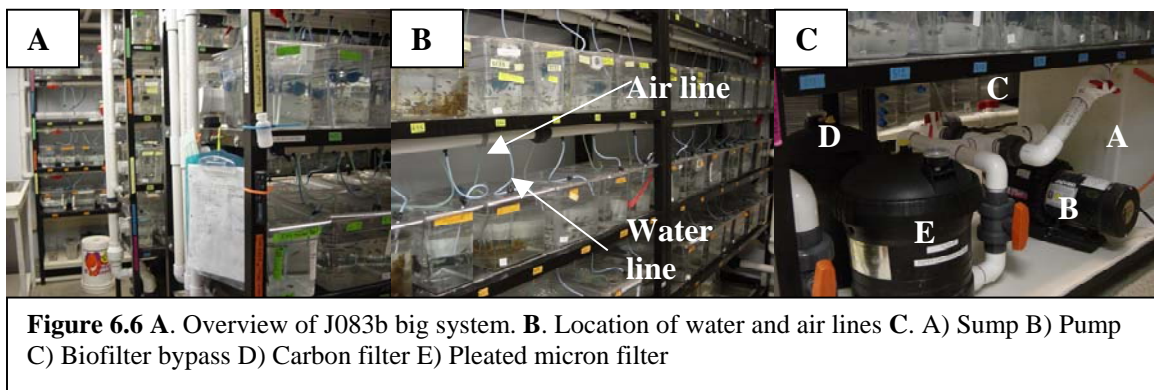




6.5 J Big System

General

This 825 gallon (3200 liters) multi-rack system occupies west half of J083b laboratory. It supports a mix of 200-250 6.0 and 9.0 liter tanks. The two different tank sizes are interchangeable on the shelf. Each tank has individual water valves (on water line) and air valves (on manifold). Water lines are blue air lines are green. Tanks are polycarbonate modified Cambro food containers. The system receives a daily-automated 2% water exchange from the system water tower via a metering pump, timer and solenoid valve system.



Water is pumped out of the sump to either a Jacuzzi pleated micron filter or a Jacuzzi carbon filter or is bypassed at 12 gpm to the biofilter and degassing tower. The water from the Jacuzzi filters moves to the top of the rack where it is sterilized by a 150 watt UV filter before being delivered to the tanks. Water enters the tanks by a water line then drains out a bulkhead screen at the back of the tank in to a gutter and finally passes through pipe sump filters that are wrapped in 1/8" screening before returning back to the sump. Water bypassed to the biofilter and degassing tower are returned directly to the sump.

Maintenance

Daily

Water Flow

Tanks are inspected daily to insure that there is adequate water flow. There should be a steady stream of water entering each tank. Water flow can be adjusted via the water line valve. Individual tanks might experience low-flows even if the water line valve is completely open. In this case it is likely that debris is blocking the water outlet. In this case carefully pull the blue water line from the barbed connector on the manifold. Straighten a paper clip, and gently push in to the barbed fitting repeat this process until the water runs freely. Caution water will come out under some pressure once the jam is freed. Quickly slide the water line back up the barbed fitting until the line reaches the top of the last barb.



David White

Bulkhead Screens

Bulkhead screens (tank drains) are inspected daily to insure that there is adequate drainage. If the water level in tank is above the top of the bulkhead screen the screen itself or just simply the tank needs to be cleaned. This often occurs when nylon screening is used on the bulkhead to prevent smaller fish from escaping. Debris can quickly clog this screening. If the fish are now large enough to not escape through the bulkhead itself simply pull off the screening. If this is not the case obtain a clean bulkhead fitting of correct size and wrap screening around it and fasten it in to place with plastic bands (do not use latex rubber bands), tank supplies can be found on the bottom shelf of the fish rack, turn off the water supply, lift the front of the tank to drain the water below the bulkhead fitting and pull out the clogged bulkhead screen. Place the clean bulkhead screen in to the bulkhead fitting.

Sumps

Also on a daily basis if need be top off the sump with system water. The sump is marked indicating where the water level needs to be.

Biofilter

The biofilter needs to be back-flushed on a daily basis to remove dead bacteria. To do this shut off the biofilter bypass valve (labeled) next to the system pump (see **Figure 6.6 C**). Then open the biofilter drain (**Figure 6.7 B**) then place and hold your finger in the air purge plug (**Figure 6.7 C** push open the flap just inside the pipe) this allows the water to drain out of the biofilter. Water will start draining in to the floor drain in front of you. Continue this process until the water stops flowing in to the floor drain. Remove your finger from the air purge plug, close the drain valve and open the bypass valve. The biofilter will refill with water.



Figure 6.7 A) Biofilter B) Biofilter drain valve C) Air purge plug D) Degassing tower

Weekly

Flushing Manifolds. Manifolds need to be flushed on a weekly basis to keep them free of debris. To do this locate the valves at the end of each shelf's horizontal water manifold (the one the water lines are attached to) below them is a master manifold drain valve (MMDV). Each MMDV is label indicating which water manifolds it's connected to. Open the MMDV for the manifolds to be flushed then open the valve at the end of the manifold to be flushed. Leave the manifold open for 5 seconds and then close, and repeat. This helps jar free debris in the manifold. Keep an eye on the water level in the sump for this takes water directly out of the system. Refill the sump with system water as needed. Repeat this process for all 20 water manifolds. Write, "flushed manifolds" on the water quality sheet under comments.

Sump Socks and Pipe Filters. Weekly the sump sock located on the center fish rack needs to be replaced. The sock hangs under this rack effluent drain. Remove the dirty socks and



replace them with cleans from the shelf above the sink. Disinfect dirty sock see disinfecting filters. There are four pipe filters located in the sump wall (14" pipe wrapped in black nylon screen) pull them out and thoroughly rinse them down with RO water and reinstall them in to the sump wall.

Lids and Shelves. Once a week the lids should be wiped down with isopropyl alcohol. Spray isopropyl on to a paper towel and clean the fish tank lids. Be careful not to push any of the debris on the lid in to the tank. Fish rack shelves can also be cleaned with isopropyl and a paper towel.

Micron, Carbon, Coral Filtration Maintenance

Weekly the pleated micron filter needs to be replaced with a clean one, carbon needs to be replaced, and coral media bags need to be washed down. Maintenance on this system is performed with the system running.

- 1) Start with either Jacuzzi canister, but do not perform maintenance on both canisters simultaneously. Record canister pressure from the gauge on the lid before and after maintenance.
- 2) Close the inflow valve then close the outflow valve (**Figure 6.8 B and C**).
- 3) Attach a hose to the spigot in front of the canister and run the other end of the hose to a floor drain. Open the spigot then open the yellow air purge valve on top of the lid. This will drain the water out of the canister. Allow it to drain for 30 seconds before proceeding to step 4.
- 4) On the ring-lock (**Figure 6.8 D**) there is a yellow tab (Sure-Lock) push it downward, turn the ring-lock counterclockwise, and remove it by pulling it over the lid.
- 5) Grab the lid (**Figure 6.8 E**) by the two small handles on the top. Gently rock the lid back and forth as you pull it upward. Set the lid and the ring-lock a side.
- 6) For maintenance of the micron pleated filter pull out the filter and the filter insert, for carbon and coral maintenance pull out the black media chamber and take them to the sink.
- 7) Micron filter, pull the pleated filter off the filter insert, rinse off the filter insert with RO water and install a clean pleated filter on to the insert. Disinfect the old pleated filter see disinfecting filters below. For the carbon and coral media chamber open the lid and remove the bag of coral and dump the old carbon in to the garbage can. Rinse out the matrix chamber and pour fresh carbon to within two inches of the top of the chamber. Rinse the carbon off with RO water until the black carbon dust particles cease flowing out of the chamber. Rinse down coral bag and place it back on top of the carbon. Place the lid back on the media chamber.

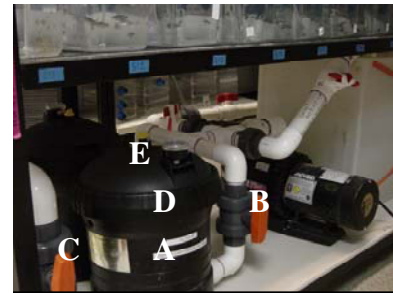


Figure 6.8 A) Jacuzzi filter canister B) Inflow valve C) Outflow valve D) Ring-lock E) Canister lid with pressure gauge and air purge valve



- 8) Reinstall the filters back in to the filter housing.
- 9) Remove the o-ring located just above the threads on the canisters housing using a paper clip to pry it out of the o-ring groove. Wipe it down with a paper towel and relubricate it with Teflon lubricate. Wipe down the threads and o-ring groove with a paper towel and reinstall the o-ring.
- 10) Clean the canister lid and ring-lock with a paper towel and isopropyl. Place the lid back over the canister housing and with even force push it down over the o-ring. Place the ring-lock down over the lid and down on to the threads and turn it clockwise until you hear it click in to the Sure Lock (yellow tab). Gently turn the ring-lock back and forth you should not be able to remove it (locked).
- 11) Close the spigot at the bottom of the canister and remove the hose.
- 12) Open the inflow valve then the outflow valve.
- 13) Close the air purge valve as soon as water sprays out on to the lid.
- 14) Check the canister lid for leaks by running your hands around the edge of the lid.
- 15) Repeat these steps for the second canister. Record before and after pressure readings and all relevant maintenance information in to the system maintenance database on the H225.

Every Nine Months

Replace U.V. bulbs see directions at the end of this chapter.

Tank Use

Big system tanks are composed of the tank itself, lid, hard-plastic air elbows, bulkhead screens and drain elbows. All of these items can be found on the bottom shelves of the system. To set up a new tank place the bulkhead screen on the inside of the tank, place the bulkhead drain in the back of the tank with the spout pointing downward. Fill the tank $\frac{1}{4}$ of the way full with system water and place the fish in the tank. Place identifying labels on the tank, and the days date on a small piece of white tape on the bottom left corner of the tank face (front of tank). Place the lid on top of the tank. There are three holes in the lid a large feeding hole, a smaller hole for the water line and a air line hole. These holes should be facing the front of the tank opposite the bulkhead fittings. Place the tank on the shelf, inset the water line in to one of the smaller holes in the other small hole place a hard-plastic elbow and attach the green air line from the manifold to the plastic elbow. When cleaning/switching out tanks shut off the water supply to the tank via the water line valve and remove it and the airline assemblage. Tip the front of the tank upward to drain down the water in the tank and remove it from the shelf. Clean the shelf were the tank sat with a paper towel and isopropyl. Then follow the directions for installing a new tank.

Adjusting Water Quality

The following is also posted on a green tag hanging on the fish system rack.

To adjust pH: pH > 6.95, no adjustment needed

pH: 6.95 > pH > 6.75, add 200 ml 1 M sodium bicarbonate solution



pH: pH < 6.75, add 300 ml 1 M sodium bicarbonate solution

To adjust Conductivity: 1500 μ s, no adjustment needed

Conductivity > 1700 μ s, 100 gallon RO water exchange

Conductivity < 1300 μ s, add 150 ml super saturated salt solution to the sump.

The big system has an overflow drain. To perform a manual water exchange to bring down the conductivity slowly overfill the sump to the desired volume with RO water. The flow rate of the RO water will need to be known and the water exchange has to be timed.

Safety Features & Emergency Shutdown

The big system has a float-switch pump shutdown in the sump next to the overflow drain. During times of low water levels in the sump the pump will shut down to avoid drawing air in to the pump that could lead to gas-bubble disease in the fish. The switch will turn back on once water levels in the sump rise again. For this system to work the pump has to be plugged in to the float switch itself. The switch is adjusted by varying the tether length, the length of the cord between the float and wherever the cord is fastened at. Longer cords will allow larger changes in water levels without any disruptions to the power of the pump short cords will have a much narrower range. The tether length need to be set to shut off before the water level in the sump reaches the intake of pump. In case of emergency the system can be shutdown by the labeled switched in between racks 2 and 3 just above the floor drain.



David White

6.6 Nurseries

General

There are two main nurseries, one in H221 the other in J-083b. The H-lab nursery can hold 36 1.0-L tanks and the J-lab nursery 32. There is a running total of the number of tanks in use on the whiteboard in H225. Once your fish have reached 4 days its time to put them on the nursery. Even if the fish are still in their yolk sac it's important to adapt them to visual stimuli of motion provided by the nurseries live feed. Find an open nursery space in H or J-laboratories. Fill out the nursery production sheet on the clipboard in front of the nursery. It asks for the date to start feeding, family name (genetic id), the approximate number of fish, the number of tanks used, the researchers initials and a question that asks if there is more than one tank can the tanks be combined upon removal from the nursery system usually around day 20 post-fertilization. This question only applies if there are more than one tank being placed in the nursery at a time and is necessary due to space constraints to sometimes combine fish if possible as they move to juvenile rearing.



Figure 6.9 Close up of the nursery system in H221

Water is drawn from these systems by magnetic drive pumps and pushed through a Red Sea Ocean Clear biological filter with polystand pads for bacterial substrate. The water then enters an Ocean Clear 25-micron pleated cartridge filter that also houses bags of carbon and coral filter media. Water then passes through a 40-watt or 8-watt Lifeguard U.V before being delivered to the tanks. Water is not streamed in to the tanks like other fish systems but rather dripped in to the tanks to protect fragile offspring.

Maintenance

Daily

Water Supply. Water on both nurseries are shut off during the morning and turned back on later in the afternoon. This maximizes the exposure time between the fish and their feed. To turn off the water close the manifold valve at the base of each water manifold (H-nursery has 3, J-nursery has 5). To turn on the water open the water manifold valves and set the water to 1 drip/2 seconds using the small dial valves on each water line.

Screen plugs

The 150 μm screen plugs in the back of tank need to inspected daily to insure adequate water flow. If the plugs are visibly dirty or the water level has risen more than half way above the screen plug they need to be cleaned or replaced. To clean them use a small brush, to replace them tip the tank forward so that no water is in contact with the plug, pull it out and install a new one.



David White

Sumps

Also on a daily basis if need be top off the sump with system water. The sump is marked indicating where the water level needs to be.

Weekly

Transfer

Fish are inspected weekly for fish that have reached adequate size and age for transferal from the nursery to juvenile rearing. Most fish will remain on the nursery for 20 days or until their bellies are swollen orange with artemia and they have some of their adult pigmentation (stripes).

Weekly

Sump Socks/Dacron Pad

Weekly the felt sump sock in the J-nursery and the Dacron pad in the H-nursery sump need to be replaced. Remove the dirty sock or pad and replace them with clean ones from the shelf above the sink. Disinfect dirty ones see disinfecting filter below.

Monthly

Filtration

Follow the directions given in section 6.4 Zebrafish Modular monthly for Ocean Clear filtration maintenance (pleated micron, carbon, and coral).

Trays

The H221 nursery uses water bathes to keep tanks at 28° c. These trays need to be cleaned. To do this carefully remove all of the tanks from the top tray. Use a sponge to wipe down the inside of the tray and siphon out the debris in to a bucket. Refill the tray with system water and carefully place the nursery tanks back in to the tray. Repeat the procedure for the trays below. Work from top to bottom.

Quarterly

See Quarterly maintenance section 6.4 Zebrafish Modular biological filter.

Every Nine Months

Replace U.V. bulbs see directions at the end of this chapter.

Tank Use

Obtain a clean nursery tank, remember that one 1-liter tank can only hold 50 fish. Make sure a 150 um drain screen is installed in the back of the tank. The screen needs to be examined to make it is not damage, if it is damaged throw it away in the garbage and get a new one out of the nursery screen beaker located on the nursery shelf. Fill the tank ¼ full with system water. Take the lid off your petridish and lower it a slight angle down in to the tank. Slowly pour the contents of the dish in to the tank. Get a squirt bottle of system water and gentle rinse out the remaining contents out of the dish in to the tank.



Place the label from the petridish on to the tank and put a clean lid on the tank. Dispose of the petridish in the garbage. Place the tank into a space with a water line. Place the line through the hole in the center of the tank lid. If you're placing a tank on the nursery during the day do not try to turn the water on to the tank. The water is shutoff at the water manifold. If you're placing the tank on the system in the evening or night set the water line valve to 1 drop/2seconds. A special note on H221 nursery use, make sure when connecting, or moving tanks that you do not move any of the water lines out of the drip tray.

Adjusting Water Quality

The following is also posted on a green tag hanging on the individual fish system.

J-lab 30-gallon nursery.

To adjust pH: pH > 6.95, no adjustment needed

pH: 6.95 > pH > 6.75, add 15 ml 1 M sodium bicarbonate solution

pH: pH < 6.75, add 20 ml 1 M sodium bicarbonate solution

To adjust Conductivity: 1500 μ s, no adjustment needed

Conductivity > 1700 μ s, 5 gallon RO water exchange

Conductivity < 1300 μ s, add 10 ml super saturated salt solution to the sump.

H-lab 40-gallon nursery.

To adjust pH: pH > 6.95, no adjustment needed

pH: 6.95 > pH > 6.75, add 15 ml 1 M sodium bicarbonate solution

pH: pH < 6.75, add 20 ml 1 M sodium bicarbonate solution

To adjust Conductivity: 1500 μ s, no adjustment needed

Conductivity > 1700 μ s, 5 gallon RO water exchange

Conductivity < 1300 μ s, add 10 ml super saturated salt solution to the sump.

To perform a manual water exchange to bring down the conductivity attach a hose to the sump valved-spigot and run the other end of the hose to a floor drain. Open the spigot and drain the sump to the desired level and refill with RO water. Record this procedure on the water quality sheet under comments.

Safety Features & Emergency Shutdown

The power can be shutdown on either nursery system by the power strip underneath of the bottom shelf.



6.7 First Generation (F1) System

General

The F1 system is composed of 8 94-liter tanks with a total system volume of 825 liters (220 gallons). This is the only system with tanks larger than 9 liters and is useful for wild-type lines and screen fish. Water is drawn from this system by a magnetic drive pump and pushed through a Red Sea Ocean Clear biological filter with polystrand pads for bacterial substrate. The water then enters an Ocean Clear 25-micron pleated cartridge filter that also houses bags of carbon and coral filter media. Just before entering the tanks the water is sterilized by a 40-watt Lifeguard U.V. Water enters the tanks by 2 4-line manifolds and drains out the tank through a bulkhead fitting into an external stand-pipe that controls the water levels in the tanks. Water is aerated by diffusers in each tank; the air can be controlled by the air manifold located on the wall next to the system.

Maintenance

Daily

Water Flow

Tanks are inspected daily to ensure that there is adequate water flow. There should be a steady stream of water entering each tank. The individual tank valves on the manifold control inflowing water.

Air Flow

Each tank needs a steady stream of air bubbles from the diffuser. To manipulate the air supplies to the individual diffusers, adjust air manifold valves located on the adjacent wall.

Bulkhead Screens

Bulkhead screens (tank drains) are inspected daily to ensure that there is adequate drainage. The water level in the tank should not exceed the height of the external standpipe. If it does, the bulkhead screen needs to be replaced. To do this, obtain a clean bulkhead fitting of correct size; tank supplies can be found on the bottom shelf of the fish rack, with the clean screen in one hand, pull out the dirty screen and quickly slide in the new one. If the tank has fish that are small enough to pass through the bulkhead screen, wrap screening mesh around it and fasten it in place with plastic bands (do not use latex rubber bands).

Sumps

Also on a daily basis, if needed, top off the sump with system water. The sump is marked indicating where the water level needs to be.

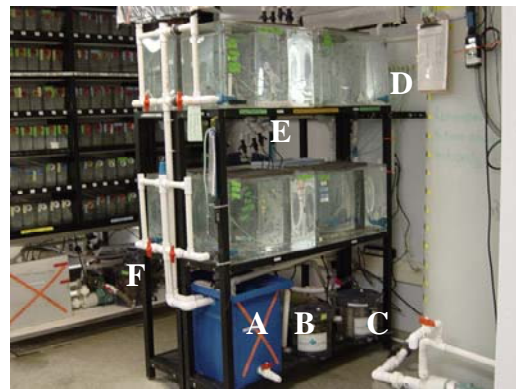


Figure 6.10 First Generation fish system. A. Sump with spigot-valve B. Biological filter C. Pleated Micron Filter D. Air Manifold E. Water manifold F. Drain stand-pipe valve



David White

Monthly

Filtration

Follow the directions given in section 6.4 Zebrafish Modular monthly for Ocean Clear filtration maintenance (micron, carbon, and coral).

Quarterly

See Quarterly maintenance section 6.4 Zebrafish Modular biological filter.

Every Nine Months

Replace U.V. bulbs see directions at the end of this chapter.

Tank Use

These tanks are disconnected and bleached-cleaned after every use. The following is only to be performed by zebrafish staff. To remove the tank, first shutoff the water supply at the water manifold and remove the water line from the tank. Next, open the drainage valve at the base of the standpipe (**Figure 6.10 F**). Allow the tank to drain. Remove the airline and diffuser. Unscrew the threaded nut on the bulkhead fitting inside the tank and pull the tank from the drainage pipe. Turn the drain-side of the tank inward, pull the opposite side outward and slip the tank off the shelf. Bleach clean tank see Chapter 7. Reinstall the tank, fill it with system water from the hose and install the water and airline with diffuser. To use the tank simply pour the fish in to the clean tank, install identifying labels on the tank face and place the lid on the top.

Adjusting Water Quality

The following is also posted on a green tag hanging on the individual fish system.

To adjust pH: pH > 6.95, no adjustment needed

pH: 6.95 > pH > 6.75, add 50 ml 1 M sodium bicarbonate solution

pH: pH < 6.75, add 100 ml 1 M sodium bicarbonate solution

To adjust Conductivity: 1500 μ s, no adjustment needed

Conductivity > 1700 μ s, 25 gallon RO water exchange

Conductivity < 1300 μ s, add 100 ml super saturated salt solution to the sump.

To perform a manual water exchange to bring down the conductivity attach a hose to the sump valved-spigot and run the other end of the hose to a floor drain. Open the spigot and drain the sump to the desired level and refill with RO water. Record this procedure on the water quality sheet under comments.

Safety Features & Emergency Shutdown

The F1 system can be shutdown by turning off the power strip attached to the leg of the fish system facing the adjoining wall.



6.8 Water Towers

System water is created in a 200-gallon water tower. One is located in each laboratory. The tower is filled with RO water. In H221 RO valve turning the water on and off is located to the right of the tower in J083b the valve is located on the left side slightly behind the tower. Next to the tower is a carboy of supersaturated salt solution 340 ppt. One hundred milliliters of this salt solution is added to every 10 gallons of RO water added to the tower. This creates water that has less than 1.0 ppm sea salt or as we normally measure it a conductivity of 1500 uS. The water



Figure 6.11 J083b laboratory system water tower.

in the tower is continually being mixed distribution/recirculating pump. This pump also delivers system water to sinks and hoses. When filling and salting the tower it is important to mix the super saturated salt solution with stir pipe prior to decanting it from the carboy, warn anyone in the lab who might be using the system water that your filling the tower, and check the conductivity before after the tower is filled. The towers should be check and refilled by the morning and afternoon fish feeder. Feeders are also responsible for recording water quality data on these systems and recording this information on the water quality sheet. System water is used for filling fish tanks, sumps, and spawning tanks. Basically **any container that holds fish should have system water in it (not RO)**. There are numerous spigots, faucets and hoses in the fish facilities and all of them are labeled as RO or System water.

Adjusting Water Quality

The following is also posted on a green tag hanging on the individual fish system.

To adjust pH: pH > 6.95, no adjustment needed

pH: 6.95 > pH > 6.75, add 10 ml 1 M sodium bicarbonate solution

pH: pH < 6.75, add 20 ml 1 M sodium bicarbonate solution

6.9 Disinfecting Filters

- 1) Place the dirty filter(s) in the sink, and wash it off thoroughly with RO water.
- 2) Place the filters in a 5 gallon disinfection bucket and add enough RO water to cover the filter(s) ~2.5 gallons.
- 3) Add 250 ml of bleach. Write the days date on a piece of red tape and place it on the lip of the bucket. Let the item soak for 12 hours, but not more than 24 hours.
- 4) Empty the contents of the bucket into the sinks. Rinse out the bucket, and thoroughly rinse off the filter with RO water.
- 5) Put the filter back into the bucket, fill it with RO water again and add 30 grams of sodium thiosulfate (dechlorinator). Remove the red tape. Write the date down on a green piece of tape and place it on the lip of the bucket.
- 6) Let the filter soak in the dechlorinator for at least 12 hours. Again empty the contents of the bucket into the sink. Rinse out the bucket, and thoroughly rinse off the filter with RO water. Allow the filter(s) to dry, and then store.



6.10 Ultraviolet Water Sterilization

Ultraviolet radiation is unmatched in its ability to destroy microorganisms. These powerful filters can destroy viruses, bacteria, algae and fungi. It works by delivering ultraviolet radiation at a wavelength of 254 nanometers that destroys nuclear material within cells destroying the microorganisms passing through the filter.

The filter's power to destroy microorganisms depends on the flow rate through the filter and the wattage of the lamp inside. The standard for these systems in aquaculture is 15,000 $\mu\text{Ws}/\text{cm}^2$ (UV light exposure at 254 wavelength in microwatt seconds per square centimeter) of power to destroy these organisms. The lamps in the UV filter are inserted into a quartz sleeve to protect it from the water since the energy must penetrate the quartz sleeve keeping them clean is very important. Additionally, the lamp is continually declining in energy output overtime. These two factors require periodic maintenance of the filter to maintain peak efficiency.

Caution: Always disconnect the power from the UV filter before performing any maintenance on it. Additionally the following is general guidelines for UV maintenance refer to manufacturers guidelines for specific directions.

Replacing the Lamp

- 1) Unplug the unit.
- 2) Loosen the hub connector on the end of the filter and unplug the lamp from the socket.
- 3) Carefully slide the lamp out (pull it straight out, even the slightest angle upon removal of the lamp can crack the quartz sleeve or lamp).
- 4) The lamp should slide out easily if not it is being removed properly.
- 5) Avoid touching the new UV with your hands oils from them can diminish light penetration. Slide the new UV in to the quartz sleeve.
- 6) Reconnect the lamp, hub connector, and turn on the power.

Cleaning UV Quartz Sleeve

- 1) Follow steps 1-4 above and remove the lamp.
- 2) Drain the UV housing, most UV's can be drained by simply shutting off the power to the pump, others have a UV bypass valves that allow the system to continue running during maintenance.
- 3) Twist off the locking-nut on the UV housing.
- 4) This will release the quartz sleeve carefully pull it out.
- 5) Wearing gloves wipe down the sleeve with a soft sponge saturated with 70% isopropyl alcohol.
- 5) Rinse the sleeve thoroughly with RO water and allow it to thoroughly dry.
- 6) Reinstall.



6.11 Stocking Densities

Maximum Tank Stock Densities

Larval systems (based on feed)

Large larval tanks H-lab ~1.0 L.....	50
Larval tanks J-lab ~1.0 L.....	50

<u>Z modular</u>	<u>Total (adult) Fish Length</u>	<u>Maximum Density</u>
0.5 L tanks.....	1.5 in (3.75 cm).....	2 Fish
2.0 L tanks.....	1.5 in (3.75 cm).....	8 Fish
4.0 L tanks.....	1.5 in (3.75 cm).....	15 Fish

H-lab and J-lab

[AHAB (blue lids), Aquaneering (green lids), and Custom built systems]

1.0 L tanks.....	1.5 in. (3.75).....	3 Fish
3.0 L tanks.....	1.5 in. (3.75).....	12 Fish
6.0 L tanks.....	1.5 in (3.75 cm).....	24 Fish
9.0 L tanks.....	1.5 in (3.75 cm).....	40 Fish

J-lab

F1 (25 gallon) tank.....	1.5 in (3.75 cm).....	80 Fish
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Q-lab

(Based on water exchange)

9.0 L tanks.....	1.5 in (3.75 cm).....	30 Fish
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Densities calculated by surface area not by volume, 1" fish length/2.5 in² surface area, adjusted to 1" FL/3.47 in² for surface areas over 60 in².