# GENERAL

## GENERAL:

The Contractor shall provide all labor, materials, tools, and equipment required to furnish and install a vertical format UV disinfection system including startup, commissioning and performance testing and shall be suitable for continuous service as shown on the plans and as specified herein.

### A. Work and Components to be provided by UV System Manufacturer (But Not Limited To):

1. Vertical UV disinfection modules.
2. Lamp power and data cables for each UV module.
3. Power Supply Unit (PSU) enclosure.
4. UV Main Control Panel (UMCP).
5. Cable trays.
6. UV intensity monitoring system.
7. UV eye shields.
8. Personnel safety equipment.
9. Automatic flow pacing energy conservation system (row-by-row).
10. Automatic fault compensation (Row-by-Row).
11. Effluent water level control (reuse existing).
12. Low/High conductivity level switches.
13. Spare parts.
14. Start-up, testing, and personnel training.
15. Module lifting frame.
16. Automatic module cleaning (wiping) system.
17. Stainless steel tank for cleaning station (reuse existing)
18. Module cleaning plate exerciser cable.

### B. Work to be Provided by the Contractor (But Not Limited To):

1. Foundations, concrete channels, conduits, handrails and stairs.
2. Removal of existing equipment.
3. UV channel clean up.
4. Installation of new equipment.
5. Main electrical power supply including a properly grounded neutral.
6. Control wiring and installation for remote signals.
7. Cable trays installation.
8. Piping, channel drains and valves.
9. Walkway Grating.
10. Channel isolation gates and motorized gate actuators.
11. Lifting crane and hoist (1/2 ton minimum, reuse existing).
12. Pulling of cables through cable trays
13. Termination of cables inside PSU and UMCP

### C. Manufacturer:

1. The process design and equipment layout specified and as shown on the contract drawings are based upon the Aquaray® 40-HO High Output Vertical Lamp System as manufactured by Veolia Water Technologies Treatment Solutions USA Inc of Leonia, NJ. If an alternate UV system manufacturer is proposed, the Contractor is responsible for all costs associated with the system evaluation and redesign including all electrical, mechanical, structural and civil aspects of installation. No alternate shall be considered unless pre-approved by the owner/engineer 14 days prior to bid opening.
2. Any alternate “approved as equal” manufacturers shall only be reviewed following bid submittal if elected by the Engineer and Owner.
	* 1. To be considered, the manufacturer will be regularly engaged in the manufacture of UV systems with a proven track record of at least fifty (50) installations of 10 MGD or more in Continental United States.
		2. The manufacturer will provide documentation of previous experience with at least 5 references – location, names and contacts - of municipal UV disinfection systems in wastewater applications with the same type and model of equipment proposed.
		3. Alternate submittals from manufacturers will include a complete and detailed proposal of equipment offered, including the number of lamps proposed and a detailed description of any exceptions taken to the specification.
		4. To be considered, the alternate manufacturer will submit a bioassay evaluation for the proposed UV system. This bioassay must follow protocols described in the NWRI (National Water Research Institute) Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse, Third Edition (August 2012), for MS2 bioassays, without exception. The manufacturer’s bioassay report must demonstrate that the proposed UV system design and number of lamps will deliver the specified dose.
		5. Independent certification of fouling factor and lamp aging factor must be submitted if values other than the specified default values are being proposed.
		6. Documentation of UV manufacturer's service capabilities including location and experience.
		7. Sample disinfection performance guarantee including scope and duration of guarantee.

### D. UV System Requirements:

1. Provide a UV disinfection system complete with UV Modules (including cleaning plate), Power Supply Unit(s), Power Centers (LPDC), UV Intensity Sensor(s), UV Main Control Panel, Cabling and Cable Trays, Module Cleaning Tank, Air-scour Hoses, Automatic Level Controls and Eye shields as shown on the contract drawings and as herein specified.
2. Provide UV modules that are suitable for continuous immersion at a depth of 1 meter for a duration of at least 24 hours. All electrical connections to the UV modules must also be suitable for continuous immersion under the aforementioned conditions.
3. The disinfection system shall be designed for maximum energy conservation and partial system shutdown by automatic flow pacing in increments not to exceed 10% in response to plant flow and UV transmittance (UVT) meter signals.
4. System sizing and dose calculations shall be based on a third-party bioassay. Dose calculations based on the Point Source Summation model, or any UV intensity model, will not be accepted.

### E. Lamp Array Configuration:

1. The lamp array configuration shall be vertical, with a uniform staggered array, with all lamps parallel to each other and 90o perpendicular to the flow. The lamps shall be spaced in vertical rows with centerline spacing which will ensure effective disinfection and low system head loss.
2. System with inclined or horizontal lamp array configurations that are not 90o perpendicular to the flow direction shall not be allowed.

## SUBMITTALS:

### A. The Contractor shall furnish the following information to insure a successful fast track completion of this project. Failure to comply with these requirements may result in the rejection of submittal.

1. UV system manufacturer references for a minimum of fifty (50) installations of 10 MGD or greater within the Continental United States using the same vertical lamp concept.
2. An Independent third party bioassay based on the 40 lamp vertical UV High Output Lamp arrangement and specific to the equipment being supplied shall be provided. This bioassay must follow protocols described in the NWRI (National Water Research Institute) Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse, Third Edition (August 2012), for MS2 bioassay.

### B. The manufacturer shall provide 5 copies of shop drawing submittals; these shall include interconnections and interface requirements, dimensions and locations of all major elements of the UV system and critical clearance requirements. Once approved no changes may be made without the written consent of the engineer and the UV equipment supplier. Information should include the following:

1. Complete description in sufficient detail to permit a thorough comparison with the appropriate specification section(s).
2. Major component dimensions and installation requirements.
3. Complete description in sufficient detail to permit a thorough comparison with the appropriate specification section(s).
4. Descriptive summary of the UV system provided.
5. Electrical and major component layouts.
6. Head loss calculations demonstrating compliance with the specified hydraulic characteristics.
7. UV dosage calculations. Dose calculations shall be based on bioassay third-party calculations.
8. Preliminary UV equipment O & M manuals prepared for this project.

### C. Project Specific Operation and Maintenance Manuals:

Final Operation and Maintenance (O&M) manuals for this specific project shall be submitted to the Engineer upon approval of shop drawings and delivery of the equipment. The O&M manuals shall include instructions on equipment storage, installation, start-up, and operation and maintenance, together with a thorough troubleshooting guide and recommended spare parts list.

## QUALITY ASSURANCE:

### A. The vertical UV disinfection system shall be capable of disinfecting the specified flows based on the minimum influent water quality specified in Section 1.04A.

### B. Acceptance Test. The UV manufacturer shall provide a test protocol for the UV system to be followed after initial start-up and following a minimum of 10 days of continuous plant operation. The Contractor shall notify the Owner and UV manufacturer in writing that the system is prepared to begin the acceptance test. The Owner shall then provide written notification to the Contractor to proceed with the acceptance testing. Results of the test done by the Contractor will be supplied for review to the UV manufacturer.

## DESIGN CRITERIA:

### A. Provide equipment which shall disinfect an effluent with the following characteristics:

Peak Flow: 8 MGD

(4 MGD per channel)

Total Suspended Solids: <30 mg/L (30-day geometric mean)

<45 mg/L (Single sample maximum)

Ultraviolet Transmittance

@ 253.7 nm: 65% (minimum)

Effluent Standards to be achieved:

Fecal Coliform < 200 MPN/100 mL (30-day geometric mean)

### B. The system shall be installed in an open channel having the following dimensions.

Length: Existing

Width: Existing

Depth: Existing

### C. The effluent depth in the channel shall be automatically maintained at a nominal 60 inches water depth (±2.5").

### D. D. A total of two (2) channels shall be provided. The two (2) existing UV channels shall be retrofitted with new UV equipment. The UV system shall deliver a minimum UV dose of 30 mJ/cm2 at peak flow of 8 MGD and minimum UV transmittance of 65% with all UV modules in service.

### E. The system supplied shall, as a minimum, include:

Number of Channels: 2

Number of UV Modules/Channel: 2

Module Layout: 1 Across by 2 Banks in Series

UV Modules, Total: 4

Number of Lamps in Each Module: 40

UV Lamps, Total: 160

Number of Power Centers (LPDC): 4

Number of Power Supply Units (PSU): 1

Number of UMCP: 1

Number of UV Intensity Sensors: 4

Number of Cable Trays: 1

Number of Low/High Level Switches : 2 sets

Number of Air Hose Assemblies: 5

Level Controllers: Fixed weirs (reuse existing)

## PERFORMANCE REQUIREMENTS:

### A. System Performance

* + 1. The end of lamp life third-party bioassay UV dose produced by the system shall not be less than 30.0 mJ/cm2 with all UV modules in service, in an effluent with 65% UV transmittance at 253.7 nm. Lamp output must be at least 90% of initial output level after 13,000 hours of operation and fouling factor as listed below.
		2. The system design shall be based on third-party bioassay dose calculations taking into consideration the criteria listed below. Dose calculations based on the Point Source Summation model, or any UV intensity model, will not be accepted.
	1. UV transmittance 65%
	2. UV lamp end of life derating factor (EOLL) = 0.90
	3. Sleeve fouling derating factor (ft) = 0.90 (in addition to 10% quartz sleeve transmittance loss)
1. Total head loss for each channel shall not exceed 1.10 inches at peak flow, this being confirmed by measurements in the field after start-up.

### B. Energy and Lamp Conservation (Automatic Flow Pacing)

1. The UV system controls shall automatically turn on and off appropriate rows in relation to variations in plant flow and UV transmittance. The signals, provided by others, shall be 4 - 20 mA DC or numerical via Ethernet Modbus TCP/IP.
2. For this project, the UV system shall be capable of responding in minimum of 10% increments within each channel for maximum flow pacing flexibility and economy.
3. The UV system controls shall allow the operator to operate the UV plant in local or remote, channels and modules in either manual or automatic modes.
4. To reduce energy consumption the UV system shall be capable of automatically adjusting the number of lamps in service by eight lamp increments within each UV module.

### C. Automatic Fault Compensation

1. Flow pacing shall be proactive and compensate for failed lamps by automatically turning on additional rows of lamps.
2. The UV system controls shall ignore the dose contribution of a row when 2 or more lamps out of 8 lamps are reported failed.

# PRODUCTS

## MATERIALS:

### A. General:

1. All metal components in contact with effluent shall be Type 316L stainless steel.
2. All material exposed to UV light shall be Type 304L or Type 316L stainless steel, Type 214 quartz, Teflon, or other suitably UV resistant material.

### B. Ultraviolet Lamps:

Lamps shall meet the following requirements:

1. Low pressure High Output UV lamps. Each lamp shall produce UV light with at least 90% of the UV emission at 253.7 nanometer wave length.
2. Low pressure mercury of the hot cathode instant start design in which the coiled filament cathodes are heated by the arc current.
3. The lamp electrode filaments shall be of the clamped design, significantly rugged to withstand shocks and vibrations.
4. The electrical connections of a UV lamp at one end shall be through a non-proprietary pigtail with molded 2-wire connector.
5. The electrical connections of a UV lamp shall be integrated to a sleeve fitting that is suitable for continuous immersion at a depth of 1 meter for a duration of at least 24 hours.
6. The rated UVC lamp output shall be approximately 52.0 UVC watts.
7. The UV lamp intensity at a distance of 1 meter in air shall be 370 microwatts/square centimeter.
8. Minimum UV lamp arc length shall be 58 inches.
9. Lamps shall not produce any ozone.
10. The lamp bases shall be of a durable construction resistant to UV.
11. The lamp design shall prevent electrical arcing between electrical connections in moist conditions.
12. The electrical power consumption of the UV module, on a per lamp basis, should not exceed 172 watts.

### C. Ultraviolet Lamps Guarantees:

1. The UV supplier shall warrant that after 13,000 hours of operation the average UV lamp output will be no less than 90% of a new lamp (after 100 hours initial burn-in).
2. The number of UV lamps required shall be as determined sufficient by the UV manufacturer to meet the required disinfection standard and the minimum UV dosage specified.
3. The UV lamps will be warranted for 13,000 hours of useful life and the warranty is to be pro-rated against actual lamp use.

### D. UV Lamp Sleeve

1. The UV lamps are to be protected from contact with the effluent by a 99.9% pure silicon dioxide fused quartz sleeve with a minimum of 90% transmittance of UV radiation at the 253.7 nanometer wave length and have a nominal OD of 24.5 mm and a nominal wall thickness of 1.25 mm.
2. One end of the quartz sleeve shall be a closed test tube end and the other open with smooth radius edges.
3. The sleeve must have an external rib located near its open end. Compressing O-rings against the sleeve rib renders the sleeve fitting suitable for continuous immersion.

### E. Power Center (LPDC)

1. The 40 lamps from each module will be powered from a remote Power Center (LPDC). The LPDC shall be auto tuned to 3-phase AC Mains voltages of 400V and 480V, 50/60 kHz.
2. An LPDC includes 10 Electronic Lamp Controllers (ELC), or ballast cards, each powering 4 UV lamps in parallel such that the failure of one lamp does not impact operation of the peer lamps. The ELC shall be designed for use with the specified UV lamps. The ELC shall turn on and off lamps upon request and provide feedback to the UV system controls as to the ON/OFF/FAIL status of the UV lamps. The ELC will automatically shut down lamps upon detection of a ground fault or ELC over-temperature.
3. The ELC shall comply with the following requirements:
	1. Specifically designed to power four (4) UV germicidal low pressure high output lamps, each lamp, with a UVC output of not less than 52 watts.
	2. Powers each UV lamp to produce lamp-output of370 microwatts/cm2UV at a distance of one meter in air.
	3. With four (4) lamps in operation, the electrical power draw shall not exceed 172 watts per lamp.
	4. Includes onboard UV LED indicators, which will simplify diagnosis and repairs.
4. The LPDC’s for each UV channel shall be housed in a separate NEMA 4X 304 SS air-conditioned Power Supply Unit (PSU).

### F. LPDC Control Card

1. Each LPDC shall include a Control Card, which will provide coordinated command, control and communications between all lamps, cleaning plate motor, cleaning plate position, UV intensity sensor reading, interlocks and the UV system controls via a dedicated Modbus TCP/IP communication link.
2. The LPDC control card will command:
3. Rows of lamps to turn on and off.
4. Cleaning plate to move up and down.
5. The LPDC control card will gather the following information for the UV system controls:
	1. Lamp on/off status, current, hours and cycles.
	2. Cleaning plate analog position as a 4-20 madc signal.
	3. ELC temperature.
	4. UV-C Intensity reading.
	5. Various faults including GFI failure (ground fault) and over-temperature shutdown (OTSD).
6. Each LPDC control card must include rotary dip switches to customize the last three digits of the LPDC card IP address for Modus communication link.
7. Each LPDC control card must be equipped with an interlock dry contact that will turn off the LPDC lamps immediately upon the following alarms, including, but not limited to, low or high water level switch, PSU door ajar and PSU over-temperature alarm.
8. Each LPDC control card must include a 10-position rotary dip switch to select a proper restart mode (All On vs. last state) following loss of power, or loss of communication with the UV system controls. The same switch is also used to enable or disable the LPDC interlock dry contact.
9. Each LPDC control card must include on board LED indicators, which will simplify diagnosis and repairs.

### G. UV Module:

* + 1. Each vertical UV module shall be precision fabricated in type 316L stainless steel.
		2. Each quartz sleeve of the UV module shall be equipped with a dedicated and easily removable molded plastic connector that is suitable for continuous immersion in water at a depth of 1 meter and for up to 24 hours.
		3. The UV module has components in addition to UV lamps, such as a UV intensity sensor, a sleeve cleaning system (e.g. motor and cleaning plate position detector). All the electrical connections to and from these components are suitable for continuous immersion in water at a depth of 1 meter and for up to 24 hours.
		4. All the UV module quartz sleeve connectors are protected from direct exposure to the elements and sun exposure via a removable hood made of SS 316L stainless steel.
		5. All electrical connections to the UV module shall be above maximum operating water elevations and centralized into a front junction box that is suitable for continuous immersion in water at a depth of 1 meter and for up to 24 hours.
		6. Ultraviolet lamps and most components at the top of the UV module can be replaced without removal of the entire module from the channel.
		7. Each module will be equipped with lifting lugs to allow for the attachment of a lifting spreader so that the modules or banks of modules can be easily lifted with a standard hoist or similar lifting device specified elsewhere.
		8. An in-service / out-of-service local push button will be provided at the UV module to locally enable or disable the UV module LPDC from powering the lamps. The corresponding IN-SERVICE / OUT-OF-SERVICE status for the UV module is displayed at the UV system controls.
		9. To minimize chemical cleaning frequency each module shall be equipped with a sleeve cleaning plate fitted with wipers. The wiper cleaning plate must be motor driven and can be operated in either manual or automatic mode from the UV system controls. In automatic, entire channel cleaning cycles are triggered at regular time intervals which are adjustable within the range of once per day to once per week. The position of the cleaning plate inside the UV module shall be precisely known at all-time via a 4-20 mA DC signal that is proportional to the said position. The wiping system shall be equipped with a current overload detection feature that stops the motor before a mechanical torque tender disengages.
		10. Wipers
	1. Wipers are designed to clean the sleeve external surface by friction without the need to inject any chemical or detergent in-situ.
	2. 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.
	3. The wipers shall be replaceable without having to dismantle the wiper drive system, complete removal of the quartz sleeves, or disassembly of the module structure.
	4. To further extend the life of the wipers, the wipers shall normally be parked above the water level elevation when not in use. This will also prevent disturbance to the flow hydrodynamics of the module during normal disinfection operation.
	5. 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.
	6. The wipers shall travel the full length of the UV lamp sleeves. Designs with the wipers traveling only part way along the sleeves will not be considered acceptable.
	7. The wiper shall be incorporated inside a fitting that can be manually tightened over time to offset the expected wiper wear and tear of the wipers and preserve sufficient contact with the sleeve surface to properly clean.
1. Module cleaning systems which rely on a centralized method (such as a compressor or hydraulic pump) for driving the wipers where the failure of that component would result in a loss of wiping capability in the whole system, shall be equipped with a back-up compressor or pump and associated automated valves to insure adequate cleaning of the quartz sleeves.
2. Each UV module housing 40 low pressure high output UV lamps shall be equipped with protruding flow dispersion baffles to improve hydraulic mixing and to create a uniform UV intensity field within the reactor.
3. The baffles shall be an integral part of the UV module.
4. The baffle material shall be 316L stainless steel.

### H. Electrical:

1. Power requirements of 480V 3-phase, Wye, 3 wires + neutral + ground, 50/60 Hz, per channel shall be provided. If necessary, the UV system supplier shall be responsible in providing one (1) 480V Delta – 480V Wye + neutral + ground /3Phase/50/60Hz/40KVA isolation transformer per channel.
2. Maximum power consumption per UV module housing 40 low pressure high output lamps shall be 6.88 kW and shall not be greater than 13.76 kW per channel.
3. Each module shall be completely field serviceable while located in the channel and shall be fitted with submersible multi-pin connectors for power and data. Combined power and data connectors shall not be acceptable.
4. Two (2) lamp power cables and one (1) data cable are provided between each UV module and the PSU. All cables shall be field terminated, and the interconnections made by the Contractor.
5. Cable trays that carry all interconnecting cables between the UV modules and PSU shall be installed by the Contractor.

## INSTRUMENTATION AND CONTROLS:

### A.Power Supply Unit (PSU):

1. The floor mounted PSUs shall be air conditioned, NEMA 4X rated for indoor/outdoor use, and will be conveniently located as shown on the drawings. NEMA-3R with forced ventilated enclosures, which allow introduction of outside air shall not be acceptable unless equipped with an active air filtration system or automatic signal to advise operators when replacement of filter is required.
2. Mains power supply will enter the PSU from below and terminate into an MCB. From the MCB power supply will be split between three UV module LPDCs and peripheral equipment such as a 24VDC power supply, remote I/O and a level transmitter.
3. Each UV module LPDC shall be protected by a panel mounted thermal magnetic circuit breaker device per NEC code. These circuit breakers shall be mounted in the PSU. Each circuit breaker shall provide visual trip indication, be capable of regular testing. To ensure safe operation, ground fault circuit detection systems, which permit remote reset, shall not be used.
4. The UV module LPDC is front rack mounted within the PSU. Up to 4 LPDC’s can be stacked on top of each other’s in a PSU LPDC bay. Stacking LPDC’s enables powering multiple UV modules from a small footprint PSU.
5. An air conditioner unit shall be provided with each PSU to maintain proper operating temperature for the internal LPDC’s. To help with cooling each PSU LPDC bay is fitted with a powerful fan tray placed underneath the LPDC’s at the bottom of the bay.
6. The PSU shall provide power to the UV lamp modules via plug-in multi-pin connectors, which makes disconnecting the modules quick and easy. This facilitates module removal from the UV channel for inspection and cleaning when required.

### B. UV Main Control Panel (UMCP)

* + 1. The UMCP, which houses the PLC controller, shall be mounted as shown on the UV Contract drawings. The PLC Controller shall be an Allen Bradley CompactLogix. The Operator Interface Terminal (OIT) shall be a programmable NEMA 4X rated Panelview Plus 7 standard 10” color touch screen display which shall be mounted on the UMCP door. The PLC will communicate with each UV module via ETHERNET Link between the UMCP and PSU.
		2. System operating information will be displayed on the OIT in both color graphic and text format. The information must be continuously updated. As a minimum the following information shall be displayed in the main screen simultaneously: Number of channels/rows/banks/modules/lamps in service, channel actual vs. target dose, UV intensity, communication link status and UV lamp status.
		3. System command, control and status shall be accomplished through the OIT. In the event of a fault the alarm blinks white on a red background until the alarm has been manually or automatically cleared.
		4. Alarms shall, as a minimum, include:
	1. Channel low & high level switch.
	2. Channel UV dose low and low-low.
	3. PSU over-temperature.
	4. PSU door open.
	5. PSU com loss.
	6. Module out-of-service.
	7. Module comms fail.
	8. Module com link fail.
	9. Module AC not good.
	10. Module lamp fault.
	11. Module multi-lamp failure.
	12. Module adjacent lamp failure.
	13. LPDC control card fault.
	14. UV Intensity sensor out of range.
	15. UV intensity sensor low & low-low.
	16. Cleaner fault:
		1. Sensor fail.
		2. Motor overload.
		3. Motor timeout.
	17. ELC GFI.
	18. ELC card over-temperature shutdown (OTSD).
	19. ELC card failure.
1. The alarm display will identify the affected module and then the actual component.
2. Information, such as individual lamp hours and cycles, normally stored in the LPDC control card shall be accessed using the OIT. Lamp cycles and hours shall be reset via a password protected screen.
3. The Automatic Module Wiper Cleaning system shall be controlled and monitored by the LPDC control card. Automatic control of each module wiper plate shall be based on time and controlled from the UV system PLC whereby the operator shall be able to alter the interval between cleaning cycles. Manual control of the module wiper cleaning system shall be provided as well (up, down, cleaning cycle, stop).

## AUTOMATIC LEVEL CONTROL

### A. The existing fixed weirs shall be reused and are placed at the discharge end of the UV disinfection channel(s) to ensure that the UV lamps are properly submerged regardless of the plant flows.

### The level of the water shall be maintained between 58” and 62” inches at all design flow conditions.

## MODULE CLEANING STATION:

### A. A. The existing stainless steel liner with drain stub and cover shall be reused. The module cleaning station accommodates one (1) module with 40 lamps immersed in citric or phosphoric acid (5-10% concentration with pH between 2.0-3.0).

## SPARE PARTS AND SAFETY EQUIPMENT:

### A. The UV supplier shall furnish as part of the system the following spare parts and safety equipment:

1. 10% of Installed UV Lamps.
2. 10% of Installed Quartz Sleeves.
3. 10% of Installed Cleaning Wipers.
4. 5% of Installed ELCs.
5. One (1) UV intensity sensor.
6. Two (2) pairs of personnel goggles for protection against UV energy between 200 - 400 nanometers wave length.
7. Two (2) UV area warning signs.
8. One (1) 50 lb. bag dry citric acid powder.
9. One (1) Cleaning System Exerciser.
10. One (1) Lifting frame.
11. Gloves.

### B. All spare parts and safety equipment are to be separately packaged. All packages are to have with quantity, item description and part number.

# EXECUTION

## 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.

## ELECTRICAL CONNECTIONS AND WIRING

1. The incoming power supply to the PSUs & UMCP, and all field terminations between the UV modules and the PSU will be the responsibility of the Contractor.
2. If needed, the Contractor shall furnish power, motor starter, and control wiring as required for the existing air blower.
3. Equipment shall be delivered to site requiring minimal on-site labor for installation.

## MANUFACTURER'S FIELD SERVICES

### A. Installation and Start-Up Services shall include a minimum of five (5) eight-hour days in two (2) trips. Training for Plant Operators and maintenance staff will be coordinated between the Owner, Contractor and UV supplier to ensure maximum effectiveness.

### B. Service personnel shall be fully qualified and full-time employees of the UV system manufacturer.

### C. Performance testing of the UV system, if required, will be the Contractor's responsibility.

### D. The UV supplier shall provide for engineer's approval a formal test protocol for use during performance tests.

- End -