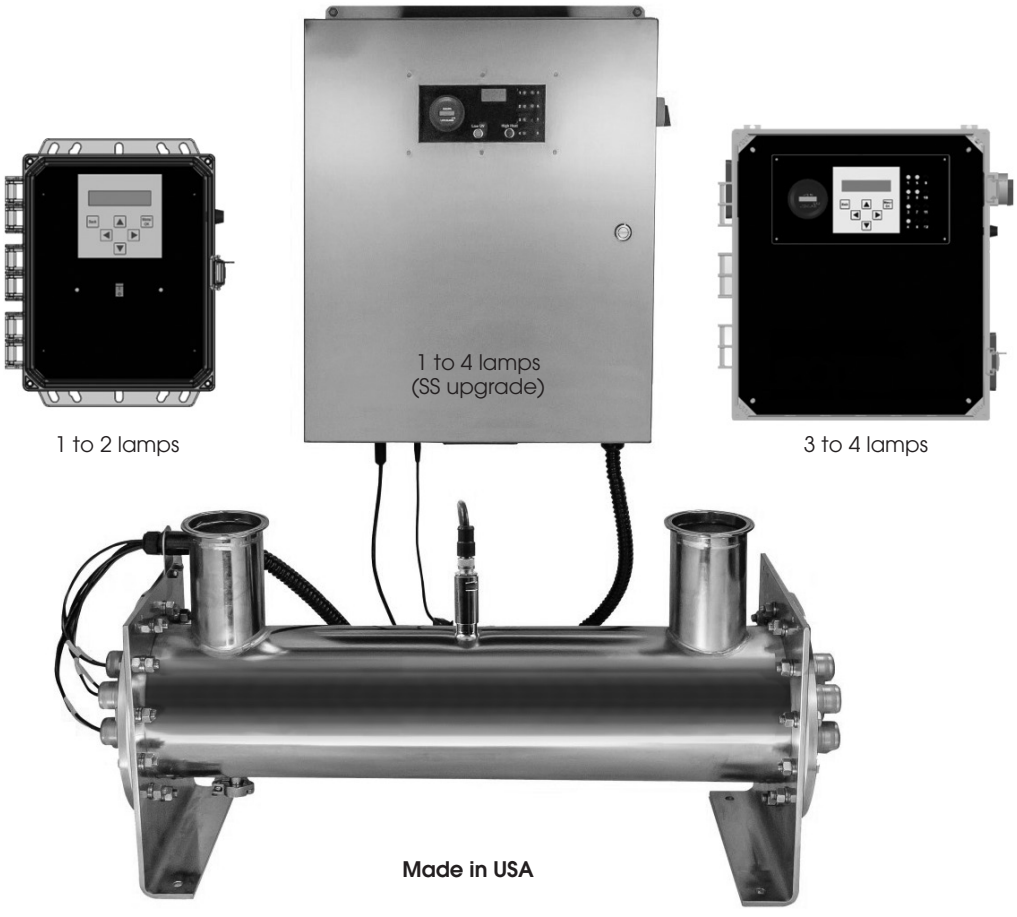
SAFE WATER TECHNOLOGIES, INC.

INSTALLATION, OPERATION, MAINTENANCE MANUAL

UVL SERIES

ULTRAVIOLET WATER TREATMENT SYSTEM



NOV 2020

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SAFETY INSTRUCTIONS

In order to protect end users and operators from injury, safety precautions must be followed. This Installation, Operation and Maintenance (IOM) Manual outlines important safety issues.

1) INFORMATION

Please read this manual prior to installing, starting up, and operating the equipment. The equipment uses the latest in UV technology, and has been designed to make operation and maintenance easy.

The quality of the liquid entering the UV system needs to be monitored. Based on water quality, the UV system will need to be cleaned on a periodic basis. Maintenance of the UV system will require replacement parts. It is suggested that key spare and replacement parts be kept on hand. For best operation, always use manufacturer recommended replacement parts. Other replacement parts could result in damage to the system and void the warranty.

2) ABOUT ULTRAVIOLET (UV) DISINFECTION

The technology uses UV light to target and disable disease-causing microorganisms and pathogens.

Over 100 years ago, scientists discovered that if you exposed pathogens to UV light, their reproduction was limited. The UV light source they used resided in the UVC range of the light spectrum. Specifically, they discovered that light in the 254 nanometer (NM) range was the most effective wavelength for this process.

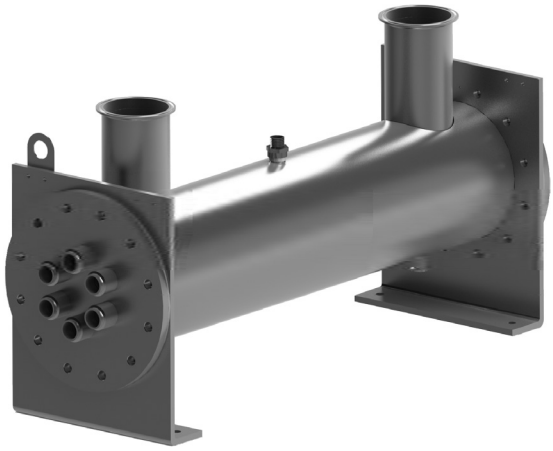
When many pathogens are exposed to UV light, their cells become damaged and this damage inhibits reproduction. The UV light, produced by a special UV lamp, damages the cells' DNA and RNA and once damaged, they are unable to replicate. This physical process renders them harmless. The amount of damage is a result of the intensity of the UVC output multiplied by the time the pathogens are exposed to the light. The applied dosage is commonly referred to as microwatts or millijoules and is often expressed as $\mu Ws/cm^2$ or mJ/cm^2. Most industrial applications require a UV dosage of 30,000 $\mu Ws/cm^2$ or 30 mJ/cm^2.

Why are plants and operators selecting UV technology?

a) UV is considered a green technology
b) No chemicals are added, so there is no need for chemical removal
c) No chemical storage
d) UV works instantly without requiring a residence time
e) Easy maintenance

3) MAJOR COMPONENTS

The UV disinfection system comes with a number of components. It is recommended to inspect the unit upon arrival.



a) Disinfection Chamber

The chamber is manufactured from high-grade 316L stainless steel. The vessel has been passivated and electropolished to protect the vessel against aggressive high purity water.

The chamber is equipped with inlet and outlet connections, drain port, sample port (model dependent), and monitoring ports.

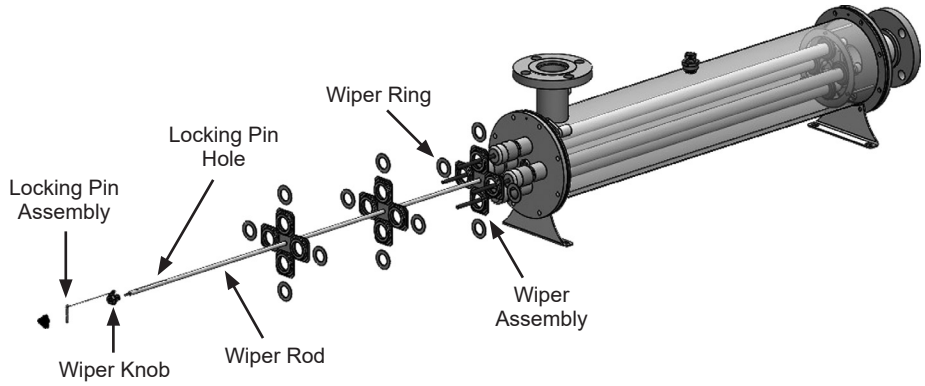
b) Lamps and Quartz Sleeves

Use cotton gloves when handling lamps and quartz sleeves to prevent them from becoming dirty. If you break the lamps or quartz sleeves, take extra care to prevent injury.

If damage has occurred during shipment, please put to the side in the original packaging and contact the supplier. A claim will have to be made immediately to the shipping company.

c) Manual Quartz Sleeve Wiper System

The quartz sleeve wiper system consists of a wiper rod attached with a wiper rings(s), wiper seal nut assembly, wiper locking pin assembly, and a wiper knob. The wiper rod slides through the wiper seal nut assembly through the lamp head plate and into the vessel. The quartz sleeve is inserted through the wiper rings(s). The wiper system is manually operated utilizing a push/pull system.



d) Electronic Control Center (ECC)

The ECC is designed to be remote mounted within four to six feet of the chamber. Prior to final placement, ensure that the supplied cable lengths are adequate to reach between the ECC and the chamber.

The ECC requires clean power. Voltage and cycle information are located on the wiring diagram inside the ECC cover. Equipment should be kept off lines where there are surges or brownouts. **Always disconnect power before servicing the system.**

The ECC contains the ballasts and other electrical controls. The ECC displays operation status via lamp status indicators, the elapsed runtime meter (ERTM), an optional UV intensity monitor, an optional low UV indicator, and an optional high heat indicator.

POLYCARBONATE ENCLOSURES

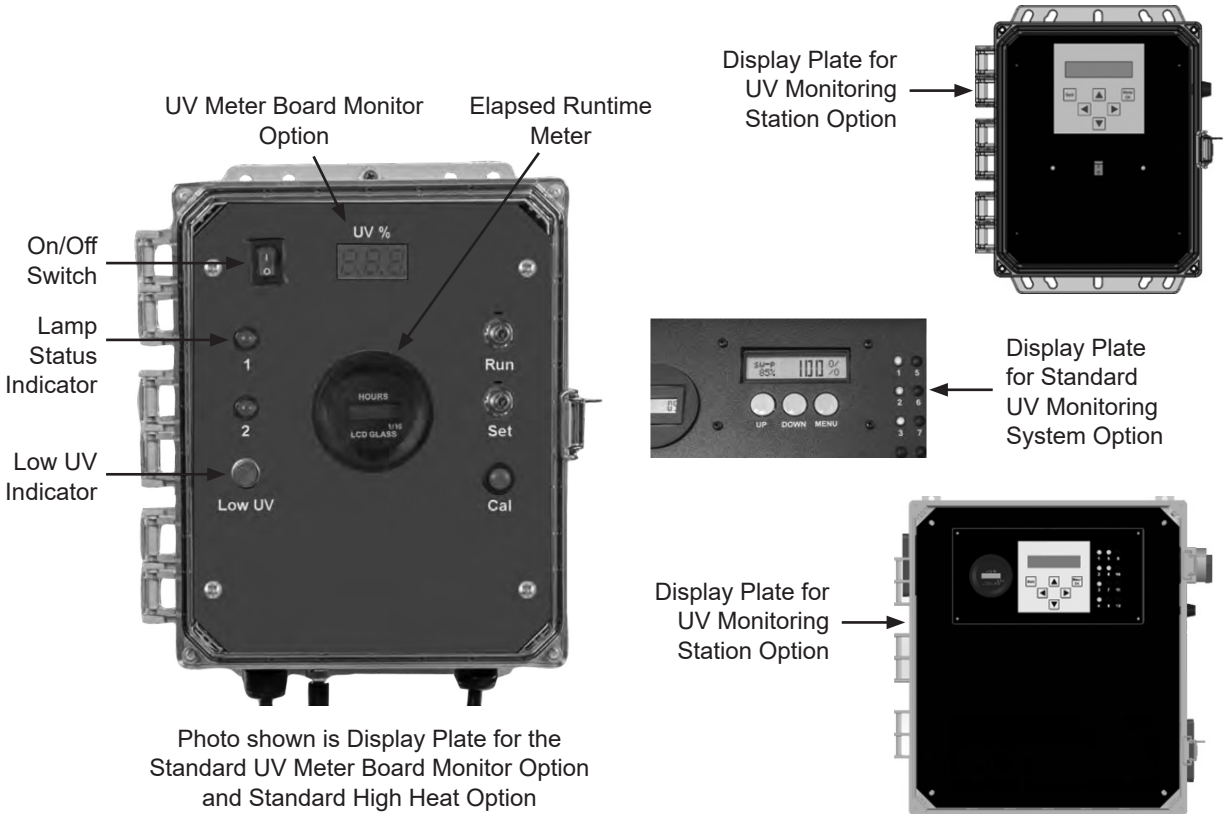


Photo shown is Display Plate for the Standard UV Meter Board Monitor Option and Standard High Heat Option

For models equipped with the Standard UV Meter Board Monitor option and/or standard high heat option, the ECC will display operation status such as individual lamp Indicator, elapsed runtime meter (ERTM), optional UV monitor intensity, optional low UV indicator, and optional high heat indicator.

For models equipped with the optional Standard UV Meter Board Monitor, the ECC displays operation status such as individual lamp indicator, elapsed runtime meter (ERTM) , lamp runtime hours, and relative UV lamp intensity.

For models equipped with the optional UV Monitoring Station, the ECC will display operation

status such as individual lamp indicator, and is capable of monitoring total runtime hours, lamp runtime hours, lamp intensity, relative UV percentage, temperature, and in some models, real-time dosage.

The ECC is equipped with a manual on/off switch for standard models. The optional HOA (Hands Off Auto) switch enables you to remotely power on/off your UV system.

STAINLESS STEEL ENCLOSURES

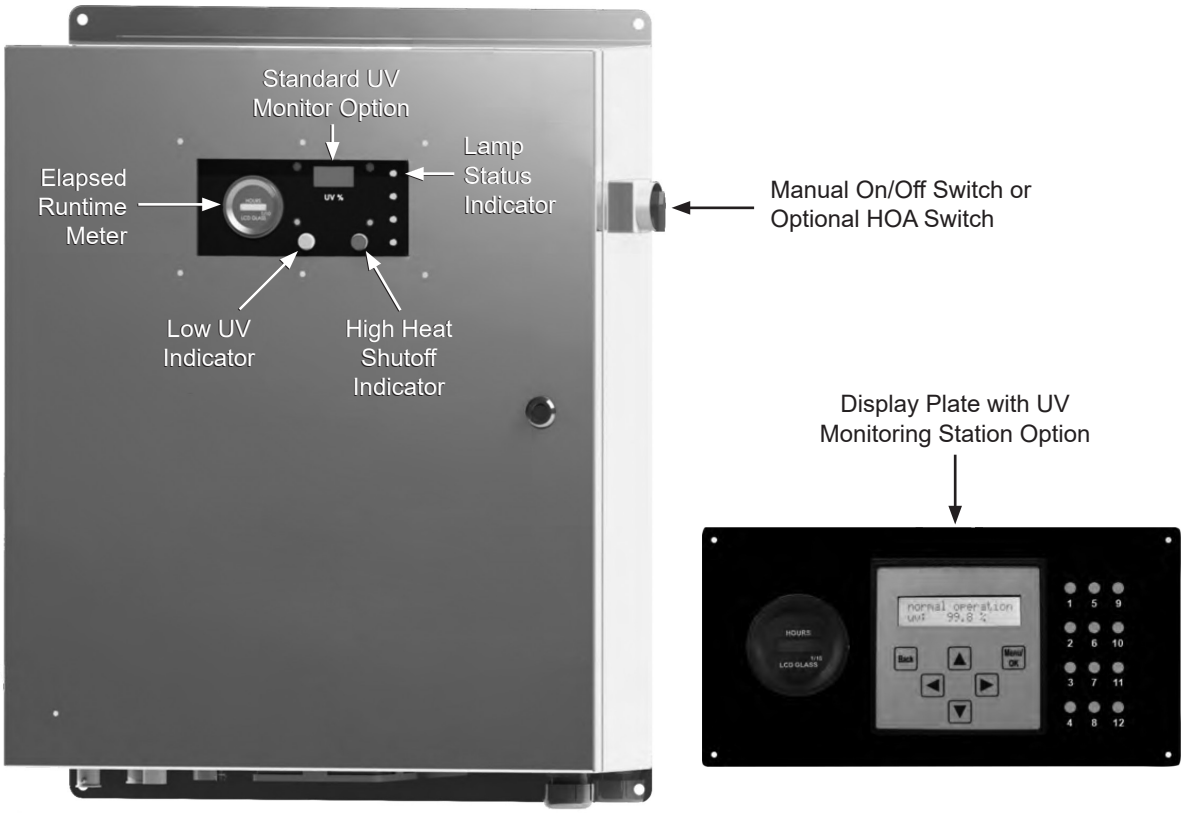


Photo shown is Display Plate for the Standard UV Monitor Option and Standard High Heat Option

For models equipped with the standard UV Monitor option and/or standard High Heat option, the ECC will display operation status such as individual lamp indicator, elapsed runtime meter (ERTM), optional UV monitor intensity, optional low UV indicator, and optional high heat indicator.

For models equipped with the optional UV Monitoring Station, the ECC will display operation status such as individual lamp indicator, and the UV Monitoring System display is capable of monitoring total runtime hours, lamp runtime hours, lamp intensity, relative UV percentage, temperature, and in some models, real-time dosage.

The ECC is equipped with a manual on/off switch for standard models. The optional HOA (Hands Off Auto) switch enables you to remotely power on/off your UV system.

4) PREPARATION FOR INSTALLING UV SYSTEM

a) Water Quality

For optimum performance of the UV system, water quality is extremely important. Proper pretreatment is essential for the UV system to operate as intended.

UV disinfection dosages are dependent upon the quality and clarity of the incoming water. Impurities in the water can interfere with the UV intensity and cause the dosage to fall to unsafe levels. Have the water tested to determine that it meets the standards in Table 1. If any of the elements exceed the maximum levels shown in Table 1, contact your water professional for recommendations for proper pretreatment.

The following Table 1 shows levels that are recommended for installation:

Table 1 — Recommended Water Standards for Installation

Element	Recommended Maximum Levels (1mg/L=1ppm)	Actual Value
Turbidity	<5 NTU	
Suspended Solids	<5 mg/l	
Color	None	
Iron	0.3 mg/l	
Manganese	0.05 mg/l	
pH	6.5 to 9.5	
Hardness	<120 ppm	

b) Important Safety Information

Read and follow all safety precautions to guard against injury. Basic safety precautions must be observed. Keep on hand for future reference.

UV lamps and their quartz sleeves can become razor sharp if broken. Take care when installing and removing quartz sleeves. Only hand-tighten compression fittings. Do not use wrenches or other tools.

CAUTIONS:

- UV light is extremely harmful to eyes and skin and will cause burns.
- Do not look directly or indirectly at the UV light.
- Do not expose your skin for any prolonged time.
- Use protective clothing and eyewear (make sure it is UV resistant) when servicing equipment.
- If accidentally exposed to UV light for an extended period, immediately seek medical attention.
- Symptoms for eye exposure include burning, itching, and redness. Symptoms for skin exposure are similar to sun burn.
- Use cotton gloves when handling lamps and quartz sleeves. Skin oils will adhere to the lamps and quartz sleeves and prevent UV light from properly emanating. If the sleeves become dirty, wipe them with a lint free cloth with denatured alcohol.

c) Optimizing System Performance

The UV lamps and their corresponding quartz sleeves need to be maintained. As a general rule, the lamps need to be changed after a year of usage (10,000 hours). Quartz sleeves should be changed about every three (3) years or sooner if degraded and/or damaged.

Quartz sleeves also need to be cleaned on a periodic basis based on real world operating conditions. The manufacturer recommends using denatured alcohol or a commercially available non-abrasive cleaning product. It is important that the cleaning product used leaves no residue.

Always remember to wear gloves when handling lamps and sleeves.

d) Environmental Issues Relating to UV Lamps

UV lamps need to be recycled like fluorescent lamps because they contain mercury. Please follow your local recycling laws. Visit www.lamprecycle.org for help finding a recycling center in your area. In the event that you are unable to find a disposal location, contact your manufacturer's representative.

e) Receiving UV Equipment and Spare Parts

Inspection of the UV equipment must be made immediately upon receipt for damage and verification of contents. It is important to compare the contents of your shipment to the actual packing list. Any deviations must be brought to the supplier's attention. Additionally, lamps and quartz sleeves need to be inspected for damage. If shipment or parts are damaged, immediately contact the supplier and hold broken contents and their containers for inspection by the shipping company. Failure to make a damage claim within two (2) business days of receipt of product can result in loss of claim.

f) Electrical Configuration and Maintenance

The UV disinfection system uses sophisticated electronics and specialty lamps. The UV system's electronics require clean power. The system has been designed to use a certain specified voltage. UV equipment must be protected from surges. If the location of the UV system is susceptible to brownouts, contact your manufacturer's representative.

Do not exceed three ON/OFF cycles per 24-hour operation. Excessive cycling of the UV system will cause the UV lamps to age prematurely.

5) INSTALLATION

Qualified professionals (contractors, plumbers, electricians) should install the mechanical and electrical components to code as per the engineering documents.

a) Electronic Control Center (ECC)

The ECC is supplied with either a power cord or conduit opening depending on the model.

Polycarbonate Enclosures

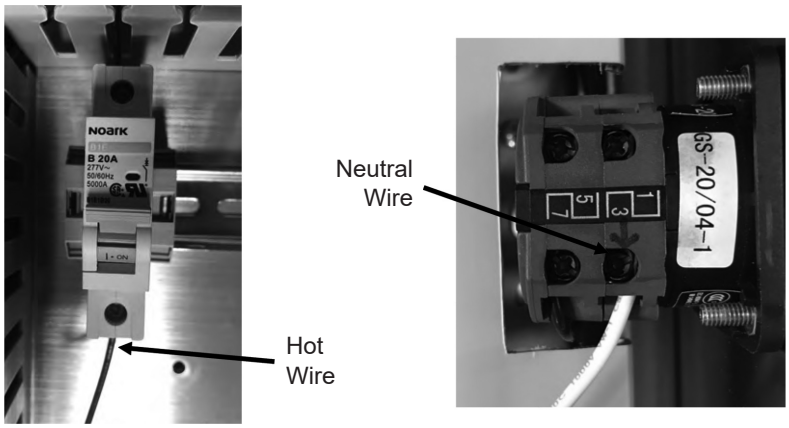
The ECC is supplied with a power cord. Make sure power to the equipment matches the voltage requirements of the system. Make sure the system is properly grounded. Plug the power cord into the appropriate outlet.

Stainless Steel Enclosure with Power Cord

Make sure power to the equipment matches the voltage requirements of the system. Make sure the system is properly grounded. Plug the power cord into the appropriate outlet.

Stainless Steel Enclosure

Make sure power to the equipment matches the voltage requirements of the system. Make sure the system is properly grounded. For complete wiring instructions, see wiring diagram inside the electrical enclosure.



To provide power to the Electrical Enclosure for 120V

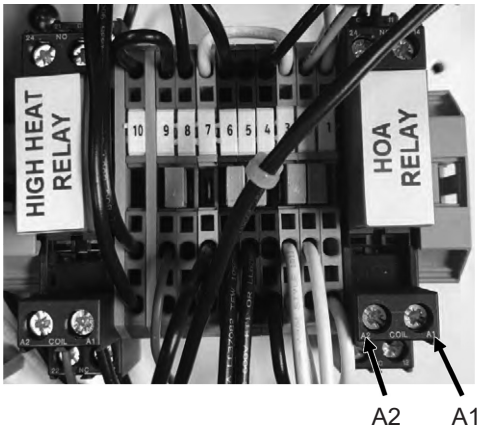
1. To make installation easy, first remove the wire duct cover to install the incoming power wires.
2. Locate the power connection point and install the incoming 120V hot wire to the breaker.
3. Install the neutral wire to # 3 on the switch.
4. Connect the ground wire to the ground bar.

To provide power to the Electrical Enclosure for 220V

1. To make installation easy, first remove the wire duct cover and unscrew the display plate (this does not need to be removed completely) to access the circuit breaker to install the incoming power wires.
2. Locate the power connection point and install the incoming 220V power wires through the strain relief on the bottom of the enclosure to the breaker.
3. Connect the ground wire to the ground bar.
4. Turn the breaker on.
5. Mount the display panel back onto the standoffs and reapply the wire duct covers.

b) Hands Off Auto Switch Wiring

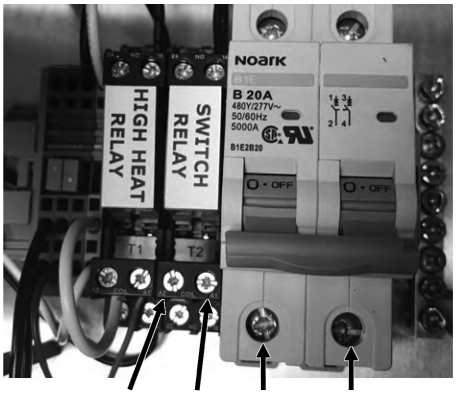
Polycarbonate and Stainless Steel Enclosure with Power Cord



To wire the HOA Switch for remote access:

1. To make installation easy, first remove the wire duct cover and unscrew the display plate (this does not need to be removed completely) to access the circuit breaker to install the incoming power wires.
2. Locate the power connection point and install the incoming 220V power wires through the strain relief on the bottom of the enclosure to the breaker.
3. Connect the ground wire to the ground bar.
4. Turn the breaker on.
5. Mount the display panel back onto the standoffs and reapply the wire duct covers.

Stainless Steel Enclosures



To wire the HOA Switch for remote access:

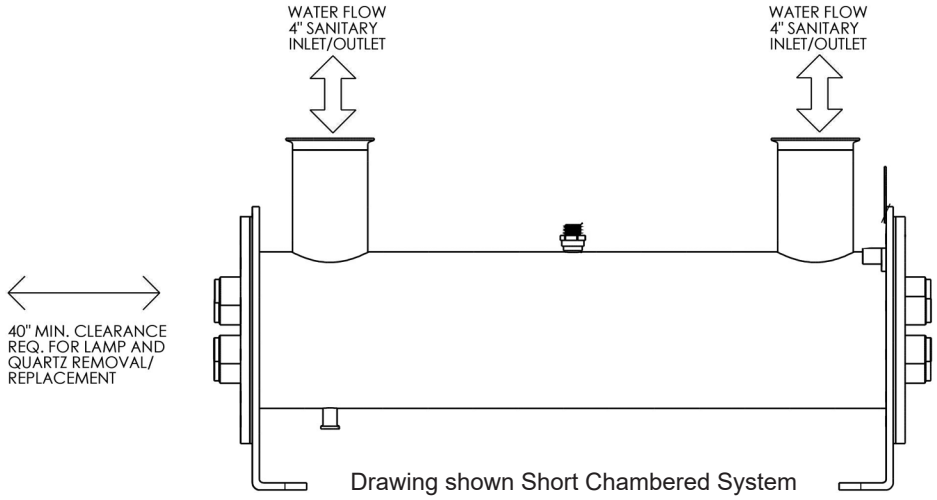
1. Remove the display plate to access the HOA switch relay connection points for the remote switch.
2. Locate the strain relief supplied at bottom of the ECC for wiring to the HOA connection points.
3. Run the 120V hot and neutral leads through the strain relief to A1 and A2 on the HOA switch relay.
4. Reassemble the display plate.
5. Turn the switch on the enclosure to "Position 2."

c) Lamp Out Alert (Optional)

For models equipped with Lamp Out Alert ballast(s), connect the external control (PLC or SCADA) to the bottom of the enclosure via the auxiliary connection.

WARNING: Control signal may not exceed 32VAC, 50VDC, 50mA current.

d) Chamber



Drawing shown Short Chambered System with 4 inch Sanitary Inlet and Outlet

Ensure that you have adequate space on the lamp side of the treatment chamber to insert and remove the quartz sleeve and UV lamp(s).

- 40 inches or more is preferred for short chambers
- 70 inches or more is preferred for long chambers

If thought is not given to this aspect, the lamps and quartz sleeves will be impossible to install.

e) Sensor Probe Installation
(For Standard UV Monitoring System or UV Monitoring Station Option)

P/N SNSR0007 Wetted Sensor

For models equipped with the Standard UV Monitoring System, a sensor probe and sensor cable will need to be installed on the UV chamber. The sensor probe contains an o-ring to ensure a watertight seal.

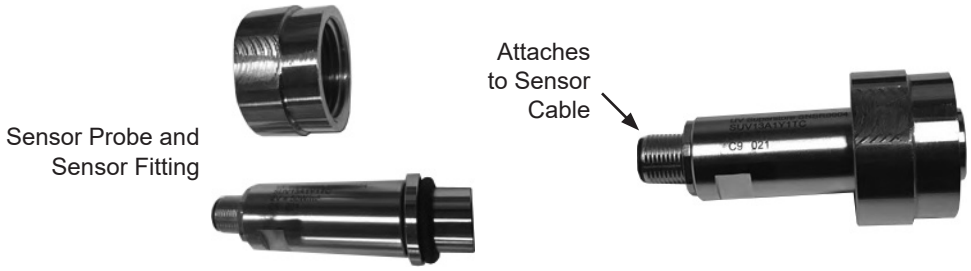
Sensor Probe and Sensor Fitting

To install:

1. Attach the sensor probe to the sensor port on the UV chamber and secure.
2. Attach the sensor cable to the sensor probe.

P/N SNSR0004 Wetted Sensor

For models equipped with the optional UV Monitoring Station, a sensor probe, sensor port fitting, and sensor cable (not shown) will need to be installed on the UV chamber. The sensor fitting and sensor probe contains an o-ring to ensure a watertight seal. To install, first attach Then attach the sensor cable to the sensor probe.

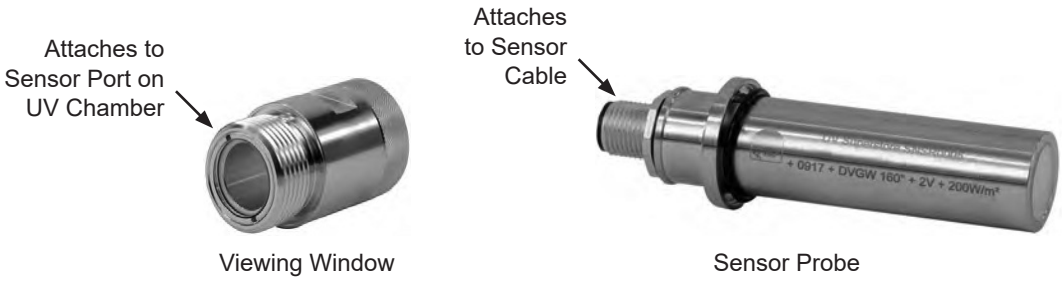


To install:

1. Attach the sensor fitting to the sensor port on the UV chamber.
2. Slide the sensor probe through the fitting and secure.
3. Attach the sensor cable to the sensor probe.

P/N SNSR0005 Non-Wetted Sensor and Viewing Window

For models equipped with the optional UV Monitoring Station, a sensor probe, sensor viewing window, and sensor cable (not shown) will need to be installed on the UV chamber. The viewing window and sensor probe contains an o-ring to ensure a watertight seal.



To install:

1. Attach the sensor viewing window to the sensor port on the UV chamber.
2. Slide the sensor probe through the viewing window and secure
3. .Attach the sensor cable to the sensor probe.

f) Quartz Sleeve Installation for Open Ended Sleeves

When working on this task a single operator is appropriate.

The quartz sleeves seal by using a compression nut, a stainless steel washer, an o-ring, and a compression nut cap. This task requires no tools. Use cloth gloves to handle the quartz sleeves and UV lamps to avoid putting fingerprints on the sleeves and lamps.

Manual Wiper System (Optional)

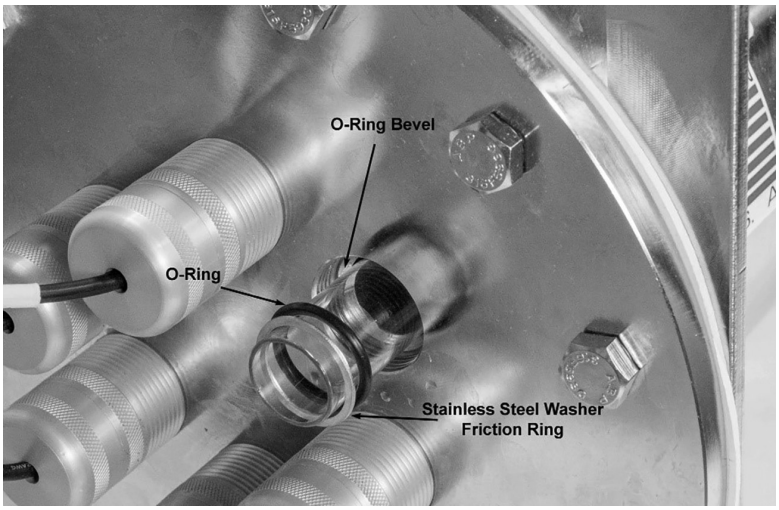
If your unit includes a manual wiper system, wet the quartz sleeve before installing. Carefully slide the o-ring onto the end of the quartz sleeve as indicated below. Slowly and carefully slide

NOTE: The o-ring should slide down the quartz sleeve about 1/4 inch. More than 1/4 inch can make installation more difficult.

the quartz sleeve through the lamp head plate and wiper ring. Make sure the quartz sleeve is aligned properly with the wiper ring(s). Then, follow the remaining steps below.

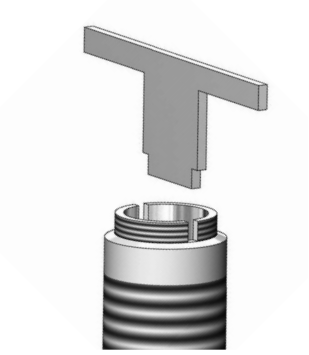
First, place the o-ring onto the end of the quartz sleeve as shown left. Next, the quartz sleeve needs to be inserted into the lamp head plate gradually and securely through to the other end. As the quartz sleeve approaches the opposite end, make sure to guide the sleeve all the way through. It is suggested that a finger or a dowel may be used to catch the end of the quartz.

Once through, make sure that each end of the quartz sleeve protrudes the same amount on both sides. Before sliding the o-ring on, it is suggested to lubricate both the o-ring and the sleeve making it slippery. Then slide an o-ring over each end of the sleeve. Once the o-rings are on, place the stainless steel washers on each end.



The compression fittings should first be hand tightened and the process needs to be completed for each quartz sleeve. **Do NOT install the UV lamp at this time.**

Do not use a wrench to tighten the compression nuts. Doing so can crack the quartz sleeves and cause leakage. A compression nut tool has been provided with the system to further tighten the compression nuts.



Compression Nut Tool

Once secure and once all other ports are closed, it is time to pressurize the system to look for any leaks at the compression seals. Slowly fill the vessel with water. Prevent any onrush of water or water hammer as this may damage the sleeves. Also ensure that the UV lamps have not been placed in the vessel. In the event of a water hammer, the quartz sleeve(s) may break and if the lamps are already installed, they too could break.

Once pressurized, let stand for 10 minutes and inspect the seals. If any are found to be leaking, stop the water, release the pressure, drain the system, and then redo the leaking seals. Once redone, run the pressurization test and ensure that all seals are not leaking.

g) Lamp and Lamp Harness Bracket Installation

Use cloth gloves to handle UV lamps to avoid putting fingerprints on the lamps.

The electrical path for each lamp is identified and carried through the whole electrical system. The LED on the electrical enclosure for lamp one corresponds to lamp one in the treatment chamber. Each lamp harness is numbered and each lamp nipple is numbered on the lamp head plate. Match the corresponding numbered lamp lead to the corresponding numbered lamp nipple.

First install the lamp harness bracket if it is not attached to the UV chamber. If this is the case, your shipment includes all the necessary components to properly install. Attach the lamp harness bracket to the back side of the lamp head plate and secure with the two additional nuts.

Once the lamp harness bracket is secured, the UV lamps can be installed.

Insert the lamp into the quartz sleeve and slowly slide in, blank end first, pin end last. Leave the lamp protruding out of the sleeve far enough to be able to push the lamp connector onto the lamp. Make sure the lamp connector is firmly pushed onto the lamp base leaving no space between the connector and base. **Failure to push the lamp connector all the way onto the base may allow electrical arcing to occur between the pins, overheating the lamp and possibly causing a fire.**

Slowly slide the lamp into the sleeve, blank end first, pin end last. Leave the lamp protruding out of the sleeve far enough to be able to push the lamp connector onto the lamp. Make sure the

lamp connector is firmly pushed onto the lamp base leaving no space between the connector and base. Failure to push the lamp connector all the way onto the base may allow electrical arcing to occur between the pins, overheating the lamp and possibly causing a fire. After the lamp harness is connected, then screw on the compression nut cap. Repeat for each lamp. The compression caps hold the lamp harness in place and prevent exposure to UV radiation.

6) ELECTRONIC CONTROL CENTER (ECC) OPERATION AND MONITORING

The ECC will be the focal point for system operation and monitoring.

Do not exceed three ON/OFF cycles in a 24-hour period. Excessive cycling of the UV system will reduce the EOL (End of Life) output and/or cause premature aging of the UV lamps.

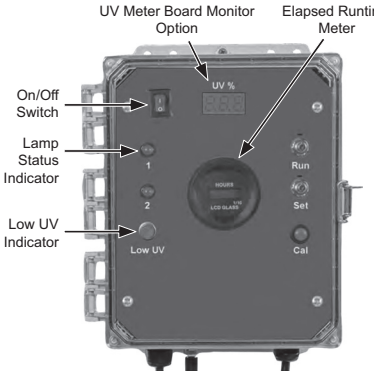


Photo shown is Display Plate for the Standard UV Meter Board Monitor Option and Standard High Heat Option

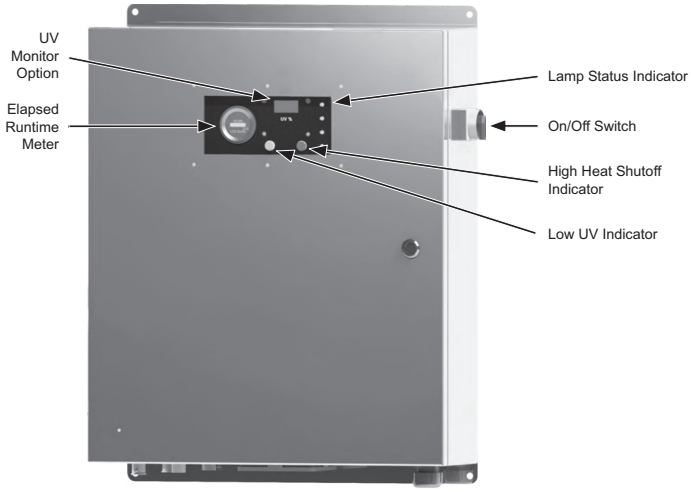


Photo shown is Display Plate for the Standard UV Monitor Option and Standard High Heat Option

a) On/Off Switch

The on/off switch controls the electrical power to the UV system, manually.

Hands Off Auto (HOA) Switch—Optional
(For Polycarbonate and Stainless Steel Enclosures with Power Cord)
This is an optional feature and is for models equipped with the HOA switch. Make sure the switch is wired as specified in the wiring diagram inside the ECC cover.

To operate remotely, turn switch to the "Auto" position.

Hands Off Auto (HOA) Switch—Optional
(For Stainless Steel Enclosures)
This is an optional feature and is for models equipped with the HOA switch. Make sure the switch is wired as specified in the wiring diagram inside the ECC cover.

To operate remotely, turn switch to the "2" position.

b) Lamp Status

The ECC will display each individual lamp status indicator in the form of light emitting diodes

(LEDs) located on the display plate behind the window on the front door. The LEDs glow green when the lamp is on. An extinguished LED indicates a possible lamp problem.

If the LED goes off, then it may mean that a lamp is no longer functioning. However, it may indicate a problem with the LED, the lamp's corresponding ballast, or a problem located within the lamp holder.

c) Runtime Monitoring

A digital non-resettable time meter has been integrated into the display plate of the ECC. This elapsed runtime meter (ERTM) tracks operational hours on the system as a whole. It does not track individual lamp run hours nor does it indicate when to service. The runtime meter is a tool to help track running hours to help operators know when it is time to change lamps.

Operators should keep tracking logs in order to know when it is time to change lamps (see last page of this manual). Lamps need to be changed every 10,000 hours (one year). UV lamps lose intensity over time and the system is designed to provide proper dosage up to 10,000 hours of lamp life. Running the lamps more than 10,000 hours could result in improper UV dosage.

d) Viewport

For models not equipped with a UV Monitor, a viewport has been installed on the UV chamber. The purpose of a viewport is to safely verify lamp operation without the potential exposure to UV rays. The viewport assembly consists of a viewport, sight glass, foam washer, and o-ring.

e) Manual Quartz Sleeve Wiper System

Water quality will determine the frequency of operating the manual wiper system. It is recommended to use the wiper system weekly; however this task may be performed more often or less depending on your water conditions. To operate, release pressure off the locking pin assembly and remove the locking pin. Always operate the wiper system with a straight and even stroke.

f) Lamp Out Alert (Optional)

Lamp out alert ballast(s) are used to connect an external control (PLC or SCADA) to the enclosure. The lamp out alert ballast contains relay contacts which provide a signal to the external control via lamp on/lamp fault conditions. The enclosure has been wired with two red terminal blocks that are specifically for this operation. An external control signal from a PLC or SCADA unit can be wired to the terminal blocks for a closed circuit/open circuit condition for external control logic.

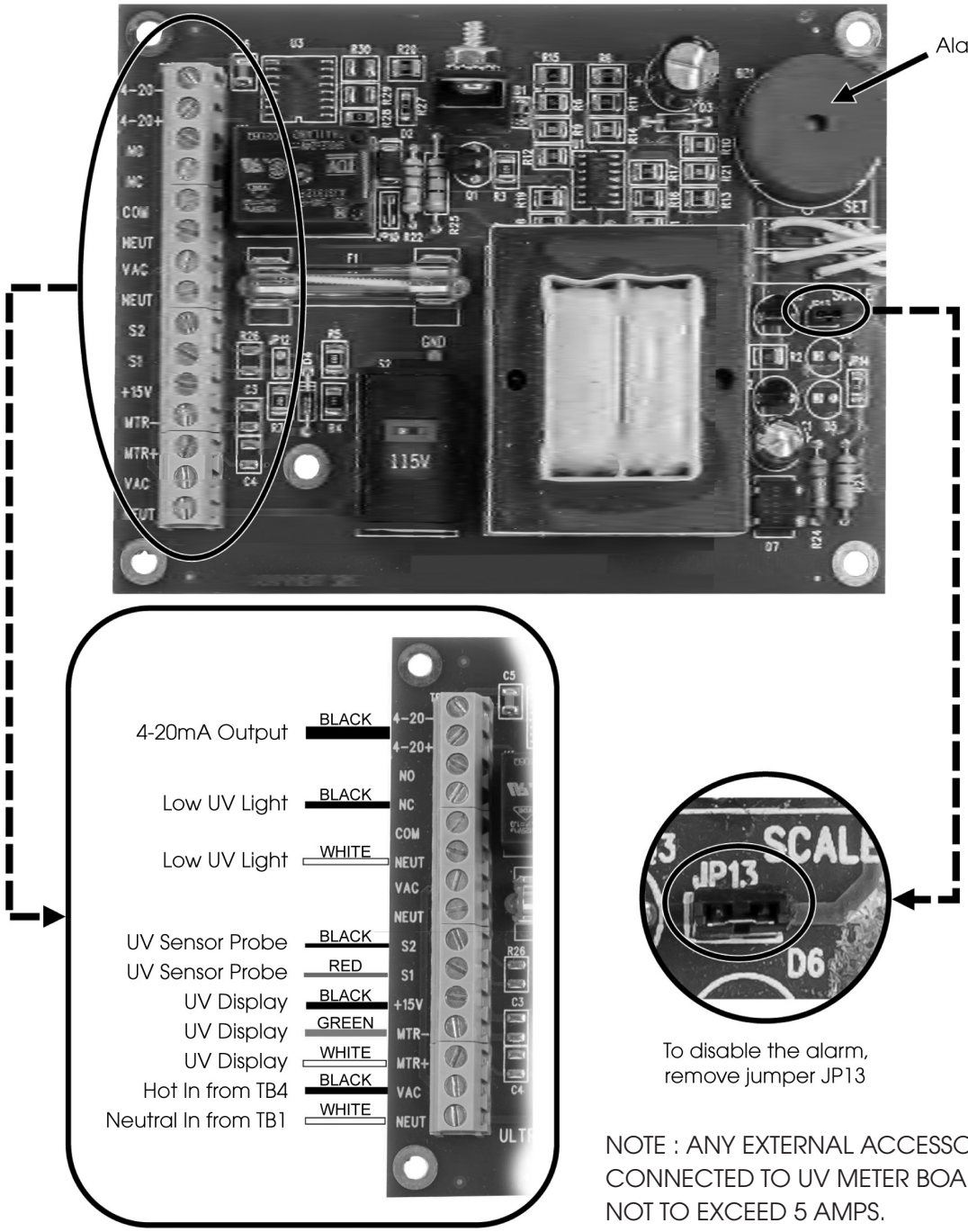
To operate, the circuit starts at one of the terminal blocks and runs to the incoming contact of the lamp out relay of the first ballast and across the closed circuit contacts on the relay. From the outgoing relay contact of the first ballast, the wires are fed to the incoming contact on the next ballast and across the closed circuit contacts of the next ballast and so on to the last ballast (according to the number of lamps in the unit) and fed back to the second red terminal block. In the normal operating state with all lamps lit, the circuit is closed. If any of the lamps in the circuit fails, the corresponding lamp out relay will switch states, the chain will be broken, and the circuit will be open. An external control signal from a PLC or SCADA unit can be wired to the terminal blocks for a closed circuit/open circuit condition for external control logic.

WARNING: Control signal may not exceed 32VAC, 50VDC, 50mA current.

g) Standard UV Monitor (Optional)

Operation

The Standard UV Monitor option consists of a UV sensor probe, a UV monitor board, and a UV digital display. UV light output is measured from Lamp #1 at the top of the cylinder by the UV sensor probe, a signal is sent to the UV meter board for processing, and displayed as a percentage value from 0 to 100% on the digital display. When new lamps are installed, the board must be calibrated for the new lamps to 100%. As the lamps age and UV intensity falls, the UV display will reflect the lowered UV intensity. When the UV intensity falls below the set trip point, the meter board relay will trip, sounding an audible alarm, illuminating the low UV lamp on the display, and switching the state on the contact outputs on the board.



NOTE : ANY EXTERNAL ACCESSORIES CONNECTED TO UV METER BOARD IS NOT TO EXCEED 5 AMPS.

Calibration
The ultraviolet meter can only be calibrated when the power switch is in the ON position and the lamps are operational. Lamps must warm up for three minutes prior to any calibrations. Recalibrate after the lamps have been operational for 100 hours; when the lamps are stable.

The board's initial state will be in the fault state. The low UV light will be lit and the alarm will sound and the relay will be in the normally open condition. The reason for this state is to allow for lamp warm-up if the unit is equipped with a solenoid valve. If the unit is equipped with a solenoid valve, the lamps will be on, but the coil in the solenoid will be de-energized for three minutes to prevent water flow until the lamps are warmed up and to proper intensity.

After three minutes, the board will revert to the operational "normal" state. If the system is at or above minimum intensity, the relay will revert to the normally closed position, the low UV light will go off, the alarm stop sounding, and if equipped with a solenoid valve, the valve will open and water will flow.

To calibrate the UV Monitor Board
NOTE: Many industrial applications do not require an audible alarm for low UV intensity. When calibrating the UV monitor board, the alarm will sound during the warm-up period. To disable the alarm, remove jumper JP13 located at the right edge of the board below the alarm.
Take caution when removing the jumper as exposed prongs may have voltage present!

1. Calibration must be made with new lamps only.
2. Lamps must be allowed to warm up for three minutes prior to any calibrations.
3. Open the enclosure door to expose the display plate. On the right side of the display plate, locate the Run potentiometer, the Set potentiometer, and the Cal switch.

4. First set the trip level. Push and hold the Cal switch and adjust the Set potentiometer until the display reads 85%. When the UV intensity falls below 85% the system will go into the fault state. The UV unit is designed to provide proper UV dosage at 85% of original UV intensity. With modern technology UV lamps, this should occur at about 10,000 hours of continuous use (approximately one year).
5. Release the Cal switch and adjust the Run potentiometer until the display reads 100%.
6. When the board is in the normal state, test the calibration by adjusting the Run potentiometer until the display reads below 85% to determine if the low UV lamp lights, indicating the board is functioning properly. Readjust the Run potentiometer until the display reads 100%. (The three minute warm-up period will restart). The UV meter board is now calibrated.

h) Standard High Heat Sensor (Optional)

Operation

The optimum operating temperature of a standard low pressure ultraviolet lamp is around 105°F. UV intensity falls off when the temperature of the lamp rises above the optimum operating temperature. In order to guard against a possible falloff of UV intensity due to high heat and possible damage to other components, an optional high heat sensor can be used. The high heat sensor option consists of a thermostat, a thermostat mounting bracket, a relay, and a high heat indicator lamp. When an overheat situation occurs, the relay will trip, shutting off power to the ballasts and illuminating the high heat lamp indicator.

Operational "Normal" State

The high heat sensor controls voltage to the high heat relay. Voltage flows from the relay's common terminal to the NO terminal, feeding operating voltage to all components of the ECC allowing "normal" operation of the unit.

Fault State

The high heat sensor is factory set at 120°F. If the vessel temperature reaches 120°F, the thermostat will not allow power to pass through, tripping the high heat relay. Voltage through the relay will switch from the common terminal to the NC terminal, feeding voltage to the high heat light and denying voltage to the ballasts and runtime meter. The UV lamps will shut off, the runtime meter will shut off, and the high heat light will illuminate. If the unit is equipped with an optional UV monitor, because the lamps are now shut off, the UV monitor will go into the fault state, illuminating the low UV light, sounding the audible alarm, switching the state of the relay contacts on the UV meter board, and the UV display should read "0." The unit will turn back on when the water flows to cool the unit, or when the water temperature falls below 90°.

7) MAINTENANCE

Always disconnect power before servicing the system.

a) Lamp Maintenance

Most ultraviolet lamps are rated to provide 10,000 hours of continuous use. After 10,000 hours, the lamp may no longer provide the sufficient amount of 254nm or 185nm that is required for UV output. Therefore, the lamps need to be replaced on a yearly basis. Lamp status should also be checked on a periodic basis by inspecting the LEDs on the ECC.

It is best to always keep spare lamps available in case of emergency needs.

If it becomes necessary to clean the lamp due to dust or fingerprints, the lamps can be cleaned with either denatured alcohol or a non-abrasive cleaner. Use cotton gloves and a clean cloth when cleaning the lamps. Wait for lamps to cool before cleaning.

b) Quartz Sleeve Maintenance

FRAGILE: Be careful when handling quartz sleeves! Always use cotton gloves when handling.

In order to ensure proper disinfection, the quartz sleeves need to be inspected, monitored, and maintained. The UV lamps produce heat and UVC output, which may cause certain water characteristics to adhere to and bond onto the sleeve preventing the UVC from reaching the targeted pathogens. This can cause the quartz sleeves to foul. To a great extent, the frequency of cleaning will depend upon the water quality (i.e. amount of minerals present in the liquid). The more minerals present in the water, the more frequently the quartz will require cleaning.

Manual Cleaning

Significant film or debris deposits formed on the quartz sleeves will impair the ability of the ultraviolet rays to penetrate through the quartz and into the water.

A periodic visual inspection of the quartz will be necessary to determine the frequency of cleaning. Initial inspection should take place after thirty (30) days of operation. If the quartz are dirty, shorten the cleaning intervals. If the quartz are clean, lengthen the cleaning intervals.

To clean quartz sleeves, depressurize the unit by first turning off the valves on the inlet and then the outlet of the vessel. Turn off the power to the UV system. Drain the vessel. Disconnect the lamps, allow to cool, and slowly and carefully remove the lamps using clean cotton gloves. Back off the compression quartz gland nuts and remove the o-rings.

The quartz sleeves may be cleaned with denatured alcohol. If this is not adequate, a mild non-abrasive cleaner can be used. It is important to use cleaners that leave no residue. **FRAGILE: Be careful when handling quartz.** Whenever the quartz sleeves are cleaned, the quartz sleeve o-rings should be replaced. Install the quartz sleeves with clean cotton gloves.

c) Manual Quartz Sleeve Wiper System Maintenance

The wiper seal nut assembly (where the rod enters the chamber head) consists of o-rings that may need to be changed. The wiper nut assembly prevents water from escaping through the wiper rod of the pressurized system. The wiper seal nut assembly consists of a total of three Viton o-rings. If leaking occurs at this point, a new seal nut may need to be installed. To replace, release pressure, drain the vessel, remove the locking pin assembly, remove wiper knob, and then unscrew the existing seal nut and install a new one.

d) ECC Maintenance

Polycarbonate Enclosures

An ECC made of polycarbonate material is custom designed with a sealed door. It should require little maintenance other than occasional cleaning. A damp cloth and mild detergent can be used to clean the outside of the enclosure. While most penetrations are sealed, it is not suitable to withstand a hose wash-down or large amounts of water. Any water penetrating the enclosure can lead to damage and possible electrical shock.

Stainless Steel Enclosures

An ECC made of 304 stainless steel is custom designed with a sealed door and sealed Lexan window kit. It should require little maintenance other than occasional cleaning. A damp cloth, mild detergent, or other stainless steel cleaner may be used to clean the outside of the enclosure.

Routine maintenance should also include checking and cleaning the filters on the air intake fans. Fans have been integrated to keep the electronics cool in order to ensure optimum performance. Prior to cleaning the filters, the ECC must be powered down. Once powered down, snap the covers off by hand then remove and wash the filter with warm water. Filters must be dry before reinstalling.

The ECC is not suitable to withstand a hose wash-down or large amounts of water. Any water penetrating the enclosure can lead to damage and possible electrical shock.

e) Viewport Maintenance

For models not equipped with a UV Monitor, a viewport has been installed on the UV chamber. The purpose of a viewport is to safely verify lamp operation without the potential exposure to UV rays. The viewport assembly consists of a viewport, sight glass, foam washer, and an o-ring.

The foam washer acts as a cushion between one side of the sight glass and the viewport itself. The o-ring provides a seal and serves as a cushion to the other side of the sight glass.

This assembly will require periodic maintenance similar to the lamp and quartz maintenance schedule. A periodic visual inspection of the viewport assembly is recommended. Unscrew the nickel plated viewport from the chamber and inspect the sight glass for any cracks. If a crack has occurred this will need to be replaced. It is recommended to replace the o-ring every three to five years as the o-ring can degrade over time.

Reattach the viewport after routine maintenance has been performed.

f) High Heat Shutoff Maintenance
(For Models with Standard High Heat)

Many applications can have significant times of no flow. During these times, heat can build up in the vessel. To prevent the lamps from overheating and the quartz sleeve fouling, a thermostat (high heat shut off) may have been provided as an option.

The high heat sensor is attached to the cylinder flange plate welded to the vessel. It is held in place with a mounting bracket held by one of the head plate bolts. The sensor is attached to the electronics via a plug in connector. The sensor generally shuts down at 120°F. This is meant to protect the lamps. The system will turn back on once the system cools down. The sensor is factory set and cannot be adjusted. No maintenance is needed other than to make sure the sensor is held tightly in place.

g) Sensor Probe Maintenance

For Models with Standard UV Meter Board Monitor

For models equipped with a standard UV monitor, a sensor probe has been installed on the UV chamber. The sensor probe contains an o-ring that will need to be replaced periodically. Annual routine maintenance is recommended similar to lamp and quartz maintenance.

Unscrew the sensor probe from the sensor port. Inspect and clean as needed. A buildup can coat the sensor probe and failure to clean may result in a false reading. It is recommended to replace the o-ring every three to five years as the o-ring can degrade over time.

Reattach the sensor probe after routine maintenance has been performed.

For Models with Standard UV Monitoring System or UV Monitoring Station Option

Wetted Sensor Probe (SNSR0007 & SNSR0004)

For models equipped with either the Standard UV Monitoring System or optional UV Monitoring Station, a sensor probe and sensor cable is used and attached to the UV chamber. The sensor probe consists of a an o-ring that will need to be replaced periodically. Annual routine maintenance is recommended similar to lamp and quartz maintenance.

SNSR0007

SNSR0004

NOTE: You must shut down the system and depressurize the chamber before performing any maintenance.

Detach the sensor cable from sensor probe and unscrew the probe from the sensor port. Inspect and clean as needed. A buildup can coat the sensor probe and failure to clean may result in a false reading. It is recommended to replace the o-ring every three to five years as the o-ring can degrade over time.

Reattach sensor probe and sensor cable after routine maintenance has been performed.

Non-Wetted Sensor Probe with Viewing Window (SNSR0005)
For models equipped with the optional UV Monitoring Station, a sensor probe has been installed on the UV chamber. The sensor probe viewing window is made of a quartz disc that will need to be cleaned and contains an o-ring that will need to be replaced periodically. Annual routine maintenance is recommended similar to lamp and quartz maintenance. Before cleaning the viewing window, you must shut down the system and depressurize the chamber.

SNSR0005

Unscrew the viewing window from the sensor port. Inspect and clean as needed. A buildup can coat the quartz disc and failure to clean may result in a false reading. It is recommended to replace the o-ring every three to five years as the o-ring can degrade over time.

Reattach viewing window after maintenance has been performed.

h) Chamber Maintenance
The chamber requires periodic maintenance. The Chamber is made of 316L Stainless Steel and is electropolished and passivated. It should provide years of reliable service. The exterior can be cleaned with a damp cloth and mild detergent or a stainless steel cleaner. **Be careful around the compression nuts as the compression cap is not watertight.** The chamber interior will require cleaning on a periodic basis depending on the quality of the water passing through. Some water will introduce solids, minerals, and other debris in the vessel. Inspection of the vessel can be made without removal of the heads.

Prior to performing inspection, ensure that the power to the ECC and that the water supply has been turned off before and after the chamber. Once isolated, drain the system. Prior to draining, release pressure in line by opening a valve. Failure to do these tasks can result in serious injury and property damage.

Once drained, the operator can remove a lamp and quartz sleeve to peek through a nipple in the lamp head to get a limited view of the vessel. The UV sensor probe (if so equipped), or the viewport can also be removed to inspect the chamber.

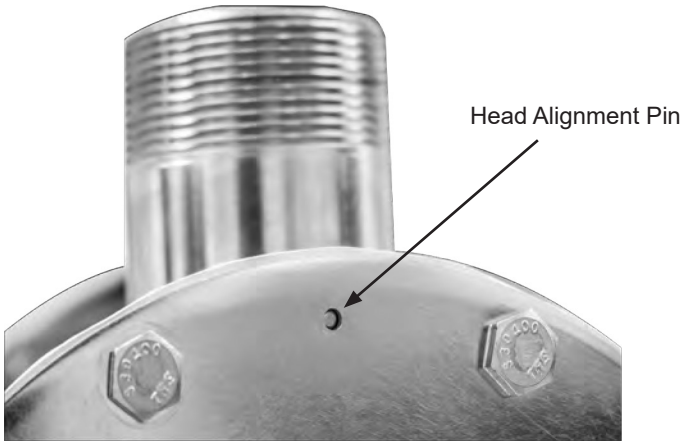
The heads can also be removed to inspect or clean the chamber.

Chamber Breakdown — Removal of Heads
Once determined there is reason to believe that the vessel needs to be cleaned, the operators will need to set aside some work time to perform a complete system break down.

As with inspection, the vessel needs to be powered off, completely drained, and allowed to cool down.

The operator will need to remove the lamps, the compression nuts, o-rings, and quartz sleeves. All of these parts should be checked for wear and should be stored in an area where they will not get lost or broken.

Operators will need to loosen the nuts and bolts on the lamp head plate and inlet head plate. Once loosened, the nuts, bolts, and lock washers need to be removed and stored.



The head will need to be replaced in the exact position in which it was removed. There is an alignment pin on the cylinder flange that mates to a hole in the removable head to ensure the head is in the proper position upon reinstallation.

Lower the head to the ground. The gasket should be inspected for wear and also stored in a safe place. Having one head off will allow for both visual inspection and cleaning.

Once cleaned, perform maintenance on the quartz sleeves and replace any gaskets/o-rings.

NOTE: It is recommended that a new gasket be installed.

When re-installing the head, use a crisscross pattern to tighten the nuts. This is similar to putting a tire on a car. Bolts should be torqued to 25 foot pounds.

8) WATER SAMPLING (FOR FLANGE MODELS)

The manufacturer recommends a program of water sampling to ensure delivery of the desired water quality. While the frequency of sampling will depend upon site conditions and requirements, the user should establish a disciplined program.

a) Sampling Valves

The manufacturer recommends installation of sampling valves on the inlet and outlet sample ports located on the ultraviolet unit risers. The wetted material should be 316 stainless steel construction. A minimal length of thread connections of the sample valve port should be maintained to reduce the dead volume on the upstream side of the valve. The inside diameter of the sample valve must not exceed one-quarter inch (1/4") to insure proper velocity. Any valve used for sampling should be constructed in a manner to reduce or prevent the retention of bacteria within its internal surfaces. The valve should also be easy to sanitize.

b) Sampling Procedure

1. Prior to sampling the water, acquire an adequate supply of bacteriological monitors, total count water samplers, and pre-sterilized plastic bottles within pre-sterilized plastic bags from a water testing laboratory.
2. With the ultraviolet system operating, open the sample valve fully and flush for at least one minute at full fast flow. Then, close the valve.
3. Sanitize the valve and sampling port in accordance with the proper standards established for the specific valve installed. Isopropyl alcohol 70% to 90% is recommended.
4. Fully open and flush the valve again to remove any contaminants. The flushing time sequence may run from a minimum of three to five minutes. Do not reduce the water flow before taking the water sample because the back of the valve (not previously exposed) may contain contaminates. If you reduce the flow prior to taking a sample, continue to flush as before.
5. When sampling, take the measurement at the center of the stream in order to reduce the possibility of bio-fouling.
6. Follow ASTM or your bacteriological monitor manufacturer guidelines when using that monitor, with a total count water sampler and a pre-sterilized plastic bag, to sample the in-line.
7. Carefully fill the pre-sterilized bottle from the bottom up allowing the water stream to overflow and flush the bottle for a minimum of one minute.

9) FOOD AND DRUG ADMINISTRATION STATEMENT

SWT provides state of the art ultraviolet water and air treatment systems for many commercial and industrial applications.

The U.S Food and Drug Administration approval process does not allow for individual approval of any material, piece of equipment, or apparatus that is not deemed a medical device. Therefore SWT UV systems and spare parts are designed to be in compliance with the U.S Food and Drug Administration Code Of Federal Regulations Title 21 Sub Section 177.

Stainless steel and quartz material are acceptable in FDA applications. All o-ring and gasket materials are in compliance with Title 21 Sub Section 177.

The U.S Food and Drug Administration regulations that deal with the items addressed above are as follows:

1. Part 129, Subpart C, Sec. 129.40 Equipment and procedures.
2. Part 177, Subpart C, Sec. 177.2600 Rubber articles intended for repeated use.
3. Part 211, Subpart D, Sec 211.65 Equipment Construction.

All UV products are built to exacting standards with the highest quality materials available to meet the above referenced guidelines.

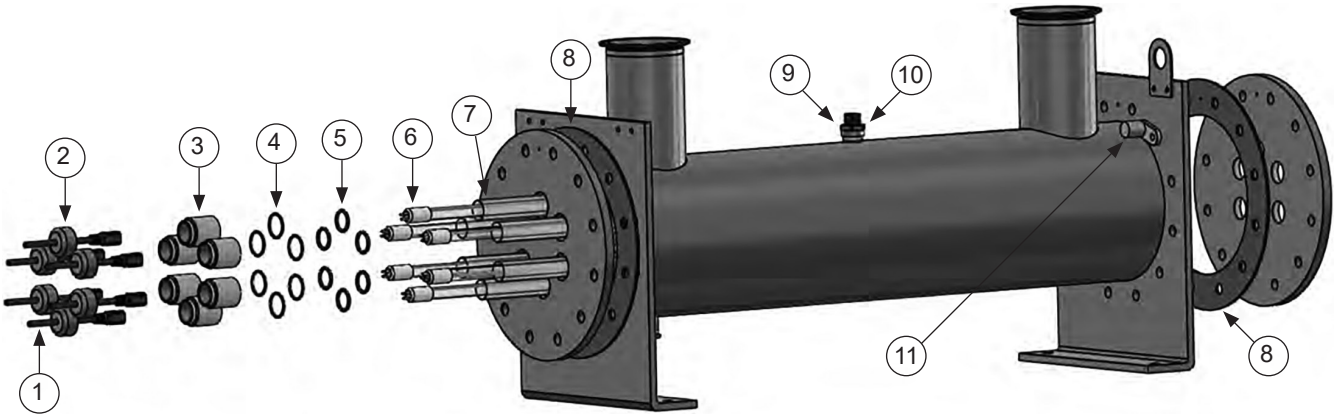
10) HEAT SANITIZATION

For heat sanitization, we recommend temperatures no higher than 194°F (90°C). If the unit has a UV monitor, the sensor probe must be removed and the sensor port plugged prior to sanitization. The sensor probe manufacturer states temperatures higher than 140°F (60°C) can possibly either damage the electronic components inside the housing, or affect sensor calibration. The sensor port for P/N SNSR0004 requires a 1/4 inch BSPP male thread plug. The sensor port for P/N SNSR0005 requires a 1 inch BSPP male thread plug.

The most critical part is that the system is not heated or cooled too quickly, as with anything made with like materials. If this is heated or cooled too quickly there is a good chance of very fast expansion or contraction and this is where the problems will come from as far as cracking of the stainless steel chamber or welds, compression fittings failure, quartz sleeves failure, and other components failure along with chances of leaking by the various seals for the UV system. **Heat and cool SLOWLY.**

- Turn UV system OFF. UV lamps should not be operational during this process.
- Maximum Temperature:
  Models without a UV Monitor: 194°F (90°C)
  Models with a UV Monitor: 140°F (60°C)
- Remove UV sensor probe and plug sensor port.
- **Heat and cool SLOWLY** to avoid fast expansion or contraction.

UVL SERIES SHORT CHAMBERED SYSTEMS REPLACEMENT PARTS

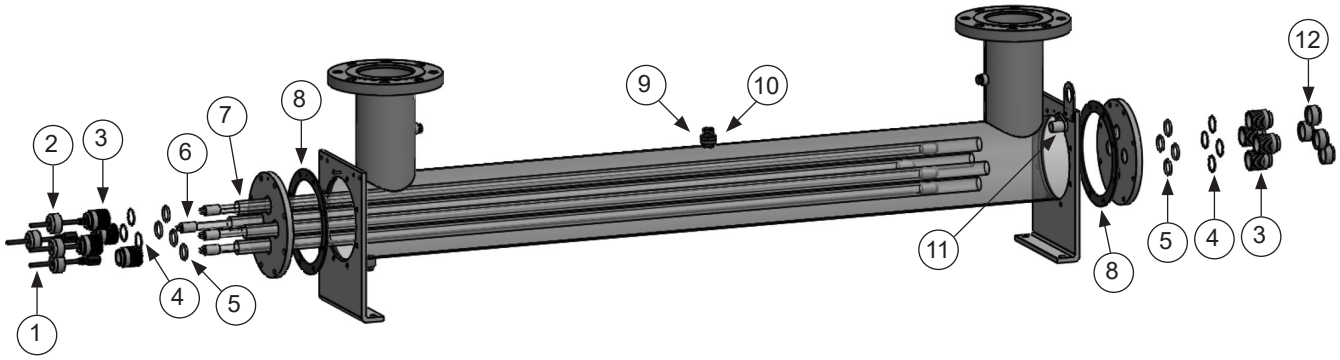


High Output Series Systems: UVL1S-2F, UVL1S-2S, UVL2S-2F, UVL2S-2S, UVL3S-3F, UVL3S-3S, UVL4S-3F, UVL4S-3S

Amalgam Series Systems: UVL1SA-2F, UVL1SA-2S, UVL2SA-2F, UVL2SA-2S, UVL3SA-3F, UVL3SA-3S, UVL3SA-4F, UVL3SA-4S, UVL4SA-3F, UVL4SA-3S, UVL4SA-6F, UVL4SA-6S, UVL5SA-6F, UVL5SA-6S

Item No.	Description	Quantity Required						
		1 Lamp	2 Lamp	3 Lamp	4 Lamp	5 Lamp	6 Lamp	8 Lamp
1	Lamp Harness, 8 ft (Standard High Output Systems)	1	2	3	4	5	6	8
	Lamp Harness, 15 ft (Standard Amalgam Systems)							
2	Compression Cap with Hole for Lamp Harness	1	2	3	4	5	6	8
3	Compression Nut	2	4	6	8	10	12	16
	Compression Cap (Not Shown)	1	2	3	4	5	6	8
4	Sleeve Washer, Stainless Steel	2	4	6	8	10	12	16
5	Sleeve O-Ring, EPDM	2	4	6	8	10	12	16
6	UV Lamp, High Output 254 nm	1	2	3	4	5	6	8
	UV Lamp, High Output 185 nm							
	UV Lamp, Amalgam 254 nm							
	UV Lamp, Amalgam 185 nm							
7	Quartz Sleeve, Open	1	2	3	4	5	6	8
8	Head Gasket for 6 inch Chamber	2						
	Head Gasket for 8 inch Chamber							
Model Options								
9	UV Viewport	1						
	O-Ring for Viewport (for Models without Monitoring Options)							
10	UV Sensor Probe	1						
	O-Ring for Sensor Probe							
	Sight Window for Sensor Probe							
	O-Ring for Sight Window							
11	Thermistor (for Models with Standard High Heat)	1						

UVL SERIES LONG CHAMBERED SYSTEMS REPLACEMENT PARTS

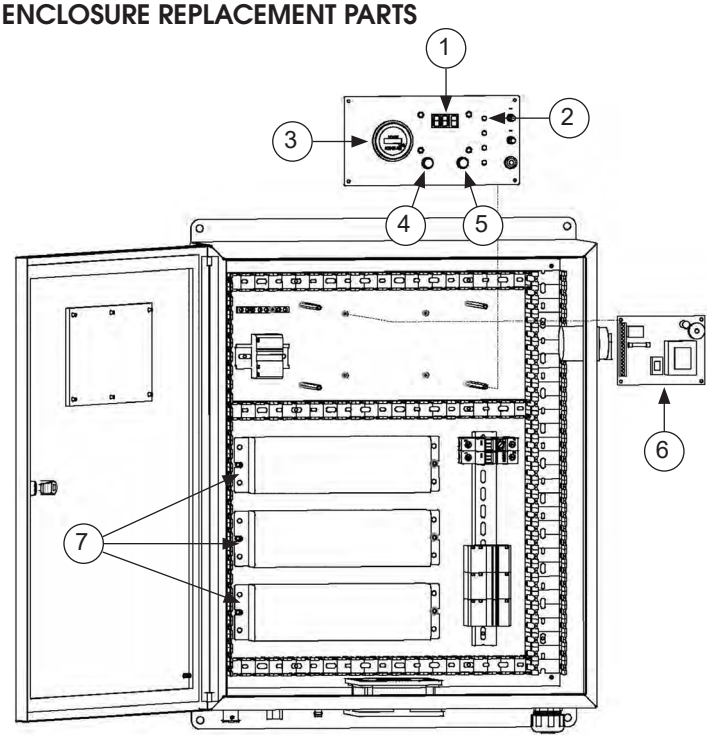


High Output Series Systems: UVL4L-4F, UVL4L-4S, UVL4L-6F, UVL4L-6S, UVL5L-4F, UVL5L-4S, UVL5L-6F, UVL5L-6S, UVL6L-6F, UVL6L-6S

Amalgam Series Systems: UVL4LA-6F, UVL4LA-6S, UVL4LA-8F, UVL4LA-8S, UVL5LA-6F, UVL5LA-6S, UVL5LA-8F, UVL5LA-8S, UVL6LA-6F, UVL6LA-6S

Item No.	Description	Quantity Required		
		4 Lamp	5 Lamp	6 Lamp
1	Lamp Harness	4	5	6
2	Compression Cap with Hole for Lamp Harness	4	5	6
3	Compression Nut	8	10	12
4	Sleeve Washer, Stainless Steel	8	10	12
5	Sleeve O-Ring, EPDM	8	10	12
6	UV Lamp, High Output 254 nm	4	5	6
	UV Lamp, High Output 185 nm			
	UV Lamp, Amalgam 254 nm			
	UV Lamp, Amalgam 185 nm			
7	Quartz Sleeve, Open	4	5	6
8	Head Gasket for 6 inch Chamber	2	2	—
	Head Gasket for 8 inch Chamber	2	2	2
	Head Gasket for 10 inch Chamber	2	2	—
Model Options				
9	UV Viewport	1		
	O-Ring for Viewport (for Models without UV Monitoring System)			
10	UV Sensor Probe	1		
	O-Ring for Sensor Probe			
	Sight Window for Sensor Probe			
	O-Ring for Sight Window			
11	Thermistor (for Models with Standard High Heat)	1		
12	Compression Cap	4	5	6

UVL SERIES ELECTRICAL ENCLOSURE REPLACEMENT PARTS



Item No.	Description	Quantity Required						
		1 Lamp	2 Lamp	3 Lamp	4 Lamp	5 Lamp	6 Lamp	8 Lamp
1	Intensity Display Board (for Models with Standard UV Meter Board Option)	1	1	1	1	1	1	1
2	Lamp Status Indicator	1	2	3	4	5	6	8
3	Elapsed Runtime Meter	1	1	1	1	1	1	1
4	Low UV Indicator, 120 V	1	1	1	1	1	1	1
	Low UV Indicator, 120 V (for Models with Standard UV Meter Board Option)	1	1	1	1	1	1	1
5	High Heat Shutoff Indicator, 120 V	1	1	1	1	1	1	1
	High Heat Shutoff Indicator, 220 V (for Models with Standard High Heat Option)	1	1	1	1	1	1	1
6	UV Meter Board with 4-20mA Output (for Models with Standard UV Meter Board Option)	1	1	1	1	1	1	1
7	Ballast, 120 V, 50-60 Hz (Short High Output Lamps)	1	2	3	4	5	6	8
	Ballast, 120 V, 50-60 Hz (Long High Output Lamps)	—	—	—	2	3	3	—
	Ballast, 120 V, 50-60 Hz (Short Amalgam Lamps)	1	2	3	4	5	6	8
	Ballast, 220 V, 50-60 Hz (Short Amalgam Lamps)	1	2	3	4	5	6	8
	Ballast, 120 V, 50-60 Hz (Long Amalgam Lamps)	—	—	—	4	5	6	—
	Ballast, 230 V, 50-60 Hz (Long Amalgam Lamps)	—	—	—	4	5	6	—

TROUBLESHOOTING

Problem	Recommended Action
Lamp status LED light is out	• Verify lamp socket and lamp connection are securely connected. • If lamp is on, replace LED assembly.
UV lamp is out	• Exchange lamp connectors from quesonable lamp to known good lamp. If lamp lights, replace bad lamp. • If the lamp does not light, exchange lamp connectors at enclosure from quesonable ballast to known good ballast. If lamp lights, replace ballast. • Check input voltage. Must be above 120V/60Hz or 220V/50Hz. Install voltage regulator or check for floating neutral at power source.
Short lamp life	• Damper excessive vibration which causes degradation of lamp filaments by checking for poorly connected pipes, erratic or improperly installed pumps, or move the UV equipment to isolate it from vibration. • Consult manufacturer for frequent start/stop requirements (recommend not more than six (6) in 24-hour period).
Leak at quartz end plate	• Ensure compression nut is tightened and o-ring is sealed properly. • Replace quartz sleeve if defective or cracked. • Replace defective or cracked quartz and/or o-rings and gaskets. • When replacing end gasket, torque bolts to 20 foot-pounds.
Low UV monitor reading (Less than 80% transmission)	• Check water quality. Ensure that color, turbidity, and iron content are within normal parameters. • Verify lamp output. • Ensure input voltage matches requirements. • Replace old or defective lamp(s). • Clean UV sensor lens. • Clean quartz sleeve(s). • If reading is at 0%, ensure UV sensor cable is connected..
Poor bacterial performance	• Replace old or defective lamp(s). • Clean quartz sleeve(s). • Check water quality. Ensure that color, turbidity, and iron content are within normal parameters. • Verify sampling technique. • Verify flow rate. • Ensure proper sample valves are used. • Check for bypass valve contamination.

If questions still remain after completing a troubleshooting procedure, please contact the manufacturer.

MAINTENANCE LOG

You must perform routine maintenance in order to achieve optimum performance levels from your UVME Series Ultraviolet Water Treatment System. As you perform routine maintenance or necessary service on your system, record the dates in the Maintenance Log below. The "Maintenance" section of the IOM Manual provides instructions for servicing and maintenance procedures.

Model Number:	**Serial Number:**

UV Lamp Replacement (every 365 days)	**Quartz Sleeve Cleaning (as needed)**	**Quartz Sleeve Replacement (every 3 years)**	**O-rings Replacement (with sleeve change)**