

Hold it...

We're Cleaning Up the Coast



SEWAGE SYSTEMS FOR RECREATIONAL BOATS



Ministry for the
Environment
Manatū Mō Te Taiao



**MARITIME SAFETY AUTHORITY
OF NEW ZEALAND**
Te Mana Ārai Hauata Moana o Aotearoa

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Sewage systems for recreational boats

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compliance

Boat owners, manufacturers and repairers...

The coastal waters of New Zealand contain some of the most spectacular marine and estuarine environments in the world, such as areas in Northland, Hauraki Gulf, Marlborough and Milford Sounds. The coast also hosts migratory whales and birds, a world-class system of marine parks and wetlands of international significance. These natural resources, in turn, support and maintain some of the most important and productive industries within the country – such as tourism, fisheries, boating, marine farms and shipping industries. The Resource Management Act 1991 requires the sustainable management of these natural resources. Regulations produced under this Act (called the Resource Management (Marine Pollution) Regulations) specifically control dumping and discharges into the sea from ships and offshore installations.

So that you can play your part in helping to protect New Zealand's marine assets, this booklet will help you install a sewage treatment system or upgrade sewage holding tank systems on your vessel to be in compliance with laws coming into effect 1 July 2000 governing the discharge of sewage. You will find information on the basic sewage system design, the selection of system components, plus helpful tips for their installation and maintenance.

The systems outlined are the three basic options on board pleasure craft. Variations to these are available with regards to the design and the supply of other components. Enquires with your ship chandler will provide you with details of the other options available.

Boaties share a common desire to play in and on sparkling clean waters. We can choose to pollute or not to pollute. We can do the right thing now, take action, and obey the law! Good environmental boaties will help assure our continued delight in clean waters. Use this booklet in choosing a sewage system that best fits your needs.



Why was the law passed?

The Resource Management (Marine Pollution) Regulations 1998 were introduced in response to growing fears of the pollution of New Zealand's coastal shores and water. The Regulations are the responsibility of the Ministry for the Environment. They are administered and enforced by regional councils who are in charge of coastal management under the Resource Management Act. This law addresses a wide spectrum of water pollution problems. One of the issues posing greatest concern at present is sewage in marine waters.

The occurrence of human pathogenic enteric viruses in seawater or freshwater, indicates that the waters or shellfish pose a potential risk to human health through contact and/or consumption, and that the waters and shell fish have been contaminated by human faecal wastes.

To contaminate environmental waters, these viruses must be shed directly or indirectly to water. Generally, this is the faecal route and this problem has escalated because of human discharge of sewage into environmental waters. Infected humans — regardless of the presence of symptoms — can excrete millions of virus particles per gram of faeces. Infectious virus particles can survive for several months in water under suitable environmental conditions.

The basis for arguments that boat sewage is “peanuts” compared to other sources of pollution, that holding tanks “stink”, and that there is no place to pump out, or treatment systems are expensive, is weakening fast in these changing times. In New Zealand, the waters in our rivers and lakes were once safe for drinking, boating and other recreational activities. This cannot be assumed in every case as disease causing microbes such as giardia, hepatitis A virus, cryptosporidium and gastroenteritis-causing viruses from human and animal faeces, have now polluted our waters. Because there are millions of micro-organisms in a gram of faeces, it only needs a tiny amount in waters to cause pollution. It is probable that there are now many carriers of these diseases in New Zealand. The facts are clear, and it is time for boaties to “do the right thing”.

What does the law say?

From the 1 July 2000, the Regulations prohibit the discharge of untreated sewage from ships of all description, including recreational boats, unless that discharge is in water depths greater than 5 metres and is more than 500 metres from the shore or a marine farm. A regional council can make stricter controls on the discharge of untreated sewage if these are necessary to address an environmental problem. You will need to contact your regional council and check their rules.

For those boats fitted with an on board sewage treatment system meeting the specified standard, treated sewage can be discharged anywhere except within 100 metres of a marine farm.

What is treated sewage?

The Regulations set out what is meant by treated sewage. Any treatment system which is installed on a boat must meet this standard. The regulations state that “treated sewage” means sewage that, when sampled 5 times or more over 24 hours, meets, or exceeds, the following standards:

- (a) A faecal coliform standard where the geometric mean of the faecal coliform count does not exceed 250 faecal coliforms per 100 millilitres; and
- (b) A suspended solids standard where the geometric mean of the total suspended solids content, when suspended solids are analysed by gravimetric methods, does not exceed - (i) 50 milligrams per litre when analysed on shore; or (ii) 100 milligrams per litre more than the suspended solids content of the ambient water used for flushing when analysed on board a ship; and
- (c) A biochemical oxygen demand count where the geometric mean of 5 day biochemical oxygen demand of the samples of sewage does not exceed 50 milligrams per litre.



Why should you act now to comply with the law?

First of all it will be the law from 1 July 2000. No boats may discharge untreated or treated sewage into the coastal marine areas (mean high water out to twelve nautical miles) unless in accordance with the law. Those not complying with the regulations will be liable for enforcement action which can be taken under Part XII of the Resource Management Act 1991.

What are your sewage systems choices?

Owners of boats operating within this area must decide which option is best for them. Three options which are available are the fitting of either a sewage holding tank for storing untreated sewage, fitting an onboard sewage treatment system, or have on board a portable toilet, which can be taken ashore to be emptied.

OPTION ONE - is to treat the sewage so that the discharged effluent meets the specified standards for bacterial content, organic matter (BOD) and suspended solids.

OPTION TWO - is to retain sewage in a holding tank for shore based disposal or discharge beyond the 500 metre limit.

OPTION THREE - is to provide a portable toilet for shore based disposal, or empty beyond the 500 metre limit.

Option one employs a sewage treatment plant. This must be one which has been tested and approved by governments, or organisations which have delegated authority from them to test and approve the plant. A list of such approved systems will be provided by Maritime Safety Authority upon request.

What system should you install?

If the boat is operated within 100 metres of a marine farm, you must retain all sewage, whether treated or not, for disposal ashore. Choosing the system that works best will depend on several factors. The answer to a few questions about how the boat is used should help you narrow the choices and determine optimal holding tank capacity:

- How many people are usually onboard for a trip?
- Is the boat used mostly for day trips, or for overnight cruises? Usually day trips do not generate much solid waste. Overnight virtually guarantees it.
- Does the boat anchor out overnight or tie up in a marina? When tied up, will you use the marina toilets?
- Are pumpout facilities located conveniently nearby? Refer to the publication *Marinas in New Zealand* available from ship chandlers and selected bookshops.
- What are the boat's design and space limitations for a sewage system?
- Is the electrical power supply adequate for an electrically operated system?



What are some of the system design alternatives?

First we will look at some of the advantages and disadvantages of portable toilets and holding tanks in general. Later we will examine holding tank systems and their plumbing arrangements in greater detail.

Portable Toilets

A portable toilet may be the simplest, least expensive way to comply with the intent of the law.

Advantages:

- Requires minimal space.
- Low cost.
- Simplicity.
- Reliability.
- Can be emptied ashore if pumpout facility is not available.

Disadvantages:

- Limited capacity and should be emptied frequently to prevent the build up of hydrogen sulphide. (*Refer to pages 23 and 27*).

Holding Tank System

Holding tank systems vary in complexity depending on what they are designed to do. There are four basic arrangements:

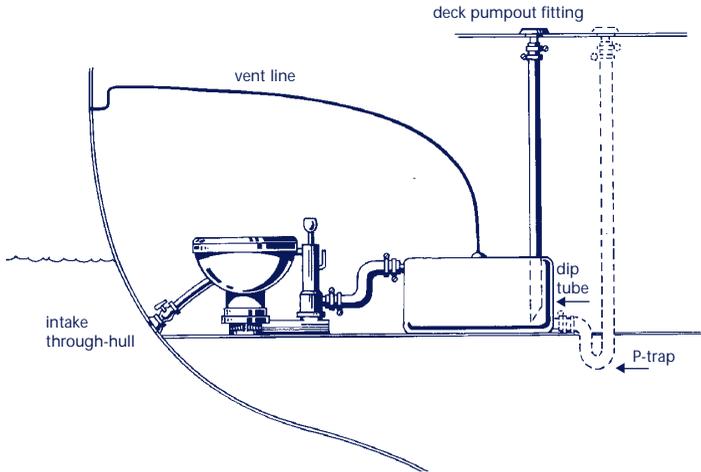


FIG. 1 – DECK PUMPOUT ONLY.

1. DECK PUMPOUT ONLY

The holding tank is installed in line between the toilet and the deck pumpout fitting. (*Fig. 1*)

Advantages:

- Allows use of existing toilet.
- Sewage goes directly into the tank.
- Simple to install.
- Minimal equipment requirements.
- Does not require a through hull fitting for discharge.

Disadvantages:

- External pump required to evacuate the tank.



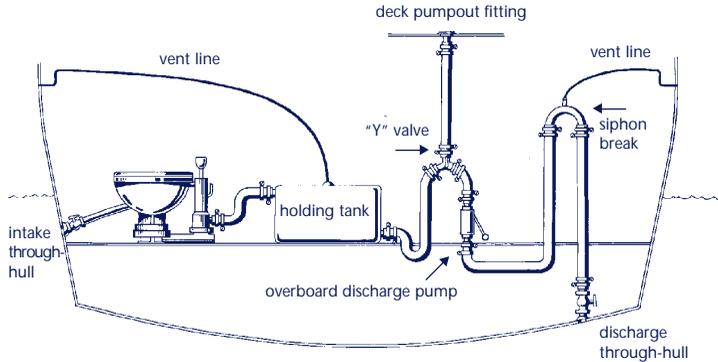


FIG. 2 – OVERBOARD DISCHARGE OPTION AFTER THE HOLDING TANK.

2. OVERBOARD DISCHARGE OPTION AFTER THE HOLDING TANK.

A diverter “Y” valve is installed in the line between the holding tank and deck pumpout fitting to allow the tank’s contents to be pumped overboard where it is legal to do so. The “Y” valve should be secured to prevent illegal overboard discharge when the boat is moored for any considerable period. (Fig. 2)

Advantages:

- All sewage is pumped into the holding tank.
- Boat will use pumpout facility in port.

Disadvantages:

- None.

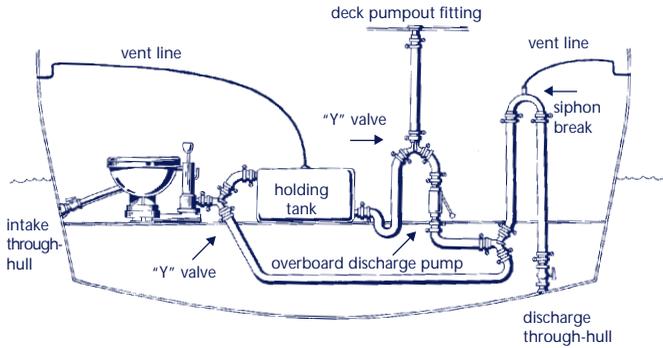


FIG. 3 – OVERBOARD DISCHARGE OPTION BOTH BEFORE AND AFTER THE HOLDING TANK.

3. OVERBOARD DISCHARGE OPTIONS BOTH BEFORE AND AFTER THE HOLDING TANK.

“Y” valves are installed in line between the toilet and holding tank, and between the holding tank and deck pumpout. (*Fig. 3*)

Advantages:

- Flexibility in discharge options. The “Y” valves should be secured to prevent overboard discharge when the boat is moored for any considerable period within the regulatory 500 metre limit.

Disadvantages:

- Flexibility is offset by complexity.



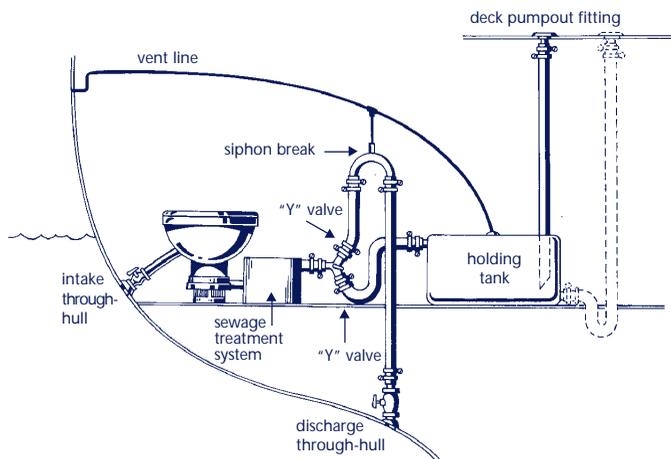


FIG. 4 – OVERBOARD DISCHARGE OPTION BEFORE THE HOLDING TANK.

4. OVERBOARD DISCHARGE OPTION BEFORE THE HOLDING TANK.

When using a sewage treatment system, you should install a holding tank for use when boating within 100 metres of a marine farm. A “Y” valve is installed in line between the treatment system and holding tank (*Fig. 4*)

Advantages:

- If a sewage treatment system is installed between the toilet and “Y” valve, treated sewage can be pumped directly overboard.

Disadvantages:

- An external pump is required to empty holding tank.

The four options shown in the foregoing, are the four basic options available. These four basic arrangements can be adapted depending on the number and type of toilet(s) installed, and whether in-line sewage treatment is desired. There are other options available such as those employing a combined three way valve and pump which can simplify the basic system, but it is recommended in all cases that provision for a deck pumpout connection be provided. Shore side reception facilities, which will include the pump, will be provided in the future.

Siphon Break before Toilet Inlet

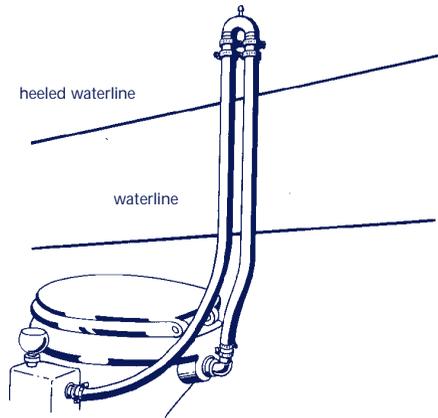


FIG. 5 – SIPHON BREAK FITTINGS MUST BE LOCATED ABOVE THE MAXIMUM HEeled WATERLINE IF THEY ARE TO OPERATE EFFECTIVELY.

In addition, to the four basic option designs shown in the foregoing, the installation of a siphon break before the toilet inlet must be considered.

The toilets on most boats are installed below the waterline. Any leakage past the pump non return valves can allow water to flow into the toilet, eventually sinking the boat if not discovered in time. It could therefore be essential that in addition to a siphon break being installed in the discharge line (as shown in Fig 2, 3 and 4), that a siphon break be installed in the line between the toilet hand pump and the point at which it discharges into the bowl (Fig 5). As an additional safeguard, the toilet intake hull fitting should be left in the closed position whenever the toilet is not in use.



How do you choose the right equipment for your installation?



Caution: Before making your final equipment selections, read the section in this booklet on “Installation Tips”. Installation considerations may affect specific equipment choices.

Toilets

The type of toilet selected depends largely on the boat's size and electric power supply as well as the owners budget.



Caution: Seacocks at seawater intake and overboard discharge should be closed whenever the boat is not in use.....regardless of the type of toilet selected.

MANUALLY OPERATED TOILETS

Advantages:

- Not dependent on power source.
- Dependable operation.
- Relative ease of installation; no electrical connections.
- Relatively low equipment and maintenance costs.

Disadvantages:

- User must flush wastes from the bowl using a manual pump.

ELECTRIC TOILETS

Advantages:

- Ease of use.
- Typically macerate solid wastes reducing the possibility of clogged waste lines.
- Macerated solid wastes are more effectively treated by disinfectants and deodorants.

- Relatively easy to interface with a sewage treatment plant for automatic treatment.

Disadvantages:

- Rely on electric power for flushing action. Manual backup, if provided, will permit system use if power is depleted or there is a malfunction.
- More complex to install; higher costs

VACUUM TOILETS

Advantages:

- Ease of use.
- Typically uses less than a quart of water per flush, a real benefit for optimising holding tank capacity.

Disadvantages:

- If not manual, requires electricity to operate.

While seawater is most often used for flushing, some electric and vacuum systems recommend fresh water. Where fresh water is used, caution must be taken to prevent contamination of the boats fresh water supply.

Tanks

The size of the holding tank selected should be based on the boats intended usage and the number of people using the toilet. Typically 15 litres per day is allowed for each berthed person i.e. weekend or extended cruises, or 7 litres per day for each unberthed person i.e. day trips.

There are four different types of tanks which can either be purchased off the shelf, or can be manufactured to a capacity and shape to suit the vessel itself.



PLASTIC (POLYETHYLENE) TANKS

Advantages:

- Readily available in a wide range of shapes and sizes.
- Generally the least expensive option
- Provides visual indication of tank content level.

Disadvantages:

- None.

FLEXIBLE TANKS (BAG SHAPED BLADDERS)

Advantages:

- Can often be used when other types of tanks will not fit in the space available.

Disadvantages:

- Susceptible to permeation.
- Susceptible to leakage due to chafing and to flexing at pipe connections.

FIBREGLASS REINFORCED PLASTIC (FRP) TANKS

Advantages:

- Highly resistant to permeation.
- Relatively inexpensive as a “do-it-yourself” project.
- Can be custom fit to the space available.

Disadvantages:

- Typically cost more than a plastic or flexible tank.

METAL TANKS

Advantages:

- Highly resistant to permeation.
- Easy to fabricate to space available.

Disadvantages:

- Susceptible to corrosion. Sewage, additives and cleaning agents may aggravate corrosion rates.

Tank level monitors and warning systems

It is recommended that holding tanks have a means of indicating when the tank is more than 75 percent full by volume. A translucent plastic tank can meet this requirement if its location permits easy regular access for viewing contents level. Tank monitoring systems are fairly simple to install. These typically include a sensor installed at the top of the tank and a small remote panel with a warning light that indicates when the tank is more than 75 percent full.

Seacocks and overboard discharge valves

Toilet intake and overboard discharge lines should be equipped with seacocks or valves fitted directly to the inside hull of the boat to stop the inflow of seawater in event of a hose failure. A seacock is operated by a lever-type handle that gives clear indication of whether the cock is open or closed. Valves are operated by a hand wheel which indicates the direction of opening or closing. They should be readily accessible for maintenance and for their operation.

Seacocks are made of bronze or plastic and can be used successfully for toilet intake or overboard discharge lines. It is generally a good idea to fit bronze seacocks or valves to steel hulls, and plastic seacocks to fibre glass hulls. Where bronze valves are used, the manufacturers specifications should be checked to ensure they are suitable for their intended service. The reason for this is to avoid electro chemical corrosion which would cause pitting to any steel which the valve is in contact with. The use of brass as a seacock or valve must be avoided because they corrode rapidly. Plastic seacocks should be made to recognised national standards or otherwise meet the approval of the Underwriters Laboratory Inc for the stated purpose.



Deck fittings

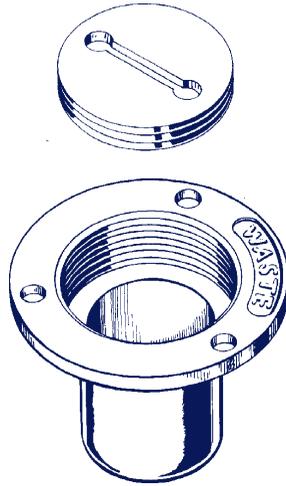


FIG. 6 - STANDARD 38 MM PIPE THREAD INSIDE DIAMETER DECK PUMPOUT FITTING.

It is recommended that the standard for a deck pumpout fitting is 38 mm inside diameter pipe thread. Into this can be screwed a 40 mm (nominal) male cam lock fitting which is recommended for the pumpout facilities installed in New Zealand and Australia. Pumpout reception facilities should have female fittings on their suction hose to accommodate this.

The top surface of the deck fitting should be clearly and permanently labelled “Waste”. Check to be certain that all of the boats other fittings are labelled “Water” and “Diesel” as appropriate. (Fig 6). You can ruin your whole day if you accidentally fill the waste tank with fuel or siphon out the fuel tank at the pumpout station.

Piping/hoses (intake, vent and discharge lines)

RIGID PLASTIC (PVC) PIPING

Rigid plastic (PVC) piping comes in different thickness (strengths) known as schedules. Schedule 40, the standard for residential plumbing, works well for boats too. Structurally superior schedule 80 pipe can also be used.

Advantages:

- Highly impermeable; will not corrode.
- Resistant to chafe.
- Readily available in hardware stores with a wide range of fittings.
- Easily cut with a hacksaw, can be glued with PVC cement. Can be readily modified later if needed.
- Virtually maintenance free.

Disadvantages:

- Susceptible to damage from flexing. To reduce potential for damage, provide additional support and use flexible (rubber hose) connectors to reduce potential for damage.
- Often takes longer to cut and fit rigid plastic PVC pipe in tight spaces than to run flexible hose.
- The “nominal” size stamped on PVC piping differs considerably from the pipe’s actual inside or outside diameter.

FLEXIBLE HOSE

Choose a hose made with one of the special compounds designed to minimise permeation of waste system odours. These are typically made of flexible PVC or rubber and labelled sanitation hose. The heavier the wall thickness, the greater the resistance to odour permeation. All waste lines should be smooth on the inside to avoid trapping waste, and reinforced to prevent collapse. Rubber hose is generally more expensive, tends to have a longer service life, and is easier to stretch over fittings than flexible PVC hose.



Advantages:

- May be easier to install in tight corners.

Disadvantages:

- Susceptible to permeation.

Pipe fittings

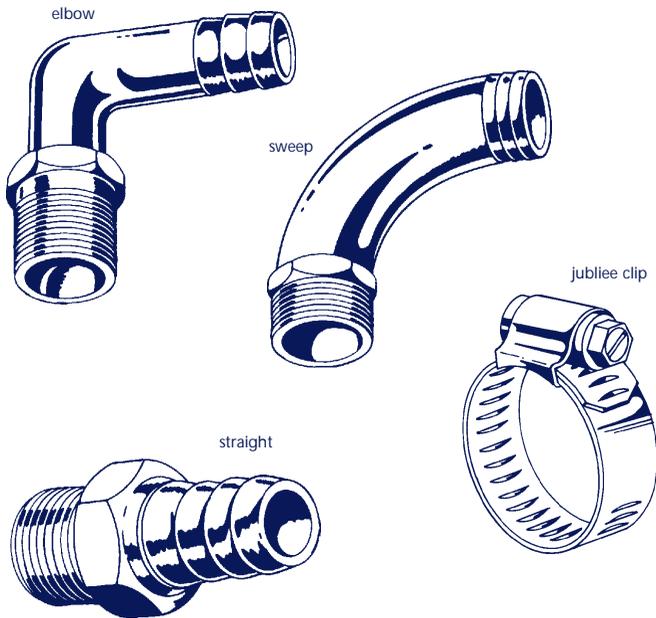


FIG. 7 – EXAMPLES OF PIPE FITTINGS WHICH CAN BE USED.

A wide variety of fittings (adapters, couplings, elbows, T-fittings, jubilee clips, etc.) is available for use with either rigid PVC pipe or sanitation hose. Each fitting joint creates a potential sewage catch point which may lead to a clog. When preparing to install the system, use curved hose sections rather than fittings where possible. Where

a fitting must be used, “sweep” fittings with a large radius bend are preferred to elbows which have sharp corners. Where a sanitation hose is secured by jubilee clips, the sanitation hose should not be fitted over smooth fittings which will not provide the necessary grip to stop the hose sliding off again under pressure or other strain. A silicon sealer should be used to ensure a watertight joint and good adhesion. Only stainless steel jubilee clips should be used, and two should be used at each connection where space permits.

Plastic fittings are recommended for installation in plastic holding tanks because the coefficient of expansion is equal for the two materials. Each hose line run to a tank fitting should be restrained (e.g. with a plastic wire tie or clamp) so that it will not put a strain on the fitting during movement of the boat in the water or operation of the sewage system itself. Without restraint there is a risk that the fitting itself may cause the tank to crack.

Vent line fittings

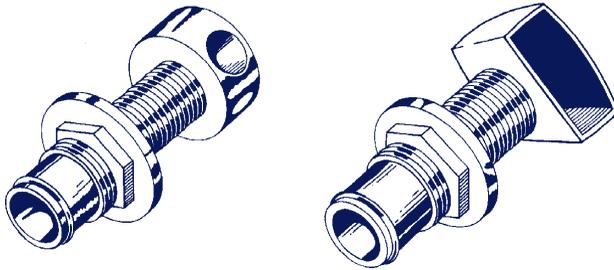


FIG. 8 – SEWAGE TANK VENT FITTINGS.

Sewage tank vent fittings are made of chrome plated zinc, brass, stainless steel or plastic. (*Fig 8*) Over filling the holding tank can force sewage into the tank vent line. A clogged vent line will be ineffective and can make it difficult, if not impossible, to pump out the tank at the pumpout station. Clogged vents can also lead to over pressurising the tank, causing leakage or rupture.



Where unpleasant odours are found to be coming from the vent pipe, a filter can be installed in the vent line to help control it. Where the vent is fitted near the cockpit or opening to the accommodation spaces, care must be taken that an accumulation of hydrogen sulphide gas can not occur.



Caution: Hydrogen sulphide is a flammable poisonous gas and extremely hazardous. The sense of smell may be affected and fail to give warning of a high, lethal concentration. Hydrogen sulphide is heavier than air and forms an explosive mixture with air in concentrations greater than 4.3% by volume. A water seal fitted between the toilet pan and the holding tank may limit the escape of gas into the craft through the toilet pumping system, but it may not be effective if the craft is subject to heavy rolling and pitching. It is also important that vents are regularly serviced to prevent them clogging. See also subsections on vent fitting and siphon breaks in the section on Installation Tips.

Siphon breaks (Vented loops)

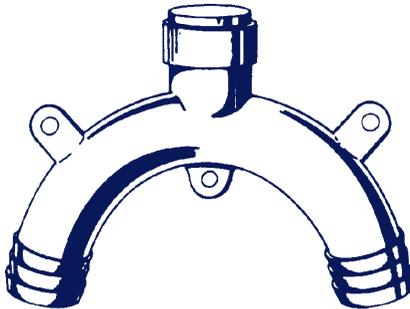


FIG. 9 – SIPHON BREAKS HAVE A ONE-WAY VALVE AT THE TOP TO ALLOW AIR TO ENTER THE LINE.

Siphon breaks are typically made of cast bronze or plastic, which is not affected by corrosion. A simple one-way valve at the top of the siphon break will allow air to enter the line but prevent water or sewage escaping. Larger vent valves are less susceptible to clogging than smaller valves. (Fig. 9)

“Y” valves

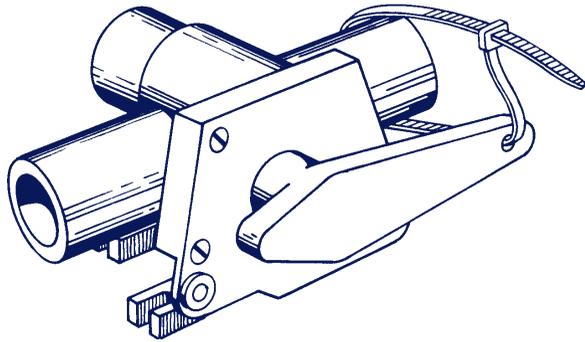


FIG. 10 – SEWAGE “Y” VALVE.

“Y” valves are used to direct waste overboard, into the holding tank or to a deck pump out fitting. Most “Y” valves used in sewage systems are made of plastic, however, bronze may also be used. Key attributes of a good “Y” valve include corrosion resistance, fully open ports for minimal restriction to flow, ease of disassembly for maintenance, and a sturdy handle with positive stops. Make sure you can readily identify the closed position. (*Fig. 10*)

“Y” valves are not required at every piping junction. In the system illustrated in Fig.2, the deck pumpout fitting and the overboard discharge valve are normally pressure tight and will typically function as selected. The advantage of using a “Y” valve at every junction is that positive diversion of sewage flow will assist to prevent blockages and will keep unused sections of piping from remaining unnecessarily “wet” with sewage. “Y” valves also serve as additional safe-guards against accidental overboard discharge.

“Y” valves must be used at junctions, where lacking a method of positive diversion, sewage would flow both to the overboard discharge piping and to the holding tank (*refer to Fig. 3 and 4*).



Pumps

Ensure that all pumps are suited for use in sewage systems. Capacity is key to pump performance. Pumps may be made of bronze, aluminium or plastic. Bronze is frequently used in constructing rugged, high capacity pumps, while aluminium pumps are typically less expensive, but prone to corrosion. Plastic pumps are lighter and corrosion resistant, but also more likely to leak since some plastics can deform over time.

DIAPHRAGM PUMPS

Diaphragm pumps, sometimes used to flush the toilet, are frequently used to pump out the holding tank. They may be manual or electric.

Advantages:

- Pass solids more readily than do piston pumps.
- Can be run dry without damage.
- Simpler design makes them less troublesome than piston pumps.

Disadvantages:

- None in waste system applications.

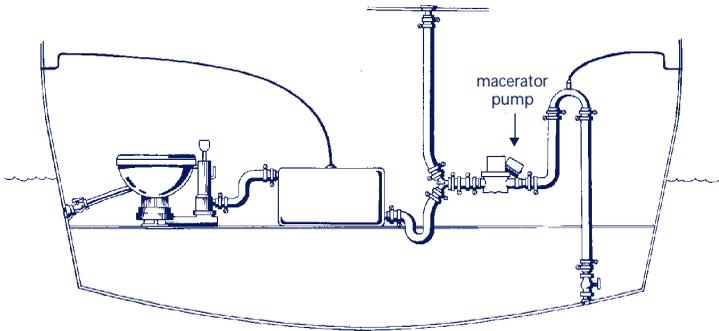


FIG. 11 – MACERATOR PUMPS CAN BE USED TO BREAK UP AND PUMP WASTES FROM HOLDING TANKS, FOR DISCHARGE OVERBOARD, OR USED TO ASSIST THE TREATMENT OF SEWAGE.

MACERATOR PUMPS

Macerator pumps are used to break up and pump wastes. They can be installed at the toilet for the initial removal of sewage, or after the sewage tank for the discharge of its waste overboard. (Fig 11) They may also be installed inside or on top of the tank. A macerator pump does not treat sewage to reduce bacteria count, but where it is part of a sewage treatment system, it breaks up solids to assist the treatment.

Advantages:

- Breaks up solid waste thereby minimising the likelihood of clogged piping down stream.
- When installed at the toilet, typically require less water for flushing than a manual pump – a plus when the holding tank is being used.

Disadvantages:

- Requires electrical power for operation.
- Motor, shaft seal and/or impeller may burn up if pump is run dry.



Additives

A variety of additives are available to reduce or eliminate sewage odours, treat sewage and/or help break down solid wastes. These are typically injected at the toilet intake line, at the toilet itself, or at an in-line sewage treatment device. The use of additives in conjunction with holding tank systems is not required. Deodorants may be desired to control odours produced by anaerobic bacteria in holding tanks.



Caution: Tanks and system fittings may deteriorate from exposure to certain additives (household bleach, caustic cleaners, etc.). Make sure you use only those additives recommended for your particular marine sewage system and ensure that they are environmentally friendly as well.

Sewage treatment equipment

Sewage treatment equipment which can treat sewage chemically, electrochemically or by other means, can also be installed in-line between the toilet and the holding tank. If a “Y” valve is installed after the sewage treatment plant, treated sewage can be pumped overboard where it is legal to do so. Otherwise, the treated effluent can be pumped into the holding tank for pumpout ashore.

Advantages:

- Treat, disinfect and deodorise sewage.
- Decreased likelihood of contact with raw sewage.

Disadvantages:

- High current draw for the electrochemical process.
- High initial cost relative to a basic holding tank system.

installation tips

System design

Think your system design through carefully and lay out piping and other system components before cutting anything. Check on each side of partitions or bulkheads to ensure that you will not be cutting into fuel or water tanks, wiring or piping, or into stringers that support the hull. If you must cut tabbing (matting in reinforcement) that holds partitions or bulkheads in place, provide additional reinforcement so that structural integrity is not compromised. (Fig. 12)

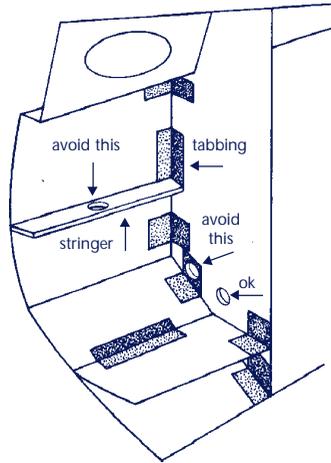


FIG. 12 – WHEN RUNNING PIPING, AVOID CUTTING INTO STRINGERS OR TABBING THAT SUPPORT THE HULL SO THAT STRUCTURAL INTEGRITY IS NOT COMPROMISED.

To reduce the likelihood of odour permeation, consider what will be “wet” (sewage filled) between pumpouts. Work towards reducing wet sections of piping. When wet sections are unavoidable, consider rigid PVC pipe rather than hose. Keep the number of connections to the minimum. Try to eliminate tight bends. Provide for easy access to system fittings, connections, and components for maintenance. The requirement for all pipes to be disassembled should be considered as blockages may occur.



Holding tanks

- Examine the area where the tank is to be located. Ensure that the tank will not be punctured by sharp objects, such as protruding screws.
- Since sewage weighs approximately one kilogram per litre, the contents of a 60 litre waste tank can weigh up to 60 kilograms. Tanks in excess of 60 litres should be fitted with baffles. Tank supports and restraints must be adequate to hold the tank in place even under extreme operating conditions. Multiply the weight of the tank and its contents when full by a safety factor of two when estimating the total weight to be restrained.
- Plywood floors, bracing, chocks, straps, etc. may need to be reinforced to perform as required. Visualise the tank restraint system with your boat operating at full speed pounding into the waves (or running suddenly aground).
- To minimise the potential for chafe and corrosion, a non-absorbent, nonabrasive material such as neoprene should be used between all tank supports, bracing, etc. and the tank itself. This is a must for metal tanks.
- Ideally, inlet and outlet fittings should be located at or near the top of the tank. This arrangement will facilitate repairs when needed, and will enable hoses to be self draining which will minimise permeation. If inlet and outlet fittings are installed at or near the bottom of the tank, hose permeation will occur more rapidly. Install a valve at the tank outlet to permit servicing of the discharge line without spilling sewage.
- The tank inlet connection when fitted in the top of the tank, must terminate not less than 75 mm inside the tank.
- If the discharge is located at or near the bottom of the tank, a rigid P-trap below outlet level in the outlet piping will allow the tank to be completely emptied. A dip tube will be required for top mounted discharge fittings (*refer to Fig. 1*). Regardless of the

type of outlet connection provided, it must be fitted so that not more than 40 mm depth of sewage remains in the tank after the discharge of its contents.

- Vent line fittings of 40 mm nominal bore are recommended and must be located at the uppermost point on the top surface of the tank, if it is to operate effectively. The absolute minimum size of the vent line fittings is to be 19mm nominal bore. The air vent should be protected so as to prevent the entry of any contaminant.
- When installing fittings in polyethylene tanks, follow the tank manufacturers directions. The tank can be damaged by over tightening fittings at connection points. This type of damage may not be detected when making the connections, but will manifest itself later in leaks at cracks.
- Most polyethylene tanks have inspection ports (typically 75 mm in diameter). While there is an increased possibility of leaks and odours if ports are installed, a properly gasketed inspection port should reduce the likelihood of a problem. Inspection ports can be used to access the tank for cleaning. They also facilitate the installation of a sewage level indicator.
- Bladder tanks used for holding sewage must have a vent line so that gasses produced by decomposing sewage can escape.
- If a tank is constructed from fibre glass, construct in accordance with the resin manufacturers recommendations.



Piping/hose

- To minimise the likelihood of permeation and odours, keep hose runs as short and straight as possible. Avoid dips in the hose run which will remain “wet”. Wherever practical, use rigid pipe below the level of the top of the holding tank since sewage will sit in this pipe when ever the tank is full (“wet” hose will permeate more quickly). Use fittings with a large radius bend instead of elbows in connections wherever possible.
- Ensure that the holding tank vent line has a constant rise from the top of the tank to the vent fitting. Otherwise low spots may fill with sewage and act as a “U” trap, effectively plugging the vent. Vent line should be as short as possible.
- Heating the end of the hose and coating the pipe fittings with liquid soap as a lubricant will make fitting sections easier. Hot water, an electric hair dryer or heat gun can be used to soften the hose.
- Use cable ties or clamps to support piping along its entire run against movement laterally as well as vertically. This will help minimise the likelihood of loosening connections during stresses of boat operation, flexing, vibration, or impact from gear stowed alongside. Visualise how a hose or pipe full of liquid might move under normal operating conditions (in response to vibration, wave action, heeling, etc).
- Provide chafe protection where the hose is run through bulkheads, and at all support brackets or ties.

Fittings

- All sewage system connections and fittings should be capable of being reached for inspection, removal or maintenance without removal of any permanent boat structure.
- Before cementing a length of rigid PVC pipe to a fitting, use a solvent cleaner on the pipe and inside of the fitting before coating them with PVC cement. Immediately the pipe is home, twist a half turn or so to spread the cement evenly. Hold the joint for about 30 seconds to give the cement a chance to set up; do not subject it to pressure for at least a half hour.

Sealants

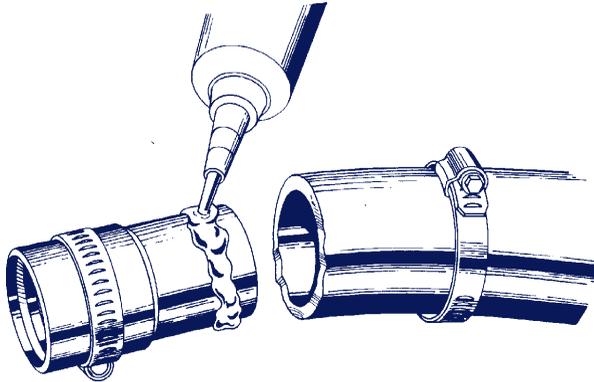


FIG. 13 – IF A SEALANT IS USED WHEN FITTING A HOSE, IT SHOULD BE APPLIED TO THE OUTER SURFACE OF THE ADAPTER ONLY.

- If a sealant is used when fitting a hose, it should be applied to the outer surface of the adapter. Do not apply sealant to the inside of the hose; it will only be pushed further inside by the adapter, where it will solidify and cause a blockage. (Fig. 13)



Jubilee clips

- Do not over tighten jubilee clips or they may cut into the hose. If the clip has to be over tightened to stop a leak, the hose to adapter fit is not good enough, and one or the other should be changed. The use of two jubilee clips at each connection (where space allows) will keep the hose in line with the adapter and lessen the likelihood of leaks.
- Make sure jubilee clips are offset from each other when tight. (Fig. 14)

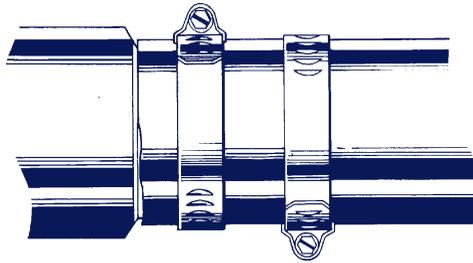


FIG. 14 – PROPER JUBILEE CLIP INSTALLATION.

Vent fittings

- The holding tank vent fitting should be located above the holding tank and above the waterline at all angles of heel. The open end should also be no less than 600 mm from any opening into an accommodation space.
- If the fitting is to be located in the deck area or in the sides of the boat, select a protected spot where it will not be subject to damage either from movement of people or gear on the deck, or from wharf pilings etc.
- Form a gooseneck in the vent line above the fitting to prevent seawater from back flooding to the tank. For deck fittings, the

gooseneck can be formed out of a metal pipe or plastic fittings passing through the deck and bent over 180 degrees at the top. Where the vent pipe penetrates the side of the boat, a gooseneck can be formed in the manner illustrated (*refer to Fig. 1*).

- Bed fitting where it penetrates through the hull to avoid water leakage into the interior of the boat.

Vent line filters

- Install per manufacturers recommendations.

Siphon breaks

- A vented loop in the discharge line which is open directly to the interior of the boat, can allow foul odours to accumulate in the boat. Always run a small hose from the siphon break vent fitting to the holding tank vent line, or to a separate vent fitting located above the maximum heeled waterline (*refer to Fig.2*).

Pumps

- Consider the pump manufacturers requirements (if any) for maximum allowable discharge line head, and the length of delivery pipe.
- Diaphragm pumps should be mounted above the level of the top of the holding tank so that they will not be immersed in sewage when the tank is full. This will minimise permeation of the flexible diaphragm material.
- If pump is not installed above tank level, service valves should be provided to enable pump removal without releasing tank contents.



Sewage treatment equipment

- Install per manufacturer's directions.
- Maintenance per manufacturer's instructions is essential to guard against malfunction and ensure sewage treatment in accordance with the regulations.

Note: To be sure there are no leaks, test a newly installed system using coloured water and soft food solids (over ripe bananas work well) under normal boat operating conditions. Inspect entire system regularly for evidence of leaks.

system maintenance

Toilets

- Do not flush paper towels or feminine hygienic products. They will clog sewage system plumbing. Keep paper usage to a minimum. Some skippers require that nothing be flushed down a toilet that has not been eaten first! In order to avoid hose permeation it is good practice to pump the toilet hand pump approximately twenty times when flushing. If sewage lies in the hose to the holding or treatment tank for a period of time, even the best hose may permeate.
- Toilet bowls should be cleaned periodically with water and a biodegradable detergent that can then be flushed through the system. This should be followed with more water mixed with a little mineral or baby oil, or one of many specialised marine toilet treatment products available to keep all rubber parts in good condition.

Caution: Do not use toilet bowl cleaners, bleach, drain cleaner, or deodorants unless made specifically for marine toilets. These substances can attack and even destroy some waste system components and harm the environment.

- To discourage calcium build up, periodically pour a cup of vinegar (a weak acid) into the toilet and allow it to sit before pumping the bowl dry. Left alone, calcium deposits will build up in valves and piping, and eventually clog the toilet. At that point, disassembly (and replacement of some parts) may be the only recourse. After about 18 months, the 38 mm diameter pipes may, without the acid treatment, be so calcified that their useful diameter is only about 18 mm. An alternative for avoiding this altogether, is where practicable, to use fresh water for flushing the toilet. Waste water from sinks and showers, placed into a separate holding tank, is sometimes used for this purposes.



- If marine life routinely gets into the toilet with the flushing water, install a strainer (external, internal or both) on the flush water intake line.
- A Teflon-based waterproof grease coating on a manual toilet's piston rod prolongs the life of the piston rod seal.
- All wire terminals on electric toilets should be checked periodically for corrosion and cleaned when necessary. Spray them with a corrosion inhibitor.
- Keep a toilet repair kit onboard with a full set of replacement seals. It is never an issue of "if" toilet seals will fail, but "when".

Holding tanks

- Rinse and flush the holding tank after each pumpout. This will help to dilute any residual sewage, and thereby reduce odours.
- At the end of the boating season, pump out and rinse the tank before winterising the waste system. As a rule, it is best to leave the system drained and dry.
- Keep the holding tank inspection port gasket greased to maintain its seal. Apply lubricant each time the port is opened and resealed.

Tank level monitors

- Wire terminals should be checked periodically for corrosion and cleaned when necessary. Spray them with a corrosion inhibitor.

Seacocks and overboard discharges

- Service and lubricate periodically to assure operation.

Piping/hose

- To find out if hose permeation is the cause of persistent odours, rub a cloth on each hose section, then sniff it. If the cloth smells, the hose is permeated and must be replaced (plastic tanks can be checked for permeation in the same way). If the cloth does not smell, check each hose connection for leaks.

Vent fittings

- Keep vent fitting opening(s) free of corrosion, insect nests and other material that may result in a clogged vent line.

Vent line filters

- For effective odour control, replace filters at the start of each boating season. They must also be replaced whenever the holding tank is overfilled (over pressurised) and sewage is forced up into the vent line.

Siphon breaks

- Unscrew the vent valve periodically and wash it with fresh water to prevent clogging.

Pumps

- Keep pump manufacturer's recommended spares kit on board.
- Consult owner's manual or manufacturer's data sheet for periodic maintenance requirements.



Standards

- AS 3542:1996:Pleasure Boats – Toilet Waste Collection, Holding and Transfer Systems
- AS 3004:1993:Electrical Installations – Marinas and Pleasure Craft at Low Voltage.
- BS:7828:Small Craft. Seacocks and Through – Hull Fittings
- BS MA 101:1986:Specification for Toilet Retention and Recirculation Systems for the Treatment of Toilet Waste on Small Craft
- ISO 8099:1985 Small Craft – Toilet Retention and Recirculating Systems for the Treatment of Toilet Waste
- ISO 10133:1994 Small Craft – Electrical Systems – Extra Low Voltage DC Installations
- ISO 13297:1995 Small Craft – Electrical Systems – Alternating Current Installations
- NZS 5465:1990:Self Containment of Caravans, Motor Caravans and Boats

Non Standards

- American Boat and Yacht Council Incorporated – Standards and Recommended Practices for Small Craft - E-8, AC Electrical Systems in Boats, and E-9, DC Electrical Systems Under 50 Volts
- American Boat and Yacht Council Incorporated – Standards and Recommended Practices for Small Craft – H-23, Installation of Potable Water Systems
- The Institution of Electrical Engineers (IEE) – Regulations for the Electrical and Electronic Equipment of Ships with Recommended Practice for their Implementation

