

Choosing and Installing Bilge Pumps

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Marine surveyors and vessel repair professionals often comment on the inadequacy of the bilge pumping systems in the vessels they inspect. **A national study of pleasure boats found that more vessels sink at the dock than at sea, and a major cause of both types of sinkings is improper sizing, installation, and maintenance of bilge pumps.** An owner will pay \$100,000 for a boat but won't pay one-half of 1% of that amount for a bilge pump system to keep it afloat.

Most small boats use submersible centrifugal pumps, which are relatively cheap, easy to install, and are rated at high rates of flow. Some use flexible-impeller pumps, either electrically or engine driven, or power diaphragm pumps. Most also carry a diaphragm- or piston-type manual pump.

Each of these types is capable of doing some jobs well and others not well at all.

Bilge Pump Criteria

The first criterion usually considered when selecting a bilge pump is flow rate. Pumps normally are rated in gallons per hour, and some boaters seem to believe that the bigger the boat the bigger the pump (greater flow rate) it requires. This is faulty logic for three reasons. First, for any given size leak, a smaller boat will sink sooner. Second, smaller boats are more likely to ship water over low gunwales, and to lack fully sealed and self-bailing decks. And, third, with small bilges comes a greater likelihood of damage to machinery and electrical systems from relatively small amounts of water. **That's why marine equipment ex-**

perts usually recommend that small boats carry the biggest pumps possible.

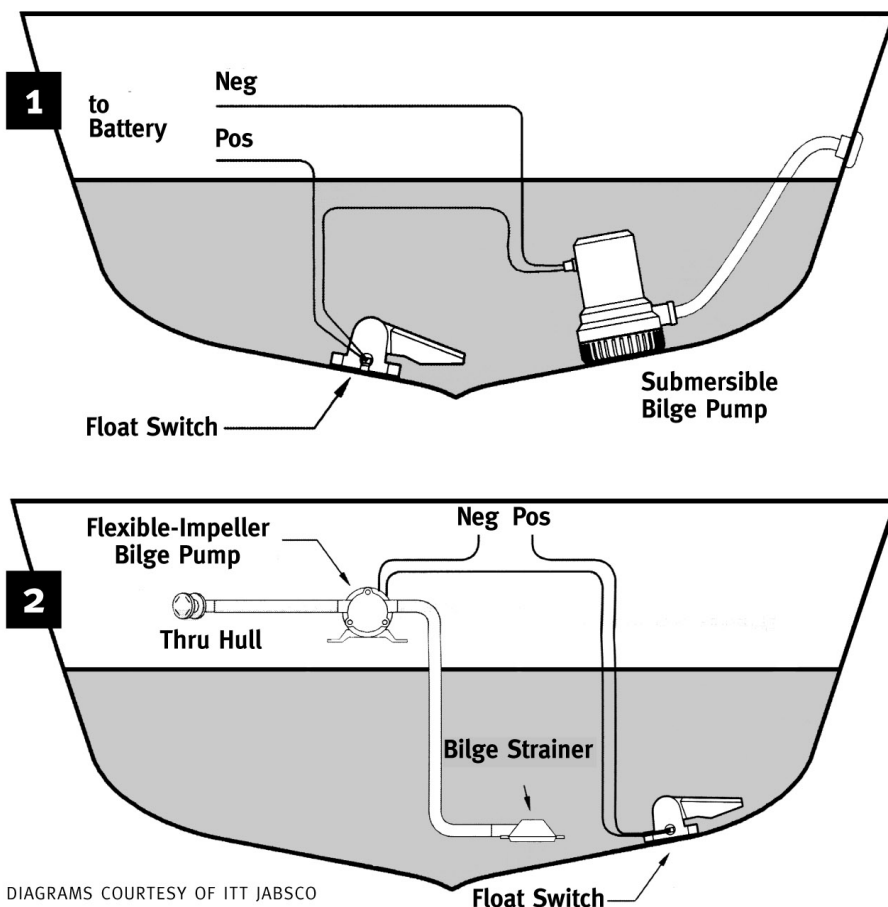
Another consideration is location of the pump. Is there room, and only room enough, for a submersible pump? Or would a remotely mounted flexible-impeller pump with a suction hose work better? Does it have to go in a space that may be flooded part of the time, or can it sit up high and dry? The bilge is an unfriendly place for a pump to reside, which is why submersible pumps tend to have a relatively short working life, often only a season or two.

Some bilge pumps are dual-purpose.

A pump suction line might be plumbed through a Y-valve to pump the bilge or supply a deck wash-down. With a Y-valve in the suction line of an engine's seawater pump, that unit can serve as an emergency high-capacity bilge pump as well as a heat exchanger pump. The Y-valve should be located before the seawater strainer so that bilge debris is filtered out before it reaches the heat exchanger and the pump.

There's also power source. An engine-driven pump can move a lot of water. AC pumps can produce more flow than DC pumps. A DC electric pump powered by a large battery bank close by and continuously charged by a running alternator can move more water than one trying to draw energy from a tired car battery at the other end of the boat.

Durability should be a consideration. Centrifugal and diaphragm pumps can be run dry for a period of time without damage, whereas a flexible-impeller pump im-



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Although submersible bilge pump systems are popular (1), they tend to have a relatively short work life in the unfriendly environment in the bilge. A remotely mounted pump system (2) can run off an engine pulley, and sometimes double as the engine coolant pump. Both systems illustrated employ float switches. Float switches are easily clogged by debris, so keep your bilge free of oil-absorbent pads and fish waste.

PELLER will burn up within a minute or two. Centrifugal and diaphragm pumps also are somewhat more tolerant of debris, although both can be stopped or damaged by too much debris or too-large pieces. Some of the more expensive pump models have ball bearings rather than bushings and are rated for longer service lives. For a tight boat with no leaks, where the bilge pump only stands by in case of emergency, the “premium” pump may not be necessary; in the leaker where the pump is cycling on and off all day, every day, the extra cost of the top-of-the-line model is justified.

Flow Rate

Flow rates, as listed by pump makers, can be somewhat misleading and serve only as a relative indicator of pump capacity compared to others of similar design.

Bilge pump capacity is usually listed at “open flow” or “open bucket” rate, which means the figures account for no vertical lift and no hose friction or discharge outlet restriction. Actual flow rates under real operating conditions are somewhat lower since water must be lifted up out of the bilge and pushed through lengths of hose to the discharge point. This resistance is called head. Head pressure, expressed in feet, can be calculated mathematically by plugging

in vertical lift plus resistance due to hose size and length, number of bends, and outlet constriction.

Because most centrifugal pumps have large internal tolerances to allow passage of small debris, their flow rate decreases dramatically with increased head pressure. Output of a typical small centrifugal bilge pump will diminish by half with a few feet of head pressure, and will cease entirely at between 13 and 20 feet, depending on the size.

Flexible-impeller and positive-displacement pumps are less affected by head pressure than centrifugal pumps, so even though their rated capacity is less than a centrifugal, they may be equally or more effective. Some vane pumps are rated for up to 70 feet of head.

There can be a big difference between the actual flow rate of a pump powered by a battery bank that is actively being recharged by a working alternator, and one powered by a battery that is being drawn down.

Two reputable organizations, the independent marine equipment consumer reporting journal *Powerboat Reports*, and the national marine equipment retailer West Marine, have tested bilge pumps under controlled conditions with varied head pressure

and electrical voltage. They found a wide range in actual performance when compared with manufacturers, open flow ratings. A few models met or exceeded their ratings; most fell short by 10-50%. To generalize, output tended to diminish by about 5% for every foot of head pressure, and by 15-30% as supplied voltage dropped from 13.6 volts (fully charged) to 12.2 volts.

Bilge Pump Switches

Bilge pumps usually are wired to automatic switches, either incorporated in the pump body itself, or mounted separately. A three-way switch panel allows the operator to turn the pump off, turn it on, or allow it to come on when the switch determines that bilge water has risen to a predetermined level.

Float switches use a hinged float containing either a ball bearing or a tube of mercury, installed such that when the float pivots upward the metal drops down to bridge the gap between contacts in the positive wire to the pump. Float switches are cheap and simple, but are prone to being jammed by debris and sticking in either the on or off position unless they are protected by a guard or housing. They must be installed where they are easily accessible for inspection and cleaning, protected from bilge surging, and safe from jamming by debris such as oil absorbent pads. Some pumps, like the Rule 40, include a float switch enclosed in an integral housing.

Float switches aren't the only automatic switches available. Another type of switch uses air pressure in a tube to expand a diaphragm to close a circuit. The Ultra Pump switch uses a magnet sealed in a rubber container to make contact and activate the pump. A relative new design called Bilge Buddy uses the conductivity of bilge water to conduct current between two electronic probes. The unit is programmed to delay ten seconds after the water level drops below the probes to provide hysteresis (that is, to ensure that the level when the pump stops is low enough that it won't immediately start up again).

Nigel Calder, in his definitive book *Boatowner's Mechanical and Electrical Manual*, notes that float switches are wired in series with the pump, meaning that the full current passes through the switch contacts. Some lower priced switches aren't rated for the current overload that can result from a partially obstructed impeller.

An interesting alternative to the automatic pump switch is the system employed in Rule's Platinum models. It uses a micro-

Bilge Pump Tips

- Don't rely on your automatic pump switch, with its tiny red panel light, to be your bilge alarm. **Install a real bilge alarm** with a loud horn. Mount the float switch a little higher up than the bilge pump so that it won't sound as long as minimal water is entering and the pump is keeping up with it.
- Only use submersible pumps that have **tinned wire electrical leads** (to resist corrosion), and install them so that the wire connections are well above bilgewater level and sealed from water intrusion.
- Use **smooth wall discharge hose** wherever possible, and keep run lengths and bends to a minimum.
- If the discharge outlet is close to the waterline, be sure to **include a riser loop** about 18 inches above waterline before the outlet to prevent back siphoning.
- **Install at least one pump, with switch, in each bilge compartment that does not drain into others.** Install redundant pump systems in the main engine compartment and lazarette bilges. Place the backup pump and switch slightly higher than the primary so that the backup can take over if debris clogs the main pump.
- Use a strum box (intake grate) **or screen on the suction hose, and mount the intake on a small pedestal** so that debris can settle out below it. Install submersibles where they can be reached and cleaned of debris easily.

processor to start the pump once every couple of minutes and then detect whether there is resistance to the spinning rotor from water in the housing. If there is resistance the pump continues running until the water is gone. If not, it shuts down after a couple of seconds. The little processor reportedly even figures out the rate at which it needs to come on, based on the amount of water leaking over time, and adjusts its rate of checking. The pump is quiet and battery draw is low, but of course over time it would drain a battery not being recharged.

Electrical Power

A bilge pump is only as good as the battery and wiring that supply power to it.

If batteries are charged daily, either by alternator or shore power, usually there is no problem. But don't expect the batteries alone to keep the bilge dry for long.

The most common cause of bilge pump failure is poor wiring and corrosion in the wiring. Inadequate wire size reduces pump performance, and can cause overheating. Refer to an AWG wire gauge chart for the correct size of wire for the amperage and length of run to the pump. Secure wiring well so that it does not flex and flop when bilge water sloshes.

If any bare wire is exposed to moisture, that moisture will travel up the inside of the insulation, causing corrosion and increased resistance in the wire some distance from the point of entry. Connections have to be secure and sealed from moisture intrusion. David Pascoe, a Florida marine surveyor who has an excellent boat maintenance website (www.yachtsurvey.com), recommends housing the connections in a covered plastic junction box, attached to a nearby vertical surface. Mount it with the wire hole at the bottom and install a small brass terminal block inside. Connect the wires with ring terminals.

Pascoe also recommends bypassing the main panel. An operator or crew member may unknowingly turn off the panel switch through which the bilge pump is wired, inadvertently disabling it.

Manual Bilge Pumps

If you need upper-body exercise, are on such a tight electrical energy budget that saving an amp-hour a day is essential, or if you simply think that a manual bilge pump gives your boat a salty, nautical look, by all means install one. **But don't expect a**

manual bilge pump to save your boat if you have a problem. First of all, the output of the biggest manuals is only equivalent to that of a small electric, and then only as long as your strength holds. Consider this: a one-square-inch hole two feet below the waterline will allow more water into the boat than the top-rated manual pump will remove, even with a college linebacker manning it. More important, if there is a real problem, your time and your crew's is better spent dealing with the problem than working a manual pump. A manual pump is OK for removing the few gallons that seeped past the packing gland but not as the primary water removal system.

Emergency Pumps

For the reasons listed above, bilge pumps are not really suitable for emergencies such as a damaged hull, or a failed through-hull fitting or stuffing box. Several big electrics will help as long as the power supply holds, but to move serious water requires an engine-driven pump. **A belt-drive flexible-impeller pump with a manual or electric clutch off the main engine is the best solution for an emergency pump.** A less expensive alternative on engines that have seawater pumps is to put a Y-valve into the suction line before the sea strainer and so that in an emergency the engine raw water pump becomes the bilge pump. Just remember not to run it dry, because it won't be able to cool your engine if the impeller is ruined. ♦