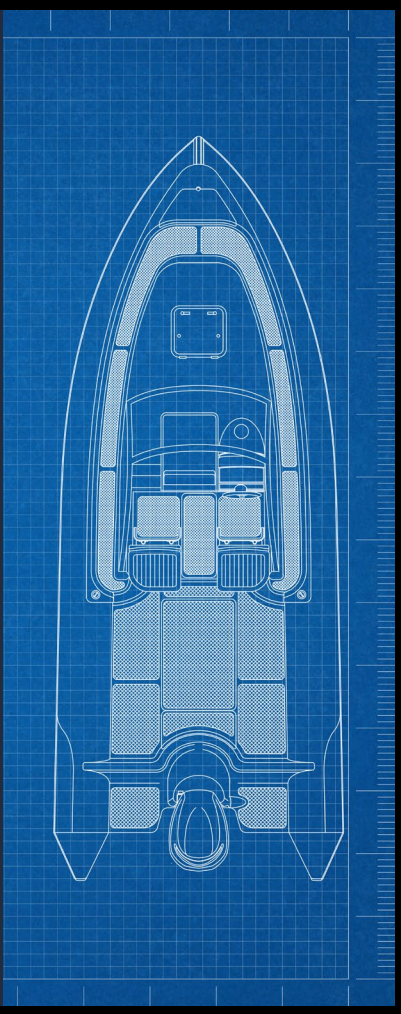
Advanced Watercraft
DECONTAMINATION MANUAL



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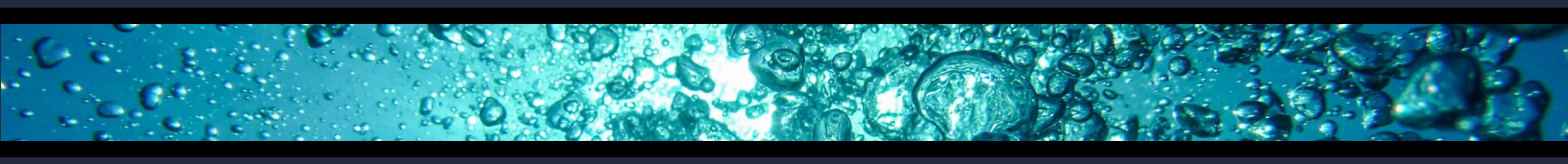
PACIFIC STATES MARINE FISHERIES COMMISSION
IDAHO • OREGON • ALASKA
WASHINGTON • CALIFORNIA

LAKE TAHOE
INVASIVE SPECIES PROGRAM

SNOWFROG DESIGN



INTRODUCTION

The discovery of quagga mussels in Lake Mead in 2007 resulted in the rapid development of Watercraft Inspection and Decontamination (WID) Programs in the West. Since that discovery, considerable knowledge and experience has been gained by inspection program staff. At the same time, mussels have continued to spread in the West, watercraft have become more complex and decontaminations more frequent. The Lake Tahoe WID Program staff understood the need for an in-depth resource with details of multiple boat types, their systems and how to best perform decontaminations. The Tahoe Resource Conservation District (Tahoe RCD), in partnership with the Tahoe Regional Planning Agency (TRPA) developed the "Tahoe Boat Book." It has become an ever-growing document to help inform inspectors and harness that knowledge and experience.

PURPOSE

The Tahoe Boat Book was initially intended for the Lake Tahoe WID Program staff but has since been utilized by WID programs' staff across the West. The Tahoe Boat Book became unwieldy when annual or more frequent updates were necessary. This revision creates a more user-friendly document, available electronically with searchable capabilities. This manual will continue to be a living document and will be updated as needed. With input from multiple WID Programs, the re-envisioned Boat Book will be a tremendous resource for WIP Programs nationwide.

AUDIENCE

This manual is intended to be a resource for WID Programs' staff across the country. The Boat Book is a supplement to other decontamination protocol manuals as an advanced manual for those that are experienced in conducting decontaminations.

USING THIS MANUAL

There is a significant amount of information in this manual, it is suggested that users become familiar with its layout so that information can be found easily. The Table of Contents is linked to the section in the manual to simplify digital navigation. Be advised that information on a particular manufacturer can be found in multiple chapters; for example: general information on Mastercraft boats can be found in chapter 6, but specific information on decontaminating ballast tanks on Mastercraft boats can be found in chapter 4.

Some guidelines are intended for more experienced decontaminators, if the guidelines require removal any part of the system, staff shall consult with, and get direction from supervisors.

ACKNOWLEDGEMENTS

Many thanks to the hard-working and dedicated inspection staff at the Tahoe RCD and the Colorado Parks and Wildlife ANS Program for developing and maintaining this information for several years. Thanks also to Stephen Phillips of the Pacific States Marine Fisheries Commission and Dennis Zabaglo of the Tahoe Regional Planning Agency for funding the redesign of the manual.

Thanks go to all the past and future contributors of the content and photographs which include too many to list and is greatly appreciated.

Special thanks to the late Wen Baldwin, without his passion and willingness to teach, the tremendous success achieved by WID Programs would not be possible.

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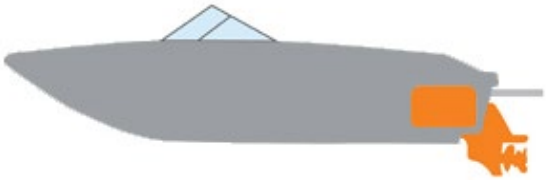
DRIVES & PROPULSION

STERN DRIVE

Stern Drive (Inboard / Outboard)

Many companies make either an engine or just an outdrive but only Volvo Penta and Mercury Marine make combo sets that most boat manufacturers utilize. You may see Outboard Marine Corporation (OMC) engines as well, who were bought out in the 90's by Volvo Penta.

The engine is mounted inside the boat; the drive unit is outside the boat, attached to the transom. The engine and drive unit are joined by a torque coupler and universal joint. Moving the drive unit steers the boat acting as a rudder.



Stern Drive Boat

Stern Drive Basics

The drive unit (outdrive) resembles the bottom half of an outboard motor, and is composed of two sub-units. The upper unit contains a driveshaft that connects through the transom to the engine and transmits power to a 90-degree-angle gearbox. The lower unit bolts onto the bottom of the upper unit and contains a vertical driveshaft that transmits power from the upper unit gearbox down to another 90-degree-angle gearbox in the lower unit, which connects to the propeller shaft.

The outdrive carries power from the inside mounted engine, typically mounted above the waterline, out through the transom and down to the propeller below the waterline. The outdrive can be matched with a variety of engines in the appropriate power range; upper and lower units can often be purchased separately to customize gear ratios and propeller RPM. Lower units are also available with counter-rotating gearing to provide balanced torque in dual-drive installations. The boat is steered by pivoting the outdrive, just like with an outboard with no rudder needed.

The engine itself is usually the same as those used in true inboard systems; historically the most popular in North America were "marinised" versions of GM and Ford automotive engines. Diesel engines can be used but are less popular in the U.S.

The main disadvantage of stern drives versus straight inboards is they are more exposed. There are hoses, rubber bellows and oil lines in the water which can be damaged. There are more exposed components in the water which are prone to corrosion and AIS.

DRIVES & PROPULSION

DECONTAMINATING A STERN DRIVE

1

- Use the hose attachment on the cooling system if one is present. Take caution when screwing metal threads onto plastic fittings.
- Ensure the sea cock on the intake is closed so that water is forced through the engine, and not out the intake.
- When using a hose hookup, start the engine just before the water, and stop the engine just after the water has stopped.
- Otherwise, locate the water intakes on the lower unit of the out drive. These can be little holes or slats cut into the drive. On most drives they are above the bullet and have 6 to 10 inlets.

2

- Attach the appropriate flusher to the drive covering up the water intake holes. If the flusher has metal wires, insert the wire through the middle intake hole (Mercury only). For all others, slide the flusher over the intakes from the rear of the drive (opposite side of the propeller).
- Always check the seating of the 'muffs' or Fake-A-Lake. Place them on snuggly, using duct tape to help seal and hold them if necessary.

Note: Different intakes require different attachments.

DRIVES & PROPULSION

DECONTAMINATING A STERN DRIVE

3

Attach the water hose to the flusher.

4

- Start the water flow and ensure your flusher did not move due to the water pressure.
- Start the engine once the water is flowing and make sure the impeller is pulling the water being fed. The amount of water spilling out from the flusher will decrease and within 30 seconds water should be exiting through the exhaust. If you have issues with the engine taking water see the trouble shooting section.

Note: Make sure to notice the amount of water overflow before the engine is started to more easily recognize when the engine is taking water before it comes out the exhaust. Stop and re-seat if needed. You may try starting the water JUST after the engine starts to avoid the attachment slipping due to trapped water pressure. Running the engine over 1500 RPM's on a hose can result in impeller cavitation or overheating and may damage the engine. Always turn off the engine before turning off the water once you have finished flushing. Failure to do so may result in impeller damage.

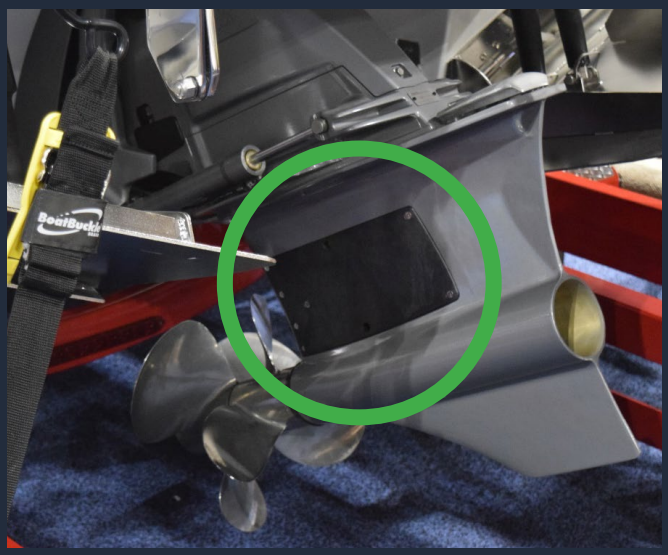
DRIVES & PROPULSION

DECONTAMINATING VOLVO PENTA FORWARD DRIVE

1

The Volvo FWD outdrive can be decontaminated in a similar manner as regular stern drive boats. There are intake grates behind the prop on the black plastic as indicated. Using a pair of Volvo muffs with duct tape should ensure proper coverage.

Some Volvo FWD systems have been seen with the blue Volvo flush adapter commonly seen inside the engine compartment. However, as shown, it is installed outside of the boat on the transom.



2

- Attach a male hose end to the on-board flushing attachment.
- Allow the water to run through with the motor off until it exits the lower unit at 140F.
- With the water still running, have the owner/operator start the engine in neutral.
- The water should then pull through the engine as it would on any other I/O.
- Allow the water to run through until it reaches 140F. Have the owner shut off engine.

DRIVES & PROPULSION

V-DRIVE • DIRECT DRIVE

V-Drive

V-drive and Direct Drive engines are inboard engines. The V-drive engine is mounted in the rear of the boat where the front of the engine faces aft. The engine uses 2 drive shafts and a gearbox to turn the propeller.

The transmission is connected to the rear of the engine. The first drive shaft connects the rear of the transmission to a gearbox, mounted in the center of the boat. The second drive shaft extends from the gearbox to the rear and out the bottom of the boat to mounted propeller.

V-Drive Basics

V-Drives are precision gear drives which allow inboard engines to be placed in the stern (rear) of a boat for greater safety, better handling, increased space, reduced drag, lower bow rise, shallower draft and less maintenance. The V-Drive enables the propeller to be tucked under the hull in front of the rudder instead of hanging off the stern next to the swim platform as with a stern drive. This safety feature is important on small recreational runabouts designed water sport enthusiasts. The V-drive has time tested precision ground, helical gears for smooth and quiet operation. The small vertical offset allows the engine to be mounted lower in the boat resulting in a lower center of gravity. This lower center of gravity greatly enhances boat handling, tracking and stability.

V-Drives are available in direct mounted and remote mounted models There is a wide variety of sizes, with numerous standard gear ratios and V-angles to accommodate nearly every application on runabouts, wakeboard boats, houseboats, and cruisers.

Direct Drive

The engine and transmission are inside the boat. The drive shaft is connected at the rear of the transmission and is run out of the hull through a sealing unit. The propeller is connected directly to the drive shaft. A separate rudder steers the boat.

DRIVES & PROPULSION

DECONTAMINATING A V-DRIVE OR DIRECT DRIVE

1

- Use the hose attachment on the cooling system if one is present. Take caution when screwing metal threads onto plastic fittings.
- Ensure the sea cock on the intake is closed so that water is forced through the engine, and not out the intake. Otherwise, locate the water intake on the hull of the boat (the bottom). It is usually the shape of a tear drop, made of brass and will be between the middle and the stern.

2

Use the Fake-A-Lake and adjust it to the right height. Cover up the water intake with the Fake-A-Lake so there is a snug seal. Do not smash it against the hull because you may not get the water flow you'll need.

Always check the seating of the 'muffs' or Fake-A-Lake. Place them on snuggly, using duct tape to help seal and hold them if necessary. Make sure to notice the water over-flow before the engine is started so you can more easily recognize when the engine is taking water before it comes out the exhaust. Stop and re-seat if needed.

DRIVES & PROPULSION

DECONTAMINATING A V-DRIVE OR DIRECT DRIVE

3

Ensure the flusher does not shift during decon. You may try starting the water JUST after the engine starts to avoid the attachment slipping due to trapped water pressure.

- Turn on the water. Double check the water pressure didn't move the Fake-A-Lake and there is a steady flow of water.
- Start the engine, check again to make sure that the Fake-A-Lake has not moved out of position. Water will stop pouring out the sides and begin pumping through the engine. After 10-30 seconds water will begin pumping out of the exhaust. If no water is coming out of the exhaust, and there is no overflow from the Fake-A-Lake (e.g. the engine is taking all the water), you may continue past the 10 second stop time.
- When you have finished flushing, turn off the engine first and then turn off the water. Failure to do so may damage the impeller.
- Running the engine over 1500 RPM's on a hose can result in impeller cavitation or overheating and may damage the engine.

Decontaminating Sea Strainers on Inboard Engines

Note: During a standing water decontamination the sea strainer will be decontaminated as part of the standard engine decon and does not require any special procedure. This protocol applies when mussels have been identified in the sea strainer.

1. Flush / decontaminate all material that is present in the sea strainer housing and filter.
2. With the strainer housing removed, backflush the intake hose leading to the sea strainer until water exits the engine intake at 140F.
3. Once the temperature is reached, return the strainer to the owner/operator and have them reinstall.
4. Once reinstalled, decontaminate the inboard engine as per the inboard engine decontamination protocol. Observe the sea strainer while decontaminating to ensure sea strainer is properly sealed and no leaks are occurring.
5. When the engine decontamination is complete, remove the sea strainer and re-inspect to confirm that no additional mussels have been flushed into the strainer.

DRIVES & PROPULSION

OUTBOARDS

Outboards

A self-contained unit that includes the engine, gearbox and propeller or jet drive. It is designed to be affixed to the outside of the transom, thus providing steering control, by pivoting to control the direction of thrust. It is the most common motorized method of propelling small watercraft. As well as providing propulsion, outboards

Large outboards are usually bolted to the transom (or to a bracket bolted to the transom) and are linked to controls at the helm. These range from 2- 3- and 4-cylinder models generating 15 to 135 horsepower suitable for hulls up to 22′, to powerful V-6 and V-8 blocks rated up to 557 horsepower suitable for boats upwards of 40′.

Small outboards, up to 15 horsepower, are affixed to the boat by screw clamps, thus easily moved from boat to boat. They typically use a manual pull start system, with throttle and gearshift controls mounted on the body of the engine, and a tiller for steering. The fuel tanks sit inside the boat. Small outboards provide sufficient power to small craft such as dinghies, canoes, etc. They may also provide auxiliary power for sailboats and for trolling aboard larger craft; the motor is frequently installed on the transom alongside and connected to the primary outboard to enable helm steering.

DRIVES & PROPULSION

ELECTRIC-POWERED • JET

Electric-Powered

Electric outboards are used on very small craft or on small lakes where gasoline motors are prohibited, as a secondary means of propulsion on larger craft, or as a thruster while fishing. They may be referred to as "trolling motors" or "electric outboard motors." Their best application is for quietness, ease of operation and zero emissions, not speed and range.

The exception to this is the Torqeedo outdrive which is electric, but also has intakes for cooling the electric motor. A Torqueedo will have to be flushed like any other gasoline outboard engine.

Jet

Jet propulsion is available as an option on most outboard motors. They are less efficient than open propeller motors, but are useful operating in very shallow water. They also eliminate the dangers of an open propeller.

DRIVES & PROPULSION

DECONTAMINATING AN OUTBOARD

New outboard engines may have a garden hose hook up on the upper casing of the unit. The hose hook up is not sufficient for a proper decontamination as it not direct water through the impeller. You may burn up the impeller if you run the engine while flushing this way. However, it is a good system to prevent saltwater corrosion inside the block. Therefore, we will use the more conventional method.

1

Locate the water intakes on the lower unit of the engine. They may be little holes or slats cut into the side. They are above the bullet and have 6 to 10 inlets on most engines.

2

Attach the appropriate flusher to cover the water intake holes. If the flusher has a metal wire, insert the wire through the middle intake hole (Mercury only). For all others, slide the flusher over the intakes from the rear of the unit (opposite side of the propeller).

DRIVES & PROPULSION

DECONTAMINATING AN OUTBOARD

3

- Start the water flow and ensure your flusher did not move due to the water pressure.
- Start the engine and ensure the impeller is pulling the water being fed to it. The amount of water spilling out from the flusher should decrease and within 30 seconds water should be exiting through the water exit or "pisser." See the trouble shooting section if you have issues with the engine taking water. Running the engine over 1500 RPM's on a hose can result in overheating and possible damage to the engine.

Turn off the engine before turning off the water when you have finished flushing. Failure to do so may result in impeller damage.

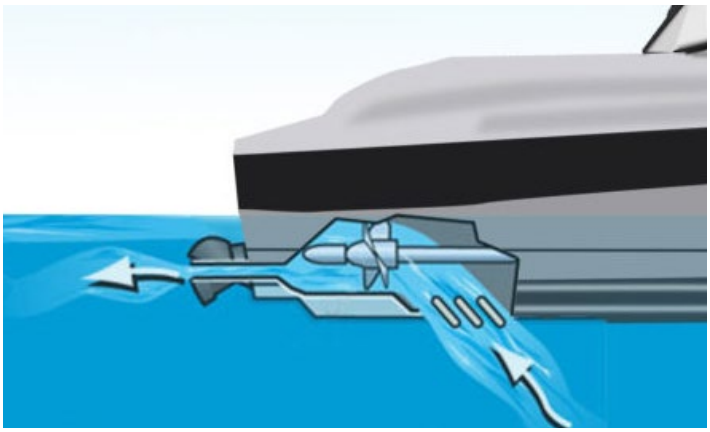
DRIVES & PROPULSION

JET DRIVES

Jet Drives

Jet drives are the least common drive. It consists of an engine mounted inside the boat that is attached to a high speed pump. The pump draws in water through an intake grate, increases its velocity, and forces it out through a directionally adjustable nozzle. The nozzle is mounted outside the boat and steers by changing the direction of this nozzle.

The uptake of water is different in a jet drive. A scoop located near the jet nozzle (picture an ice cream scoop) catches the flow of water and sends it towards the engine. While the engine is running, the drive shaft and impeller are pumping water. The water is forced through by pressure and expelled out the exhaust.



DRIVES & PROPULSION

DECONTAMINATING A JET DRIVE ON A PWC

1

- Decontaminate the intake grates by using the low flow adapter and running hot water over the intake area.
- Next, run hot water backwards from the jet exhaust through the intakes to decontaminate the rest of the system.

Always start the engine first, then the water. Stop the water before the engine has stopped when the decontamination is complete. Do not run the engine for more than 10 seconds without water. Manufacturers have been contacted about acceptable times to run the engine dry and there is variation. However, it is recommended to keep it no more than 10 seconds.

2a

Locating the flush point:
Most PWCs have a flush point located somewhere on the body of the watercraft. In most cases it's a female garden hose attachment. Here are few examples where they may be located:

Kawasaki Jet Ski:
Under front hatch, left or right side.

DRIVES & PROPULSION

DECONTAMINATING A JET DRIVE ON A PWC

2b

Kawasaki Ultra 300X Race Ski:
The flush point for the engine (black) is on the port side of the transom on 2013 models and newer. There is an additional flush point for the intercooler (grey). The supercharger compresses air for the engine, thus heating it, which is then cooled by raw water in the intercooler. You should also flush the intercooler when doing an engine flush. Flush them separately and ONLY run the engine when flushing the cooling system, and NOT when flushing the intercooler.

2c

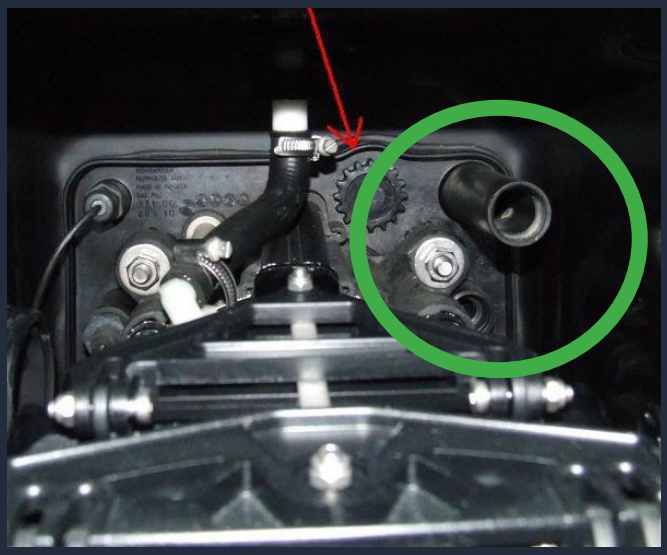
Yamaha Wave Runners:
Under back seat. Use the Yamaha adaptor to fit the hose.

DRIVES & PROPULSION

DECONTAMINATING A JET DRIVE ON A PWC

2d

Sea Doo (Pre - 2010):
Attached to the transom on either side of the jet nozzle.



2e

Sea Doo (2010 - current):
It is placed on the rear of the watercraft on the port side on 2010 and newer models.

DRIVES & PROPULSION

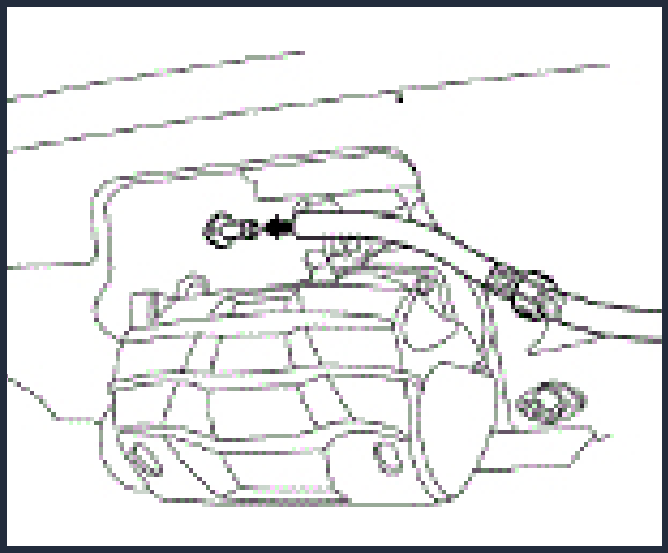
DECONTAMINATING A JET DRIVE ON A PWC

2f

Honda Aquatrax:

There are two main placements:

- Located in the rear to the top right of the jet nozzle. It is a 5/8" or 3/4" barb. Using a redirector or taking the male end out of the "ultimate" will allow you to use the hose attachment to flush it.
- Located on the outside, top left of the jet area. It is a 5/8" or 3/4" barb. It usually faces in towards the jet. You can use a "redirector" or gently bent "ultimate" without the other end on this intake. You may ask the owner to put the unit in reverse to access the port easier, then put it back towards the forward position so the deflector helps hold the hose in place. Be careful to not pinch your fingers.



2g

Polaris:

The hose hookup is on the "water bar" under the seat and on top of the engine. It is difficult to get to, and may need an elbow to affix the hose end.

Locate the hose adaptor on the machine and attach the hose.

DRIVES & PROPULSION

DECONTAMINATING A JET DRIVE ON A PWC

2h

Gibbs Quadski:
The impeller is always spinning when the engine is on, whether on land or water. The intake for the jet is located to the left of the jet area, similar to Honda's. The system will not take water without revving the engine, which is impossible to do without engaging the wheels. The Quadski has no neutral as it employs a centrifugal clutch, so revving the engine results in forward movement. Perhaps idle is enough to push water through the system, or perhaps the rear-wheel-drive unit would have to be lifted or supported and put into ski-mode.

3

Turn the water off first when the flush is complete, then run the machine run for a few seconds without flowing water. Rev it several times to about 3000 RPM then turn it off. Disconnect the hose and replace the cap.

DRIVES & PROPULSION

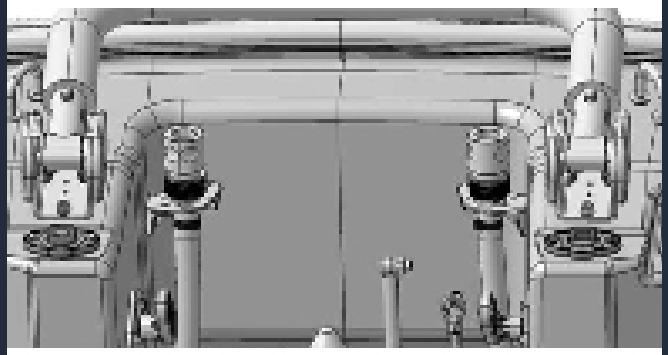
DECONTAMINATING A JET DRIVE ON A PWC

4a

PWC WAKE EDITIONS

Some PWC wake editions include a hookup for ballast tanks. Note that the tanks fill with the same system that propels the vessel forward. There is a hose barb on the right side of the venturi (opposite the barb for the OPAS system seen below) leading to two quick connects inside the transom area.

Rev the engine several times while decontaminating and open the quick connects to ensure that system is being decontaminated. Decontaminate the ballast tank.

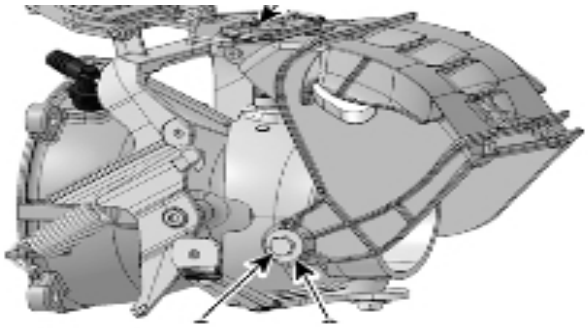


4b

OPAS SYSTEMS

Off Powered Assisted Steering systems are available on many Sea Doo's. These are fins on the rear of the watercraft that lower and turn to help steer the vessel when there is no throttle. OPAS on the Sea Doo RXP's are not mobile and do not raise and lower.

While running the jet ski with the water hose attached, rev the throttle several times. If the Sea Doo is equipped, this should decontaminate the water pressure system that disables the OPAS system at speed.



DRIVES & PROPULSION

DECONTAMINATING A JET DRIVE BOAT WITH HOSE ATTACHMENT

1

Most large jet drive setups, like Hamilton, CAN NOT be run out of water. If the engine compartment has a hose attachment, you can run the raw water-cooling systems, as long as you DO NOT start the engine.

Remove the cap and attach the hose.

2

Turn the engine on ONLY if you have instruction by the owner; otherwise leave it off. Start the water flow after the engine has been started (if you start it). Water should be spilling out the exhaust after a few seconds.

Turn the water off first when the flushing is complete. Let the engine run for a second or two without flowing water, then turn it off. Disconnect the hose and replace the cap.

Note: Running the engine over 1500 RPM's on a hose can result in overheating and may damage the engine.

DRIVES & PROPULSION

DECONTAMINATING A JET DRIVE BOAT WITHOUT HOSE ATTACHMENT

1

Never start the engine during this process without hose attachment.

- Locate the heat exchanger in the engine compartment. It is located in front of the engine or in some configurations off to either side of the engine.
- Remove the water from the engine hose. The hose is located on the port side and can be traced back to the transom area. It may have a sea strainer on the line. You have the wrong hose if green or orange fluid spills out.

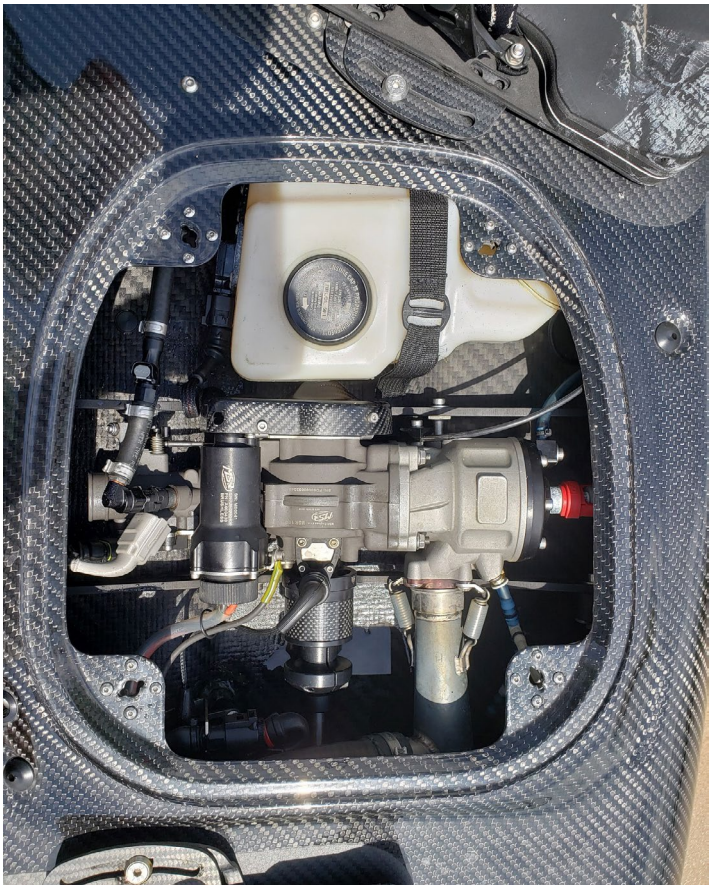
  GM motors have a different heat exchanger, and therefore, a different inlet hose under the unit.

2

- Connect the hose directly to the heat exchanger and start the flow of water.
  DO NOT START THE ENGINE.
- Water will begin flowing through the exchanger and exhaust system. Shortly, water will start flowing out the exhaust.
- Replace the hose when finished and ensure the clamp is tight or the engine may over heat under normal operating conditions.

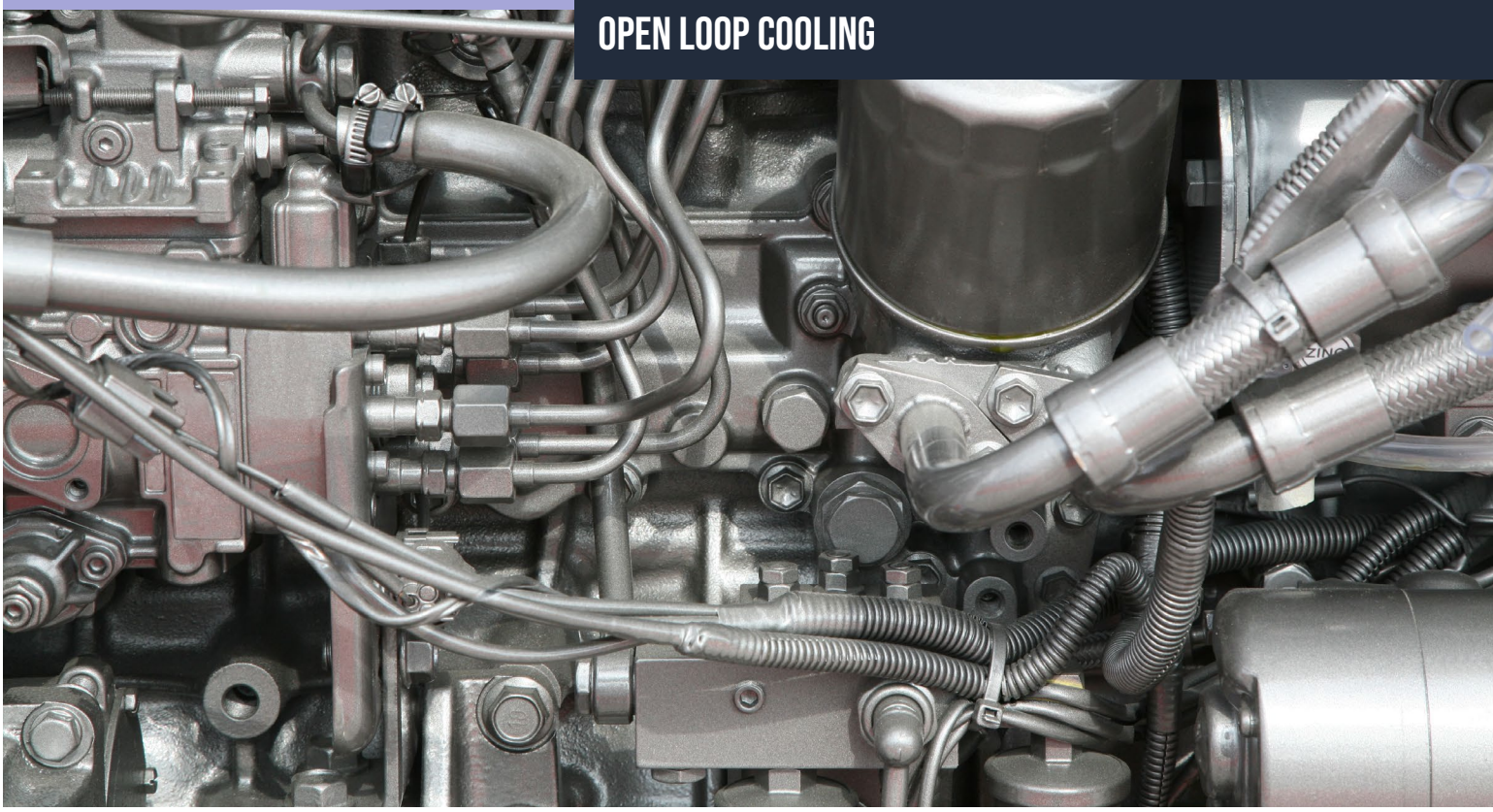
Jet-powered Surfboards

Jet-powered surfboards utilize a direct drive jet pump and may have 2 stroke engines. Investigate the cooling system for a flush port and if not, you may have to pull a hose to decontaminate. You can decontaminate the drive system passively. You should inspect the bilge. Currently, we do not have any experience decontaminating these watercraft.



COOLING SYSTEMS

OPEN LOOP COOLING

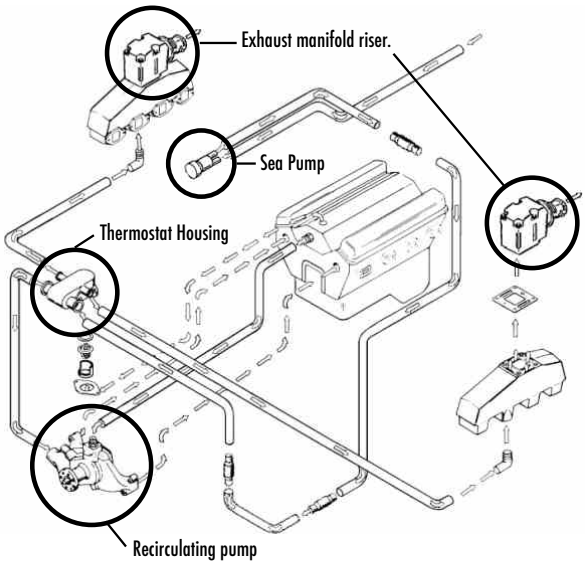


Cooling Systems

An engine will fail if just one part overheats. Therefore, it is vital that the cooling system keeps all of the parts at suitably low temperatures. Liquid cooled engines are able to vary the size of their passageways through the engine block so that coolant flow may be tailored to the needs of each area. Locations with either high peak temperatures (narrow islands around the combustion chamber) or high heat flow (around exhaust ports) may require generous cooling. This reduces the occurrence of hot spots, which are more difficult to avoid with air cooling. Air cooled engines vary their cooling capacity by using more closely spaced cooling fins in that area, but this can make their manufacture difficult and expensive.

Open Loop Cooling

Open loop cooling systems circulate water through the engine, instead of antifreeze. This cooling system works well in fresh water, but tends to shorten the life span of the engine.



COOLING SYSTEMS

The system starts with the impeller drawing water through the intake. It travels through lines to the engines recirculating pump. It builds pressure to run through the engine block where the water is heated. The water exits the boat through the exhaust ports.

Decontaminating Open Loop Cooling

Decontaminating this system requires flushing hot water wherever raw water is pumped to cool the engine. There are a variety of ways to accomplish this, depending on the water intake system. The intakes differ mostly between types of propulsion. See **Drives and Propulsion** and select the drive system to find more information on decontaminating the different intake systems on open loop cooling systems.

It is often good to know the water requirements of the vessel you are decontaminating. In most cases (for vessels equal to or less than 36' long) you will have no issues. However, in some watercraft, you will have to adjust for 3 major issues:

1. The engine(s) require more than 5 gal/min
2. The intake is too large for the Fake-A-Lake or for earmuffs
3. The hull is deep, leaving the engines several feet above the intakes

1. The engine(s) requires more than 5 gal/min:

If you are using a containered decontamination machine, you can use one of the supplied hose Y-splitters as a combiner. Use the appropriate number hoses to equal the amount of water pressure needed. You may not be using an attachment tool (as you will read later), thus you can also feed multiple hoses into the sea strainer (or flush tub if applicable), allowing you to use all 4 hoses on the machine for the one engine (~20gal/min). Test the output of your hoses to make sure your supply will be adequate prior to running the engine.

If you are using a mobile unit and have 2 on site, turn them on and test the output; you should be able to get ~10gal/min. If you are unable to achieve more water pressure, you will have to get inventive. You could use:

- A sump pump
- A 70gal flush tubs.
- Reclaiming vacuums have built in pumps that can supply about 6 gal/min and also have a hose connection.

You can use a variety of these items to obtain the flow needed by filling the flush tub with HOT water first and using the available pumps to supply that water in tandem to the output of the working machines.

2. If the intakes are too large for attachments:

If the watercraft has single intakes through outdrives of some sort, it may be possible to use the flush tub to submerge the intakes. If the intakes are through-hulls, this will not be possible. Follow the instructions under #3.

3. If the engine is too high to pump water to:

You should be able to tell whether the water will make it to the pumps based on the location of the engine. In most large boat (36 feet or greater), it likely will not uptake water. To get water to the pump, open the sea strainer inside the engine compartment and close the sea cock that leads to the intakes. If possible, remove the hose at the impeller and lower it (with water flowing into the sea strainer) to prime that length of hose. The hose may be old, or far too big to do this with.

COOLING SYSTEMS

CLOSED LOOP COOLING (CLC) • DECONTAMINATING CLC

The intakes to the sea strainer are frequently very close to the top [of what], leaving no reserve of water for the engine. This could lead to the engine taking more water than is flowing at that exact time and suck air, and possibly damage the impeller. You could use a cone (small or medium), inverted into the sea strainer, with a seal around it so that you can raise the level of water above the top. To make a seal, we can use rubber gloves, duct tape (NOT on the sea strainer nut on the cone), vacuum attachments, etc.

It is common for engines to initially require much more water than it indicates. In all cases, start the engine with the water running into the sea strainer (make sure the bilge plug is out). Ask the operator to turn over the engine without starting, several times to prime the lines and manifolds. This allows the initial startup of the engine to not require such a sudden burst of water. Make sure the water level does not dip, indicating the engine is using more water than you have available. Finish the decon by opening the sea cock and decontaminating back out through the intakes.

Closed Loop Cooling

Closed loop cooling systems can be found on many different types of watercraft. Closed loop cooling systems have a few similar basic characteristics as an open loop system. The system uses coolant and raw water, to prevent damage to the engine from salt or brackish water corrosion. A heat exchanger is used to cool down the coolant, similar to a radiator in a car. The sea pump pulls raw, cool lake water through the heat exchanger to cool the coolant. The water then runs through the exhaust manifold risers and exits the exhaust ports.

A recirculating pump pressurizes the coolant and runs it through the block and certain channels of the exhaust manifolds and into the heat exchanger.

Decontaminating Closed Loop Cooling

Decontaminating this system requires flushing hot water wherever raw water is pumped to cool the coolant. There are a variety of ways to accomplish this, depending on the water intake system. The intakes differ mostly between types of propulsion. See Drives and Propulsion and select the drive system to find more information on decontaminating the different intake systems on open loop cooling systems.

If there are complications, refer to Decontaminating a Jet Drive (pg. 26) for more information on issues concerning heat exchangers.

Jet drive systems most frequently have closed cooling systems. This is due to the appeal of a jet drive system is that it has no prop and can drive in shallow water where you are likely to suck up rocks, mud and debris that you would not want to send through your engine cooling system). If this is the case, see the section on decontaminating a jet drive boat (pg 26) under Drives and Propulsion.

If the jet drive does NOT have a closed loop cooling system, it is not enough to supply the cooling system with water. The impeller (which spins with the engine) may use bearings or wax/wire seals which rely on the water around them to lubricate or cool. You can run one hose to the cooling system (hot) and another through the jet impeller inspection cover (cold). The impeller cover is a triangular lid removable by screws. However, this provides minimal water and cooling to the bearings. These systems were designed to be operated in water only. There is no perfect and risk-free solution to these systems. It is best to decon them without running the engine.

Below is a list of pump manufacturers and whether it is safe to decontaminate without operating the engine. However, there are no guarantees it will work.

COOLING SYSTEMS

Pumps that you CAN decontaminate without the engine running:

- Dominator
- Berkeley (berkelyjets.com)

A Berkeley pump can be run out of the water as it has a greased thrust bearing and lubricated tailshaft bushings. The impeller does not touch the wear ring, but due to the fact that the bottom of the pump is open during trailering the boat, it is best to run water into the pump through the nozzle while running on the trailer. The only issues with running out of the water is that after about 15 to 20 minutes the bowl seal can get hot from lack of cooling and cause seal damage. The packing gland may have to be re-tightened when the boat is used the next time as well.

Pumps that you CANNOT decontaminate without the engine running:

- Kodiak Pumps- unless using a Dry Run Kit (KM2046)
- Hamilton Pump- unless using a Dry Run Kit (KM2046) 770 series only
- American Turbine

If you decontaminate a vessel using cold water on the drive system while it is running, you will have to then decontaminate the drive system using hot water in the same manner as you would for a PWC. Decontaminate the grates and the intake area, and then back flush from the jet exit through to the intakes using hot water.

Be sure that the owner knows of these risks and that we are looking into a manufacturer approved flushing method that does not involve disconnecting the drive shaft.

Air Cooling

Air cooling is uncommon in the marine industry and only used on small outboard engines; typically one cylinder four stroke engines. Some models can have odd looking plastic or aluminum fins that help keep optimal air flow on the engine. Others are just an engine sitting on a drive shaft and no cover. This system uses no water or coolant at all.

Decontaminating Air Cooling

Provided the exterior of the air-cooled outboard is dry, they do not need to be decontaminated, as they do not siphon raw water. This is the same for fully electric outboards that do not siphon water.

COOLING SYSTEMS

SEA PUMPS • DECONTAMINATING SEA PUMPS

Sea Pumps

Sea pumps are a simple machine used to uptake raw water to cool a marine engine. All marine engines except for a few outboards have a sea pump and they come in all shapes and sizes. Sea pumps have an off-set housing that a rubber impeller sits in. The pump will spin along with the RPM's of the engine whether it's in an outdrive or mounted to the front of the engine. The off-set housing and the rubber impeller create a suction of water that is passed through the engine.

A sea pump is most commonly found mounted on the front of the engine with a pulley connecting it to the serpentine belt or a belt connected to the crank shaft. On Mercury Alpha drives, some OMC drives and all outboard engines the pump is located inside the upper unit of the drive system. The drive shaft in the upper unit is always spinning with the engine RPM's even when it's not in gear.

Decontaminating Sea Pumps

Sea pumps are integral to the cooling system flush. If the pump is not taking on water, first check your seal on the attachment. Second, try to rev the engine a few short times to increase the suction the impeller creates. Impellers that have not been changed in a while will not always create enough of a seal to perform the decontamination (although they will work in the water). Intake hoses can be traced in the bilge, and the decon may proceed by forcing water through the hose that leads from the outdrive, as long as the sea pump is not located in the outdrive, or "leg." When doing this, start the engine just before starting the water and stop the water just before stopping the engine.

TYPES OF MARINE ENGINES

CARBURETED TWO-STROKES

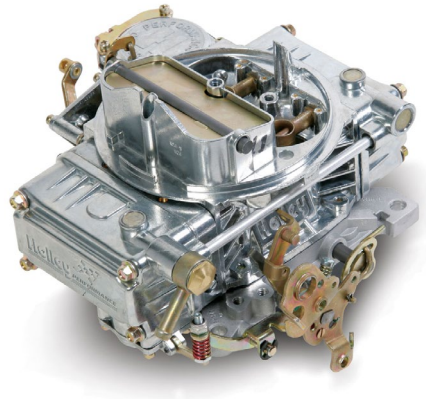
Types of Marine Engines

The type of engine is important to understand to properly conduct a decontamination.

Very similar to automotive engines, unless you know how they work you may not be able to tell them apart. A very common engine is the GM 7.4 (454) V8, this is an engine that GMC and Chevrolet have been using for decades. If this engine is in your truck and you have a 7.4 in your boat they are similar but not the same. The 7.4 in your boat is "marinized" which means; they use brass freeze plugs on block. The camshaft and valve springs are different for the different RPM range that a boat runs in. This calls for proper jetting of the carburetor or tuned ECU's and water-cooled manifolds and risers. The alternator and starter are marinized as well with a spark shield to prevent and spark from igniting gasoline vapor. The fuel system has a return line that runs from fuel pump to carb airhorn so when the diaphragm in pump should break gas is recovered into carb by a piece of tygon tubing instead of dripping into bilge.

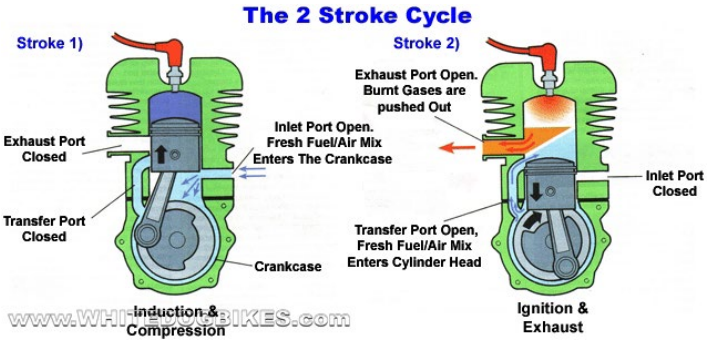
Carburetor: a device for mixing vaporized fuel with air to produce a combustible or explosive mixture, as with an internal-combustion engine.

Engine Control Unit (ECU): a type of electronic control unit that controls a series of actuators on an internal combustion engine to ensure the optimum running. It does this by reading values from a multitude of sensors within the engine.



A. Carbureted Two-Strokes

A two-stroke engine is an internal combustion engine that completes the process cycle in one revolution of the crankshaft (an up stroke and a down stroke of the piston, compared to twice that number for a four-stroke engine). This is accomplished by using the end of the combustion stroke and the beginning of the compression stroke to perform simultaneously the intake and exhaust (or scavenging) functions.



Electronic Fuel Injection (EFI) two-stroke engines do not use a carburetor. Instead, they use a computer to time the injection of fuel into the intake tract or cylinder port. Other than that, they work exactly the same. See page 38 under EFI 4-Strokes for more information on electronic fuel injection.

TYPES OF MARINE ENGINES

CARBURETED TWO-STROKES

Two-stroke engines often provide high specific power, at least in a narrow range of rotational speeds. The functions of some or all of the valves required by a four-stroke engine are usually served in a two-stroke engine by ports that are opened and closed by the motion of the piston(s), greatly reducing the number of moving parts.

Many designs use total-loss lubrication, with the oil being burned in the combustion chamber by mixing the gasoline and oil together. This causes blue smoke and other types of exhaust pollution. This is a major reason for two-stroke engines being replaced by four-stroke engines in many applications. The picture below shows the "Blue Smoke" coming from a two-stroke outboard.

Two-stroke engine

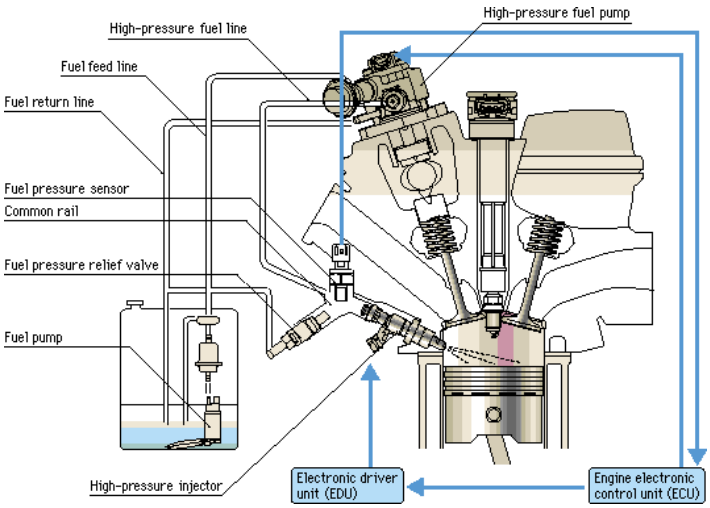
TAHOE: Carbureted and EFI Two-stroke engines are NOT allowed on Lake Tahoe because of their impact on the environment. Pictured below on the left is a SeaDoo GTX, first notice the splash of 80's colors, that's your first sign. Next check to see if it has a choke, if yes then it is not allowed on Tahoe. DFI, DI, and GDI jet skis and outboards are allowed, you will see one of those three printed on the side. If not, look at the engine, if there is no carburetor it has some type of fuel injection. The first four stroke jet ski didn't come into the US until 2001.

Carbureted Two-stroke PWC

Carbureted Two-stroke Outboard

B. Two-Stroke Direct Fuel Injection (DFI)

The gasoline in a DFI engine is highly pressurized and injected via a common rail fuel line directly into the combustion chamber of each cylinder, as opposed to conventional multi-point fuel injection that happens in the intake tract, or cylinder port.



Two-strokes engine have the exhaust and intake ports open at the same time, at the bottom of the piston stroke. Conventional two-strokes use a large portion of the fuel/air mixture that enters the cylinder from the crankcase. The unburned mixture then goes through the intake ports and directly out the exhaust port (blue smoke).

Direct injection engines have only air (and usually some oil) coming from the crankcase. The fuel is not injected until the piston rises and all ports are closed.

The fuel in DFI engines is not injected at the intake stroke but rather at the latter stages of the compression stroke, thus the small amount of air-fuel mixture is optimally placed near the spark plug. This leads to an "ultra-lean burn." This stratified charge is surrounded mostly by air, which keeps the

Evinrude E-Tec 2 Stroke DI

fuel and the flame away from the cylinder walls for lowest emissions and heat losses. The combustion takes place in a toroidal (donut-shaped) cavity on the piston's surface. The cavity is displaced to one side of the piston, the side that has the fuel injector. This technique enables the use of ultra-lean mixtures that would be impossible with carburetors or conventional fuel injection.

Motors that are Direct Fuel Injected commonly say DFI or DI. This is not to be confused with electronic fueled injection (EFI) engines which simply have an injection system rather than a carburetor.

Some DFI motors do not have "DFI" displayed on the motor. These include Evinrude (called E-Tec), Mercury (Optimax), and Yamaha (Vmax HPDI). The Yahama Max SHO series are four-stroke engines. Other versions of the direct injection (Johnson, Evinrude) technology known as FICHT or FICHT Ram Injection, are also excluded from Lake Tahoe's two-stroke ban.

TYPES OF MARINE ENGINES

DECONTAMINATING TWO-STROKE PWC

Newer engines do not always imply they are DFI. Many new 2-strokes are still manufactured with carburetors.

In the newly emerging sport of MotoSurf, there are even new carbureted 2-stroke engines being manufactured by a company named MSR who make the JetSurf, a motor-powered surf board. These engines comply with all 2015 EPA Clean Air Act requirements. We are still waiting to hear if that makes it compliant for use on Lake Tahoe.

Similar systems can be seen on Onean, Lampuga, Waterwolf and WaveJet boards and Kayaks but these are currently all electric powered.

Decontaminating Two-Stroke PWC

Older two stroke engines tend to need less water than standard PWCs. If too much water is pumped into the cooling system, pressure can build and cause blown connectors or engine lines. Consider using a loose connection to mitigate this issue. Depending on the connection, one person might need to hold the flush hose in place with a glove while the other person takes the exhaust water temperature. Excess water may spray out in the surrounding area. Warn the boater to stay out of the spray area. Use a vacuum hose to prevent the bilge from filling. Never let the bilge fill up to the carburetors, this can harm the engine. Alternatively, you can use a bypass connector which allows excess water to flow onto the containment area.

Steps to determine how to flush the 2-stroke engine:

1. Standard Flush Method:

Some models have similar set-ups to their four stroke counterparts that allow them to be flushed with a garden hose. These systems are straight forward and easy to flush. Use normal PWC flushing protocols but be careful with the amount of flow you input into the system. (See note above)

2. Owner or Factory Modifications:

If there is no obvious flush point on the PWC then ask the boater if they have any knowledge of flush point modifications. Sometimes the proper water hose will have a homemade "T" junction that the current or previous owner installed. This "T" junction flush modification can be used to flush the PWC. It might not resemble a garden hose intake and may just be a barbed hose or nipple with a plug or cover. Similar set-ups are often found on the early DFI supercharged PWCs that were not equipped with the standard rear hookups. If the owner does not know of a flush point on their PWC then take a second to look to determine if there are flush point modifications that they are unaware of. You will need to make sure water is flowing in both directions from the "T" to be sure the entire system is decontaminated.

3. Pulling the Correct Hose:

If there are no flush hook ups, you will need to pull the correct hose and supply water to it while running the engine for decontamination. There are several ways to determine the correct line to pull to minimize the risk of putting water where it doesn't belong. Look inside the rear bilge where the jet turbine attaches to the hull. This part is usually recessed from the outside and protrudes farther into the bilge. There will be one or two hoses coming from the turbine. (Ignore any hose that goes to the transom) If only one, that is most likely the one to pull.

Some PWC models (more common with stand ups jet-skis) restrict your ability to see where the turbine meets the hull on the inside. These can be harder to determine the correct line. The other end of the line may go into the top of the engine, the exhaust or split and go into both. The following tests may help determine the correct line:

As there are many different models of PWCs it is difficult to detail exactly what hose to pull. Use your best judgment or seek help if possible.

4. Determining correct intake line is chosen:

See what is inside the line when you pull it. If the line is empty or contains water you are on the right track; stop if the line contains gasoline. **Before sending water through the engine block, send it the other way first.** This will need to be done to decontaminate that half of the system. If water begins to empty out of the turbine on the back then that is the intake line and it is safe to send water the other way through the engine and exhaust as you would normally do. Follow the basic jet engine flush procedures.

Note: It is **very** important NOT to send water through the incorrect line as it may cause permanent damage to the PWC. Consult an experienced inspector for help.

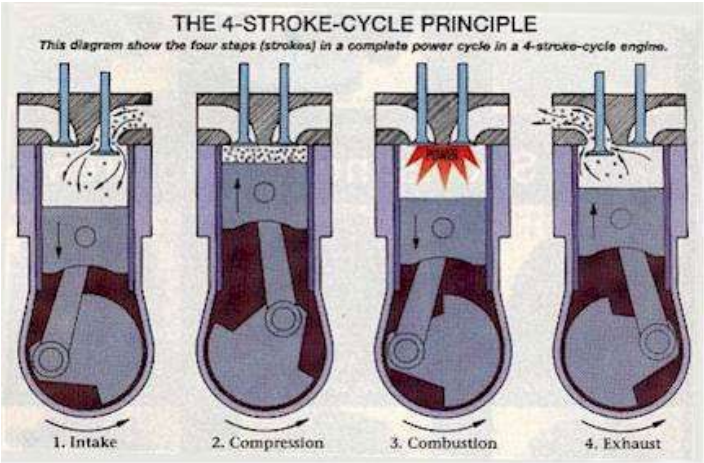
C. Carbureted Four Strokes

A four-stroke engine, also known as four-cycle, is an internal combustion engine in which the piston completes four separate strokes: intake, compression, power, and exhaust during two separate revolutions of the engine's crankshaft, and one single thermodynamic cycle.

1. **INTAKE-** The piston descends from the top to the bottom of the cylinder, which reduces the pressure inside the cylinder. A mixture of fuel and air, or just air in a diesel engine, is forced by atmospheric (greater) pressure into the cylinder through the intake port. The intake valve(s) then close. The volume of air/fuel mixture that is drawn into the cylinder, relative to the volume of the cylinder is called, the volumetric efficiency of the engine.
2. **COMPRESSION-** The piston returns to the top of the cylinder with the intake and exhaust valves closed. This compresses the air, or fuel-air mixture into the combustion chamber of the cylinder head.
3. **POWER-** This stroke is the start of the second revolution of the engine. The compressed fuel-air mixture in a gasoline engine is ignited, usually by a spark plug. The fuel is injected into the diesel

engine, which ignites due to the heat generated in the air during the compression stroke. The resulting massive pressure from the combustion of the compressed fuel-air mixture forces the piston back down toward the bottom.

4. **EXHAUST-** The piston again returns to the top while the exhaust valve is open. This action evacuates the burnt products of combustion from the cylinder by expelling the spent fuel-air mixture out through the exhaust valve(s).

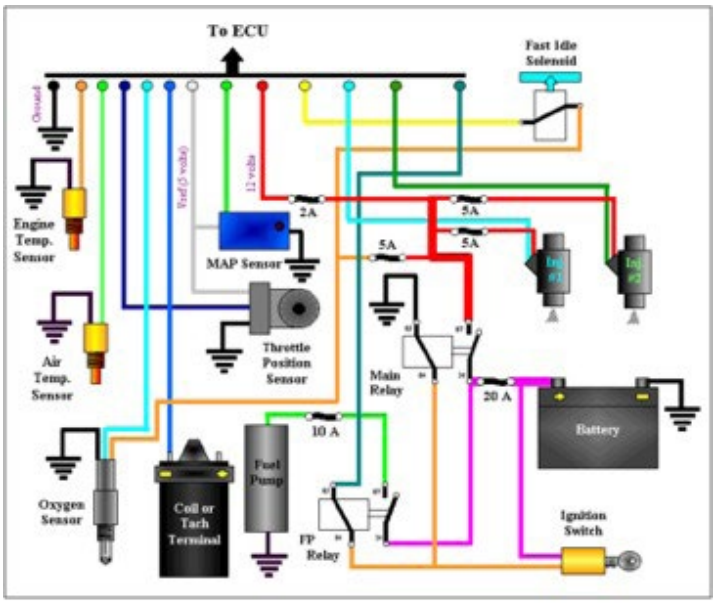


D. Electronic Fuel Injection (EFI) Four Strokes

Almost all boat engines produced recently have some type of electronic fuel injection. Fuel injection is a system for admitting fuel into an internal combustion engine. It has become the primary fuel delivery system used in marine engines, having almost completely replaced carburetors in the late 1990s.

Operational benefits to the driver of a fuel-injected boat include smoother and more dependable engine response during quick throttle transitions, easier and more dependable engine starting, better operation at extremely high or low ambient temperatures, increased maintenance intervals and increased fuel efficiency.

An engine's air/fuel ratio must be precisely controlled under all operating conditions to achieve the desired engine performance, emissions, drivability, and fuel economy. Modern electronic fuel injection systems measure fuel very accurately, and use closed loop fuel injection quantity control based on a variety of feedback signals from an oxygen sensor (O2), a mass airflow (MAF) or manifold absolute pressure (MAP) sensor, a throttle position sensor (TPS), and at least one sensor on the crankshaft and/or camshaft(s) to monitor the engine's rotational position. Fuel injection systems can react rapidly to changing inputs such as sudden throttle movements, and control the amount of fuel injected to match the engine's dynamic needs across a wide range of operating conditions such as engine load, ambient air temperature, engine temperature, fuel octane level, and atmospheric pressure.



RAW-WATER SYSTEMS

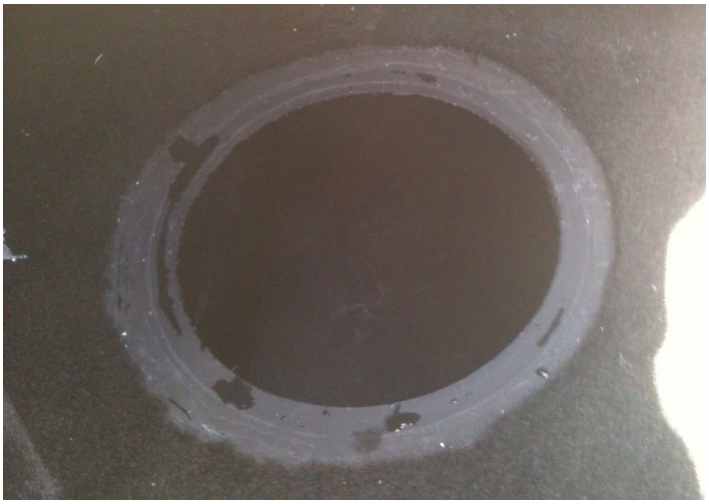
BALLAST SYSTEMS

Ballast Systems

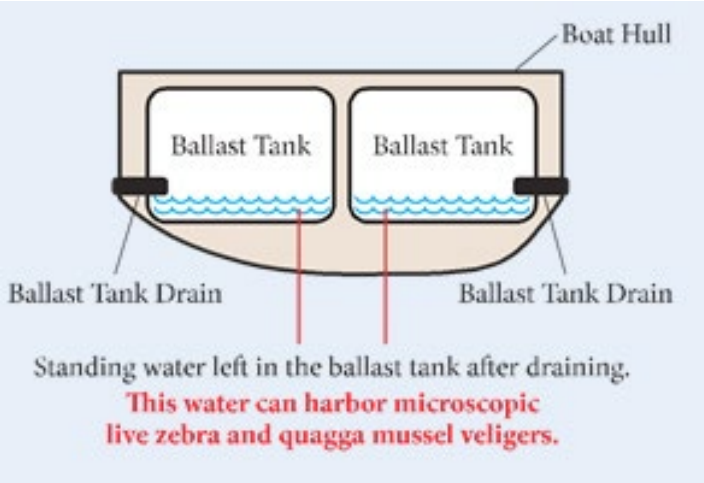
A ballast tank is a compartment within a boat, ship or other floating structure that holds water. Ballast water taken into a tank from one body of water and discharged into another body of water can introduce viable aquatic invasive species that can cause environmental and economic damage. The introduction of zebra mussels in the Great Lakes is an example of this damage.

Ballast systems are designed to hold water to increase the weight in the watercraft, thus creating a larger wake. Many watercraft may have them including large shipping vessels to stabilize at sea, sailboats to counteract the force and leverage of the wind on the mast, wakeboard boats and PWCs. Ballast inspection ports began appearing in 2014 on these systems, as in the 2014 Centurion Enzo 244. Ballast systems incorporate a scoop design ballast fill, valve design ballast empty (like MB Sports and Calabria) and an individual intake for forward ballast bags.

The diagram to the right shows the cross section of a boat with two water ballast tanks. The placement of the drains of this particular tank does not allow all the water to be drained when the drain pump is activated. Manufacturers have reported that on average, two gallons of water remain after draining each tank.



These tanks must be decontaminated if last in a high risk waterbody prior to being launched elsewhere because the tanks do not fully drain.



Ballast tanks or bags come in a variety of materials and sizes. Most wakeboard boat manufacturers have installed factory ballasts tanks which can be hidden by upholstery or carpeting, or even be built into the hull itself. Some manufacturers install bag systems. Operators use add-on ballast bag systems to augment the stock system (examples to the left) if more weight is needed. Bags can be hidden under ski equipment or coolers and also kept inside the tow vehicle. Make sure to ask and check thoroughly for these systems, as the indicators may not be integrated into the vessel design.

The first indicator of ballast systems is the through hull fittings on the side of the vessel (often in groups of 3 or 4) and switches on the dash that say fill or empty. Check for these items first if you suspect ballast tanks or bags. Multiple pumps and intakes in the bilge(s) also indicate the presence of a ballast system. Look for all the parts of the ballast system listed below to help you verify.

RAW-WATER SYSTEMS

DECONTAMINATING BALLAST SYSTEMS

Decontaminating Ballast Systems

Locate all the ballast bags and tanks to ensure that they all get decontaminated. The Likely locations include: in the stern on either side of the engine, lengthwise under the rear seat, under the passenger side dash (to compensate for driver weight) in the center bilge or ski locker, and foreword under the 2 seats in the front to prevent 'porpoising' (sinking and popping).

Decontaminating ballast bags or PWC tanks can sometimes be done separately if they can be removed like an add-on system. You do not have to run the pumps if the hoses are dry; just decontaminate the bags themselves. You do not have the fill the bags completely. Generally 5 gallons per bag will suffice, at which point the bag can be massaged to ensure that all inside walls have been decontaminated.

Decontamination Troubleshooting: First, ensure you understand the system components you are decontaminating to help troubleshoot issues during a decontamination.

The pumps may be very slow, may not cooperate, or in many cases, over-heat and shut off. In these cases, the system can be dismantled (with permission by the boater). Some have found that pushing a small garden hose directly into the fill ports on the

bottom of the watercraft has worked well to speed up the process and make sure the pumps are picking up all the water. Use a piece of garden hose with a 3/8" quick connect attachment to the trigger. Always keep a close eye on the attachment you are using to ensure it hasn't come off; damage to the pump will occur with no water flowing.

Remove the pump hoses; some are quick-connect style plastic fittings, others are PVC and/or screwed in, while most are simply hoses clamped onto barbs on the pump. Be careful to not break off the barb connectors. Old hoses can be difficult to remove; use the hot water from the trigger to heat up the hoses until pliable (about 30-45 seconds) to more easily remove.

You may not be able to remove the hoses for one reason or another. Other options include trying to get the system to work, try to dismantle the system at the other end of the hose, or the tanks (assuming that the tanks are accessible). The fill and breather ports on the tanks will be on the top, and the empty will be on the bottom on one side. You may have to fill through the empty ports if this is the only one you can reach. Only attempt this if the trigger and hose can be physically connected (hose clamp, hose connector, etc.). DO NOT attempt to hold the trigger in place as the pressure will build and it may spill/spit hot water at you or others. Drain the water into the bilge and allow bilge to drain onto the containment mat. Decontaminate the bilge area again.

RAW-WATER SYSTEMS

Through Hull Fittings

Through hull fittings are used extensively on ballast systems as intakes, breathers, and discharge ports.

Decontaminating Through Hull Fittings:

It may be difficult to determine which through hull goes with which system because the plumbing is often hidden. Here are a few things to consider while decontaminating:

Intakes:

1. Some systems have multiple intakes, one for each bag/tank. They must all be addressed individually. Only run the pump for the bag/tank you are filling. Make sure to trace the hoses so you know which pump you are using. If you cannot see the hoses adequately, put your hand on the pump and have the owner turn on each pump in VERY short spurts until you feel the pump turn on.
2. Some intakes are on the rear of the vessel. Screens sometimes screw off and allow for the female hose adapter on the decon unit to screw on. Be careful whenever screwing the metal adapters to plastic threads.
3. Sometimes one intake can service multiple bags/tanks and only have one discharge port or breather, such as in the X-Star add-on ballast system for the forward two ballasts.
4. Systems with manifolds can be run to fill all the tanks through one intake. They may all share a discharge port or there may be several discharge ports.

It has been found that decontaminating is easier using either the redirector, low flow nozzle or the ballast buster to push directly into the intakes (also see Troubleshooting section).

Breathers:

1. Each ballast BAG needs a minimum of one through hull for both fill and empty (using a reversible pump). A breather is not necessary because the bag expands and contracts, but they may still exist. Be VERY careful with this system as the hot water, steam, and pressure from the decon machines could rupture the bag. Check to make sure the bag vents out a through hull. If it is not, fill in short spurts, and remove your decon attachment from time to time to relieve the pressure.
2. Each ballast TANK needs at least one breather valve to let the air escape or enter.
3. For systems that can fill or empty very fast (e.g. Calabria and MB Sports), there are usually multiple breathers to let the air escape as fast as possible. The 2014 Centurion Enzo 244 has VERY large "Ramfill" breather ports. One option to decon these tanks is shown. Another option is through the inspection port, or the transom drain valves (like those on Calabria's and MB Sports).

Discharge Ports:

1. Some pumps have 2 or more discharge ports per tank, sometimes on opposite sides of the vessel.
2. Some systems discharge out the side of the hull, and others through the intake. Remove the Fake-A-Lake before flipping the empty switch so that water is not trying to escape the sealed intake.

RAW-WATER SYSTEMS

MUSSEL MAST'R BALLAST • BALLAST INSTALLATION

Vessels with the Mussel Mast'r ballast filtration system may be exempt from ballast decontaminations in some states. [VERIFY CURRENT STATE] However, the system up to the filter should be inspected for water or moisture. The installation of these systems has not yet been homogenized.

Inspect the filters for the appropriate security seals and dated tags. There should be security ties that prevent the filter from being removed, or the system from being opened. If they are missing, the system is NOT exempt.

The system is installed to be self-draining from the filter back through the intakes. Decontaminate the system if it is not self-draining or moisture is found. Pump hot water through the system as you would normally for 1 minute. Or, as we have requested, the filters will include a flush point on them to hook up a hose attachment.

Filters may also include a drain on the bottom of the cup to drain the water out. The bilge will have to be decontaminated if it drains into the bilge.

Ballast systems are installed 4 main ways:

1. Single Intake- A single intake and pump with a distribution center (manifold) that may use electronic valves to direct the flow of water from the pump to one or all of the tanks or bags. These are seen on Mastercraft, Supra and Moomba for example. Mastercrafts use several pumps mounted AFTER the manifold, and no valves. Supra and Moombas mount a single pump BEFORE the manifold and use valves AFTER the manifold to direct the flow of water.

Decontamination- Install the Fake-A-Lake to the single intake and fill the tanks. Fill the tanks all at once or individually. Filling one tank at a time is recommended to ensure it fills properly and allows it to drain while filling the next one. It also limits the amount of water dumped on the containment prevents excessively.

2. Multiple Intakes- Each tank/bag on board has an intake and pump; each considered a separate system. These are found on Malibu and Sanger.

Decontamination- Decontaminate one tank at a time. Ensure the intake being filled is for the correct tank, otherwise damage may occur to pumps it is run dry. Empty each tank as the next is filled.

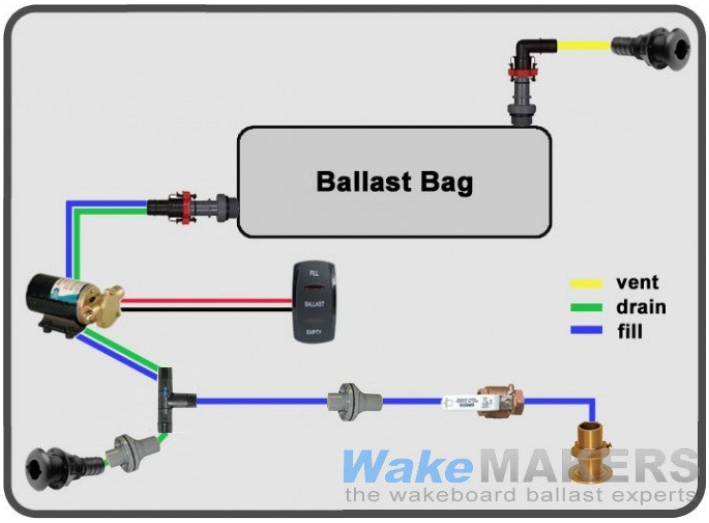
3. Gravity Fill/Ram Fill- Gravity fill tanks are usually incorporated into the hull of the watercraft to be below the water line. Large gates (3"- 4") on the rear of the vessel open to fill when not moving, and open to empty when moving forward. These are found on Calabria, MB Sports wake boats, and Hunter and MacGregor sail boats. Do not confuse this with the "Gravity Ballast System" on Moomba watercraft. They use several pumps and not gravity. Ram Fill systems, such as the 2014 Centurion Enzo 244, have large scoops under the boat to fill while moving. They have valves on the transom to empty (e.g. MB Sports and Calabria) and an intake and pump system for forward ballast bags (e.g. Malibu).

RAW-WATER SYSTEMS

BALLAST SYSTEM DEVICES

4. Removable System- Any of the above systems may be added to create or add to an existing ballast system. They are sometimes kept separate with a hose that is tossed in the water over the boat and are not wired or plumbed into the boat. An owner may want the advantages of ballasts without the cost or complications of cutting holes in the boat, adding plumbing or wiring new lines.

Decontamination- Aftermarket bags can be removed and inspected for dryness which may eliminate the need for decontamination. Decontaminate in parts if the system comes apart. Decontaminating the intact system requires the pump to be placed in a bucket constantly filling with hot water. Bags do not need to be filled all the way; 5 gallons per bag usually suffices. Massage the bag to ensure the entirety of the inside walls are decontaminated.



Devices that may be found with a ballast system (see below for more information)

1. **1/4 turn ball valve, or Sea Cock**
2. **Sea Strainer**
3. **Check Valve**
4. **Anti-siphon or Vented Loop**
5. **Manifold**
6. **Solenoid Valves**
7. **Aerator style**
8. **Flex Vein, Impeller, or Reversible Pumps (Johnson)**

1. The Sea Cock is located very close to the through hull for that particular intake. It is used as an emergency valve to prevent taking on water should the rest of the system fail.

2. The sea strainer is used to remove large solids from the water prior to entering the manifold or pumps. Debris in the water could block the electronic valves or harm the pump.

Some systems will have an intake screen, which is not a sea strainer. It can be removed to flush the ballast system or clean debris from it.

RAW-WATER SYSTEMS

DECONTAMINATING BALLAST SYSTEM DEVICES

Decontaminating: Inspect for debris, remove and clean prior to completing the decontamination on the rest of the ballast system.

Hand-made Sea Strainer Back-flush attachment

It is a 1/2" 45- degree angle fitting pvc cemented into a 1/2" treading fitting. It is attached to a couple of brass fittings to make it adaptable to our quick disconnect system off the extension hose. "It is wrapped in electrical tape until I can get heat shrink protector as I wasn't sure if the heat from the water would compromise the cement application. It seems to be holding up like a champ!"

Note, consider doing this with the burner off when back flushing this line or clean out the sea strainer as it will be hit with the hot water when you flush the motor. Some of these sea strainers are in difficult access locations and not all the water can be directed into the line 100% of the time and this will prevent your hands from getting burned.

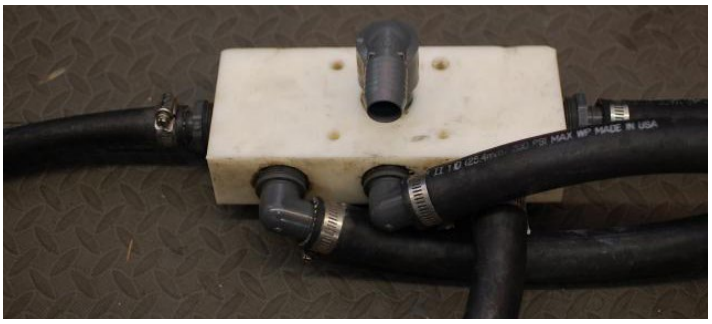
3. Check valves are one-way valves that prevent water from passively draining from the ballast tanks/bags.

Decontaminating: Do not force water in the opposite direction than intended as it can damage the valve or hoses.

4. Vented loops have a similar use as check valves. They allow water to pump through, and when stopped, air seeps in to prevent a siphon from being formed. It prevents ballast tanks/bags from passively filling or draining when the vessel is in motion.

Decontaminating: More air is let into the system the higher it is mounted, thus it may be harder to push air through when decontaminating. You can hold a finger over the valve to prevent letting any more air into the system. This allows you perform multiple attempts if needed.

5. A manifold separates a single source of water from a single through hull and directs it toward each ballast tank, acting as a splitter.



Decontaminating: Some provide places for either hose hookup or additional tanks/bags to be added. Use this to hook into the system provided you verifiy the tanks/bags have vents, the sea cock is closed, and all the other valves to the ballasts (if present) are open. Start the pumps FIRST, but only by a fraction of a second, as you will not be able to force water through when the reversible pumps are not running.

6. Solenoid valves may be found after the manifold (depending on the pump). It is common with Moomba and the Supra prior to 2008 (the system was designed for sprinkler systems, and is notorious for failure and slow operation).

Solenoid valves are electronically controlled designed to maintain pressure in the line so that pop-up sprinkler heads would stay risen.

Decontaminating: The ballasts will not fill if you are unable to supply significant pressure to open the valves. The single aerator pump on these systems is incapable of producing much additional pressure to help.

RAW-WATER SYSTEMS

DECONTAMINATING BALLAST SYSTEM DEVICES

The valves usually have a manual override that can be switched up so the valve remains open. This restricts the flow from the pump and causes the ballasts to fill very slowly (10-15 min each). It may be better to disconnect the hoses first to decontaminate the system in parts.

7. Aerator style pumps are smaller and usually made of plastic. The pumps employ a small plastic fin on a motor shaft that turns at high speed (like in a fish tank filter). Common brands include Rule, Whale, Tsunami, Sumo, and Shurflo Piranha.

Only certain ballast / bilge / livewell / and wash pumps are rated to the temperatures we are using. Jabsco pumps are rated to 180°F (black metal with silver tag), but Shurflo pumps (blue and white plastic) such as the Piranha, Pro Baitmaster, Bait Sentry, Blaster, Xtreme, and Aquaking are only rated to 130°F. Shurflo only recommends temperatures up to 110°F. Rule pumps (red/blue and white) are only rated to 125°F.

Ensure this information is understood by the owner when you are decontaminating the pump. No damage from heat has occurred yet to these pumps, but the pumps may turn off temporarily due to excessive heat/use, and warranties may be voided, it may decrease the life of their pump, or render it inoperable.

Decontaminating:

a. The fin does not flex against the sides of the pump housing (like impeller pumps) so water can flow freely through them whether the pump is on or off. Some sort of check valve or vented loop is required.

b. These pumps create NO suction power and are NOT self-priming. They must be primed after trailering because they do not pump air. You must ensure a very tight seal to decontaminate these.

c. They move a lot of water but have little ability to create pressure, thus relatively small blockages are a big issue.

d. The pump is not reversible, thus there must be a fill pump and an empty pump for every ballast bag/tank, as well as extra plumbing.

e. They can run for much longer periods and can run dry.

8. Reversible pumps have a pliable impeller wedged into the pump housing which creates a seal. This pump has some advantages and disadvantages.

Reversible Pump

Decontaminating:

a. The pump acts as its own check valve as the impeller creates a seal. No additional check valves are necessary.

b. The seal allows it to pump air and create suction, or self-prime. Thus it can be mounted nearly anywhere and still create water flow, making it much easier for use on decontaminations.

c. The seal also creates pressure, allowing it to push air bubbles and debris through the system, rather than clogging.

d. It can both fill and empty the ballast so only one pump is necessary per system and requires less plumbing. In some cases, the pump is through the same through hull fitting as the intake. Other times, a check valve allows the water to escape through the side of the hull so the operator knows when the tank is empty.

e. This pump uses more amperage.

f. Reversible pumps must not be run dry and if run for too long can overheat due to the friction from the impeller fins. Most pumps have a temperature override to shut down if it gets too hot. This makes decontaminations with hot water slightly as they frequently shut off for several minutes to cool.

"Note: The pump may shut off as they are sensitive to heat from operation and from the hot water. You will have to wait while it cools down before trying again. It can seize if the impeller is sticking or the interior magnets can misalign.

First check that the wires are properly connected; then attempt to turn the pump on while tapping and shaking it. Forcing water through at pressure for a second will turn the impeller, which may start the pump."

Newer ballast systems sometimes operate the fill and empty cycles based on a certain time. We cannot provide the volume of water that would be pumped if in a lake, and therefore, the process is slower and the ballast systems sometimes turn off prior to actually being filled. Continue to press the fill button water comes out the overflow. The same may occur when emptying. You may have to hit the empty switch several times to recover all of your water.

RAW-WATER SYSTEMS

MASTERCRAFT X SERIES

Mastercraft X Series 2016+ Ballast Decontamination

Mastercraft recommends ballast systems on their X series vessels be filled while the engine is running to supply proper electrical current to run their high power Jabsco pumps. However, the pumps will still function with the engine off, but will not operate at full power, and will cause the pumps to turn off before the tank is filled.

Options to alleviate this issue while performing decontamination:

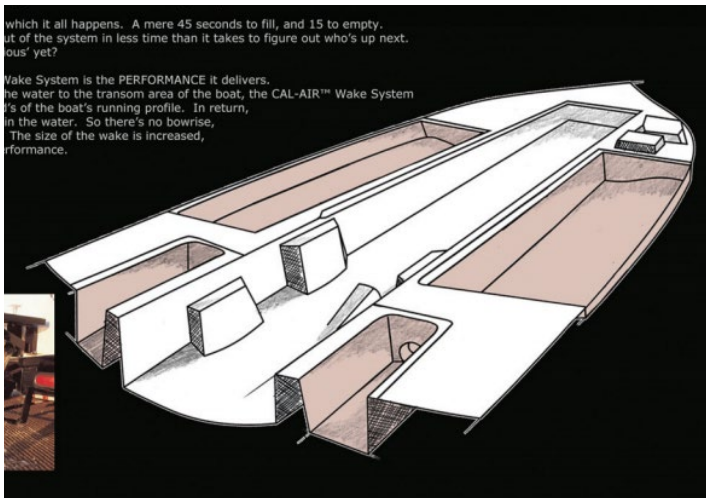
1. Supply cold water to the engine for the duration of the decontamination process. Turn the burner off, and have the boater keep the engine running at 1500 RPM for the duration of the decontamination process.
2. Run one pump at a time; newer pumps have an Artificial Intelligence system that blinks and senses low power, running-dry, clogs, timers, etc. It will turn off if it senses low power (<9.5VDC).
3. Older models have a set timer that counts pump rotations to determine when the system is full/empty and are not changeable. New systems operate on time intervals and can be changed in 30 second intervals. A pump turns slower if it has low power, but the timer will still run the same, resulting in an unfilled tank.
4. Use booster power if power is low. Make sure the owner sets the battery switch to utilize both batteries. A battery booster pack can also be used and connected to the onboard batteries.

Additional considerations:

Mastercraft and many other manufacturers that utilize Jabsco pumps for the ballast systems have dry run protection to shut off if they do not sense enough water supply. Ensure you have a tight seal on the ballast intake and water flow is sufficient. Make sure to fill one tank at a time on systems that share a single intake for two or more ballast tanks

Many of these vessels have lines that contain low points and priming the pumps can be difficult when the boat is not on the water. This causes the pump to auto shut-off, thus making it extremely difficult to decontaminate. Reversible pumps can backflush the tanks through the breather through hulls for a minute or two by switching the pump to drain to fill the lines. You can now begin the fill process the primed lines. Performing a quick flush requires a backflush through the breather holes. Allow the intake lines to drain normally, thus decontaminating them.

If the pump does not seem to be pumping water, first check the fuses and circuit breakers. Locate the pump that is associated with the tank that is not operating properly if they are intact. The pump is likely in need of a new impeller if it is vibrating, which indicates the pump is turning on. Mastercraft recommends the impeller on Jabsco ballast pumps be replaced annually if not sooner.



Gravity Fill System

Gravity fill systems use large gates at the rear of the vessel to fill water into the ballast system incorporated into the hull of the vessel. The vessel essentially sinks while the gates are open until the tanks are filled.

Gravity fill systems can be easily filled through the large rear gates until they begin to pour out. Inspectors found it easier to do with a long hose on

the end of the trigger. You can through the fill ports on the transom or through the breather ports on the side of the vessel. MacGregor's have ports on the inside of the vessel (left). MB Sports will also have fill/empty pumps.

Another helpful hint is to use small cones as a restriction in the ballast tanks fill ports (pointy end in the fill port). Fill through the small hole in the cone (feel free to cut the hole out if it hasn't already been done) to allow the tanks to fill more, if not completely. If they are not yet full, the rest of the filling process can be completed through the breathers, as long as there are multiples, or it is large enough not to create a seal around your attachment. Fill in spurts so the pressure does not increase in the tank if there is only one breather and it is tight on the redirector or hose.

Centurion Ramfill Ballast System Decontamination:

Similar to the Mastercraft X series, the Centurion Ramfill ballast systems are designed to work only while the engine is running and moving through the water. The system will not function normally during the decontamination process. However, the ramfill system can be closed with the engine off, allowing the tanks to fill through the large breather holes on the outside of the vessel on both the port and starboard sides. Centurion designed these systems with AIS decontamination in mind and includes a trailer mode feature. The trailer mode feature opens both the ramfill intake valves and the rear drain gates. The operator should select the trailer mode once the tanks are filled via the breather ports. The tanks should drain completely and decontaminate both the fill and drain ports.

The rear valves can be manually opened if you cannot get the tanks to drain and the rear valves are not opening. Some models have a handle directly on the gate valves about 6" from the stern, in the bilge on the port and starboard side. Some models do not have a manual opening handle; however, they have an Allen key bolt on the valve and with an Allen key clipped on the side. Turn the Allen bolt to open the gate and allow the tank to drain.

RAW-WATER SYSTEMS

GATE FILL BALLAST SYSTEM (CENTURION & MB)

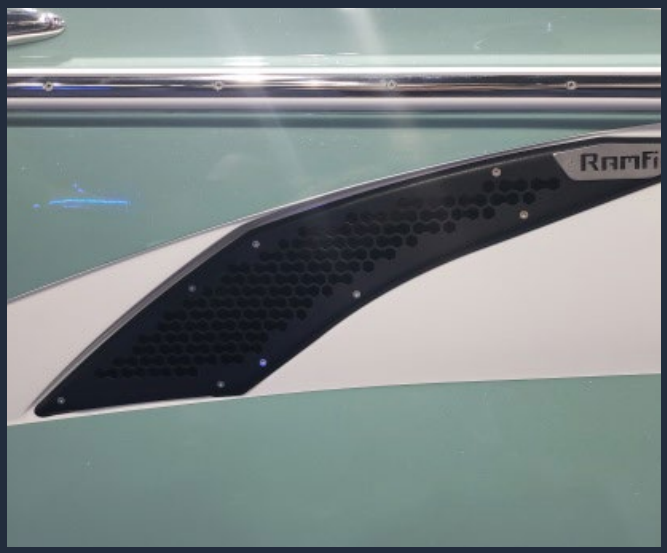
1

Make sure tanks have been drained as best they can. Close gates and scoop (if applicable) for the ballast system.

Gate on 2019 Centurion

2

Make sure you have the appropriate temperature (120F). Add water through the air vent using the diffuser.



Air Vents on 2019 Centurion Models

RAW-WATER SYSTEMS

GATE FILL BALLAST SYSTEM (CENTURION & MB)

3

Fill each Ramfill ballast tank for a minimum of 10 minutes - ideally 20 if water resources allow. Allow water to rest for a minimum of 5 minutes.

Decontaminator filling through air vent on 2019 MB Tomcat

4

Have the boat operator open the gates and allow them to drain. Ensure that the exit water is exiting the system at 120F.

Decontaminator measuring exit temperature at gate on 2019 MB

RAW-WATER SYSTEMS

MB & YAMAHA BALLAST SYSTEM • BILGE OIL SEPARATORS

MB Sports, Calabria, and Tige Gravity Ballast Decontamination:

These manufacturers use a simple pumpless gravity fed system for their primary ballast tanks. There are two large ballast tanks molded into the hull of the vessel that are usually fed by two large gates on the transom. Unlike the large breather vents found on Centurion systems, the breather holes are usually standard bilge sized through hull fittings, and are difficult to backflush.

The simplest way to flush these systems is to have the boat on as much of an angle as possible with the bow facing downward. You can have the boater drive the trailer onto wood blocks or use wheel chocks and disconnect the trailer from the vehicle and lower the bow of the vessel as much as possible. Then have the boater open the rear gates and fill the tanks through the transom. Once water begins to flow back out of the gates, verify you have proper decontamination temperatures, shut off the hoses and have the boater close the gates. Have the boater raise the bow of the vessel and open gates to drain. You can place blocks under the rear tires of the tow vehicle and have the boater drive on to them if needed to better drain the system. Be sure to check for any additional ballast systems onboard. Many models also incorporate additional ballast bags that use a traditional pump system.

Locate the gates inside the bilge and check for a manual override handle that will allow you to open them if the gates fail to open. There should be an Allen headed screw that will allow you to manually operate the valves with the appropriate tool, if no handle is present.

Note: Old MB Sports boats have a gravity fill ballast system, which is much smaller than those we see today. The small fill ports are on the bottom of the vessel and partially covered. Fill through the drain ports (similar to the bilge plug, only located port and starboard on the transom) using a ½" NPT male pipe end.

Yamaha Ballast Systems:

Yamaha's line of ballast boats come with a plumbed in ballast system. Many 2016 and newer Yamaha ballast systems operate from a touchscreen computer system and does not allow the system to fill or drain without the engine on. You need to supply cold water to the engine(s) and have the vessel running during the ballast decontamination; or you need to disconnect the lines from the bag and flush the intake lines, drain lines and bags manually.

Ballast systems with hard tanks and overflow bags

Wakesurfing has become increasingly popular, thus many manufacturers are producing vessels specifically designed or modified to have larger ballast systems to create the large wakes needed for surfing. Many vessels incorporate both hard tanks and bag ballast systems and can prove difficult to decontaminate. This is a popular aftermarket addition to older model wakeboard boats as well.

Most of these systems have 3-4 hard tanks (port rear, starboard rear, center, and optional front tanks). They may also have 2 additional bags on top of the port and starboard rear tanks. The bags are placed inline from the hard tank overflow system. The hard tank overflows into the bag once it is full; the bag overflows once full and the begins to flow out of the side of the vessel. Completely fill the hard tanks to decontaminate these systems and let them overflow into the bags before you drain the system. If you attempt to fill the bags by backflushing through the overflow through hull on the side of the vessel, it will simply drain into the hard tank until the hard tank is full. If the fill pump is not functional, the boater will need to get the pump fixed, or remove the bags; then backflush both the tanks and bags separately.

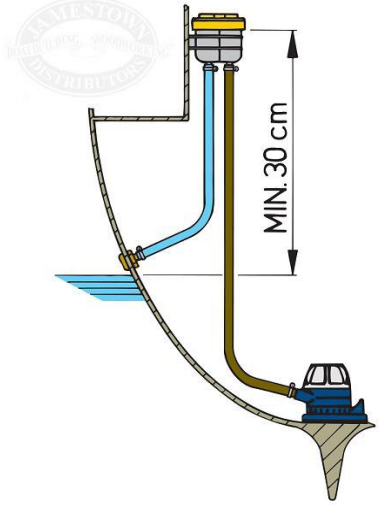
Bilge Oil Separators

Bilge oil separators are used on mostly larger vessels such as tankers and fleet ships that may have large amounts of oil accumulation. However, there has

RAW-WATER SYSTEMS

AIR CONDITIONING UNITS • DEVICES • DECONTAMINATION

been a push to include smaller sizes on pleasure boats because it is illegal to dump oily bilge water most places. They passively filter oil from the water pumped out of the bilge before it is discharged. Air Nautiques from 2013 and later may have a separator. They are configured as illustrated below.



Backflushing is not possible because it is a filter. Remember to always feel for backpressure whenever backflushing any system.

Air Conditioning Units

Air conditioning units are used to cool the inside of the vessel and are rarely found on vessels less than 26 feet in length. Air conditioning units are easy to identify, and quite simple to decontaminate. However, A/C systems require 120V power and will not turn on unless the generator is running or you have supplied shore power to the vessel.

Decontamination

Decontaminate an air conditioning unit in reverse (using an A/C attachment) through the discharge port, otherwise shore power or running the generator is necessary. A/C systems are almost always free flow allowing the flow to occur in reverse with out causing damage. There may be multiple discharge ports or multiple condensers, thus you may have to decontaminate more than one system. In most cases, going in one discharge port produces enough pressure to push water through all the condensers and discharge ports, as long as they share an intake. Use the supplied air conditioner flushing tool which is small enough to fit in the air conditioner through hulls. The exit for the air conditioner is usually very small (1/4") but still must be traced to make sure backflushing is not flooding the drip tray or another system. Make sure you have the correct through hull, as forcing water in others could flood or damage the boat.

You will find the following devices on an air conditioning system:

1. **Intakes / Sea cocks-** These are usually inside the bilge and run directly to a sea strainer, and then a pump.

2. **Sea strainers-** These are always present on A/C units to filter solids because plumbing inside the condenser is small.

   Decontamination: Remove the strainer and rinse it clean of debris.

3. **Impeller / reversible pumps-** Pumps almost always have an impeller. Deck showers use the same system, but usually run to the stern, whereas A/C units run forward to the cabin. It is important that you trace the lines so you are sure the pump is for the A/C. Ask the owner if they have deck showers and if so, turn the pump on and feel to make sure it is running. A/C units will not turn on unless the generator is running, or you have supplied shore power to the vessel.

   Decontamination: Decontaminate the pump in reverse as explained below under discharge ports. Decontaminate a running A/C system by hooking the water to the correct intake and turn on the A/C (shore power or the generator must also be running). Turn on all of the AC condenser units if there are multiple. Decontaminate one A/C condenser at a time.

4. **Condenser-** Condenser(s) can be inside the bilge or in the cabin. They are usually white or black and on a containment tray to gather condensate. There is an intake and discharge hose for water used to cool the condenser. There is an intake fan and filter which pumps cool air through ducting hoses throughout the vessel.

   Decontamination: See Impeller Pumps, above.

5. **Discharge Port**- The water exits the condenser through a discharge port. Air conditioning discharge ports are usually the smallest ones on the vessel die to its small plumbing. There may be a port that drains the drip tray (which may also drain into the bilge or the shower drain box). Decontaminate these systems in reverse, so it is important that you know which port is which. Pumping water in the wrong through hull will flood the drip tray and then the cabin. Some A/C systems have multiple condensers and/or multiple discharge ports.

   Decontamination: Use the appropriate tool to force water through the discharge port until you see water exiting the intake port. Be careful to notice excessive push back because it may indicate you have the wrong through hull or there is a check valve on the system. The plumbing is long and small so there will be some pressure. Do this for each discharge port unless the water comes out of all discharge ports and intakes at the same time.

Generators

Generators are gasoline engines hooked up to an electrical generator. They are usually red or white. You will rarely see these on vessels less than 26 ft. You will encounter the following systems on a marine generator:

1. Intake/sea cock
2. Sea Strainer
3. Generator
4. Exhaust/discharge

Generators take in water to cool the engine and discharge it with the exhaust, much like the drive engines.

Decontamination:

Decontaminate generators the same as a normal inboard engine, with a few notable differences:

1. Generators do not use as much water.
2. They are notorious for being poor at taking in water.
3. Impellers heat up faster than drive engines, be careful not to run dry, or for too long.

Cabin Heaters

Types of heaters:

- Fan/radiator heaters use the circulating coolant from the engine and only work if the engine is on.
- Hydronic/circulating coolant furnaces use the heat from a running engine to circulate to a furnace or fan, but also have a furnace that runs on fuel to heat the same coolant when the engine is not running. This system is also used to heat the engine on cold mornings or could double as a hot water heater.
- Electric space heaters are similar to home portable heaters, but draw too much power, and therefore will drain batteries or require the generator to be running.
- Vented propane heaters use a propane burner and a fan.
- Pot burners use the same fuel as the engine to provide radiation heat to small areas.
- Forced air furnaces use the same fuel as the engine and an air heat exchanger and blower to heat a larger area.

Non-vented portable heaters use kerosene, white gas, or alcohol and do not use fans or exhaust.

RAW-WATER SYSTEMS

SINKS AND SHOWERS

Decontamination:

The only types of heaters that need to be decontaminated are those that utilize the engine coolant (fan/radiator and hydronic/circulating coolant heaters) and only when raw water is used as the coolant (there is no heat exchanger on the engine). There may be heaters water as well, including for the deck shower, so ask and look for those.

The operator shall turn the heater on after you have started an engine flush, and continue your engine flush as normal. If you are unsure what type of heater is present, and it needs to be decontaminated, turn it on during your engine flush.

Sinks and Showers

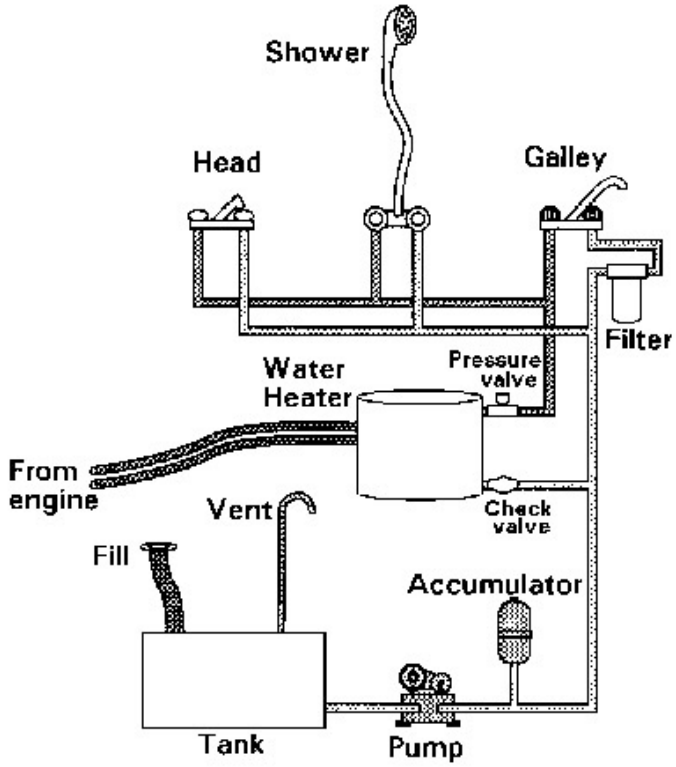
The plumbing on a boat is relatively simple. Most systems only have the ability to use fresh water not raw water. The systems on the boat use water from a tank onboard filled with water from shore.

Decontamination:

If the tank can be filled with raw water, hook up a Fake-A-Lake to the intake port, fill the tank to the top, wait 1 minute, and then run all the systems separately until the water has been fully discharged through the various systems (explained below).

You may see the following devices on the sink and shower system:

1. **Fill/intake**
2. **Sea strainer/water filter**
3. **Pump**
4. **Storage tank**
5. **Accumulator**
6. **Check valves**
7. **Water heaters**
8. **Pressure valves**
9. **Sinks**
10. **Showers**
11. **Raw water deck shower**



1. Fill/intakes- Some systems are capable of siphoning raw water that have an intake and sea cock on the bottom of the vessel.

Decontamination:
The entire plumbing system will need to be decontaminated, including the tank, heaters, sinks and showers as follows. Decontamination is not necessary if the holding tank can only be filled from shore.

2. Sea strainers or filters are usually found on a raw water system to remove solids. They may also have a more in-depth passive water filtration system to bring the water quality to a higher standard.

Decontamination:
Remove the strainer and clean/flush it out.

3. Pumps are used to pump raw water into the tank. They are also used to distribute the tank water around the vessel. The pump turns on when pressure is lost in the system (the sink/shower knob is opened).

RAW-WATER SYSTEMS

DECONTAMINATION

Decontamination:
Open the faucets and turn on both hot and cold water at all sinks and showers.

4. Storage tanks simply store the water and there may be multiple.

Decontamination:
Fill the tank to the top and drain by using the faucets as listed above.

5. Accumulators operate passively by allowing pump pressure to build against a diaphragm, and then supplement the pressure to allow the pump to turn off intermittently while water is flowing.

6. Check valves create water flows in one direction and prevent hot water from going back into the holding tank.

7. Water heaters can either be electric (using a heater coil) or hydronic (using the heat from the engine coolant when it is on) or both (allowing it to switch from one to the other for efficiency).

Decontamination:
See hydronic/circulating coolant furnaces under Cabin Heaters.

8. Pressure valves release pressure on a system with a heater in case pressure becomes too high as water is heated.

9. Sinks usually drain the water through a through-hull directly outside the vessel.

10. Showers use the same system as a sink, however the drain may be below water line, thus requiring a pump to discard the used water. The drain pump is usually inside a sealed box in the center bilge to prevent the shower water steam from filling the cabin.

Decontamination:
Showers rarely need to be decontaminated because they use fresh water. The entire system will need to be activated, including the shower drain pumps in the bilge, if raw water is used.

11. Raw deck showers have a separate intake/sea cock, sea strainer and pump to pump raw water. The pump runs water to the shower nozzles throughout the boat and typically have a switch on the dash. A hot water option may be found. Water is heated by circulating through the engine cooling system or through a hydronic water heater that uses engine coolant water. Hot water options for a raw water shower will have to be turned on when the engine is being decontaminated. If the shower gets its water from a separate intake (not directly from the engine cooling system), supply water to that pump as well as the engine.

Decontamination:

Clean the sea strainer, hook up water to the intake and activate the shower with the trigger pulled. Pay close attention to the potential buildup of pressure within this system and design your decontamination techniques to compensate; particularly when using high pressure decontamination equipment. Lower pressure equipment is recommended.

Only use a Fake-A-Lake if possible. Ballast busters should not be used on transom or other intakes for deck showers as the nozzle on the shower creates significant restriction to the flow of water, and therefore pressure is increased within the system. A redirector nozzle can be used if you feel for back pressure; release the attachment from the intake to relieve this pressure.

Do NOT back flush these systems from the shower nozzle or hose end backwards through the intake. The pump diaphragm and reversible pumps do not back-flush, and may have an in-line check valve creating a restriction Thus causing pressure buildup and the hose to rupture.

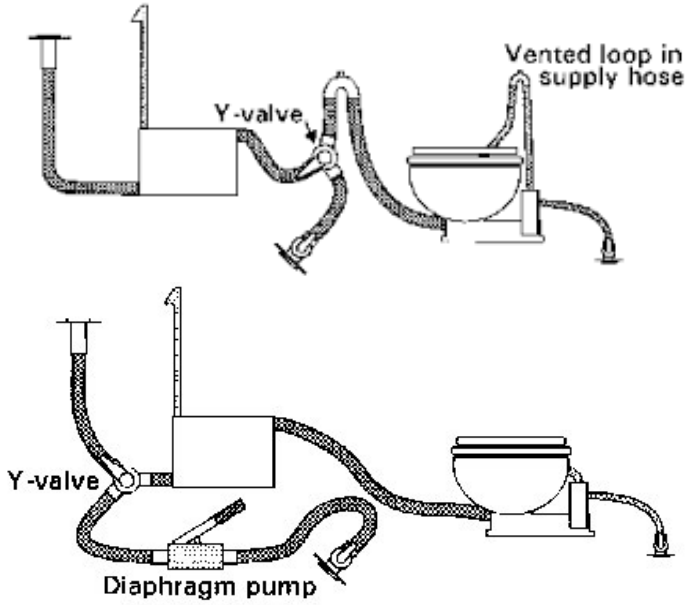
Turn on the hot water to decontaminate the lines from a water heater while running the engine. See Cabin Heaters.

RAW-WATER SYSTEMS

TOILETS • LIVE • BAIT WELLS

Heads

Toilets on a watercraft are referred to as heads. It is illegal to dump in coastal waters (<3miles out) and inland waters (lakes and rivers). Some only have the ability to dump overboard. Some have a holding tank to allow them to use the head when they are not in



open-ocean. These have a "Y" valve to select the destination of the waste (tank or overboard) and may be before or after the tank. The valve must be sealed by the Coast Guard when on inland waters to ONLY use the tank system. All tanks have a hose set up to vacuum it out when at a service station.

There are 5 different types of toilets.

1. Portable units are small units that have a holding tank on board like a porta-potty.
2. Manual/electric head pumps use either a manual or electric pump to push water into the bowl, which then gravity drains into the holding tank.

3. Macerator heads use a motor with blades to chop solids before entering the tank, or before discharge into open water.
4. Vacuum heads use a jet to create a vacuum that sucks clean water into the bowl and waste into the holding tank.
5. Jet heads use high pressure water jets to clear the bowl and gravity drains the contents into the holding tank.

Decontamination:

An intake through the hull supplies water as you flush the toilet several times. Hot water is not necessary as it is assumed that no AIS survive in the tank. Furthermore, the contents cannot be legally discharged into a waterbody. The toilet will not need to be decontaminated if the flush water is provided from the fresh water tank.

Live Wells

Live wells are basins designed to keep game fish alive while on board the vessel. They are also commonly found on pontoon boats. They pump lake water into a basin which may be re-circulated or aerated within the basin.

Bait Wells

Bait wells continually pump in new water and push the old water out to have well oxygenated water.

Decontamination:

Supply water to the appropriate through hull fitting and have the owner run the system as though it were fully operating; including the recirculation and aeration pumps. Pontoon boats have the pump alone and screwed to the outside of the pontoons. Remove it from the bracket and place it in a bucket of water that you continually fill with hot water. Run the empty pump to decontaminate that plumbing after it is immersed in the bucket.

TYPES OF WATERCRAFT

SKI AND WAKEBOARD BOATS

TYPES OF WATERCRAFT

There are many types of watercraft you will experience. The following is a basic categorization, realizing different programs will use different terminology. This is intended to be a basic guide of what the watercraft is and what systems you can expect to encounter. Although some are detailed separately, they may be considered the same type of watercraft (off-shore racers, are considered pleasure boats for example).

SKI BOATS

Ski boats have a sleek look and a low free board, meaning they sit close to the water. They are designed to have as little wake as possible when they pass through the water. They are not manufactured with ballast tanks, however "Fat sacks" or ballast bags are sometimes added to create more wake. These boats are becoming less common.

Drives used:

Direct Drive
Outboard
V-Drive

These systems could be on board:

Raw water shower
Fresh water shower
Heater

WAKEBOARD BOATS

Wakeboard boats are designed to make a large wake; the purpose of this is so the wakeboarder can use the wake as a jump. To make a wake larger, most boats use a ballast system (page 40) but some use a wake wedge (a wedge to sink the rear of the boat) mounted on the transom or both. Some boats only have one ballast tank and others have up to five. In most cases these tanks are filled from the bottom or transom area by pumps. You can tell wake boats apart because of their low freeboard (meaning they sit close to the water), extreme graphics, large tow towers and ballast tank through hull fittings.

Generally, wakeboard boats are inboard, V-drive boats. The V-drive engine is placed backwards in the rear of the boat to keep more weight in the back of the boat and create a larger and steeper wake. Some wakeboard boat models have direct drive engines, in which the engine is in the middle of the boat.

Drives used:

V-Drive

These systems could be on board:

Raw water shower
Fresh water shower
Raw water sinks
Fresh water sinks
Heaters
Head
Ballast tanks
Ballast bags

TYPES OF WATERCRAFT

OFF-SHORE RACERS / PLEASURE BOATS

OFF-SHORE RACERS

A type of pleasure boat made to go very fast 'off-shore' where they have room to reach higher speeds .They are usually very long (around 36'-50') and sleek and contain a lot more horsepower than most watercraft (1000 to 4000 total horsepower).

They are commonly set up as a very deep V hull, catamaran, or tri-hull race boats.

Because these boats are so powerful and large, they require large bodies of water to get up to their top speeds when not off-shore. Many of such water bodies in the western US are infested with mussels. You may find that they have frequently been in Lake Mead, Havasu, and Shasta. Do a thorough inspection for mussels.

Drives used:
Outboards, Inboard/Outboards

These systems could be on board:
These boats are made to go fast and usually don't have many other systems on board. Ballast systems are rare and help to stabilize the vessel at high speeds.

PLEASURE BOATS

The "pleasure boat" class has the largest variety of boats. These are the family fun boats, designed for being universal. Unlike ski boats that have a similar design, these boats have many different styles. Some are made for specific needs like boat camping, speed or a large capacity of people. Some may have wakeboard towers and or say "wake edition" on them, this DOES NOT make them wakeboard boats. You will find most engine varieties.

Drives used:

Stern Drive	Jet Drive
Outboard	Direct Drive
POD drive	Surface Drive

These systems could be on board:

Fresh water shower	Raw water shower
Fresh water sinks	Raw water sinks
Head	Heater
Generator	Air conditioner
Diverted exhaust system	

TYPES OF WATERCRAFT

FISHING BOATS / SAILBOATS

FISHING BOATS

Fishing boats come in all different shapes and sizes. Some are made for specific types of fishing such as bass boats, mud boats, ocean fishing and shallow lakes and rivers. They are frequently aluminum. Outboard engines are more popular on these boats than any other type for a few reasons; less maintenance, less weight and no winterizing. These boats can have many raw water pump systems like live wells and bait tanks etc. They are also more likely to be used in multiple water bodies compared to other watercraft.

Drives used:

Outboard
Stern drive
POD drive
Jet
Direct drive

These systems could be on board:

Live well
Bait tank
Fresh water shower
Heater
Raw water deck wash
Raw water shower
Generator
Head

SAILBOATS

Sailboats are vessels that are powered by the wind. They frequently have outboard motors or small inboard motors to allow the boater to get in and out of port where movement is restricted and wind may be limited. The motor may not be on the vessel during transport and may be stored in the tow vehicle and installed at the ramp or once launched.

TAHOE: This may be a point of contention where the motor is not currently on the vessel as the presence of the motor, electric or otherwise, determines the need for an inspection, the level of decontamination, and the fee.

Sail boats vary in size, shape, and styles, but are recognized most easily by masts and rigging that supports the sail(s). The sail may not be assembled and may not be visible at the time of inspection. There are also large keels on the bottom of the boat that may retract. These keels keep the vessel stable against the wind by putting the vessels center of gravity below the waterline. Instead of, or along with keels, some vessels may have ballasts on board (MacGregor & Hunter). Sail boats are sleek to allow for low water resistance. However, catamaran or trimaran styles are also common.

Drives used:

None (oars)
Direct Drive
Electric
Outboard

These systems could be on board:

Head
Raw water sink
Ballast

TYPES OF WATERCRAFT

WOODEN BOATS / PERSONAL WATERCRAFT

WOODEN BOATS

Until the mid 19th century most boats were made of all natural materials; primarily wood although reed, bark and animal skins were also used. By the mid 19th century, many boats had been built with iron or steel frames but still planked in wood. Pine, larch, cedar, mahogany, okoumé, iroko, Keruing, azobé and merbau are the most popular types of wood used for boats. These boats require a lot of maintenance and up keep, not making them ideal for the family fun boat. Today these boats are generally owned by boat enthusiasts because of the upkeep cost. These boats are collector's items and pieces of art. The wood boat generation had all the same boat classes we have today such as runabout, performance, day cruisers etc. It was the pioneer age of pleasure boating. Today some boat manufacturers still make replicas of these classic boats with modern day modifications and power plants.

Drives used:
Direct Drive Outboard

These systems could be on board:
Head Raw water sink

PERSONAL WATERCRAFT (PWC)

A personal watercraft (PWC), also called water scooter, is a recreational watercraft that the operator rides or stands on. They have an inboard engine driving a pump jet that has a screw-shaped impeller to create thrust for propulsion and steering. They are often referred by the trademarked brand names such as Jet Ski, WaveRunner, or Sea-Doo. There are a wide variety of "jet boats" that may exceed 30-40' in length. The Coast Guard defines a personal watercraft, amongst other criteria, as a jet drive boat less than 13' in length, in order to exclude from that definition, more conventional sized jet boats. Most are designed for two or three people, though four-passenger models exist.

Have the operator remove the cover in front of the handlebars and the seat over the motor when inspecting a PWC. Check for AIS and moisture.

Typically, there are two bilge plugs located on the rear of the PWC on either side of the steering nozzle. These must be opened and inspected for mud, water, animal and plants.

On the bottom of the hull, is an intake grate that must be inspected for plant life, mud, or suspected AIS attachment.

Drives used:
Jet Drive

TYPES OF WATERCRAFT

INFLATABLES

These systems could be on board:
PWC's don't normally have any type of systems however some models are equipped with bilge pumps and exterior ballast tanks.

Engine Types:
Normally the manufacture of the watercraft also produces the engine. PWC range from 2-4 cylinders with "muscle craft" having some type of forced induction, such as a supercharger or a turbo.

INFLATABLES AND RIGID HULLED INFLATABLES

Commonly used as fishing, rescue, research, and pleasure vessels, this category of boat is extremely vast. The best-known make in this category is Zodiac.

These vessels should be fully inflated in order to perform a proper inspection. Creases are difficult to inspect when folded. Folded inflatables also retain water and moisture for extremely long periods of time (>6 months) so owners should leave them inflated until they are completely dry.

The plastic glues and welds can become weakened by extended exposure to very hot water, so exercise caution when decontaminating. Either lower temperatures or less exposure to the joints should mitigate this risk.

Results of correspondence with various manufacturers are as follows:

Vanguard, Sotar, Maraira, Sea Eagle and APEX manufacturers said that their fabrics could be exposed to120 – 140° F water without any damage. AIRE sent us a sample of their inflatable fabric and we tested it with 120 and 140° F water at low (700 psi) and high (2500 psi) pressure. However, Sea Eagle said that the pressure directed at the seams would cause damage over time. NRS Rafts stated that these temperatures would damage their fabric. They did not offer an acceptable temperature for decontamination.

TYPES OF WATERCRAFT

EFOIL BOARDS

EFOIL BOARDS

The Lift eFoil uses a water-cooling system to cool the electronic module located inside of the board. The cooling system includes ~12″ of plastic tubing that has the potential to hold residual water and may require decontamination.

Decontamination Protocol

1 — Follow the standard operating procedures for your decontamination unit.

2 — Turn on the burner and measure the temperature of the water. Either 120°F or 140°F has been confirmed to not cause any damage to the system.

3 – At the lowest pressure, firmly apply the diffuser to the water intake at the front of the nose cone. (Board does not need to power on for water to flow through)

4 – Wait for the water to exit the discharge port on the underside of the board.

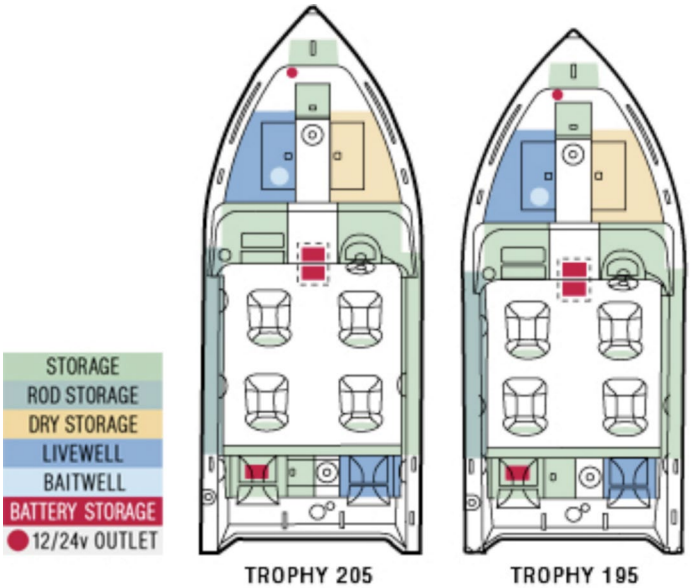
Do not disconnect the 12″ line to blow water out. There is also tubing that goes under the cover that you can see in the top image. Removing that cover for visual verification voids the manufacturer's warranty.

SPECIFIC MANUFACTURERS

ALUMACRAFT

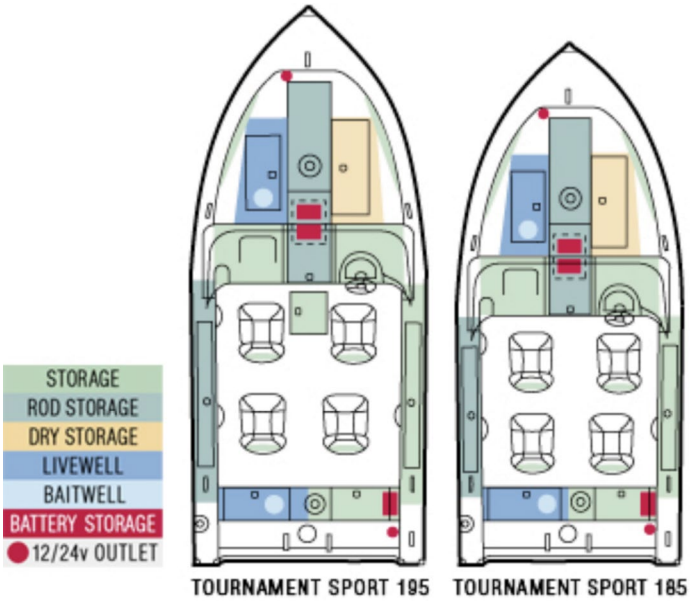
ALUMACRAFT

Alumacraft has been manufacturing aluminum, outboard driven boats since 1946. They focus on fishing boats from 10 feet to 20 feet 8 inches and have many different styles of boats ranging from simple to complex.



The **Trophy** fishing boat models are featured in their Sport and Fish boat series. They have live wells, bait wells, numerous storage areas, and a bilge area with a bilge pump.

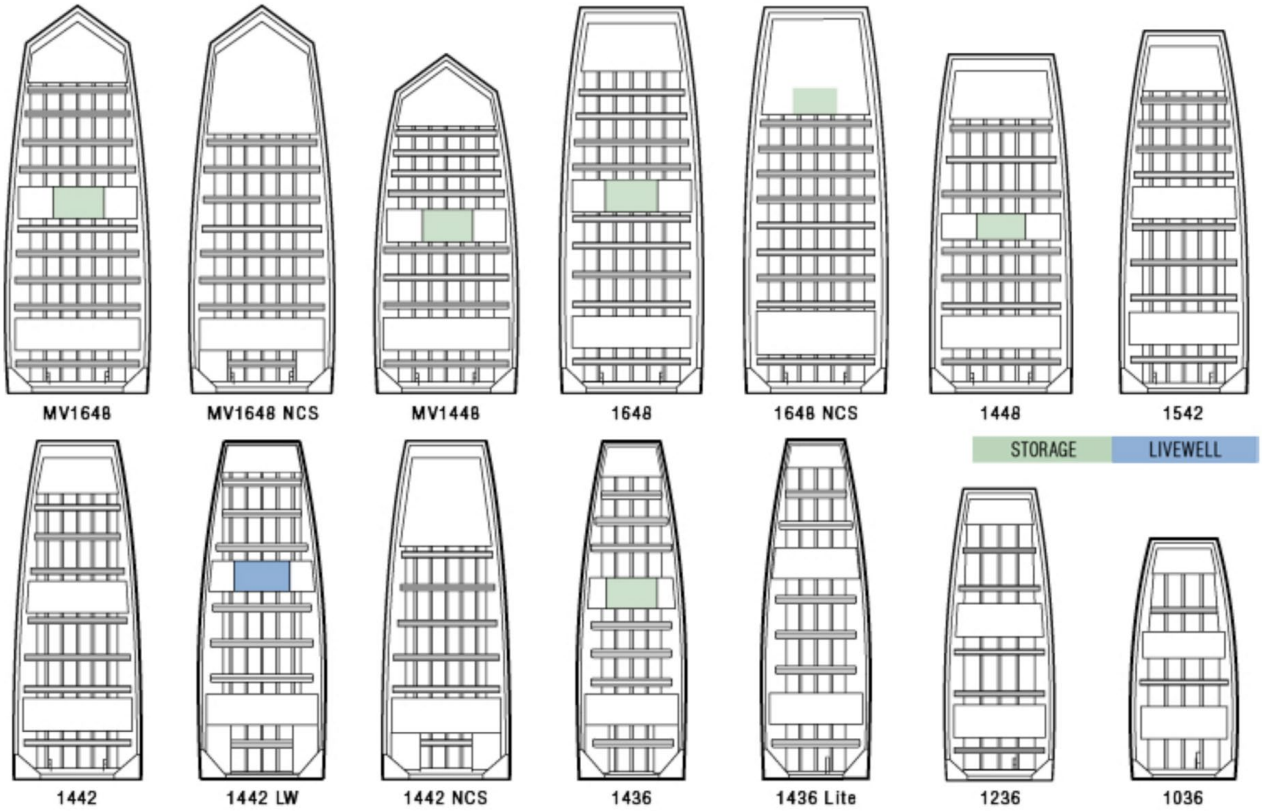
Another model of the Sport and Fish boat series is the **Tournament Sport** boats. These have larger sized live wells (12 to 30 gallons) that must be thoroughly drained prior to the boat leaving the reservoir.



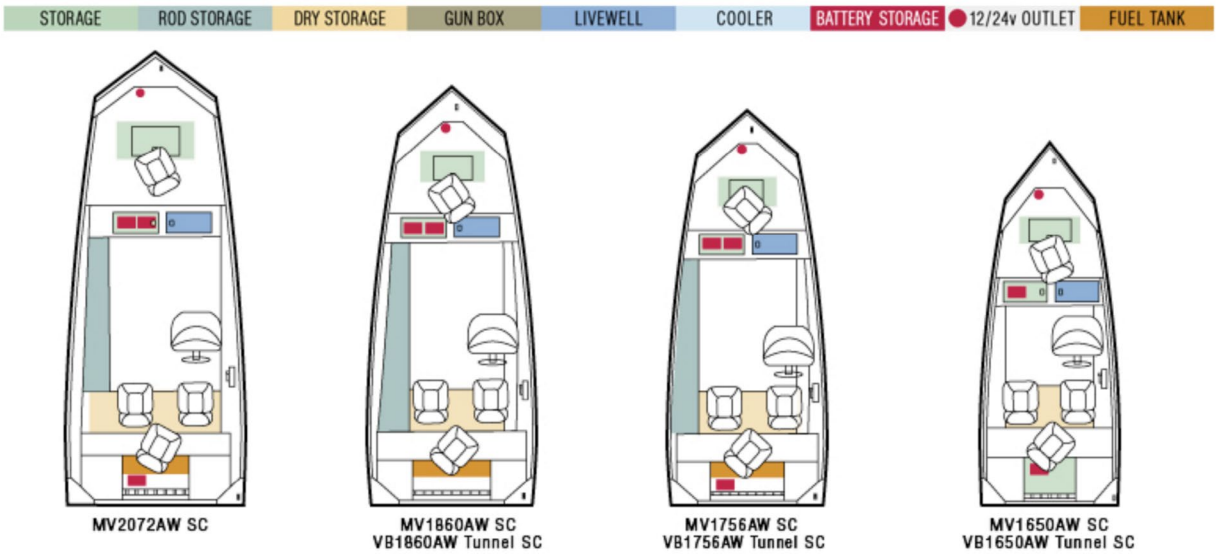
SPECIFIC MANUFACTURERS

ALUMACRAFT

The riveted **Jon** boat series has numerous models; some are simple boats with no compartments and a single outboard motor, while others have storage compartments or a live well.



All of the welded, side console Jon boat series have live wells, numerous storage compartments and bilge pumps.



SPECIFIC MANUFACTURERS

BAYLINER

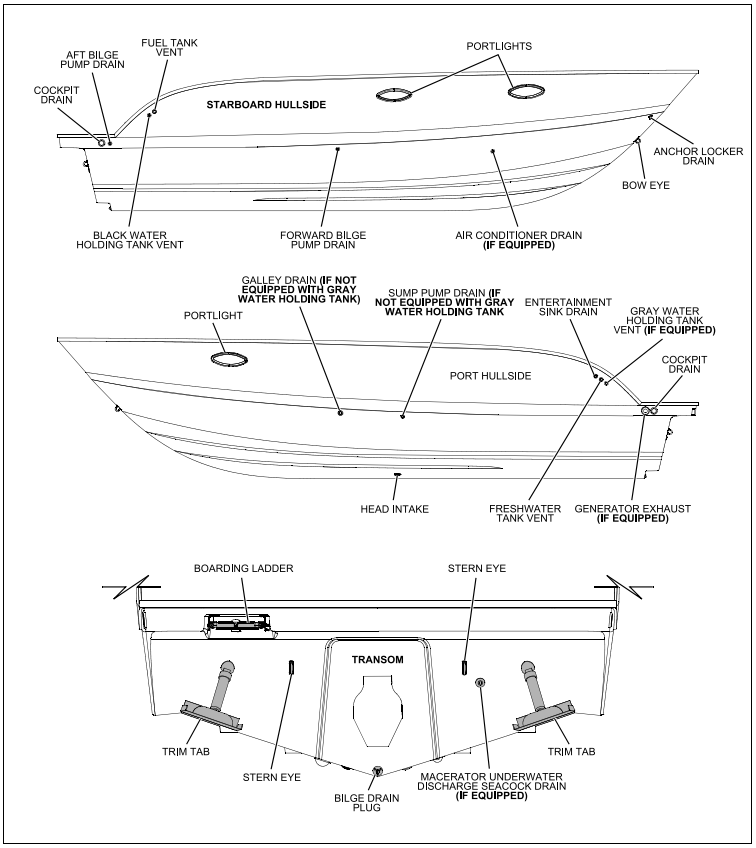
BAYLINER

Most Popular Models: Runabouts, Cuddys, Deck Boats, Cruisers, Bowriders.

Bayliner boats have been manufactured for over 50 years. They have too many models and types to publish. Our attempt is to focus on the most popular models and the specific areas that a boat inspector should be aware of in order to complete an inspection and decontamination.

When inspecting the exterior hull of a boat such as the Bayliner Cruiser series, the inspector may not be familiar with many of the items. This is when it is important to ask the boat owner questions about those items so that the inspector is doing a complete inspection and ensure a safe and effective decontamination.

Hull Views



SPECIFIC MANUFACTURERS

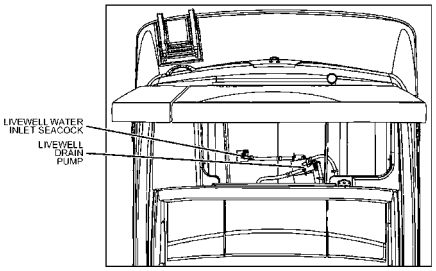
BAYLINER

All models have storage compartments which could hold an anchor or equipment such as skis, life jackets and other water toys that could have come in contact with the water body. Some have under-seat storage, cockpit floor storage, bow storage compartments (some dedicated and others hidden behind the backrests) and cockpit deep in-deck storage lockers.

Many of the swim ladders have a hide-away cover and can be located either in the front or back areas of the boat.

The Cruiser Discovery model has an under seat live well option which is quite hidden. The inspector needs to ask the boater if they have a live well so that this very important compartment is inspected. Never assume that a boat does not have a live well.

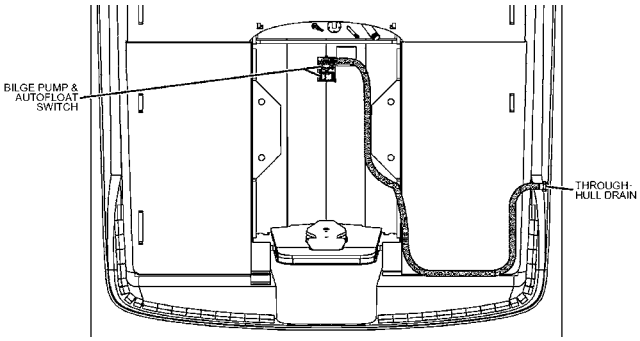
A few of the models have aerated live wells. Examples of this may be found on: 185 Ski N Fish, Bowriders, 195 Discovery, Cuddy 192 Discovery, and the Cruiser 266 Discovery.



The Bayliner models that are equipped with an in-board/outboard have a bilge pump in the engine compartment. The inspector can identify the pump's manufacturer and then adjust their decontamination unit's temperature accordingly.

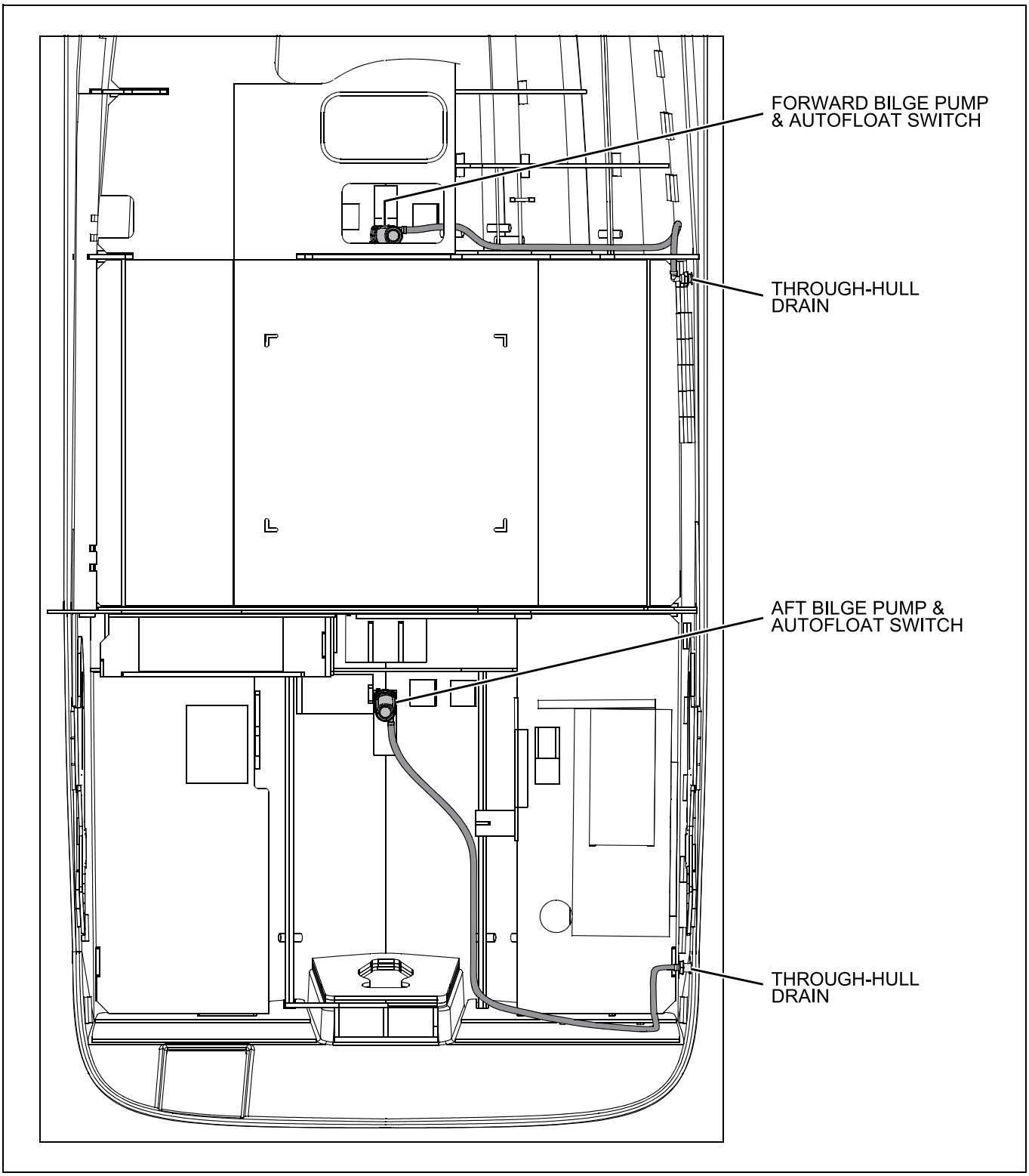
This photo shows a Johnson pump that is temperature rated at 170°F. Please note how it is lifted off the bottom of the interior hull. Water will still be present after this pump has been activated and no more water exits through the through-hull drain.

The Cruiser boat series have two bilge pumps with their corresponding through-hull discharge drain. Each of these pumps will need to be activated during inspection and decontamination. During decontamination this diagram emphasizes the need to first run the low pressure hot water into the through-hull fittings due to the length of the hoses between the pumps and the exterior of the hull.



SPECIFIC MANUFACTURERS

BAYLINER



SPECIFIC MANUFACTURERS

CHRIS-CRAFT

CHRIS-CRAFT

Chris-Craft has manufactured boats for over 130 years. They have numerous models and series that include: Runabouts, Cuddy Cabins, Bowriders, and Express Cruisers. They have a line of center console fishing boats that are very complex.

Catalina Fish Boat Series

These boats may have in the helm seat module a 28 gallon live well/bait well, two fish boxes on both the port and starboard sides with a macerator pump. Fish boxes are typically mounted into the floor of the vessel and are very often below the waterline or only partially above the waterline. The macerator pump is the ideal pump for the emptying of a fish box and live well receptacles due to its self-priming capabilities and its grinding properties. Typically, on this series, there are forward and aft bilge pumps with corresponding discharge through-hull drain fittings, a ladder storage area, and a raw water wash down outlet at the port entry.

There are numerous storage areas underneath the bow seating area. Inspectors must ask the boater to remove the cushions to access and inspect the numerous storage areas underneath.

SPECIFIC MANUFACTURERS

FISHER

FISHER

The Fisher lineup includes a full range of Mod V fishing boats, Deep V fishing and Sport boats, plus Jon and utility boats. The Jon and utility boats include options which have basic unpowered boats with only bench seats in their interior.

However, a number of their models do have bow and aft aerated live wells with bait well inserts, rod storage and equipment storage compartments.

As with other manufacturers, the differences between the models include size, equipment, and seating arrangement.

SPECIFIC MANUFACTURERS

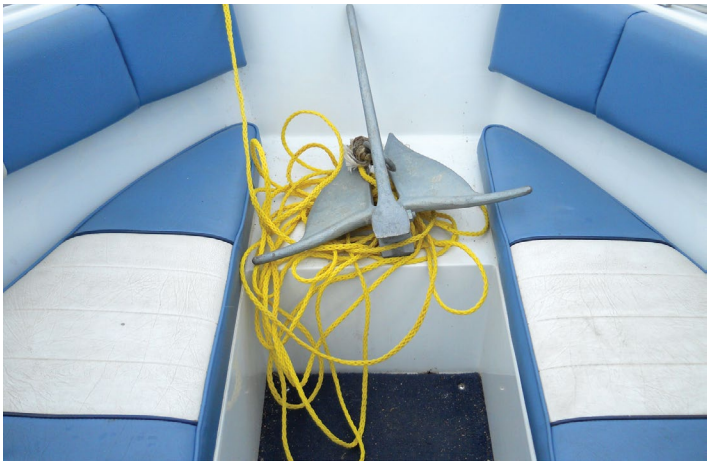
FOUR WINNS

FOUR WINNS

The Four Winns boat manufacturer has five series which include the H, SS, SL, F, and V Series. Within these series there are numerous models that differ in size and the equipment that is offered.

All of these series boats have interior compartments which makes them "complex" boats when determining risk factors. Typically they have anchor storage beneath the bow seat, a storage compartment for the aft ladder, and an in-floor ski locker with a rubber mesh or carpet liner.

For the models that have an inboard or inboard/outboard engine there is an engine compartment that must be inspected for standing water.



The engine motor compartment is located in the rear of the boat.

SPECIFIC MANUFACTURERS

GLASTRON

GLASTRON

The Glastron boat manufacturing company has been building fiberglass boats since 1956. They make Bow-riders, Ski & Fish, Deck boats, and Cabin models.

All models have bilge pumps, ample storage areas, ladder, and anchor storage compartments.

Many have the option of adding aerated live wells.

SPECIFIC MANUFACTURERS

GRENADA BALLAST TANK SAILBOATS

GRENADA BALLAST TANK SAILBOATS

Grenada sailboats utilize water ballast which allow the sailboat to be very light for trailering but heavy enough for safe sailing.

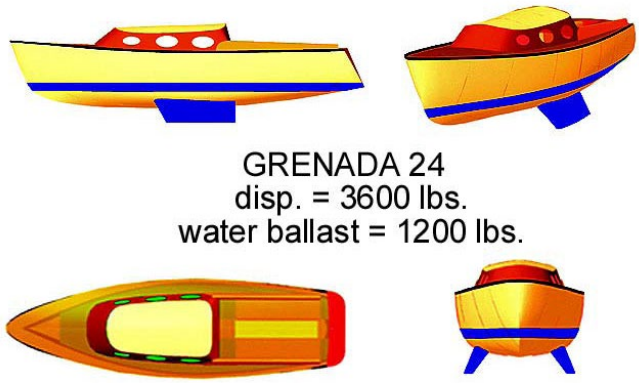
Water ballast is carried in the hull as well as the keels, which allows the keels to be thinner, resulting in reduced drag at high speed. The water ballast system is very simple, one valve for each keel. Open the valve and the keel fills (or drains if you're out of the water). Close the valve and the water is captured. If you want more performance, especially in light conditions, pumps may be added to transfer ballast. Each keel contains roughly 20 gallons of water.

In this photo, the sailboat on the left is un-ballasted. However, the one on the right is an example of a twin keel ballast sailboat and the water intake and drainage is the same as the Grenada 14.

Grenada 14

14 ft. LOA	66 in. Beam
18 in. Draft	110 sq. ft. Sail Area
1,150 lbs. Loaded Displacement	350 lbs. Water Ballast
250 lbs. Dry Weight	

The Grenada 24 combines the advantages of twin bilge keels and water ballast. The boat can be beached safely, gains stability by placing the water ballast low in the twin keels, and is light enough to be trailered.

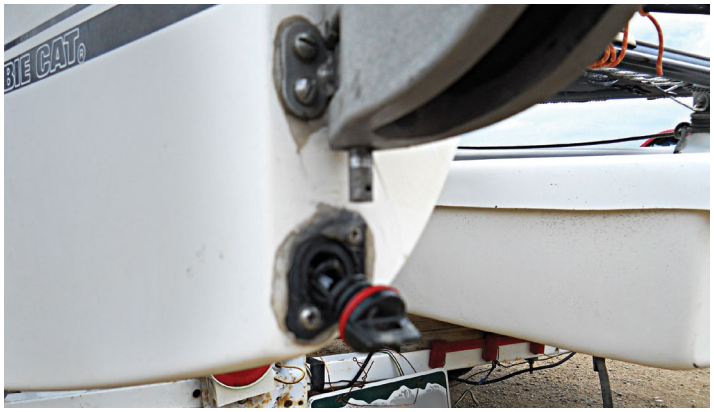


Internal and Water Ballast—The ballast within a sailboat is the weight that pulls the boat upright after a knock down. The lower you can get the weight, the better a chance the boat has of righting itself after a knock down. Some designs have the ballast attached inside the hull in the bilges in the form of concrete and iron, custom molded lead weights, or water tanks. This form of ballast works, but isn't as effective as an externally held ballast. In the case of water ballast, you fill the tanks when launching your boat and drain them when retrieving it back onto the trailer, so you don't have to pull all that weight on the road.

Water ballast sailboats are becoming popular in part due to their low trailer weight. With the water drained, these boats can be pulled by a small car, and are one solution to high slip fees. Trailering also opens up vast cruising area, from the Pacific Northwest, Florida and the Bahamas, Chesapeake Bay, and the Great Lakes.

SPECIFIC MANUFACTURERS

HOBIE CAT SAILBOATS



HOBIE CAT SAILBOATS

Hobie Cat manufactures two types of sailboats: Roto-molded sailboats with models that include the Bravo, Wave, and Getaway; and Fiberglass sailboats with models that include the Hobie 16, FX One, and Wild Cat. All of these models are simple to inspect. However the plugs on the back end of the catamarans must be open during the inspection, the rudders clean, and all ropes and equipment must be dry.

Open plugs on back end of catamarans.

Many trailers are tubular and therefore must be inspected and/or decontaminated thoroughly.

SPECIFIC MANUFACTURERS

JETCRAFT

JETCRAFT

Since 1996, Jetcraft has been manufacturing fully welded, heavy gauge aluminum boats. They have two series that may encounter, the Outboard and Jet Series. All of the models in both series have bow and anchor storage areas.

All of the models in the Outboard Series have bilge pumps and transom wells. The three models of the Outboard Series that have a transom fish locker are the 2025 Discovery, 2225 Discovery, and the 2425 Discovery.

A jet boat is a boat propelled by a jet of water ejected from the back of the craft. Unlike a powerboat or motorboat that uses a propeller in the water below or behind the boat, a jet boat draws the water from under the boat into a pump inside the boat. The water then passes through a series of impellers and stators— known as stages—which increase the velocity of the water flow. The water is then expelled through a nozzle at the stern. Most modern jets are single stage while older water jets may have as many as three stages. The tail section of the waterjet unit extends out through the transom of the hull above the waterline. This jet stream exits through a small nozzle at high velocity to push the boat forward.

When inspecting or decontaminating a jet boat, the boat inspector must locate the intake port on the bottom of the hull. Also, as with a PWC, inboard, or inboard/outboard engine, the engine compartment must be inspected/ decontaminated.

SPECIFIC MANUFACTURERS

KENNER

KENNER

Kenner boat manufactures two different Series, the VX and Vision series. The models in the VX Series include: 180 VX, 180 VX Tunnel, 19 VX, and 19VX Tunnel. The models in the Vision Series include: 1800, 1800 Tunnel, 1860, 1902, 1902 Tunnel, 2103, and 2103 Tunnel. Their focus is primarily fishing boats. They provide the boat owner with numerous equipment options.

- Aft live well w/recirculator
- Aft live well w/Max-AirTM induction system
- Fish 02TM oxygen generator
- Aft live well w/Pro-Air System and recirculator
- Aft live well w/Pro- Air System
- High-speed freshwater pickup

It is important to inspect these systems and to take extra precautions when performing decontamination as to not damage any of the equipment. The Vision Series has numerous storage areas, a transom well and live well areas.

SPECIFIC MANUFACTURERS

LUND

LUND

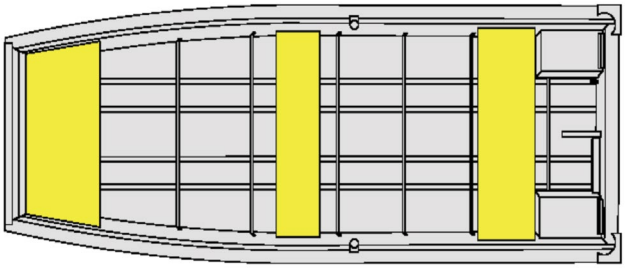
Lund boats are a popular brand used by many fishermen across the country. They manufacture six different series of styles, which include: the Rebel Series, Sportsman Series, Tournament Series, Sport & Fish Series, Jon Boat Series, and the Wilderness Series. Each series has a unique style and placement of the storage compartments, live wells, bait well, and bilge area.

All Lund boats, except for some of the Wilderness Series and Jon Boat Series, have a bilge pump and a live well with a possible attached bait well.

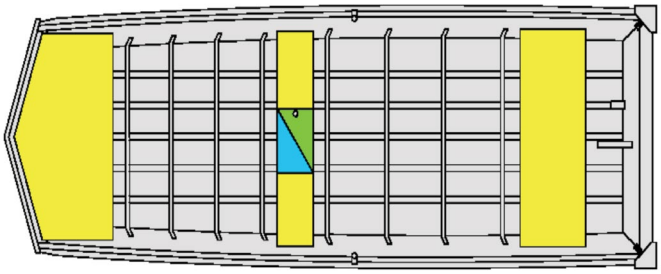
Following are diagrams of some of the series models. The **storage compartments** are colored **green**, the **live wells** are colored **blue**, and the **bait well** is colored **orange**. **Yellow** indicates **seating** and the **fuel tank** is colored **pink**.

Jon Boat

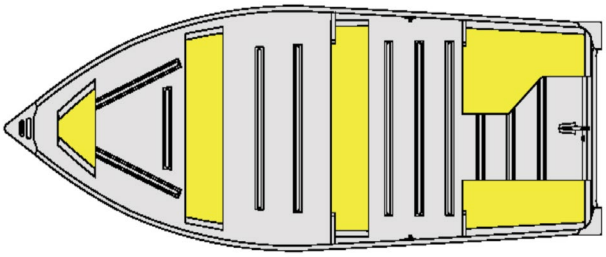
The Jon Boat models are #1436L, #1236, #1232, and #1032. These would be classified as a simple boat (an open hull design with no interior compartments).



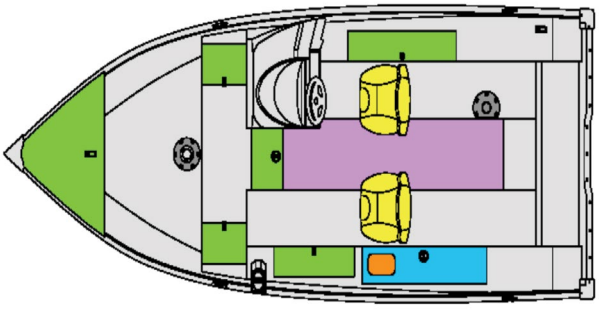
Other models of the Jon Boat series have a small live well (in blue) and a storage compartment (in green) in the center of the boat.**Wilderness**



The Wilderness Series models that would be categorized as a simple boat are: **WC-#12**, **#14** and **#16**; the **SSV-#14**, **#16**, and **#18**; the **A-#12** and **#14**; and the **WD-#14**. Below is an example for that Series.



The more complex boats in the Wilderness Series either have a live well located in the forward area of the boat or a live well with a bait well located on the port side of the boat. An example of a live well (in blue) and the bait well (in orange) are seen in the diagram of the **1600 Alaskan SS** model below.

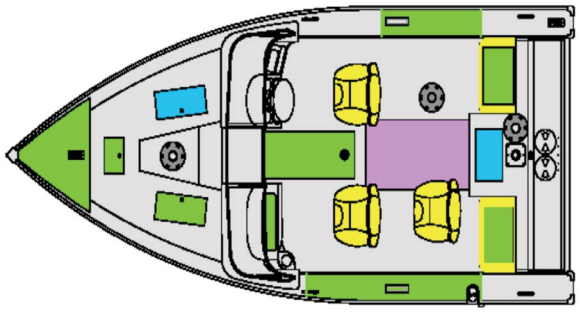


SPECIFIC MANUFACTURERS

LUND

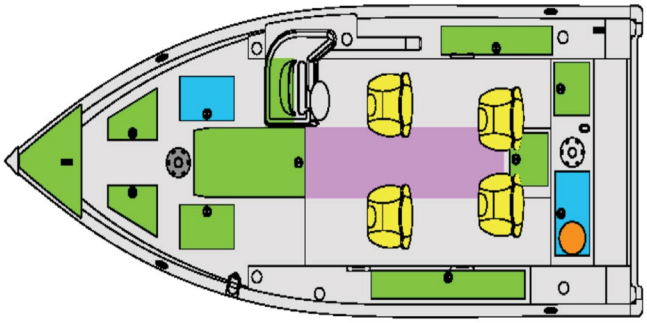
Sport & Fish

In the Sport & Fish Series, there are four models, the 2150 Baron, 1950 Tyee, 1850 Tyee and the 1750 Tyee. These all have two live wells located in the forward starboard side and in the rear of the boat. The **2140 Baron** and the **1950 Tyee** both have a bait well in the rear live well area. They also have two high-capacity bilge pumps. Below is a diagram of the **1750 Tyee** with the two live wells (in blue), and numerous storage compartments (in green).



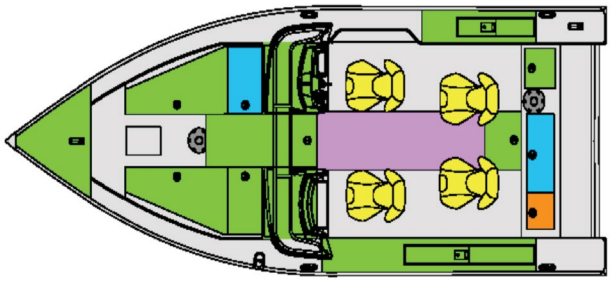
Sportsman

The focus on the Sportsman Series models is big decks, big storage and big capacity live wells. Most of the models will have two live wells, one aft and one bow, with many having an 18-gallon capacity and bait well. Depending on the model, they usually have a one manual bilge or one manual/auto bilge. The two models of the **Sport Angler**, **1800** and **2000**, may have a wash basin as optional equipment. This area needs to be inspected and possibly flushed during the decontamination process.



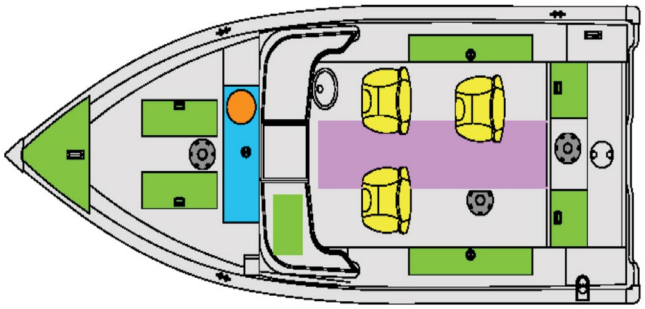
Tournament

The Tournament Series models have a huge bow casting platform which doubles as extensive storage. They have an aft bait well, a 27.5 gallon aft live well and a 10 gallon bow live well on the starboard side. They also have two high-capacity bilge pumps. These models are very complex and added time is needed in order to complete an inspection.



Rebel

The Rebel Series models are known for their live well systems and numerous storage compartments. All models have one manual bilge pump. The **XL** models have a 20 gallon aerated live well with a bait well. All other models have an aerated 10 gallon live well.



SPECIFIC MANUFACTURERS

LUND LIVE/BAIT WELLS

EXAMPLES OF LIVE WELL AND AERATOR PUMP DIAGRAMS

Below are some examples of live/bait wells from the Lund Boat Company. This section is intended to provide inspectors and decontaminators additional information regarding the complexities of wells.

Only low pressure and 120°F water can be used when decontaminating a live/bait well to ensure no damage is done to any of the numerous parts.

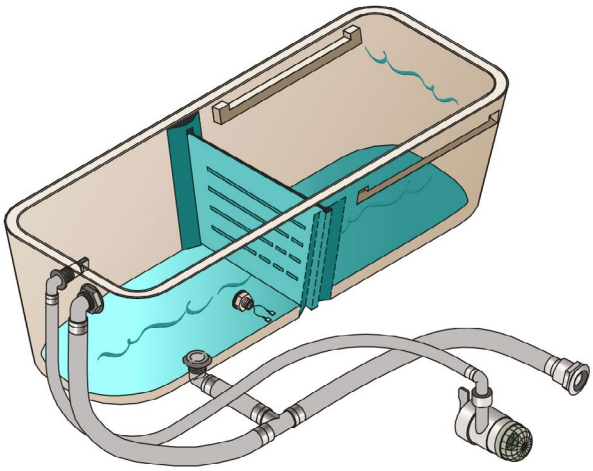
This is a two-pump design. One pump fills and aerates the well from above the fish while the other recirculates and injects fresh air via the Max-Air system for the oxygenation.

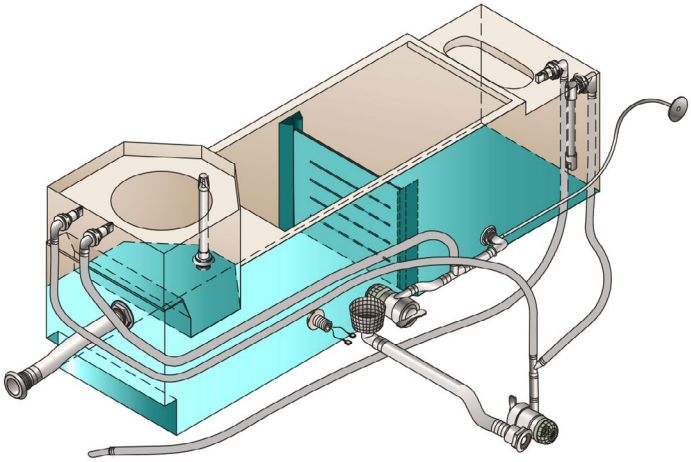
This live well features a single pump with a single-switch control. The aerator pump can be run continuously in manual mode or intermittently in automatic mode when equipped with a timer.

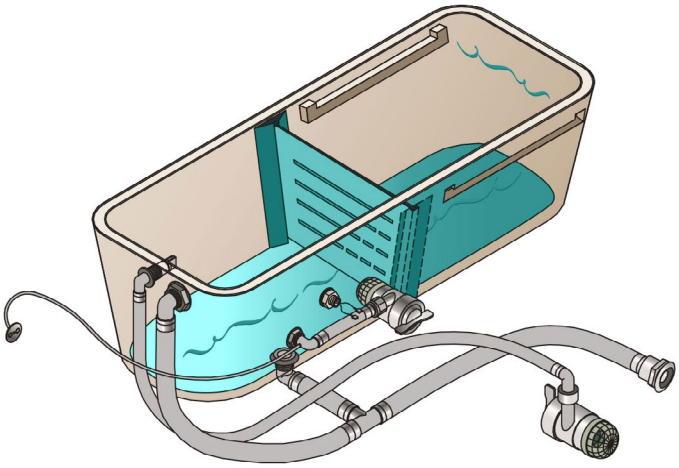
When decontaminating a live well and possibly a bait well, make sure that you use low pressure and turn your decontamination unit's temperature down to 120°F. Make sure that the live well pump and aerator pump are activated during the decontamination process to ensure that the pumps and the connecting hoses have been decontaminated.

The numbers on the following list refer to individual parts shown in all three diagrams.
1—Removable divider
2—Baitwell drain
3—Fill spray head
4—Overflow
5—Freshwater pickup
6—Waterproof light
7—Freshwater pickup spray head
8—Recirculating spray head
9—Max-Air intake
10—Recirculating outlet
11—Recirculating pump with filtration screen
12—Aerator pump with filtration screen
13—Through-hull drain
14—Drain with plug

The ProLong Plus is designed with a freshwater pickup integrated into the bottom of the hull where it forces a steady flow of water into the live well while the boat is running.







SPECIFIC MANUFACTURERS

MACGREGOR SAILBOATS

MACGREGOR SAILBOATS

MacGregor sailboats utilize water ballast which allow the sailboat to be very lightweight for powering and trailering, and also have the heavy stability necessary for safe sailing.

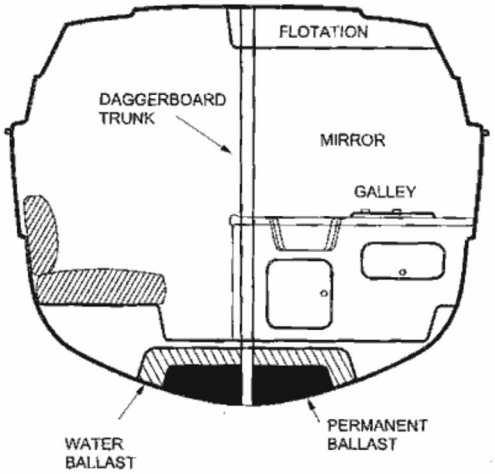
After launching, the transom valve is opened and a tank in the bottom of the hull is gravity filled with 1,150 lbs. of sea water. It takes about five minutes to fill. The valve is then closed, trapping the water. Under power or sail, the ballast makes the boat stable and self righting. When the boat is floated back onto its trailer, the valve is opened. The car and trailer start up the ramp and gravity drains water out of the boat, resulting in a trailering package that is lighter than most small powerboats. You can also empty the tank while the boat is in the water. Under power, at about six mph, open the valve on the transom and the tank will drain in about five minutes.

The daggerboard trunk is lowered during launch and retracted when the sailboat is in shallow water or being trailered. This area can't be decontaminated from the top and there is limited space from below to perform a decontamination with a trailer cross member in the way.

The diagram above represents a schematic of the MacGregor sailboat and its complexities.

A daggerboard is a retractable keel used by various sailing craft. While other types of centerboard may pivot to retract, a daggerboard slides in a casing. The shape of the daggerboard converts the forward motion into a windward lift, countering the leeward push of the sail.

Daggerboards are often long and thin, thus providing a better lift-to-drag ratio. Daggerboards are usually found in small craft such as day sailors, where their size is easily handled by a single person. When a daggerboard is extended through the keel, it improves a ship's stability.



SPECIFIC MANUFACTURERS

MALIBU

MALIBU

Malibu has four basic boat models: Wakesetters, Rides, Sunscape, and Response. All Malibu boats use inboard marine engines. Many of the boats share hull designs, but come equipped with different features:

- Wakesetters include VTX, VLX, 22MXZ, 23LSV, and 247LSV.
- All come standard with three ballast tanks.
- All may be ordered with an additional front ballast tank.
- Rides include 21V and 23V.
- Both come standard with two rear ballast tanks.
- Both may be ordered with an optional center ballast tank.
- Sunscape include 20LSV, 21LSV, 23LSV, and 247LSV.
- Ballast tanks are optional on all models.
- If ordered, the only option is three ballast tanks.
- Response include TXI, LXI, and FXI. • TXI and LXI have no ballast tanks.
- FXI has one ballast tank.

2019 Malibu 22MXZ

The sea strainer is located in the rear in between the engine and the transom on the starboard side as opposed to other models where it is forward near the transfer case.

SPECIFIC MANUFACTURERS

MASTERCRAFT

MASTERCRAFT

MasterCraft has been manufacturing boats since 1968. Their focus is in building ski, wakeboard, and luxury performance powerboats. MasterCraft has numerous models that include: the V, X, Prostar, Maristar, CSX, and the 300.

V model

The V model has the 200V, 215V, 225V, 235V, 245V, 255V, and 280V. This model has many storage/equipment compartments located in the bow and at the rear of the boat under the expansive sun pad. Many have a compartment for the ladder and anchor located in the bow of the boat.

- The 200V and 215V have I/O engines and bilges with pumps.
- The 225V (comes standard with ballast tanks), 235V, 245V, and 255V come equipped with an inboard engine.
- The 280V has twin inboard engines.

X model

The X model has the X-1, X-2, X-7, X-14, X-14V, X-15, X-25, X-30, X-35, X-45, X-55, X-80 and the X-Star. These are all complex boats with storage areas, a center drain plug in the floor compartment, bilges, I/O engines and inboard engines.

- The X-1 and X-14V can be ordered with either two or three ballast tanks.
- The X-7 and X-14 have the MTS Ballast System with port, starboard, and rear ballast tanks possible.
- The X-25 and X-30 have three ballast tanks, two in the back and one forward.
- The X-2, X-15, X-35, X-45, and X-55 have one ballast tank located under the floor board in the front of the boat. These also have an anchor/ladder storage compartment on the bow of the boat, and forward and aft bilge pumps.
- The X-80 and X-Star have three ballast tanks and twin inboard engines.

2019 X22 & X24 models

Location of the through hull configuration for the X24 and X22 models that contain the stacked tanks. There are check valves in the rear ballast bag vent hoses to aid in completely draining the bags. The bags can be quickly taken out without tools as there are quick connect fittings on the connections to the bag. They can be flushed and/or inspected once removed. The connecting hoses can be inspected and flushed if needed but they will not hold water once the system is drained.

There is X-Star model has the same tank configuration but doesn't have the check valves in the system. All of those ballast zones can be flushed through the vents on the side of the boat.

SPECIFIC MANUFACTURERS

MASTERCRAFT

New Mastercraft X22

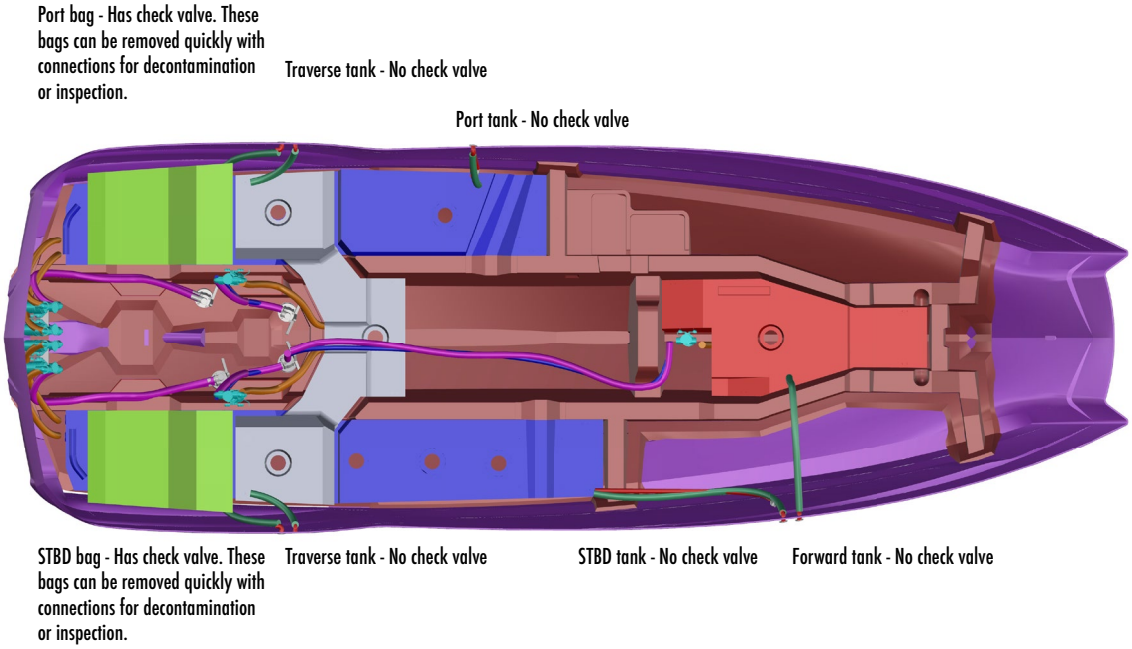
New Mastercraft X22 offers an engine flushing port as an option. The flushing port is located inside the engine compartment. Experts tested this out and have two observations to share:

1) If you force water in without the engine being on it does not backflush through the intake so you are not decontaminating that portion of the system.

2) The line is spliced into the cooling system AFTER the sea strainer. If you use this internal flushing port you are not getting water through the strainer.

Conclusion - if you are concerned with decontaminating the entire cooling system I would not suggest utilizing this flushing port. I would continue to flush through the intake as it does on the water to ensure you are decontaminating the entire system.

A side note - there are 3 intakes for four hard tanks and 2 overflow bags. The most forward intake filled both the center and front tanks. The rear intakes were oriented as I would expect with the right rear intake filling the right rear tank and the left rear intake filling the left rear tank.



SPECIFIC MANUFACTURERS

MASTERCRAFT

Prostar

The Prostar model has the 190, 197, 214, and 214V.

- All Prostar boats have the MTS Ballast System with the option of having a port, starboard, and rear ballast tanks.
- Prostar 190 and 197 have two ballast tanks standard.
- Prostar 214 has three ballast tanks standard.
- They have a bilge through-hull drain fitting on the starboard side.
- There is a center drain plug located in the floor compartment.
- Most of the Prostar boats have a shower wand attachment at the starboard aft.

Maristar

The Maristar has the 200, 215, 230, 235, 245, 255, and 280 boat styles.

- The Maristar 200 and 215 have a ballast tank located beneath the floor board. They also have a forward and aft bilge.
- The Maristar 230 has three ballast tanks, two in the back and one forward, and a forward and aft bilge.
- The Maristar 235, 245, and 255 have one ballast tank located in the front, a forward and aft bilge, and an anchor/ladder compartment on the bow of the boat.
- The Maristar 280 has three ballast tanks and two twin inboard engines.

CSX

The CSX model has the 220 and 265 boats available. It is the only model that has a fishing package as an option.

- CSX 220 comes with three ballast tanks, forward and aft bilge pumps and an anchor/ladder compartment on the bow.
- CSX 265 has three ballast tanks, three bilge pumps, twin inboard engines and an optional live well.

Tournament

The MasterCraft 300 is the cabin cruiser of the line. It comes with twin inboard engines, anchor/ladder compartment in the bow, a sink and shower, and bilge pumps. The engine compartment is located in the floor of the boat in the aft. There are numerous storage compartments for ski and wakeboarding equipment.

SPECIFIC MANUFACTURERS

MAXUM

MAXUM

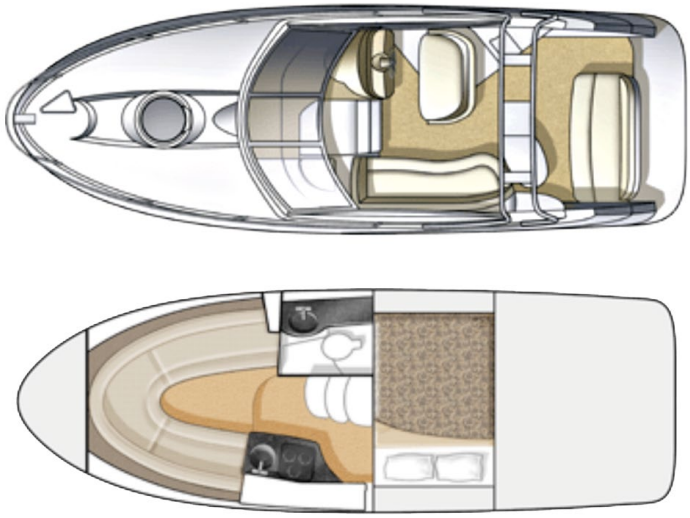
Maxum boat manufacturer has three types of boats: Sport Boats, Sport Cruisers, and Sport Yachts. Each type has numerous models each with unique challenges to a boat inspector.

Sport Boats

Their sport boats usually come with either an inboard/outboard engine or inboard engine. Within the engine compartment they have a bilge pump and corresponding discharge through-hull drain fitting on the outside of the hull. They have numerous seating areas with storage under the seat cushions that may hold equipment that has come into contact with the water body. Typically, they have two compartments on either side of the engine compartment that also contain storage areas.

Sport Cruisers

The cabin cruiser models from Maxum are complex and need to be carefully inspected. Within the engine compartment, they typically have two bilge pumps with their corresponding discharge through-hull drain ports. On deck, there are side storage shelves, storage under seat cushions, and an anchor line hatch and anchor. The transom has, among other items, trim tabs and a transom zinc.

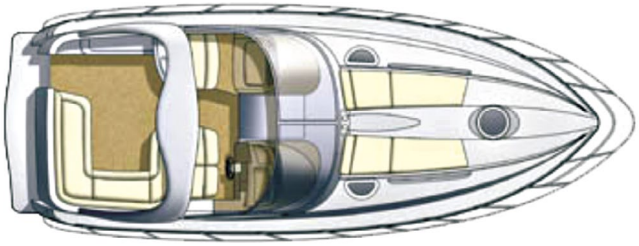


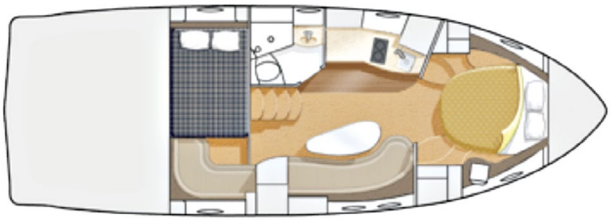
SPECIFIC MANUFACTURERS

MAXUM

Inside the "cabin" area, they have a head and galley. In the head, they have a sink and shower. In the galley there is also a sink.

The Sport Cruiser comes with a water holding tank (typically 20+ gallons). The boat inspector must ask the boat operator if tap water is used in these areas or if they are using lake water.





Sport Yachts

The length of these yachts, 37+ feet, is typically too large for our reservoirs and lakes. However, it is possible that they can be found at locations such as Horsetooth, Pueblo, or Navajo Reservoirs. They are equally as complex as the cabin cruisers and must be inspected carefully.

- A head with a sink and shower
- An on deck sink
- A galley with a sink

It is important for the boat inspector to find out if the boat operator is using the 30+ gallon water storage tank with tap water or lake water.

SPECIFIC MANUFACTURERS

PONTOON

PONTOON

There are numerous manufacturers of pontoon boats. They include but are not limited to: **Premier Marine, Manitou, Sun Tracker, South Bay, Starcraft Marine, JC Pontoon, Ponder, Ercoa, Landau,** and **Lowe.**

A pontoon boat typically floats and balances by means of two large, closed cylinders mounted lengthwise.

Some of those cylinders have vents on the top of the pontoons that release condensation that occurs naturally within the cylinder. Typically, pontoons do not have drain plugs or pumps installed to release this trapped condensation water. Other pontoons have welded seals. Some pontoons have partitions, creating two or more separate internal compartments. The insides of pontoon tanks cannot be visually checked for mussels or other aquatic invasive species.

• Check pontoons for water by knocking on them. If you hear a dull thud, they could be holding water or be filled with "dock foam". If you hear a hollow empty sound, the pontoon is most likely dry.

• Listen to pontoons. A sloshing sound when stopping the trailer will indicate trapped water in the pontoon. The inspector must then look for damage, holes or water leaking from the pontoon.

Pontoon boats can be simple to very complex; some have active live wells with pumps.

The live well pump is usually located in a cage-like area at the end of one of the pontoons. Some of the live well pumps are intake only; some can also assist in the drainage of the live well.

When performing an inspection, the trailers for pontoons are usually quite high off the ground providing the inspector good views of the underside of the pontoon and exposure to the trailer. However, as demonstrated by the photos below, there are lots of areas where ANS attachment is possible. During decontamination, the inspector has to be very meticulous and contact every portion with 140°F water and high pressure. Please note the large areas of carpeted bunks. These must be decontaminated by soaking them with 140°F water at low pressure.

Pontoons typically have lots of seating with removable seat cushions. During a high risk inspection, the inspector must ask the boat operator to open these areas and inspect the equipment, ropes, and all items that may have come into contact with the water.

This photo shows a pontoon that has two pumps located in the cage at the back of the pontoon. One pump is for the live well, the other is for a wash station.

One of the best aspects of a pontoon boat for an inspector is that the outboard motor is typically lowered during transport, which means that it should be fully drained when it is inspected.

SPECIFIC MANUFACTURERS

RANGER

RANGER

Ranger has been manufacturing boats since 1968. Today they have more than 40 different models within five different series: Bass, VX/VS, Fish-N-Play, Multi-species, and Saltwater.

Bass Series

The Bass Series has 12 models available. One of the most popular in this Series is the Comanche model. As shown below, it has a Venturi air and live well pump out system, and numerous storage compartments.

VX/VS Series

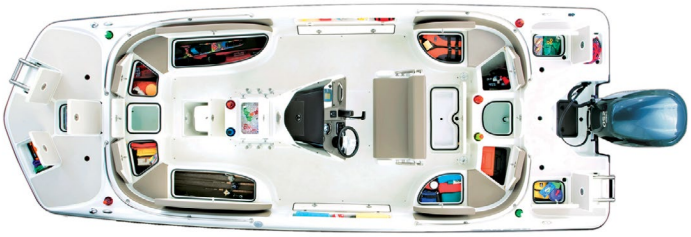
The VX/VS Series is complex in its floor plan. It has numerous storage compartments and a recirculating aerated live well with divider and filter screens.

Fish-N-Play Series

The Fish-N-Play Series has three models with numerous styles available: Reata, Angler, and SS.

The Reata shown below has larger seat capacity and is complex.

The SS model shown below has two live wells, a bow ladder area, and even more storage compartments.



SPECIFIC MANUFACTURERS

TRACKER

TRACKER

The Tracker lineup includes a full range of Mod V fishing boats, Deep V fishing and Sport boats, plus Jon and Utility boats. The Jon and Utility boats include options which have basic unpowered boats with only bench seats in the interior.

However, a number of their models do have bow and aft aerated live wells with bait well inserts, rod storage and equipment storage compartments.

As with other manufacturers, the differences between the models include size, equipment, and seating arrangement.

TROPHY SPORTFISHING

Trophy Sportfishing Boats offer a full line of fishing boats. Models include:
Bay Boats (19–24 feet), Center Consoles (17–22 feet), Dual Consoles (22 feet), Rolled Gunnel Series (16–18 feet), and Walkarounds (18–23 feet).

Bay Boats

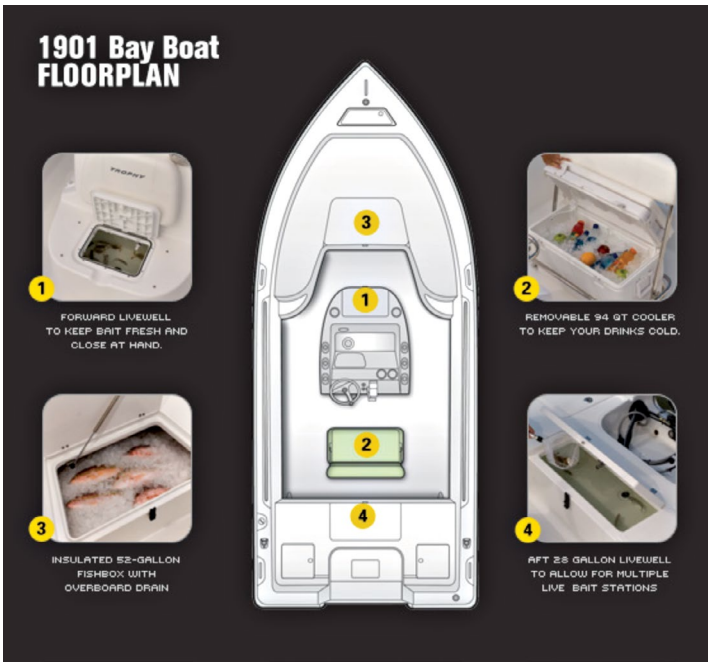
These models have two live wells and some have an insulated fishbox. These must be inspected to make sure they are dry. These models also come with a bilge pump that must be activated to make sure the bilge and its discharge hose are water free.

Center Console

There are four models of the center console manufactured by Trophy Sportfishing. They include the 1703 which has a 13 gallon live bait well, the 1903 which has a 18 gallon live bait well, the 2203 which has a 35 gallon live bait well and the 2803 which has a 25 gallon live bait well. Each of these models has a bilge pump with an exit through-hull discharge drain port on the aft side of the hull. See the floorplan below for an example of the well placement.

Dual Consoles

As shown below, the Dual Console is a complex boat with fish boxes, a sink with storage area and a 35 gallon aerated live well.

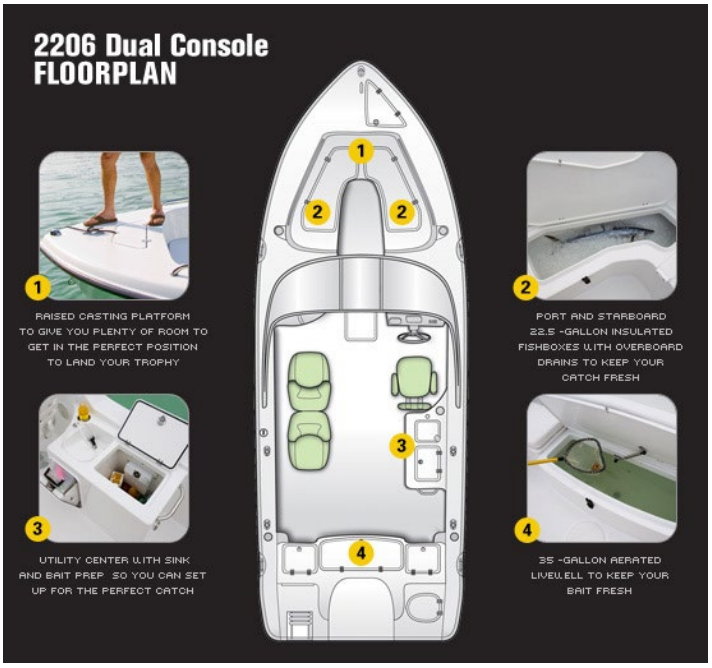


SPECIFIC MANUFACTURERS

TROPHY SPORTFISHING

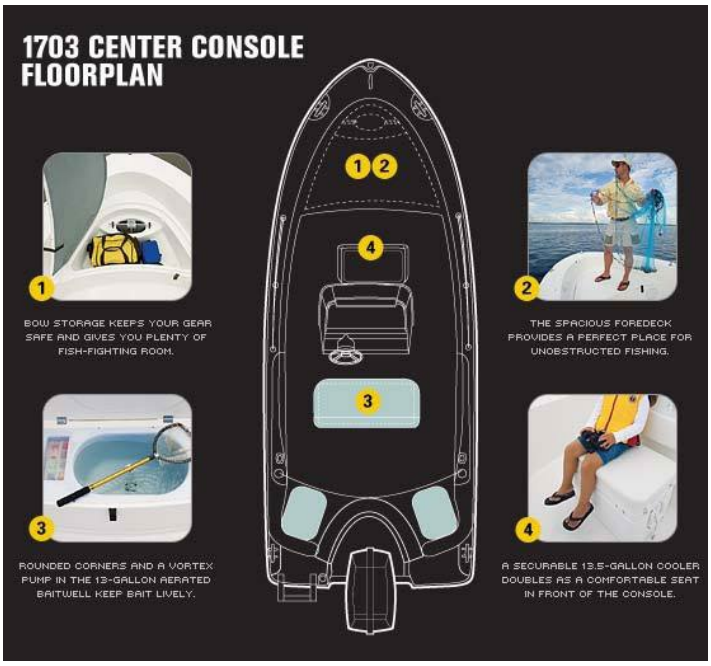
Walkarounds

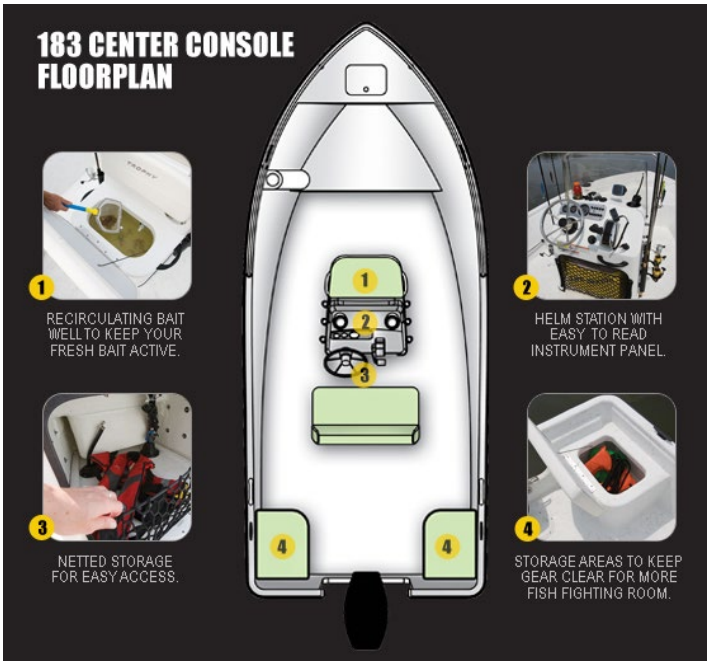
These are the "cabin cruisers" of the fishing boat. They can be equipped with 16 to 25 gallon live wells, fish boxes, and raw water deck showers. They are large boats starting at 17 feet 17 inches to over 27 feet.



Rolled Gunnel Series

There are three models in this series: 163 Center Console which is 16 feet and typically has no live/bait well; 181 Bay Boat which is 17 feet 17 inches and sometimes has a live/bait well under the center seat cushion; and the complex 183 Center Console which is 17 feet 17 inches and has a bow storage area, recirculating bait well under the center seat cushion, and two storage areas in the aft port and starboard areas of the boat.





SPECIFIC MANUFACTURERS

YAMAHA

Yamaha 212X

YAMAHA

2019 Yamaha 212X

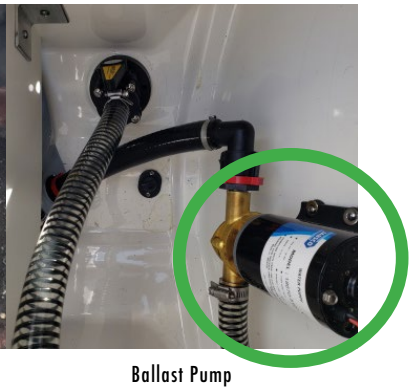
Ballast System (Direct From Yamaha):

This boat is equipped with 1 internal ballast bag and 2 internal ballast tanks. The ballast bag is located in the ski locker and the ballast tanks are located on the sides of the engine compartment under the deck. The ballast bag and ballast tanks can be filled and emptied using the multi-function display at the helm. The ballast bag and ballast tanks have a separate water passages for drawing in and discharging the ballast water. In addition, the amount of water in the ballast bag and each ballast tank can be set independently. The height and shape of the wake can be adjusted by changing the amount of water in the ballast bag and each ballast tank. When the ballast bag and tanks are filled, each ballast pump operates to draw in water through the water cock on the bottom of the boat and send it to the ballast bag and tanks. When the ballast bag and tanks are emptied, the ballast pumps rotate in the opposite direction to discharge the water in the ballast bag and tanks through the water cock. Each ballast tank is also equipped with an overflow hose to discharge excess water from the boat if the tank is overfilled.

Center Bag

The center bag is easily accessible from the center compartment. It has its own single reversible ballast pump and associated intake that is easily accessible from the underside of the boat on the starboard side near the bow. This intake is not covered by a bunk and could easily be decontaminated through the intake if two water sources were available. In the situation that only a single water source was available, there is a drain cap on the ballast bag that could be removed and used to fill the ballast bag. Alternatively, the water line coming in to bag could be used to fill the ballast bag.

Ballast Intake



Ballast Pump

Ballast Hose

Drain Cap

Rear Hard Tanks (Port & Starboard)

The rear hard tanks are much more difficult to access. They have their own shared intake that is dedicated to these two tanks. This intake is located directly beneath the bunk and is not accessible when the boat is the on the trailer. Each of the tanks does have an

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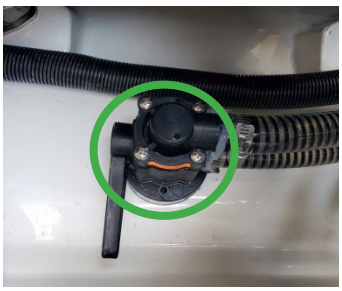
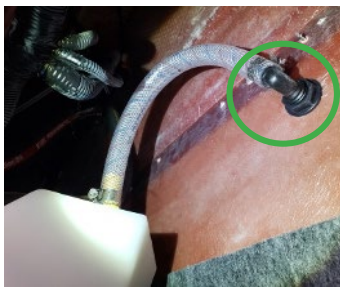
air vent on the hull. As per the schematic provided, these air vents do have check valves that would make them unusable for filling the ballast tanks. There is a disconnect on each of the water lines after the ballast pumps that could possibly be disconnected and used to fill these tanks.



Ballast Intake Valve



Ballast Air Vent Interior

Ballast Air Vent Exterior

Engine

The 212X is a dual jet system. The flushing ports for each of the engines are located on the aft side of the back seats. Flushing these jets will require the use of the Yamaha flushing adapter.

Yamaha 212x Engine Flushing Port Locations

Decontamination Procedure for 2019 Yamaha 212X:

Note: The on-board computer for the 2019 Yamaha 212X does not allow the ballast pumps to run unless at least one of the jet engines is operating. As a result, decontamination will require at least 2 independent water sources with an adequate flow rate (5gpm+) in order to decontaminate.

Yamaha On-board Computer

At this time it seems that from the factory the intake for the rear ballast system is completely covered by the starboard side bunk. The air vents for these tanks have check valves and cannot be back filled. It is not currently clear an effective method to decontaminate the rear tanks without modification to the boat.

1. Have the owner drain the ballast system to the best of their ability.
2. Follow the standard operating procedures for your decontamination unit.
3. Hook a fake a lake up to ballast intake located on the starboard side towards the bow of the boat.
4. Turn on the burner, and measure the temperature of the water. For decontaminating the ballast system you will need your water temperature confirmed at (120°F)
5. Turn on your secondary water supply. It should be at ambient temperature.
6. Utilizing the Yamaha flushing adapter, have the owner start one jet engine and begin running water into the jet.

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7. With the water running through the jet, have the owner turn on the fill for the center ballast tank.
8. Allow the ballast to fill to at least 50%. The ballast gauges on the 212X are based on the time running and not the actual volume of water in them.
9. UNKNOWN HOW TO DECONTAMINATE THE REAR BALLAST TANKS
10. Decontaminate each of the two jet engines following the jet engine decontamination protocol.
11. As the engines are being decontaminated, drain all water from the ballast system ensuring that it has reached 110°F. NOTE – The engine MUST be on to drain the ballast system.

2019 Yamaha 242X

Yamaha 242X

Ballast System (Direct From Yamaha):

This boat is equipped with 3 internal ballast bags. The ballast bags can be filled and emptied using the multi-function display at the helm. In addition, the amount of water in each bag can be set independently. The height and shape of the wake can be adjusted by changing the amount of water in each bag. When the ballast bags are filled, each ballast pump operates to draw in water through the water cock on the bottom of the boat and send it to each ballast bag. When the ballast bags are emptied, the ballast pumps rotate in the opposite direction to discharge the water in the ballast bags through the water cock.

Ballast Intake covered by Trailer Bunk

Bilge Discharge Port & Pilot Water

There is a single through hull fitting on this boat which was traced back to the bilge pump. There does not appear to be an air vent on this system. The other two ports are associated with the jet system like you would see on a PWC.

Center Bag

The center bag is easily accessible from the center compartment. In the situation that only a single water source was available, there is a drain cap on the ballast bag that could be removed and used to fill the ballast bag.

Drain Cap

Rear Bags (Port & Starboard)

The rear bags are much more difficult to access. They are each enclosed within a very narrow compartment and the intake line comes in from the aft. They would be extremely difficult to detach to get water in to the bags. There are vent or drain caps on the tops of the bags like the center bag but they are also very far back in this narrow compartment and would be difficult to access.

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Engine

The 242X is a dual jet system. The flushing ports for each of the engines are located on the forward side of the back seats. Flushing these jets will require the use of the Yamaha flushing adapter.

Decontamination Procedure for 2019 Yamaha 242X:

Note: The on board computer for the 2019 Yamaha 242X does not allow the ballast pumps to run unless at least one of the jet engines is operating. As a result, decontamination will require at least 2 independent water sources with an adequate flow rate (5gpm+) in order to decontaminate.

1. Have the owner drain the ballast system to the best of their ability.
2. Follow the standard operating procedures for your decontamination unit.
3. Turn on the burner, and measure the temperature of the water. For decontaminating the ballast system you will need your water temperature confirmed at (120°F)
4. Turn on your secondary water supply. It should be at ambient temperature.
5. Utilizing the Yamaha flushing adapter, have the owner start one jet engine and begin running water into the jet.
6. With the water running through the jet, insert a ballast buster or similar attachment to the ballast intake on the starboard side. Have the owner turn on the fill for the center ballast tank.
7. Allow the ballast to fill to at least 50%. The ballast gauges on the 242X are based on the time running and not the actual volume of water in them.
8. Repeat steps 7 & 8 for the rear starboard and rear portside ballast bags. All three bags fill through the same port.
9. Decontaminate each of the two jet engines following the jet engine decontamination protocol.
10. As the engines are being decontaminated, drain all water from the ballast system ensuring that it has reached 110°F. NOTE – The engine MUST be on to drain the ballast system.

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