# **EXAMPLE 300,000 GPD WASTEWATER HORIZONTAL**

100% REDUNDANCY IN A PRE-PACKAGED 2 BANK STAINLESS STEEL CHANNEL

# **SECTION 11**

**HORIZONTAL ULTRAVIOLET DISINFECTION SYSTEM**

1. GENERAL
	1. SCOPE OF WORK
2. Furnish, install, test and put into operation a two (2) bank horizontal 304L stainless steel open channel with modules, inlet and outlet transition boxes and built in level control.

Each bank of UV disinfection modules shall have its own remote power enclosure and system control center. The system shall be a gravity flow, low-pressure – high output UV lamp-based technology as shown on the Drawings and as specified herein.

1. UV system shall be biologically designed to USEPA standards. Copy of independent validation report shall be provided. Bioassay summations shall be forwarded with the bid.
2. The EQUIPMENT SUPPLIER shall furnish all components of the SYSTEM as specified herein, including:
	* + 1. Two (2) bank stainless steel channel with inlet and outlet boxes with built in level control.
				1. Two (2) banks of horizontal UV modules
				2. Two (2) Remote Ballast Control Centers (BCC)
				3. Two (2) UV monitoring systems
				4. One (1) Set of spares and safety equipment per system
3. 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 the stainless-steel SYSTEM channel, components, stainless steel anchor bolts, stainless steel flange bolts, supports, fittings, valves and appurtenances.
			2. Electrical installation of SYSTEM power and control components.

* 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 ten (10) years in at least twenty-five (25) separate installations.
		3. The SYSTEM shall be designed, fabricated, assembled and tested by UVSYSCO NY USA. The system shown on the Drawings is the **WMT Series (fka HXE-Siemens/Sunlight)**. Model WMT-4L2-HO-2.

If other equipment is proposed, the Contractor must demonstrate to the Engineer and the Owner that all requirements of materials, biological validation, experience, performance, and workmanship have been met or exceeded by the equipment proposed. Contractors proposing alternate manufacturers shall be responsible for all costs associated with system evaluation and redesign including all electrical, mechanical and civil aspects of the installation to meet the purpose and intent of the above specification.

* + 1. 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. NWRI Ultraviolet Disinfection : Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (2012)
			7. American Welders Society (AWS)
			8. Underwriter’s Laboratories (UL)
		2. Thirty Party Validation Report in accordance with UVDGM
			1. Documentation shall demonstrate through testing performed elsewhere, that the system will deliver an end of lamp life dosage of 30 mJ @ 65% with fouling on the quartz sleeves.
			2. Report shall indicate dosage on a lamp per gallon per minute flow rate at a range of transmission.
			3. Testing documentation shall demonstrate that the system was tested at rates from 50 to 80 % UVT. Testing shall be state of the art and utilize MS-2 for dosage.
		3. Manufacturer’s Representative
			1. The services of a full-time employee of the MANUFACTURER’S REPRESENTATIVE / EQUIPMENT SUPPLIER shall be provided on the project site as the 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

 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:

# Validation Report. Biological testing overview report shall be provided.

# 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

# Draft installation manuals.

# Data sheets

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

1. Maximum headloss through each bank at peak flow conditions.
	* 1. Design Data
			1. Supporting documentation from manufacturers’ calculations 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 life.
			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. 4 UV lamps
			2. 4 quartz sleeves
			3. 4 ballasts
			4. 4 orings
		2. Two (2) Operators Kit including one (1) UV face shield, one (1) set of gloves and one (1) Lime-A-Way cleaning solution
		3. The EQUIPMENT SUPPLIER shall furnish all special tools required for the proper installation, operation and maintenance of any component of the SYSTEM.
		4. 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 system is a standalone stainless steel horizontal disinfection packaged style to treat a peak of 500,000 GPD with 100% redundancy. Inlet and outlet boxes shall be provided to attached to inlet and outlet piping. The equipment specified herein shall be low pressure UV light disinfection equipment designed to reduce the fecal coliform microorganisms of a domestic, wastewater with UV influent characteristics as specified so that the final effluent shall meet the final effluent discharge conditions as specified. The UV system shall be hydraulically rated for 500,000 gpd peak flow and shall provide a minimum dose of 30,000 uWs/cm2 at this peak rate.
		2. The lamp array configuration shall be horizontal, with all lamps parallel to each other and parallel to the flow. The lamps shall be spaced with 3” centerline spacing that shall 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: 300,000 GPD

# Average Flow: 100,000 GPD

# Minimum Flow (MGD) 0

# Total Suspended Solids (mg/L) <30

# BOD (mg/L) <30

# UV Transmittance @ 253.7-nm 65%

# Wastewater Temperature (°F) 35-85

# Fecal Coliform Concentration (MPN/100 mL) <200 MPN/100mL

* + 1. UV Channel Configuration
			1. A 12-gauge 304L free-standing stainless-steel channel with two banks, with inlet and outlet boxes and built in level control shall be provided. Boxes shall have flange patterns or flange. Outlet box shall have integral level control system.
			2. The minimum design requirements of the UV system supplied shall be as follows:
				1. Number of UV Channels 1
				2. Number of UV Banks per Channel 2
				3. Number of UV Lamp Modules per Bank 8
				4. Number of Lamps in Each UV Lamp Module 2
				5. Number of Lamps in channel 16
				6. Water level 6”
				7. Number of UV Intensity Sensors per system 1
				8. Channel Dimensions (approximate)

Channel Length (ft) 20 feet (240”)

Channel Width (in) 12”

Channel Height (in) 30”

Water level (in) 6”

Inlet size (in) ??” flange pattern

* + 1. Bacteriological Inactivation Requirements
			1. Fecal Testing Criteria
				1. 30 Day Geometric Mean of Daily Samples <420 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 90% of initial level after 12,000 hrs of operation and with no fouling on the quartz sleeves. This shall be based on validation.
			2. The system design shall be based on bioassay 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)

Higher values will not be accepted.

1. PRODUCTS
	1. MATERIALS AND EQUIPMENT
		1. General
			1. The UV system shall be installed in prefabricated stainless steel two (2) bank channel. UV manufacturer shall provide the UV modules, ballast control center, system controls and UV intensity monitoring system.
			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.
	2. UV DISINFECTION CHANNEL
2. Stainless steel free-standing channel shall be provided by the UV manufacturer as shown on the drawings.
3. Channel shall be designed with stainless steel light covers to protect light from emanating.
4. Channel shall be 12-gauge 304L stainless steel and shall be provided with the shown flange size pattern.
	1. ULTRAVIOLET “UV” LAMPS
		1. The UV lamps shall be low-pressure UV lamps of standard or high output styles.
		2. The specified lamp technology is low pressure high output, if low pressure standard output is used, the system will require additional modules and lamps to meet biological validation.
		3. UV Lamps shall have the following characteristics:
			1. Lamp shall be low pressure standard or high output type (non amalgam) .
			2. Lamps in specified system 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 GHO64T5L.
		4. 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.
		5. Changing lamp shall not require removal of the quartz sleeves from the UV lamp module. Lamps shall be capable of being replaced by plant operating personnel.
		6. The UV system manufacturer shall guarantee operating life of lamps for a period of 12,000 hours.
		7. Lamps shall be non-ozone producing type.
	2. 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 shall not be subject to solarization over the length of their life.
		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. UV LAMP MODULE
		1. The UV module shall be fitted in a horizontal position within the stainless effluent flow channel. 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 bank shall have the required number of UV lamps to meet the discharge permit and shall be provided with validation calculations and report.
		3. Each module shall be constructed from aluminum, Type 304L or 316L stainless steel.
		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.
		5. The modules shall be directly wired to the Ballast Control Center (BCC) in a UL watertight flexible conduit.
		6. The modules shall be able to be removed by lifting out of channel by hand.
		7. 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.
		8. The sleeve nut shall not require special tools for removal.
	4. UV INTENSITY SENSOR
		1. Bank shall have one (1) UV intensity sensor.
		2. The sensor shall be manually cleaned.
		3. The sensor shall be solar blind and shall measure only the germicidal spectrum wavelength (254 nm).
		4. The UV intensity shall be displayed in the UV module window kit through a digital meter with a 0 to 100% output reading.
	5. ELECTRICAL

The system shall be provided with a remote modified NEMA 4x fan cooled stainless steel Ballast Control Centers (BCCs). Enclosures shall be twelve (12) feet away from the disinfection channel and shall be installed by the contractor. The purpose of this enclosure is to provide power to the UV lamps.

BCC shall be protected from the environment with a shield to provide for optimum performance. The structure/shield shall be designed to provide protection from heat load. BCC shall be designed for outdoor use, but care shall be given to shading the electronics for longevity and worker safety.

Electrician is responsible for punching and wiring to Ballast Control Center (BCC).

* + 1. BALLAST CONTROL CENTER / SYSTEM CONTROL CENTER

The system shall be 120 Volt 20 amp service per BCC.

* + - 1. The plant electrician or contractor shall bring protected power to the BCC, providing necessary conduit and field terminations.

Each BCC shall require the following:

1. 1.5 max kW/hr

UV meters

* 1. 120-volt 50/60 Hz 5 amp service x 2
		+ 1. Displays

Lamp Status. The status of each lamp (on/off) shall be displayed via a dedicated LED. An energized LED shall indicate proper functioning of the UV lamp. The LED shall indicate lamp off status when extinguished.

Run Time shall be integrated to track lifetime hours.

UV monitor as described above.

* + - 1. Wiring

All wiring, which may be exposed to ultraviolet light, shall be Teflon coated or sheathed and shall be rated for 600 volts service. All other wiring and electrical connections shall be protected against moisture to prevent electrical shorts or failure. All connections must be landed on a terminal or soldered; "butt" connections are not allowed anywhere in the system.

* + - 1. Ballasts

Electronic ballast shall be provided to control, operate and display information for the low-pressure lamps. Ballasts shall be wired in a manner, which allows them to be readily removed from the electrical enclosure.

* + - 1. Module Interconnect Cables
1. 600 Volt multiconductor cable shall be suitable for outdoor installation.
2. Insulation shall be thermoplastic rubber with operating range of minus 60 to 125 degrees C minus 76 to 52 degrees F with low temperature flexibility and flame retardants.
3. The UV stabilized jacketing shall be resistant to oils, chemicals, fuels, solvents, and to mechanical abuse and abrasion.
4. Cable shall be supplied by the equipment manufacturer and shall be of sufficient length and number for a complete system.
5. Cable shall be of a modular repairable type and shall allow for field replacement and repair of its components by plant operators.
6. 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 / MANUFACTURER’S REPRESENTATIVE 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. Water level shall be checked to ensure that the lamps are covered at no flow.
		4. The EQUIPMENT SUPPLIER shall coordinate initial SYSTEM start-up to ensure operating procedures are followed in accordance with approved submittal’s instructions manuals. This shall be for 1 ½ days and combined with the ½ day training.
	3. TRAINING
		1. The EQUIPMENT SUPPLIER/ MANUFACTURER’S REPRESENTATIVE shall provide operator training at the site for a period no less than 1/2 - 8-hr day. Training shall include operation, maintenance and troubleshooting 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.