

4.4.3 Normal Operation – Ozone

All operations of a Clean Water System with Ozone disinfection work as batch system with four phases:

- **Start-up and Fill Phase:** water is filtered, micro-filtered, and ozonated
- **Transition Phase:** raw water is flushed from Big Blue filters
- **Use Phase:** water is ozonated on a second pass for bottling or storage in a gravity-feed tank
- **Shut-down Phase:** The system is put in condition ready for the next operation

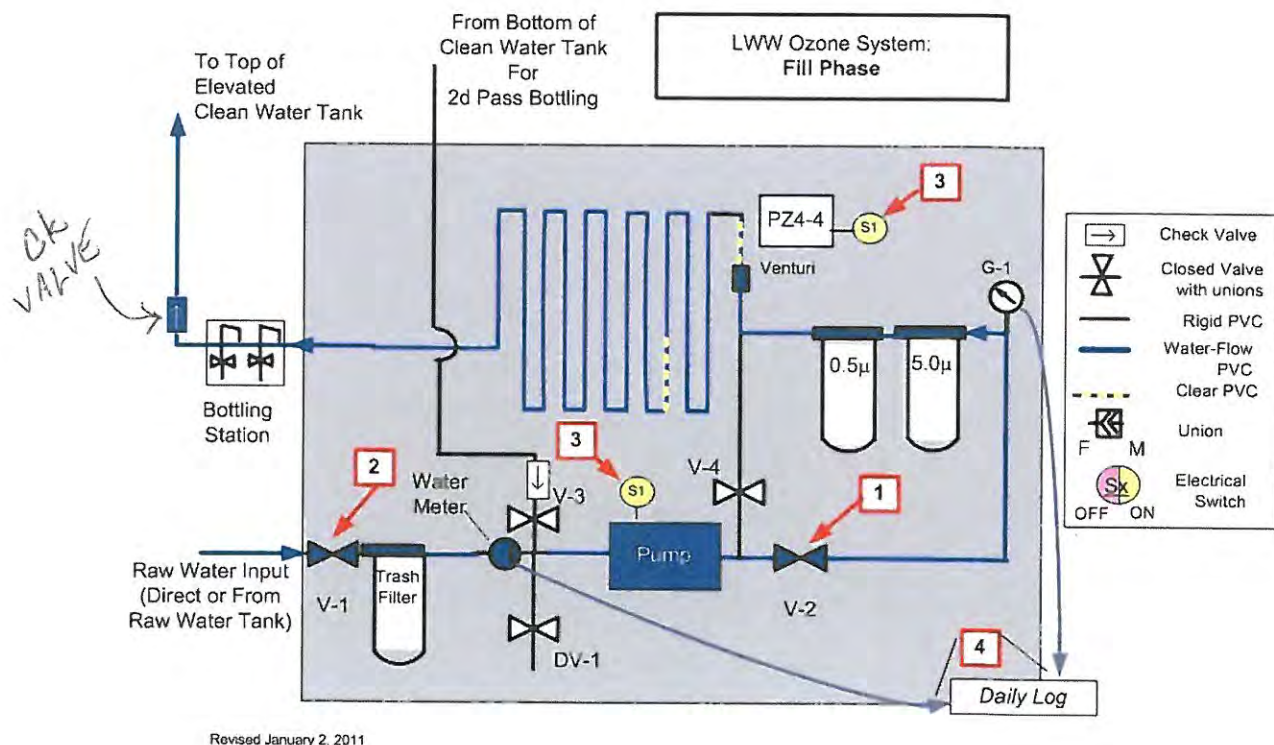
!!!NOTE!!! *These phases must be performed in the order noted. If they are not, there is the possibility that untreated water will enter the clean water tank.*

The steps in each phase are given below. The diagrams that follow the steps graphically illustrate the operation.

LWW recommends that laminated copies of the graphical instructions be used during system installation and training and be left with the OP system operators after the installation!

1 -- Start-up and Fill Phase

1. Open V-2
2. Open V-1
3. Turn on S-1
4. Record the water meter reading and G-1 pressure in the **Daily Operation Record**.

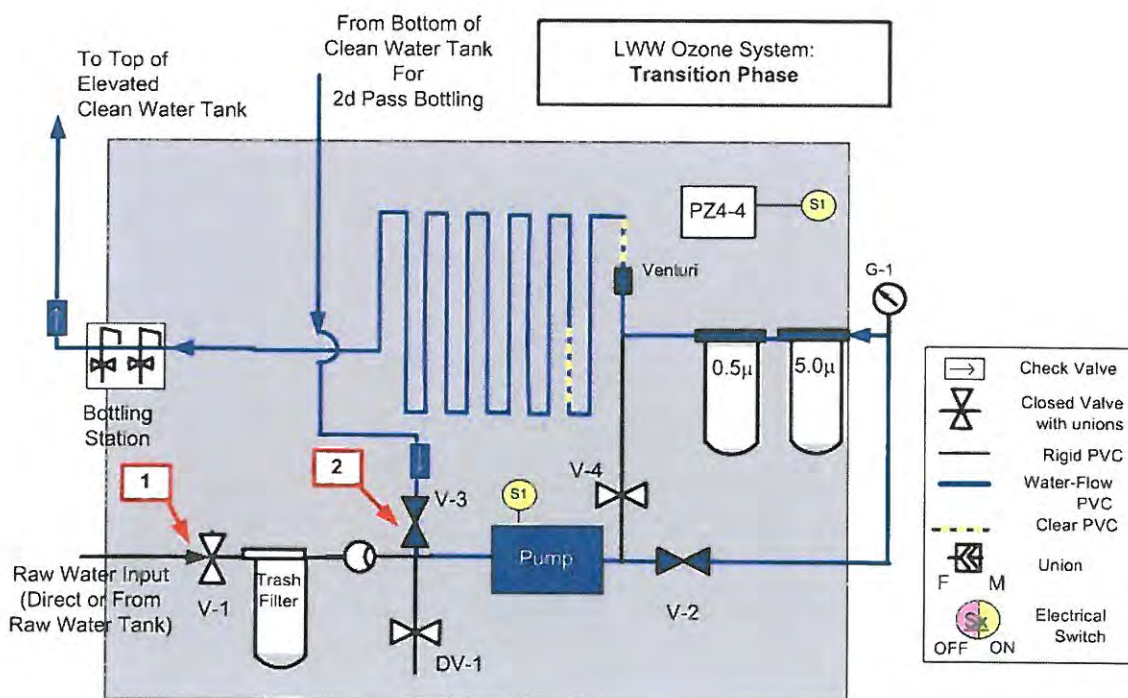


When the Clean Water Tank is full, then switch to the Transition Phase

2 --Transition Phase

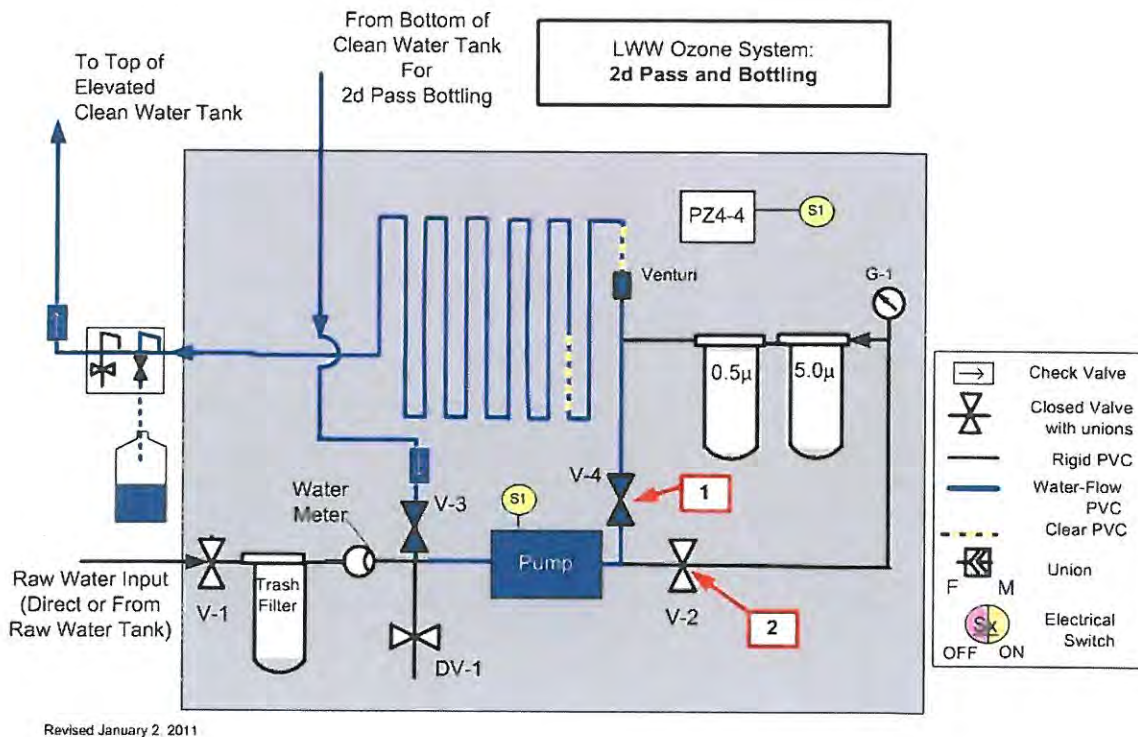
1. Close V-1.
2. Open V-3.

Run in this configuration for 2-3 minutes to disinfect the remaining untreated water in the Big Blue filters and lines.



3 -- Use Phase

1. Open V-4.
2. Close V-2.
3. Prepare the bottles with the wash-disinfect-rinse protocol (See Chapter 8.)
4. Fill the bottles, cap, and seal them with shrink-wrap sleeves.



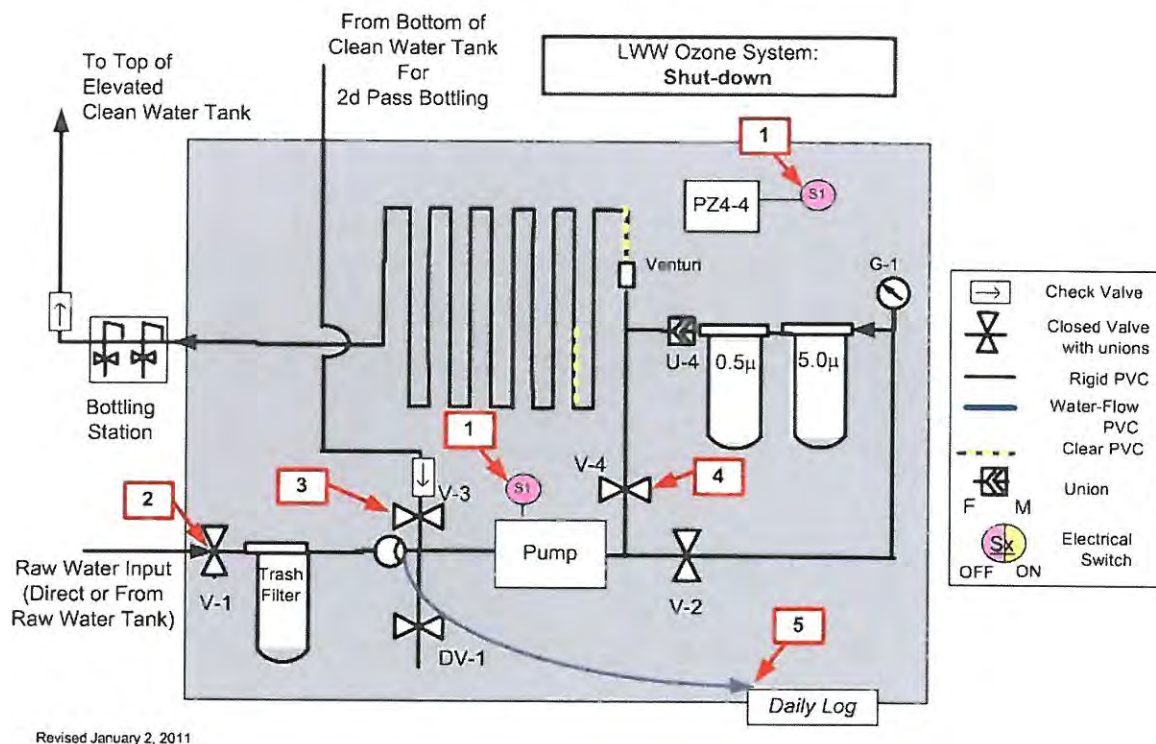
!!!NOTE!!! Putting clean water in a dirty container makes dirty water!!! Be sure to follow the steps in "The Use Phase for Bottling".

!!!NOTE!!! Water may now be bottled, or returned to the tank to be used for gravity-feed delivery. If water is to be used for gravity-feed delivery, continue the current operation for 30 minutes (for a 300 gallon tank) before using the water.

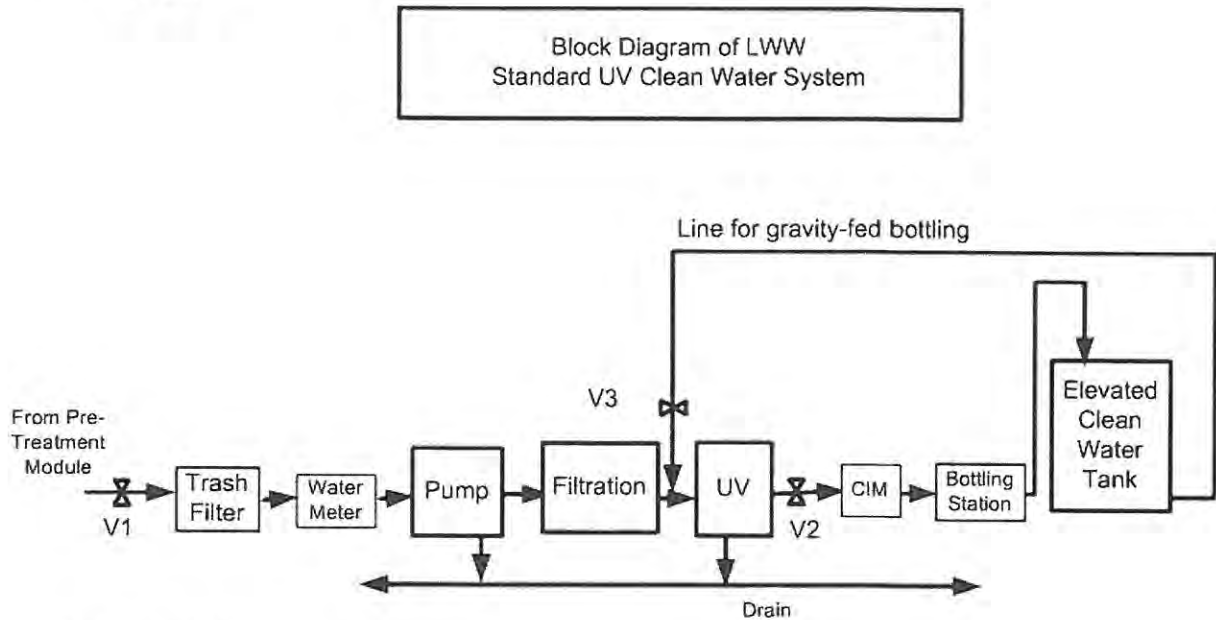
Continue Use Phase as long as bottles are being filled.

4--Shut-down Phase

1. Turn off S-1
2. Close V-1 - *set CLOSED @ TRANSITION ph.*
3. Close V-3
4. Close V-4
5. Record the final water meter reading in the Daily Log.
6. If water was bottled, open V-2, V-4, and V-5 to drain *DV-1*
7. When complete, close all valves.

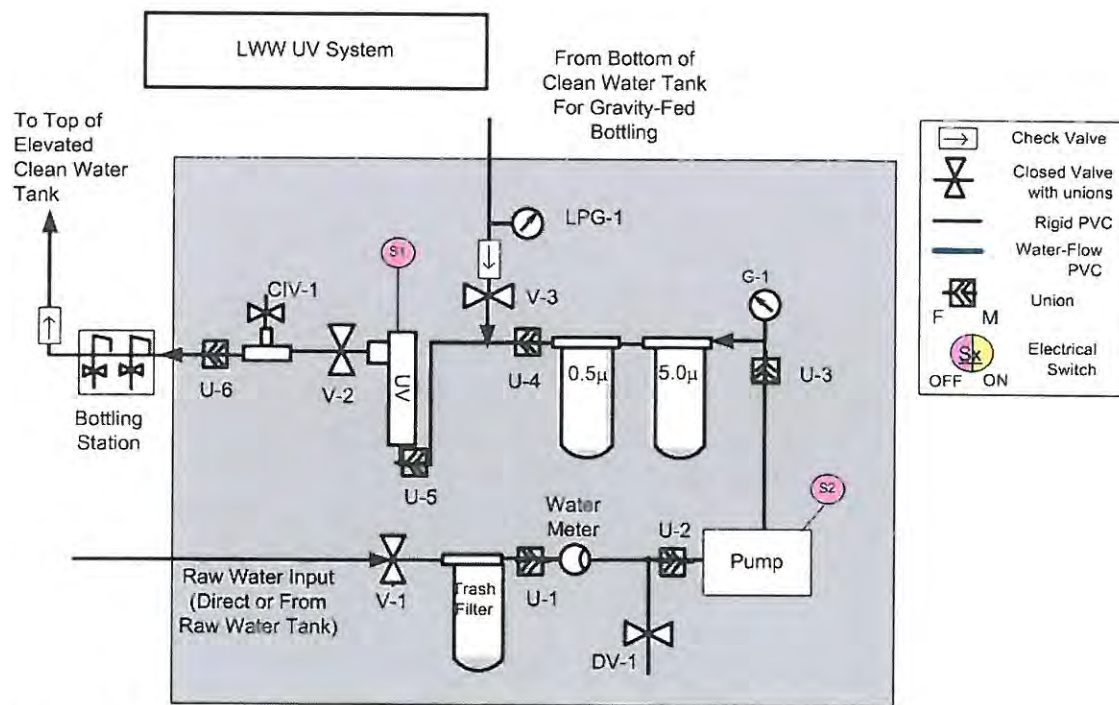


4.5 Systems with UV Disinfection and an Elevated Clean Water Tank



- Systems that use UV for disinfection have been approved as LWW water treatment systems since 2006
- UV disinfects water in a single pass, so
 - There is no need for a 2d pass, and the associated plumbing for the 2d pass is eliminated
- The standard UV system uses an elevated Clean Water Tank
 - Gravity flow through the UV light allows gravity fed bottling
 - Gravity fed bottling is particularly important when the power source is DC from solar, because power is saved by not running the pump
- Because UV does not provide residual disinfection, LWW recommends that chlorine be added to the clean water for residual disinfection
 - If the Chlorine Injection Module (CIM) is used, the water must be processed as a batch operation in which 300 gallons of clean water is put into the clean water tank with the chlorine from the CIM
 - The chlorinated clean water is then bottled using gravity
 - If drops of bleach are added to the bottles during bottling, water may be bottled continuously.
 - Water that is not bottled goes to the Clean Water Tank
 - And can then be bottled using gravity feed, with drops of bleach added to the bottles
- If the OP community will not accept chlorine, then use an Ozone system
- Technical information about UV Disinfection can be found in the Technical Addendum – Section 9.1

- UV disinfection allows water treatment systems without any tanks or with only a Raw Water Tank. For information about these systems, see Section 9.3
- The UV lamp must be warmed up before beginning to process water,
 - The warm-up time normally takes up to two minutes.
 - When the green lights stop blinking, it is warmed up.
- The drawing below shows the state of a Standard UV board with an Elevated Clean Water Tank before start-up each day and after shut-down each day. (All valves closed and all switches off.)
- Union placements are suggestions for modular construction and maintenance of the system.



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4.5.1 Building the Standard UV System

Raw Water Entry Assembly

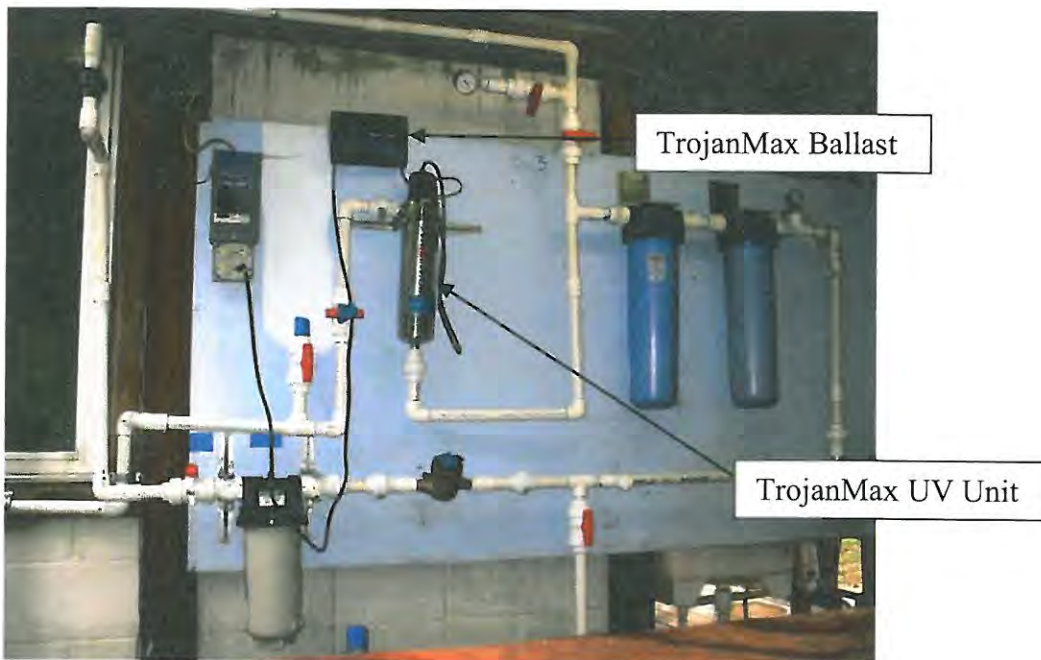
The Raw Water Entry Assembly for the UV System with a Clean Water Tank is the same as the Ozone System. See Section 4.2.3 for details.

Filtration Assembly

The Filtration Assembly for the UV System with a Clean Water Tank is the same as the Ozone System. See Section 4.2.4 for details.

UV Disinfection Assembly

- All UV equipment must be installed per manufacturer's specifications. Consult the TrojanUVMax Owner's Manual for specifics on their unit.
- When building the system, set the output of the UV unit at the same level as the top of the Big Blue filters so that:
- Water will stay in the UV compartment at shut down
- Operators have easy access to change the UV lamp and clean the protective quartz-glass sleeve
- The power source for the TrojanUVMax unit must be within 10 ft of the UV unit.



Bay 3 at CWU is a UV system

Electrical Components and UV Disinfection Assembly

- A single 20 amp circuit breaker feeds two switched outlets.
 - The UV ballast is supplied by one outlet, with the switch denoted S1
 - The other outlet supplies the pump, with the switch denoted S2
- See Chapter 7 for electrical wiring details.

Batch Operation versus Continuous Operation

UV Standard Systems can be operated in batch mode or continuously. Because LWW recommends adding chlorine to UV processed water to increase residual disinfection, each mode must be handled differently. The chart below outlines these differences in disinfecting the processed water.

Batch Operation	Continuous Operation
Chlorine bleach or other chlorine-containing liquid is put in the CIM during the Start-up and Fill Phase .	No chlorine bleach is put in the CIM during the Start-up and Fill Phase . Water is bottled the first time it passes through the bottling station.
All 300 gallons is processed through the filters, disinfected by the UV light, and stored in the Clean Water Tank.	Drops of bleach are added to the bottles for residual disinfection. Any water not bottled goes to the clean water tank.
After processing 300 gals, the operators place the system in the Transition Phase .	After the total number of gallons have passed through the UV, the operators place the system in the Transition Phase .
After the Transition Phase, water is bottled during the Bottling Phase using gravity-fed water.	The remaining water is bottled during the Bottling Phase using gravity-fed water. Drops of bleach are added to the bottles filled during the Bottling Phase .
Water cannot be bottled during the Start-up and Fill Phase because the chlorine concentration would be very high at the beginning of the operation and no chlorine would be in the water late in the operation.	

4.5.2 UV System Start-up, Operation, and Shutdown

1 - Check for Leaks

!!!NOTE!!! *Do not place either of the Big Blue cartridges in their canisters.*

- First, unplug the UV disinfection so that it does not operate during this procedure.

1. Remove the cartridges from the Big Blue Filters
2. Install the cases of the Big Blue Filters (without the cartridges), making sure that the O rings make a good seal to maintain pressure
3. Open V-1 and V2
4. Allow the system to fill as much as possible by gravity
5. Turn ON S2 (pump)
6. Press the pressure relief buttons at the top of the Big Blues to bleed air out of the system
7. Note the locations where leaks occur
8. Note the pressure reading on G-1
9. Slowly close V2 until the pressure reading has increased by 10 psi
10. Note locations where leaks occur when pressure is increased
11. Turn OFF S2 (pump)
12. Close V1 and leave V2 Open to keep water in the UV unit.
13. Open the drain valves and drain the system (water should remain in the UV compartment and the Big Blue canisters)
14. Repair leaks as necessary
15. Go back to Step 3, above. Repeat as many times as necessary until all leaks have been fixed.

2 - System Shocking

Before the initial start-up and at other times for preventative maintenance, it will be necessary to super-chlorinate or "shock" the tank, all hardware, and all plumbing to ensure the system is sanitized prior to use.

!!!NOTE!!! *DO NOT INSTALL either of the Big Blue filter cartridges until after this procedure has been completed. Chlorine will degrade the activated carbon in the Big Blue filters.*

Verify that the Trash filter cartridge is installed.

Step 1 - Washing the Water Tank

- Wash the Water Tank whenever the Water Tank gets contaminated with dirt, mud, or other material that washes best with mild soap and water.
 - This same procedure can be used for either the Clean Water Tank or the Raw Water Tank.
1. Prepare 5 gallons of a mild soap and water solution
 2. Disconnect the tank at its unions and turn the tank on its side
 3. Wash out the inside of the tank and lid with the soap solution using a sponge or mop.
 4. Rinse the tank with water to get rid of soap residue.

Step 2 - Disinfecting the Water Tank

- Disinfect the Water Tank at the initial startup and whenever the Water Tank gets contaminated.
 - This same procedure can be used for either the Clean Water Tank or the Raw Water Tank.
1. Add enough 10% bleach powder or liquid bleach (1/4 cup) to 2 gallons of water in the sprayer to make a 500 ppm – 800 ppm chlorine solution.
 2. Spray the inside of the tank and lid.
 3. Leave the bleach solution inside the tank and move the tank to its elevated position. This chlorine solution will be used to shock the rest of the system.
 4. Reconnect the tank at its unions. Be careful not to spill or get any bleach solution on you.

Step 3 - System Shocking

1. Record the reading on the water meter.
2. Remove the canister that holds the 5.0 micron filter. Empty the water from the canister.
3. Pour 1 cup of liquid bleach into the canister and replace the canister.
4. Turn ON S1 (UV unit)
5. Wait until the green light on the UV unit shines steadily without blinking. All Standard Clean Water Systems with the UV are shocked with the UV unit – ON.
6. Open V-1 and V-2
7. Press the pressure relief valve on the 5 micron and 0.5 micron filter heads until water runs out
8. Turn ON S2 (pump)
9. Run the pump until water begins to enter the Clean Water Tank.
10. Turn OFF S2 (pump).
11. Close V-1.
12. Open V-3 and the faucets at the bottling station.
13. Allow the chlorinated water to run into a bucket for about 10 seconds.
14. Close the faucets at the Bottling Station.
15. Close V-2 and V-3.
16. Turn OFF S1 (UV)
17. Let this super-chlorinated water sit in the tank and lines for 30 minutes.

Step 4 - Transition from Shocking to making the system ready to make Clean Water

1. Open V-2
2. Open V-3 and open the faucets at the Bottling Station.
3. Allow all of the chlorinated water to drain from the Clean Water Tank. Save this water for bottle rinsing. ***Note that chlorinated water remains in the UV compartment, in the Big Blue canisters, and in the pump.***
4. Close V-3 and the faucets at the Bottling Station.
5. Remove the Big Blue Canisters. Observe safety precautions about contact with chlorinated water
6. Open DV-1 and allow all the water in the system to drain.
7. Close DV-1 after the system has been drained.
8. Install the cartridges into the Big Blue canisters and install the Big Blue Filters. Do not forget to lubricate the O-rings and gaskets with KY Jelly.
9. Turn ON S1 (UV)
10. Wait until the green light on the UV lamp stops blinking and glows steadily.
11. Using a Sharpie pen, mark "0" at the current position of LPG-1. This will indicate when the Clean Water Tank is empty.

UV
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5 - Final System Flushing

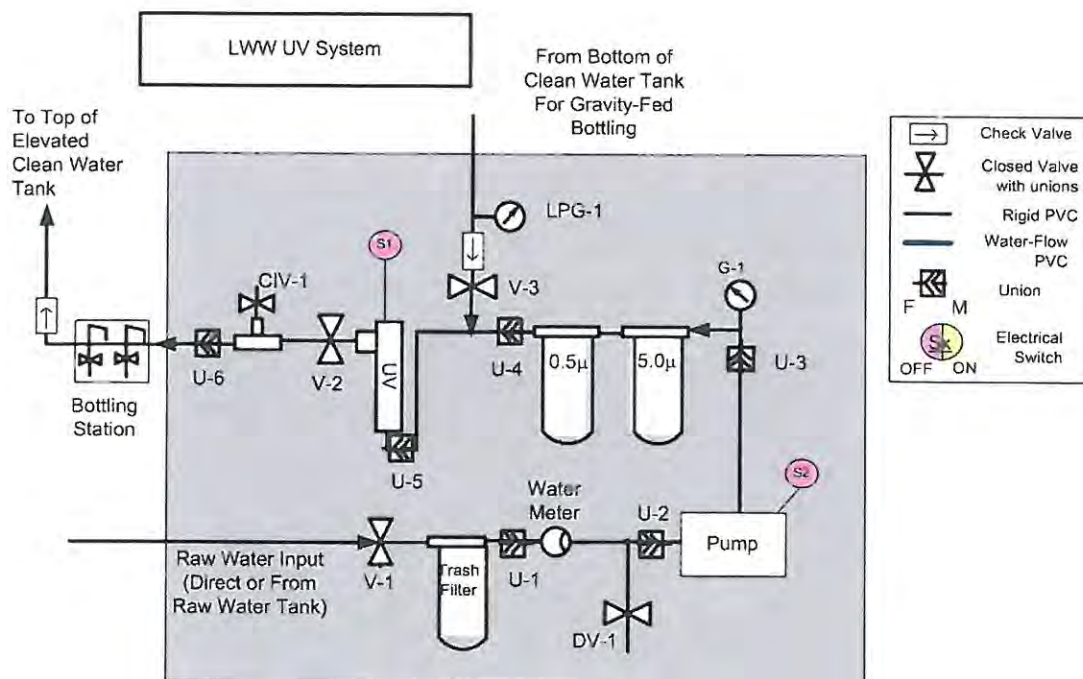
1. Open V-1 and allow water to fill the system.
2. Press the pressure relief valve on the 5 micron filter until water flows.
3. Open V-2.
4. Turn ON S2 (pump)
5. Wait until 25 gallons of clean water has entered the Clean Water Tank. Use the water meter to measure the amount of water pumped to the Clean Water Tank.
6. Turn OFF S2 (pump)
7. Close V-1. Using a Sharpie pen, mark "25" at the current position of LPG-1.
8. Open V-3.
9. Open the faucets at the Bottling Station.
10. Drain all the water from the Clean Water Tank.
11. Close V-2 and V-3.
12. Turn OFF S1 (UV)

The system should now be in the normal "Before Start-up and After Shut-down" mode.

All valves should be CLOSED, all switches are OFF, and there is clean water in the UV chamber.

4.5.3 Normal operation - UV

The schematic below shows the Standard UV System before Daily Start-up, all switches are OFF and all valves are closed.



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All operations of an LWW Clean Water System with UV disinfection that use gravity-fed water for bottling have three phases:

- **Start-up and Fill Phase:** water is filtered, micro-filtered, and disinfected with UV light
 - Because UV disinfects on a single pass, water may be bottled during the Start-up and Fill Phase if drops of bleach are added to the bottles
 - Any water not bottled will be stored in the Clean Water Tank and bottled using gravity feed
 - The UV System can be operated as a batch system using the Chlorine Injection Module (CIM) to provide residual disinfection in the Clean Water Tank
- **Transition Phase:** the pump is shut off and the system is prepared for gravity-fed bottling
- **Bottling Phase:** water is gravity-fed from the Clean Water tank and disinfected again by passing through the UV light chamber on the way to the bottling station

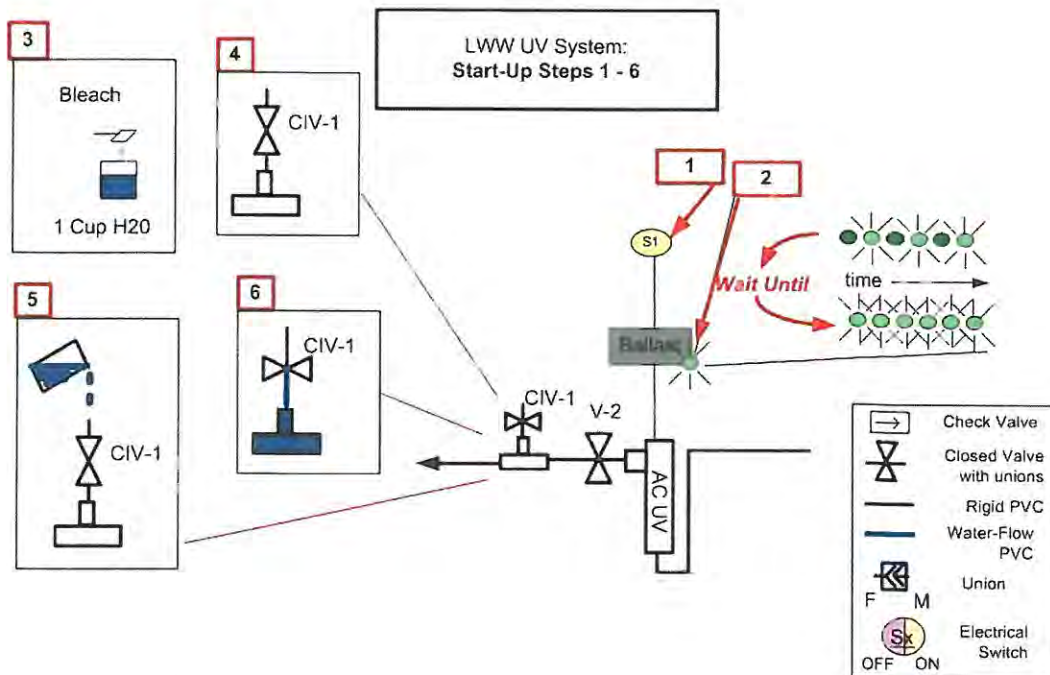
The steps in each phase are given below. The diagrams that follow the steps graphically illustrate the operation.

LWW recommends that laminated copies of the graphical instructions be used during system installation and training and be left with the OP system operators after the installation!

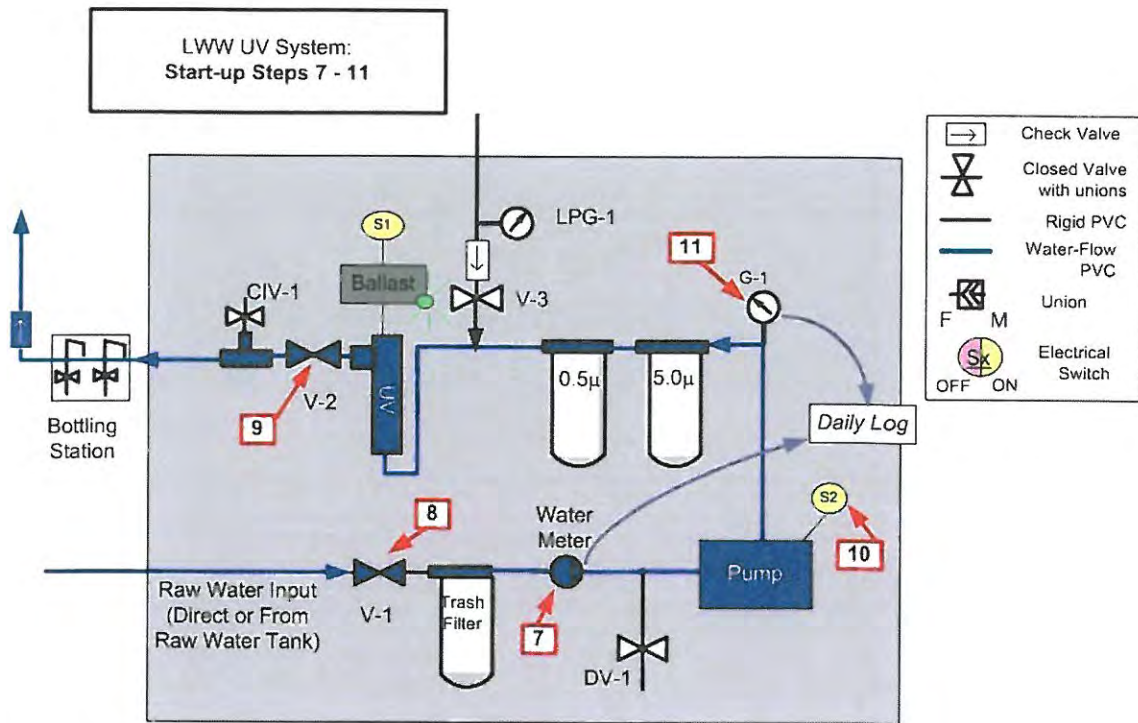
1 -- Start-up and Fill Phase

1. Turn ON S1(UV)
2. Wait for the green light on the UV unit to stop flashing.
3. Add enough bleach to 1 cup H₂O to give 1 ppm in 300 gallons. This level of chlorine will provide residual disinfection in the Clean Water Tank for 12-24 hrs. (Batch Operation only)
4. Open Chlorine Injection Valve CIV-1. (Batch Operation only)
5. Pour the bleach solution from step 3 into CIV-1. (Batch Operation only)
6. Close CIV-1 (Batch Operation only)
7. Record the water meter reading in the *Daily Log*
8. Open V1
9. Open V2
10. Turn ON S2 (pump)
11. Wait 2 minutes, and then record the pressure on G-1 in the *Daily Log*.

- The drawings that follow graphically illustrate the steps given above.
- ***LWW recommends that the installation team leave laminated copies of the “text-less” instructions with the OP system operators***



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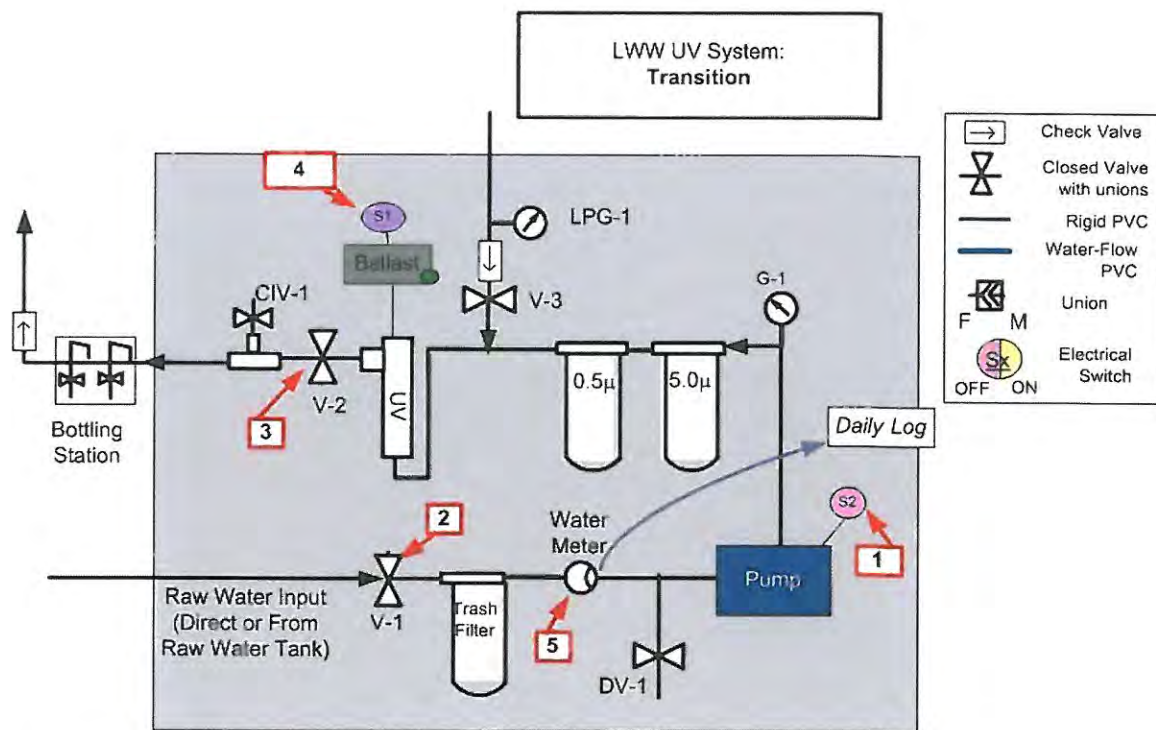
Step 2 – UV System Transition Phase

To make the transition to gravity-fed bottling, put the system in the UV Transition Phase.

When the Clean Water Tank is full, shut down the system following these steps:

1. Turn off the pump - S2.
2. Close V1
3. Close V2
4. Turn OFF S1 (UV)
5. Record the water meter reading in the *Daily Log*.

The following diagram covers the Shutdown Steps graphically.

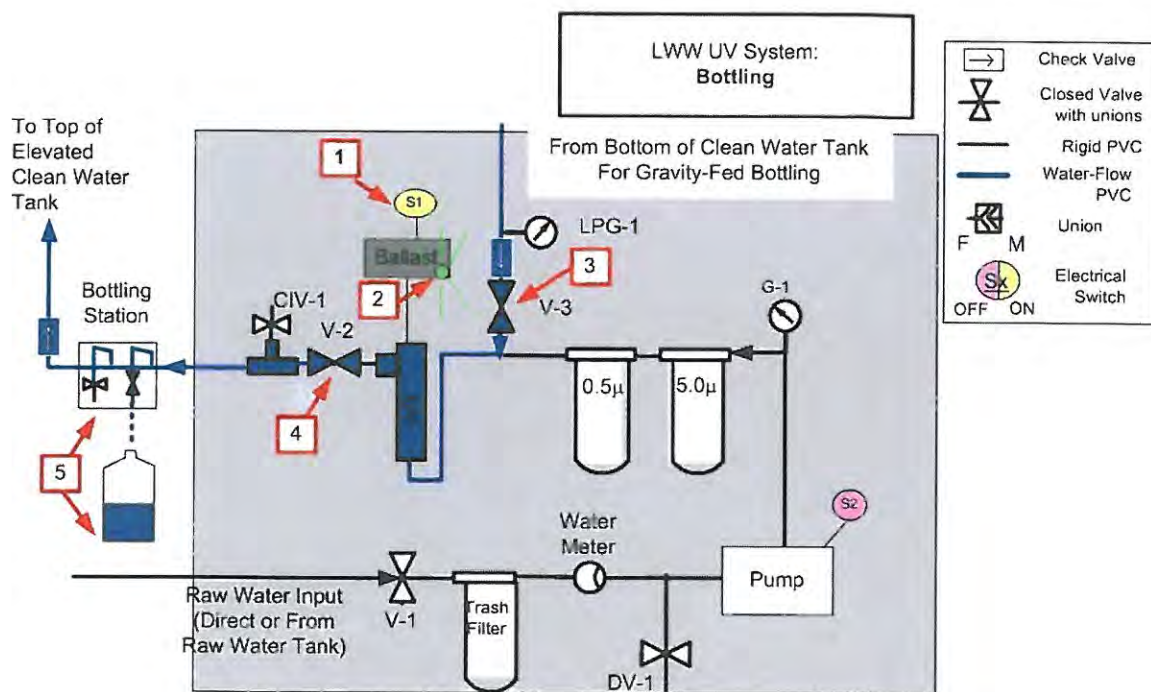


Step 3 -- Clean Water System Bottling

The processed water in the Clean Water Tank can now be bottled by gravity-feed.

1. Turn ON S1 (UV)
2. Wait for the green light on the UV unit to stop flashing.
3. Open V-3.
4. Open V-2.
5. Prepare the bottles with the wash-disinfect-rinse protocol (See Chapter 8.)
6. Fill the bottles, cap, and seal them with shrink-wrap sleeves. (For Continuous Operation, add drops of bleach to the bottles.)
7. Close V-2
8. Close V-3
9. Turn OFF S1 (UV)

The following diagram covers the Bottling Steps graphically.



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4.6 Procedure for treated, long-stored water

!!!NOTES!!!

- Repeat this procedure every day the water remains used in an Ozone System. If water remains in the tank longer than 24 hours, then prior to distribution, operate the system in the Use Phase at a rate of 10 minutes per 100 gallons to ensure the continued disinfection of the water.
- After treating water for 6 days without use, the shocking procedure outlined in Section 4.4.2 must be followed to ensure disinfection of the tank and lines.

When in doubt, disinfect!

4.6.1 Ozone System

After water has been stored for more than 24 hours, the full procedure of *Normal Operation-Ozone* is repeated with the exception that no raw water is added to the system! Instead the water stored in the tank is treated again. This is explained in the steps below.

Procedure to treat long-stored water

- Close all valves
- Open V-3 and V-4, and turn on S1 (pump and ozonator)
- Run in this configuration for 10 minutes per 100 gallons of water remaining (30 minutes for 300 gallons)
 - Do not bottle until the system has run for the required time
- Record information on the Daily Operations Record
- After appropriate length of recirculation, begin the bottling operation

!!NOTE!! Putting clean water in a dirty container makes dirty water!!!

Be sure to follow the steps in The Use Phase for Bottling.

Continue Use Phase as long as bottles are being filled, then follow the shut-down instructions.

4--Shut-down Phase for Ozone System

1. Turn OFF S1 (pump and ozonator)
2. Close all valves.
3. Record the final water meter reading.

4.6.2 UV System with Batch Operation

- The UV system does not have a return path to the pump, so water cannot be recirculated
- For UV, test the chlorine levels in the Clean Water Tank and add chlorine as necessary to keep 0.2 ppm - 2 ppm of chlorine in the water
- Test and replenish chlorine in the Clean Water Tank daily until the water is used
- If water has not been used for 6 days, then use the water for gray water and shock the system

4.6.3 UV System with Continuous Operation

If significant water remains in the Clean Water Tank after bottling, either

- Bottle the water immediately, adding drops of chlorine bleach to the bottles, or
- Add chlorine bleach to the water in the Clean Water Tank to bring the level to between 0.2 ppm and 2.0 ppm
- Add bleach daily, as necessary, until the water is bottled
- This water may be bottled with gravity-feed as in the Batch Operation
- Do not add additional drops of bleach at bottling
- If the water has been in the Clean Water Tank for 6 days, use the water for gray water purposes and shock the system

4.7 Other Water Use and Transfer

Gravity-fed:

If the system has been built with an elevated tank (both Ozone and UV systems), this allows the clean water to be used in a variety of ways:

- in a kitchen
- in a bathroom for oral hygiene
- in water fountains
- to be transferred to another distant location

Pressure-fed:

This is allowed by the operation of the Use Phase of an Ozone system and the clean water is transferred:

- to water fountains
- to another distant location

4.8 General System Maintenance

The Standard System is designed to be used regularly. Many systems operate 5 days on and 2 days off.

4.8.1 Pump Maintenance

- The pump normally supplies reliable service for many years.
- The most common problems with the pump include:
 - cavitation (pump sounds as if it is pumping gravel),
 - shutdown because of overheating,
 - and plugging of the impeller.
- If the pump is cavitating, there is probably air in the system that will have to work its way out.
 - Use the red pressure relief buttons on the filters to purge air out of the system.
 - If the cavitation persists, check to see if the system line is plugged.
- If the pump is shutting down on high heat overload,
 - Check the line voltage to the pump. Inconsistent voltage supply could cause the pump to overheat.
 - Make sure the pump is well ventilated and if necessary, use an auxiliary fan to cool the motor.
- If pump output is lacking, check the impeller for restrictions or plugging by removing the head.

If, however, a pump stops working and these initial trouble-shooting steps do not solve the problem, replace the pump with a new unit.

4.8.2 Sediment Filter Maintenance

1. The sediment filter cartridge is 50 microns and contains a washable filter medium made of Mylar plastic that is reusable for many times.
2. At least once per month, the sediment filter must be washed out thoroughly, paying close attention to the interior folds of the medium. Check the filter condition weekly.
3. Then soak the cartridge soaked in a chlorinated solution for 20-30 minutes.
4. Use 1/4th cup of 6% Clorox in 5 gallons of water

4.8.3 Big Blue Maintenance

- All filter canisters and heads are permanent.
- The "O" rings are critical for the successful operation of the 5.0 and 0.5 micron filters
- Be sure to use a water-based lubricant when installing or re-installing the canisters
- Canisters should be HAND-TIGHTENED only – never with a wrench.
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4.8.4 When to change the Big Blue Filters

- The filter cartridges are nominally rated for 100,000 gallons of water.
- The 0.5 micron filter is impregnated with activated carbon that will remove chlorine and some organic impurities from the water.
- The Big Blue filters cannot be cleaned when they are plugged, they must be replaced.
- As the filters trap bacteria and other materials, the resistance to the water flow increases.
- This resistance will show itself in rising pressure on the gauge before the filters.

When to change the Big Blue filter cartridges:

- Change both the 5.0 micron filter and the 0.5 micron filter whenever:
 - they have processed 100,000 gallons of water, or
- If the pressure gauge G-1 reads 10 psi or higher than its reading at initial installation, then:
 - Change the 5.0 micron filter
 - If the pressure reading does not return to near its original reading, then change the 0.5 micron filter
- Note that both criteria are much easier to apply if the readings have been recorded.
- At start-up and after filter cartridges are changed, using a permanent marker:
 - place duct tape on each canister head and record the date and water meter reading.
 - place duct tape below each gauge and record date and pressure reading.
- Be careful not to damage the O-rings or dislodge washers while changing the filter cartridges. After installing new cartridges, use K-Y jelly or other water-based lubricant (silicone) to protect the rings and washers.

4.9 Forms for Operators:

1 - Daily Operations Record

Unit -

Site -

Date/Operator Initials	Beginning Water Meter Reading	UV or Ozonator Operation	Pressure Gauge #1 Reading (psi)	Pathoscreen Testing (Weekly) (Monthly)	Sediment Filter Washing (Monthly)

2 - Daily Ozonator Operating Checklist

DATE		Revised: August 2007
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1. Verify that inlet air and other vents not blocked.
2. Verify Blue-Green glow at the ends of Ozonator lamp cartridges.
3. Verify presence of Ozone - Odor in water tank or using Ozone test strips.
4. Check for suction at the venturi inlet with water flowing.
5. Verify air flow through the system by checking suction at the inlet air filter after the system is up and running.

OK	Not OK

If No Flow through system, check:

1. Check for water in tubing, tubing breaks, or tubing crimped.
2. Verify check valve operation - blow through valve both ways.
3. Verify Blue-Green glow at ends of Ozonator lamp cartridges
4. Disconnect tubing from lamp cartridges, verify flow in each direction.
5. Blow through other tubing to verify flow.
6. Check for suction at the venturi inlet with water flowing.

OK	Not OK

Monthly Ozonator Operating Checklist

DATE	
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1. Perform Daily Operating Checklist.
2. Remove the cover from the Ozonator.
3. Verify there is no liquid in tubing.
4. Inspect and feel all tubing for crimps, blisters, bubbles, etc.
5. Check for loose clamps and brittle plastic fittings.
6. Check ballasts for evidence of overheating.
7. Replace any tubing that shows signs of bubbles, blistering, or thinness.
8. Check for loose electrical wires or connections including Ground Wire.
10. Inspect the check valve for proper operation.
11. Replace the cover on the Ozonator.

OK	Not OK

