\_\_\_, complete shop drawings to establish compliance with this section. Submittals shall include the following and all other information requested in other paragraphs of this specification section for approval:

# Manufacturers Data - The following information shall be submitted to the engineer as required by this specification:

# Complete description of equipment being proposed in sufficient detail to permit a thorough comparison with this specification

# UV system equipment layout including channel dimensions and installation requirements

# Electrical schematics and enclosure dimensions

# Documentation on cleaning and maintenance requirements of the equipment

# Manufacture’s literature including cut sheets on all components and accessories

1. Nominal average intensity within each module.
2. Retention time of effluent within each module.
3. Maximum headloss through each module at peak flow conditions.
4. Control Panel ladder diagrams.
   * 1. Design Data
        1. Supporting documentation from the US EPA UV DIS calculations or manufacturers’ bioassay demonstrating that the dose required in the performance section is being met or exceeded.
     2. The EQUIPMENT SUPPLIER shall submit two (2) copies of complete Instructions Manuals with detailed operation and maintenance data for each component of the SYSTEM. The instructions manual shall include:
        1. Safety Precautions
        2. Protective Equipment and Clothing
        3. Technical Data, including detailed descriptions of SYSTEM operation, and each component.
        4. Installation data, procedures and recommendations
        5. Operation instructions, including startup and shutdown procedures and sequence.
        6. Service and Maintenance data, include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design lift
        7. Illustrations
        8. Project Parts List
        9. Name, address and phone number of manufacturer and manufacturer’s local service representative.
   1. SPARE PARTS AND SPECIAL TOOLS
      1. Included in the proposal, the EQUIPMENT SUPPLIER shall furnish spare parts required to ensure adequate operation of the SYSTEM. Spare parts shall include as a minimum:
         1. A number of spare lamps equal to four (4).
         2. A number of spare quartz sleeves equal to four (4).
         3. A number of spare wiper rings equal l to four (4).
      2. One (1) Operators Kit including one (1) UV face shield, one (1) set of gloves and one (1) Lime-A-Way cleaning solution.
      3. One (1) Lifting sling to be used with hoist by UV manufacturer.
      4. The EQUIPMENT SUPPLIER shall furnish all special tools required for the proper installation, operation and maintenance of any component of the SYSTEM.
      5. 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 CONTRACTOR at the completion of the contract.
   2. DESCRIPTION OF SYSTEM
      1. The equipment specified herein shall be low pressure high output UV light disinfection equipment designed to reduce the fecal coliform microorganisms of a domestic, wastewater with UV influent characteristics as specified in Paragraph 1.05C so that the final effluent shall meet the final effluent discharge conditions as specified in Paragraph 1.05E. The UV system shall be hydraulically rated for peak flow, and shall provide a minimum dose of 30,000 uWs/cm2 at 500,000 GPD.
      2. The lamp array configuration shall be vertical, with a uniform staggered array, with all lamps parallel to each other and perpendicular to the flow. The lamps shall be spaced in vertical rows with 3” centerline spacing that will ensure effective disinfection while maintaining practical system headloss.
      3. Influent Characteristics to Disinfection
         1. The UV disinfection system shall be designed to disinfect at the flow rates and with the characteristics shown below:

# Peak Flow (GPD) 500,000 GPD

# Disinfection Flow (GPD) 800,000 GPD

# Minimum Flow (MGD) 0

# Total Suspended Solids (mg/L) <30

# BOD (mg/L) <30

# UV Transmittance @ 253.7-nm 65%

# Wastewater Temperature (°F) 33-85

# E-coli Concentration (MPN/100 mL) <126 colonies /100ml

* + 1. UV Channel Configuration
       1. The system shall be installed in an open channel having the characteristics shown on the Drawings.
       2. The minimum design requirements of the UV system supplied shall be as follows:
          1. Number of UV Channels 1
          2. Number of UV Lamp Modules per channel: 2
          3. Number of Banks per module: 2
          4. Number of lamps in each UV Lamp Module: 40
          5. Number of lamps in each bank: 20
          6. Total Number of Lamps 80
          7. Minimum UVC Lamp Output (W) 27 (85 watt input)
          8. Water Level (in) 29.5 +/- 1.5
          9. Number of UV Intensity Sensors per Module 1
          10. Channel Dimensions

Channel Length (ft) As Shown

Channel Width (in) 24”

Channel Depth (in) 40”

* + 1. Bacteriological Inactivation Requirements
       1. E-Coli Coliform Testing Criteria
          1. 30 Day Geometric Mean of Daily Samples 126 MPN/100 mL
    2. System Performance
       1. The end of lamp life UV dose produced by the system shall not be less than 30,000 uWs/cm2 in an effluent with 65% UV transmittance @ 253.7-nm. Lamp output must be at least 80% of initial level after 12,000 hrs of operation and with no fouling on the quartz sleeves.
       2. The system design shall be based calculations with the following criteria:
          1. UV transmission (T10) 65%
          2. UV Lamp End of Life Factor 90%
          3. Quartz Sleeve Fouling Factor 0.90

(based on clean sleeves)

1. PRODUCTS
   1. MATERIALS AND EQUIPMENT
      1. General
         1. The UV disinfecting system shall be furnished complete with vertical UV modules, stainless steel mounting brackets, stainless steel wire ways with communication and electrical ports, power distribution center, automatic level controller, UV intensity monitoring system and automatic wiping system. A PLC system shall be provided to perform flow pacing in relation to a 4-20mA plant flow signal.
         2. All metal components exposed to or in contact with plant effluent, including all anchoring hardware, shall be Type 304L or 316L SS. All materials exposed to UV light shall be unaffected by prolonged exposed to same and shall be Type 304L or 316L SS, Type 214 quartz, Viton, EPDM or Teflon.
         3. All metal components not in contact with plant effluent and/or UV light shall be Type 304L SS.
         4. The UV system shall be able to continuously provide disinfection while replacing UV lamps, quartz sleeves, and ballasts and while cleaning the UV lamp sleeves.
   2. ULTRAVIOLET LAMPS
      1. The UV lamps shall be low pressure high output UV lamps.
      2. UV Lamps shall have the following characteristics:
         1. Lamp shall be low-pressure high output type with a UV output per lamp of 28 watts and lamp input of 85 watts.
         2. Lamps shall be low-pressure high output style mercury slim line type of the pre-heat design with a 4-pin connection at one end.
         3. Lamps shall be equal to or exceed the performance of type GHO36T5L watt.
      3. Lamps shall have electrical connections at one end with four pins per connection and shall be dielectrically tested for 2,500 volts. Lamp bases shall be of ceramic construction resistant to UV and ozone. Lamp socket should also be of ceramic construction resistant to UV and ozone and should be of a multi level (step) design to prevent arcing. Lamp tubes shall be of a material capable of transmitting 94 percent of the radiation produced therein.
      4. Changing lamps will not require removal of the quartz sleeves from the UV lamp module. Lamps shall be capable of being replaced by plant operating personnel.
      5. The UV system manufacturer shall guarantee operating life of lamps for a period of 12,000 hours.
      6. Lamps shall be non-ozone producing type.
   3. QUARTZ SLEEVES
      1. Lamp sleeves shall be type GE TYPE 214 clear fused quartz circular tubing. Sleeves shall be rated for transmission of 94% or more and sleeves shall not be subject to solarization over the length of their life. The nominal wall thickness shall be between 1.0 and 2.0 mm.
      2. One end of each sleeve shall be closed and the other end sealed by a lamp end seal and compressed O-ring. The closed end of the quartz sleeve shall not come in contact with any metal in the frame.
      3. Quartz sleeves shall be inserted through the wiper rings in the module.
   4. UV LAMP MODULE
      1. The UV module shall be fitted in a vertical position within the effluent flow channel. Systems incorporating horizontal arrays shall not be acceptable. The UV lamps shall be symmetrically centered on 3” centerline spacing to maximize the dosage of UV radiation seen by the wastewater effluent.
      2. Each UV module shall consist of forty (40) lamps with each lamp placed in their individual quartz sleeve. In the event that a quartz sleeve breaks no other lamps shall be exposed to the effluent.
      3. Each module shall be constructed from stainless steel and with a modified NEMA 4X rating.
      4. Modules shall be constructed in a manner not to allow UV light to radiate above the channel when the lamp modules are energized and fully immersed in the effluent. Modules shall be designed such that operating personnel at the plant can change the lamps and quartz sleeves with other modules in the channel still operating.
      5. The modules shall be directly wired to the Power Distribution Center in a UL watertight flexible conduit.
      6. The modules shall be able to be removed by lifting out of channel by hoist as supplied by UV company. UV manufacturer shall provide a lifting bar or strap.
      7. Systems that require the modules to be removed from the effluent in order to change lamps or service ballasts shall not be acceptable.
      8. The open end of the lamp sleeve shall be sealed by means of a UV resistant polymer, which shall thread onto a sleeve cup and shall compress the external O-ring sleeve seal.
      9. The sleeve nut shall not require special tools for removal.
      10. Modules shall have integral environmental controls in the form of dehumidifiers or air cooling to remove moisture from the module.
      11. Automatic Cleaning System
          1. The UV module shall have an automatic quartz wiping system to allow the protective sleeves to be cleaned on a predetermined basis.
          2. Wiping system should be air driven and should be constructed of Type 316 stainless steel (piston and wiper blades).
          3. The cleaning system shall be pneumatically driven. A solenoid valve located within the UV module shall control the cleaning stroke.
          4. The cleaning system shall integrate a quick stroke approach. Systems incorporating a motorized traveling worm gear shall not be accepted.
   5. UV INTENSITY SENSOR
      1. Each module shall have one (1) UV intensity sensor.
      2. The sensor shall be enclosed in a watertight stainless steel probe that shall be inserted into a dedicated quartz sleeve. Sleeve shall be cleaned as part of the wiping process. Systems that require the sensor to be handcleaned shall not be acceptable.
      3. Sensor shall be able to be removed without system shut down to clean probe.
      4. The sensor shall be solar blind and shall measure only the germicidal spectrum wavelength (254 nm).
      5. The UV intensity shall be displayed in the form of 0-100%.
   6. AIR COMPRESSOR
      1. The SYSTEM SUPPLIER shall provide a 15 gallon air compressor to actuate the automatic cleaning system.
      2. Air compressor shall be oil lubricated type.
      3. The air compressor discharge piping shall include:
         * 1. ASME safety valve
           2. Filter/Regulator
           3. Norgren Excelon 74 Desiccant Compressed Air Dryer
           4. 120 Volt Automatic drain valve
   7. LEVEL CONTROL
      1. The SYSTEM SUPPLIER shall provide a level control weir fingers to be manufactured from Type 304 stainless steel. Fingers and support bracket shall be stainless steel. Mounting hardware shall be Hilti stainless steel by others.
      2. The effluent water level shall be maintained at 29.5” (+/- 1.5”).
      3. Weir shall be sized for peak flow of 500,000 GPD.
      4. The weir shall be installed at the discharge end of the channel and shall be supported by a concrete base as installed by contractor.
      5. Fingers shall have drains.
   8. HOIST – Exact Model to be discussed
      1. Thern Style.
   9. ELECTRICAL – POWER DISTRIBUTION CENTER
      1. System shall operate at 230 Volt.
      2. A remote stainless steel Power Distribution Center (PDC). The UV disinfection system shall be divided into electrical sub-systems. Contractor shall bring protected power to this centralized enclosure.
      3. The channel’s modules shall be powered from a remote Power Distribution Center (PDC) and connect through pre-wired cabling.
      4. The air compressor shall be powered by a dedicated outlet as by others.
      5. A level sensor shall be provided to be pre-wired to plug directly into the PDC. The floast shall require no power and shall be normally open / normally closed.
   10. INSTRUMENTATION AND CONTROL
       1. Power Distribution Center (PDC)
          1. One (1) wall mounted PDC shall be furnished to control and monitor the operation of the SYSTEM and shall house the PLC controls.
          2. The function of the PDC shall be to gather data, control lamps and distribute information to the plant operators.
          3. The PDC shall be comprised of the following components:
             1. HOA switches to control lamps operation.
             2. Circuit breakers
             3. Lighting contactors
          4. The PDC shall provide the following volt-free contacts for remote monitoring:
             1. UV intensity low alarm
             2. UV intensity low low alarm
          5. The PDC shall provide the following analog outputs for remote monitoring:
             1. UV intensity (4-20 mA)
          6. PDC enclosure shall be 304 SS NEMA 4X.
       2. System Control Center (SCC) – Built into PDC
          1. One (1) System Control Center (SCC) shall be furnished to control and monitor the operation of the SYSTEM. SCC shall be an Allen Bradley MicroLogix series with Maple Systems color touch screen.
          2. The function of the SCC shall be to gather data, control lamps, cycle banks on and off in relationship to a flow signal by others, and distribute information to the plant operators.
          3. A 4-20 mA signal provided by others shall be integrated and used for flow pacing and bank cycling. Based on the signal, UV system shall be able to cycle banks on and off in relationship to flow.
2. EXECUTION
   1. SHIPPING AND EQUIPMENT DELIVERY
      1. All equipment and materials shall be inspected against approved Shop Drawings at time of delivery. Equipment and materials damaged or not meeting requirements of the approved Shop Drawings shall be immediately returned to the EQUIPMENT SUPPLIER for replacement or repair.
      2. The CONTRACTOR shall handle and store the equipment and materials in a dry location and protect them from the elements according to the manufacturer’s instructions.
   2. COMMISSIONING AND START-UP
      1. The EQUIPMENT SUPPLIER shall inspect equipment installation, piping and wiring to ensure proper installation of each component in accordance with approved submittals. CONTRACTOR shall make at its own cost any modifications required to meet EQUIPMENT SUPPLIER installation recommendations. A written statement certifying that the equipment has been properly installed and interconnected shall be provided by the EQUIPMENT SUPPLIER.
      2. The EQUIPMENT SUPPLIER shall coordinate commissioning of the system and verify that each component of the SYSTEM is ready for operation. SYSTEM commissioning shall include testing and calibration of each component of the system. A written statement certifying that the SYSTEM has been commissioned and is ready for operation shall be provided.
      3. The EQUIPMENT SUPPLIER shall coordinate initial SYSTEM start-up to ensure operating procedures are followed in accordance with approved submittal’s instructions manuals.
   3. PERFORMANCE TEST
      1. In order to determine compliance of the SYSTEM with the performance requirements set forth in this specification, a performance test shall be performed.
      2. Necessary pre-requisites for the performance test are:
         1. System has been started up to the satisfaction of Owner and Manufacturer.
         2. System must be running before the test period starts.
         3. Water quality and operating conditions set forth in Paragraph 1.05C have been met and confirmed.
   4. START UP and TRAINING
      1. The EQUIPMENT SUPPLIER shall provide 1 ½ days of start up support. And shall porivde operator training at the site for a period no less than 1/2 8-hr day. Training shall include operation, maintenance and trouble shooting for each component of the SYSTEM.

* 1. WARRANTY
     1. The SYSTEM shall be free from defects in materials and workmanship for a period of 12 months from Final Acceptance of the system, or 18 months from shipment, whichever occurs first.
     2. Lamps shall be warranted for a period of 12,000 hours operating time under normal operating conditions.

END OF SECTION.