

Integrity—Load Line Vessels), or Part C Subsection 2B (Watertight and Weathertight Integrity—Non Load Line Vessels) of the NSCV.

Where the diameter of the pipe outlet exceeds 18 mm, a corrosion-resistant wire gauze screen shall be fitted. The open area of the screen shall be not less than the cross-section of the vent pipe.

A short flexible section of hose of length no more than 760 mm may be incorporated into the vent pipe for vibration damping or to facilitate installation. The flexible section of hose shall be made of reinforced synthetic rubber of a type resistant to fuel, salt water and vibration.

The flexible section of hose shall be fastened to the rigid section of the vent with two corrosion-resistant clips at each end.

4.7.1.4 Inspection opening

Non-portable fuel tanks, unless they are of the freestanding type and less than 800 L capacity, shall be fitted with an inspection opening to facilitate cleaning and inspection.

4.7.1.5 Fuel shut-off

A fuel shut-off valve or cock shall be fitted in each tank outlet line. Non-metallic piping and fittings shall not be fitted in the line between the tank and this shut-off valve or cock. The fuel shut-off valve or cock shall be provided with a means of closing located outside a machinery space in a position not likely to be isolated by a fire in the machinery space. Where remote fuel shut-off arrangements lead from or pass through a machinery space, they shall be capable of operating when exposed to flame and heat from a fire within that space.

NOTE: Locating the fuel shut-off valve on or near the fuel tank reduces the risk of uncontrolled fuel spillage in the event of a rupture in the pipe between the shut-off valve and the tank.

4.7.1.6 Fuel filling stations

Fuel filling stations shall be located outside machinery spaces and shall be arranged to—

- a) prevent any possibility of overflow coming into contact with a hot surface; and
- b) prevent or minimise pollution of the environment by any possible overflow.

4.7.1.7 Filling pipes for non-portable fuel tanks

Non-portable fuel tanks shall incorporate a permanent filling pipe. The filling pipe should extend from the open deck to the tank.

A short flexible section of hose of length no more than 760 mm may be incorporated into the filling pipe for vibration damping or to facilitate installation. The flexible section of hose shall be made of reinforced synthetic rubber of a type resistant to fuel, salt water and vibration and shall comply with a relevant national or international standard.

The flexible section of hose shall be fastened to the rigid section of the filling pipe with two corrosion-resistant clips at each end.

NOTES:

1. The use of flexible sections of hose in filling pipes that are also used for sounding may prevent proper soundings being taken unless the pipe is straight and a sounding tape is not used.
2. Electrical bonding similar to that mandated in Clause 4.10.10 for fuel systems of flashpoint less than 60°C is considered to be good practice on vessels having fuel of flashpoint 60°C or more.

4.7.2 Specific requirements for built-in fuel tanks which are integral to the vessel's hull structure

4.7.2.1 Construction

Built-in fuel tanks integral to the vessel's hull structure shall comply with the relevant provisions of Part C Section 3 (Construction) of the NSCV.

4.7.2.2 Arrangement

Fuel tanks shall not be located forward of the collision bulkhead. Built-in fuel tanks should be located to reduce the risk of spillage in the event of minor collisions or grounding.

NOTE: Cofferdams are used to separate fuel tanks from potable water tanks, see Part C Section 1 (Arrangement, Accommodation and Personal Safety) of the NSCV.

4.7.2.3 Fuels having a flashpoint below 60°C

Built-in fuel tanks shall not be used to contain fuels having a flashpoint below 60°C.

4.7.2.4 Sandwich construction

Sandwich construction shall not be used in way of built-in fuel tanks.

4.7.2.5 Large built-in tanks

Deep tanks and double bottom tanks extending more than half the breadth of the vessel shall be subdivided with a longitudinal division.

4.7.2.6 Baffles

Baffle plates shall be fitted in built-in fuel tanks to reduce the surging of the tank contents. Baffles should be fitted at intervals not more than 1 m along either the longitudinal or transverse axis of the tank. Access openings through baffles should be the minimum size required for inspection and cleaning in order to maintain their effectiveness as baffles.

NOTE: Baffles are usually fitted perpendicular to the axis of larger dimension. They are not normally provided along both axes.

4.7.3 Specific requirements for non-portable, free-standing fuel tanks

4.7.3.1 Construction

Non-portable, free-standing fuel tanks shall be constructed of carbon steel, stainless steel, copper, marine-grade aluminium alloy or FRP. No part of a metallic fuel tank shall depend on soft solder for tightness.

4.7.3.2 Location

Non-portable, free-standing fuel tanks should be located or arranged to permit inspection of the exterior of the tank and the hull and structure adjacent to the tank.

NOTE: Non-portable fuel tanks in machinery spaces are also required to comply with the fire rating requirements contained in Part C Section 4 (Fire Safety) of the NSCV.

4.7.3.3 Support and securing

Non-portable, free-standing fuel tanks shall be adequately supported and braced to prevent dislodging due to high accelerations that might arise through motions at sea or by a collision. The supports and braces shall be insulated from contact with the tank surfaces with a non-abrasive and non-absorbent material compatible with the tank material.

4.7.3.4 Baffles

Baffles shall be fitted in non-portable, free-standing fuel tanks at a spacing not greater than 1 m along the length of the tank (tank major axis), and shall have a thickness not less than that of the tank plating or tank shell laminate.

4.7.3.5 Minimum thickness—metallic tanks

The minimum thickness of metal used in the construction of a non-portable, free-standing fuel tank shall be the greater of the two values determined in accordance with Items a) and b) as follows:

- a) The thickness determined using the formulas in Clauses 4.7.3.7, 4.7.3.8 or 4.7.3.9 as appropriate, based on the dimensions of the largest unsupported panel.
- b) The thickness determined from the following formula:

$$t_{min} = 3 \sqrt{\frac{410}{UTS_{tank}}}$$

where

t_{min} = minimum plate thickness of tank, in millimetres

UTS_{tank} = welded ultimate tensile strength of tank material, in megapascals (MPa).

NOTE: The minimum thickness determined by the formula in Clause 4.7.3.5 (b) equates to 3 mm for carbon steel, 2.4 mm for 316 stainless steel and between 3.7 mm and 4.7 mm for aluminium depending upon the grade. Where material of the calculated thickness is not readily available, the preferred stock thickness of material in excess of that required is normally used.

4.7.3.6 Largest unsupported span—carbon steel tanks

When determining the largest unsupported panel for use in Clauses 4.7.3.7 and 4.7.3.8, account shall be taken of the support afforded by the following items:

- a) Tank boundaries.
- b) Baffles, where the thickness of the baffle is not less than the thickness of the tank plating in way (see Clause 4.7.3.4).

- c) Stiffeners, where—
- i) the thickness of the stiffener is not less than the thickness of the tank plating in way; and
 - ii) the depth of the stiffener is not less than that determined from the following formula:

$$d = 12 + \frac{b}{10}$$

where

d = depth of stiffener in carbon steel, in millimetres

b = unsupported span of stiffener, in millimetres.

4.7.3.7 Carbon steel tank of depth not exceeding 2.5 m

Where the depth from the top of the filling pipe to the bottom of a non-portable, free-standing carbon steel fuel tank does not exceed 2.5 m, the minimum plate thickness of carbon steel shall be obtained from Figure 10, which is developed from the following formula:

$$t = 0.024 a c$$

where

t = minimum carbon steel plate thickness, in millimetres

a = length of minor axis, in millimetres

c = corresponding numerical value for the ratio of length of major axis of panel l to length of minor axis of panel a , as given in Table 2

l = length of major axis, in millimetres.

4.7.3.8 Carbon steel tank of depth exceeding 2.5 m

Where the depth from the top of the filling pipe to the bottom of a non-portable, free-standing carbon steel tank exceeds 2.5 m, the minimum plate thickness of carbon steel shall be calculated from the following formula:

$$t = 0.024 a c \sqrt{\frac{h}{2.5}}$$

where

t = minimum carbon steel plate thickness, in millimetres

a = length of minor axis, in millimetres

c = corresponding numerical value for the ratio of length of major axis of panel l to length of minor axis of panel a , as given in Table 2

h = distance from top of filling pipe to bottom of tank, in metres

l = length of major axis, in millimetres.

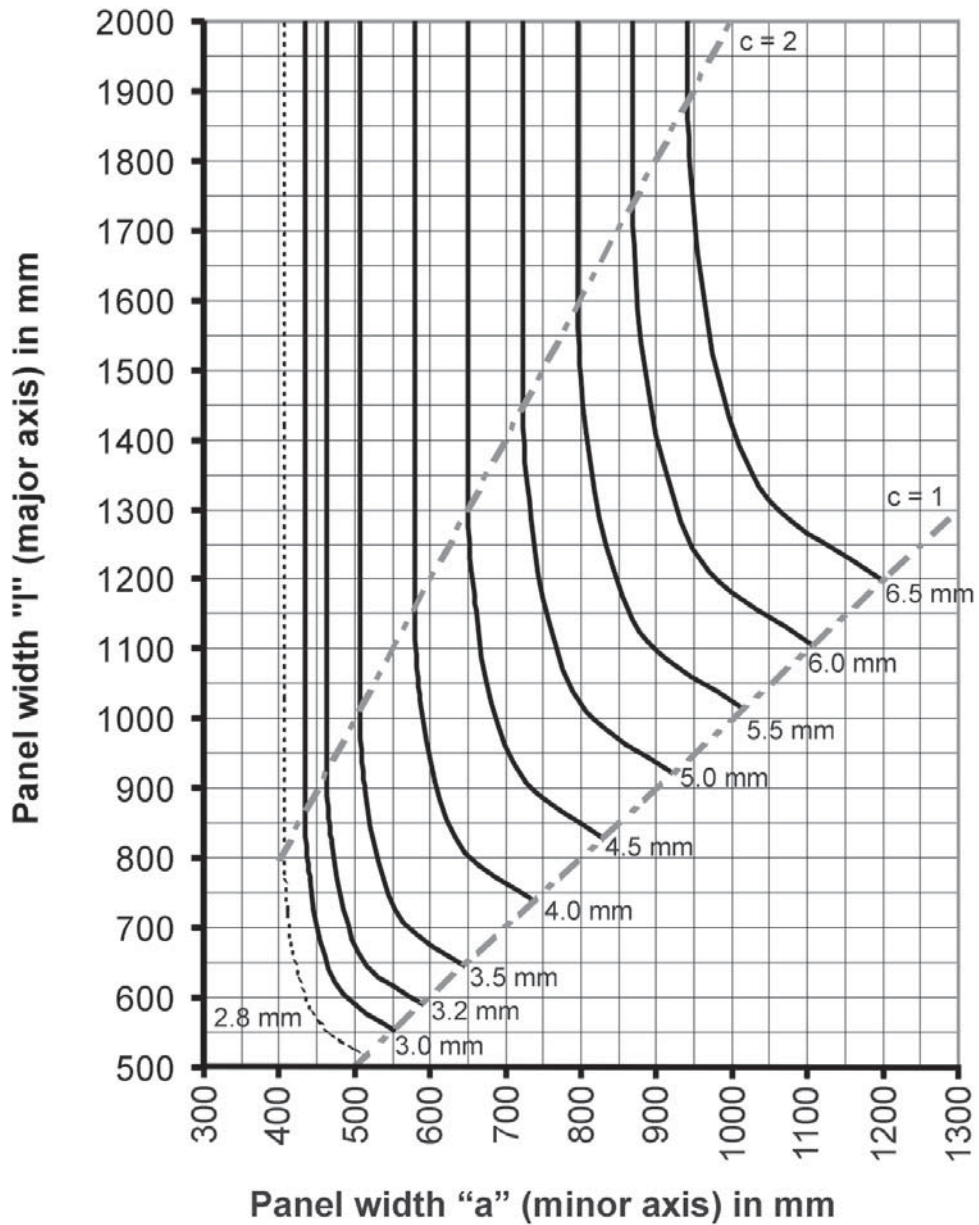


Figure 10 — Minimum thickness of fuel tanks plated in carbon steel for heads not exceeding 2.5 m

Table 2 — Ratio of major/minor axes of panel (l/a)

| l/a | 1 | 1.25 | 1.5 | 1.75 | 2 and over |
|-------|-------|-------|-------|-------|------------|
| c | 0.226 | 0.258 | 0.275 | 0.284 | 0.288 |

NOTE: Values for coefficient c corresponding to values of l/a between those shown in the table may be obtained by linear interpolation.

4.7.3.9 Metallic tanks manufactured from metal other than carbon steel

Where a fuel tank is manufactured from a metal other than carbon steel, the plate thickness shall be determined from the following formula:

$$T = t \sqrt{\frac{410}{UTS_{tank}}}$$

where

- T = minimum plate thickness of tank, in millimetres
- t = minimum plate thickness, in millimetres, for carbon steel, determined in accordance with Clause 4.7.3.7 or 4.7.3.8 as appropriate
- UTS_{tank} = ultimate tensile strength of tank material, in megapascals (MPa).

Where the stiffener material is a metal other than carbon steel, the minimum depth of stiffener referred to in Clause 4.7.3.6 (c) shall be determined from the following formula:

$$D = d \sqrt[4]{\frac{410}{UTS_{tank}}}$$

where

- D = minimum depth of stiffener in metal other than carbon steel, in millimetres
- d = depth of stiffener for carbon steel, determined in accordance with Clause 4.7.3.6(c)
- UTS_{tank} = ultimate tensile strength of tank material, in megapascals (MPa).

4.7.3.10 FRP non-portable, free-standing fuel tanks—general

Sandwich construction shall not be employed in FRP free-standing fuel tanks. Scantlings for FRP free-standing fuel tanks shall be calculated in accordance with AS 4132.1 and AS 4132.3. Alternatively, the scantlings for FRP free-standing fuel tanks may be determined in accordance with Clauses 4.7.3.11 and 4.7.3.12 below.

4.7.3.11 FRP non-portable, free-standing fuel tanks—basis for scantlings

The scantlings for FRP free-standing fuel tanks in Clause 4.7.3.12 are based on the following minimum requirements for mechanical properties:

- a) Tensile Strength—80 MPa
- b) Bending Strength—120 MPa
- c) Modulus of Elasticity:
 - i) Tensile (E_s)—7000 MPa
 - ii) Bending (E_b)—7000 MPa

NOTE: A mass per square metre of reinforcement material of 430 grams per square metre per millimetre ($\text{g/m}^2/\text{mm}$) of laminate thickness has been assumed.

4.7.3.12 FRP non-portable, free-standing fuel tanks—tank shell laminate and stiffener requirements

The scantlings of the shell laminate and stiffeners for non-portable, free-standing fuel tanks manufactured from FRP shall be in accordance with Table 3 and Table 4 respectively.

Table 3 — Laminate for free-standing fuel tank shell

| Depth of Tank (m) ^A | Head (m) ^B | | | |
|--------------------------------|---|------|------|------|
| | 1.8 | 2.4 | 3.0 | 3.6 |
| | Laminate Weight (g/m^2) ^C | | | |
| 0.6 and less | 4260 | 4760 | 5210 | 5660 |
| 0.9 | 4540 | 4980 | 5430 | 5825 |
| 1.2 | 4760 | 5210 | 5660 | 6050 |
| 1.5 | 4980 | 5430 | 5825 | 6220 |
| 1.8 | 5210 | 5660 | 6050 | 6380 |

LEGEND

- ^A The depth of the tank shall be measured from the lowest point of the tank panel to the crown of the tank.
- ^B The head shall be measured from the crown of the tank to the top of the air or overflow pipe, whichever is the greater, but cannot be less than 1.8 m.
- ^C The laminate weights are for stiffeners spaced 460 mm apart. Where the spacing differs from 460 mm, the laminate shall be modified in direct proportion.

Table 4 — Stiffening of free-standing fuel tanks

| Length of stiffeners (m) | Minimum head for vertical stiffeners (m) ^A | Head (m) | | | |
|--------------------------|---|--|------|-------|-------|
| | | 1.8 | 2.4 | 3.0 | 3.6 |
| | | Stiffener Section Modulus (cm^3) ^B | | | |
| 0.9 and less | 2.25 | 17.0 | 22.5 | 28.5 | 34.0 |
| 1.2 | 2.40 | 30.5 | 40.5 | 50.0 | 59.5 |
| 1.5 | 2.55 | 46.5 | 62.5 | 77.5 | 92.5 |
| 1.8 | 2.70 | 67.0 | 90.0 | 111.5 | 134.0 |

LEGEND

- ^A The head shall be measured from the centre of the span to the top of the air or overflow pipe, whichever is the greater, but shall not be less than the value given in the table for vertical stiffeners, or 1.8 m above the crown of the tank for horizontal stiffeners.
- ^B The modulus values are for stiffeners spaced 460 mm apart. Where the spacing differs from 460 mm, the modulus shall be modified in direct proportion.

4.7.3.13 Internal structure and coatings for non-portable, free-standing fuel tanks constructed of FRP

The minimum laminate for internal baffles in non-portable, free-standing FRP fuel tanks shall not be less than 2400 g/m². A fuel-resistant flow-coat shall be applied to the internal surface, preferably over a heavy resin-rich (2.5:1) chopped strand mat layer using vinyl ester.

4.7.4 Portable fuel tanks

4.7.4.1 Design

Portable fuel tanks shall be designed to minimise the possibility of overturning and facilitate ease of handling and securing against movement.

4.7.4.2 Manufacture

Portable fuel tanks shall comply with the following:

- a) Unless part of the original engine manufacturer's equipment, the tank shall be manufactured from corrosion-resistant metal or shall be coated with a material to provide protection from corrosion.
- b) Where applicable, the tank shall have mated parts that are galvanically compatible.
- c) The tank shall have all service and vent openings above the full contents level.
- d) The tank shall be fitted with a fuel contents gauge.
- e) AS 2906, unless the tank is part of the original equipment as supplied by the engine manufacturer.

NOTE: AS 2906 specifies material, design, properties and marking requirements for refillable, portable fuel tanks of capacity up to 25 L.

4.7.4.3 Location

Where a vessel is fitted with a flush or sealed deck, portable fuel tanks shall be situated above that deck in such a position as to prevent any fuel from draining to spaces below the deck in the event of a spillage.

4.7.4.4 Fuel lines

Fuel lines for portable fuel tanks shall be of heavy-duty synthetic rubber and shall be fitted with bayonet-type fittings at the tank or engine connection which, when disconnected, will automatically shut off fuel from the tank.

4.8 SAFETY ARRANGEMENTS FOR POWER-OPERATED FUEL PUMPS AND MOTORS

4.8.1 Relief valving

If the closed discharge pressure of a cargo oil pump, fuel transfer pump or fuel pressure pump exceeds the maximum design working pressure of the discharge system, a relief valve discharging back to the suction side of the pump shall be fitted.

4.8.2 Stop valves

Stop valves shall be fitted on the suction and discharge lines of cargo oil, fuel transfer and fuel pressure pumps.

4.8.3 Means of stopping

A fuel transfer pump or cargo oil pump shall be fitted with means to stop the pump from both inside and outside the space in which it is located.

The remote fuel transfer pump or cargo oil pump shut-down arrangements shall be capable of operating when exposed to flame and heat from a fire within the space containing the pump.

4.8.4 Fuel filters

Transparent filter casings of plastic or glass shall be resistant to both mechanical impact and thermal shock, and shall either be fitted with guards or located in protected positions.

Where fuel filters are not installed in positions such that any spillage is directed overboard, they shall be designed and installed such that their disassembly will result in minimum spillage.

NOTE: Fuel filters may be fitted at any position in the fuel system after the fuel shut-off valve or cock referred to in Clause 4.7.1.5.

4.9 ADDITIONAL REQUIREMENTS FOR FUEL SYSTEMS IN VESSELS WITH NON-PORTABLE FUEL TANKS AND WHICH OPERATE ON FUEL WITH FLASHPOINT MORE THAN 60°C

Refer to Figure 11.

NOTE: AS 3570 specifies 61.5°C as the minimum flashpoint for diesel. Australian fuels meet the requirements of AS 3570. Some overseas standards specify a temperature less than 60°C for the minimum flashpoint of diesel.

4.9.1 Fire risk

The fuel system of a vessel shall be designed and installed so that failure of any part of the fuel system does not increase the risk of fire to unacceptable levels.

NOTE: Measures to reduce the risk of fire from a failure in the fuel system include separation from potential sources of ignition, sheathing of fuel piping, spray guarding, and the fitting of alarms.

4.9.2 Fuel tank contents measurement

Non-portable fuel tanks shall be fitted with a means for determining the amount of fuel contained in the tank. It shall not be possible for fuel to leak through the measurement device in the event of the tank being overfilled.

Where a level indicating gauge glass is fitted on a non-portable fuel tank, it shall be fitted with self-closing valves or cocks. Where the upper end of the gauge glass is connected to the tank through the top plating, only one such self-closing valve or cock at the lower end need be fitted.

Fuel tank sounding pipes should not terminate in accommodation spaces. Where such sounding pipes terminate in alleyways, flush deck screwed caps should be fitted.

4.9.3 Fuel tank drains

Non-portable fuel tanks shall be fitted with a drain valve or drain cock, the open end of which shall be blanked with a screwed plug. Alternatively, fuel tanks with a capacity less than 400 L may be provided with just a screwed drain plug.

4.9.4 Rigid Fuel piping

Unless provided for in Clause 4.9.5, fuel piping for non-portable fuel tanks shall be of seamless, heavy gauge metal. The piping shall be connected by flanged joints, metal to metal joints of the conical type or other suitable means. Such connections shall be kept to a minimum, and shall be readily visible and accessible.

Where cone nipples are used, they shall be welded. Olive-type compression fittings shall not be used.

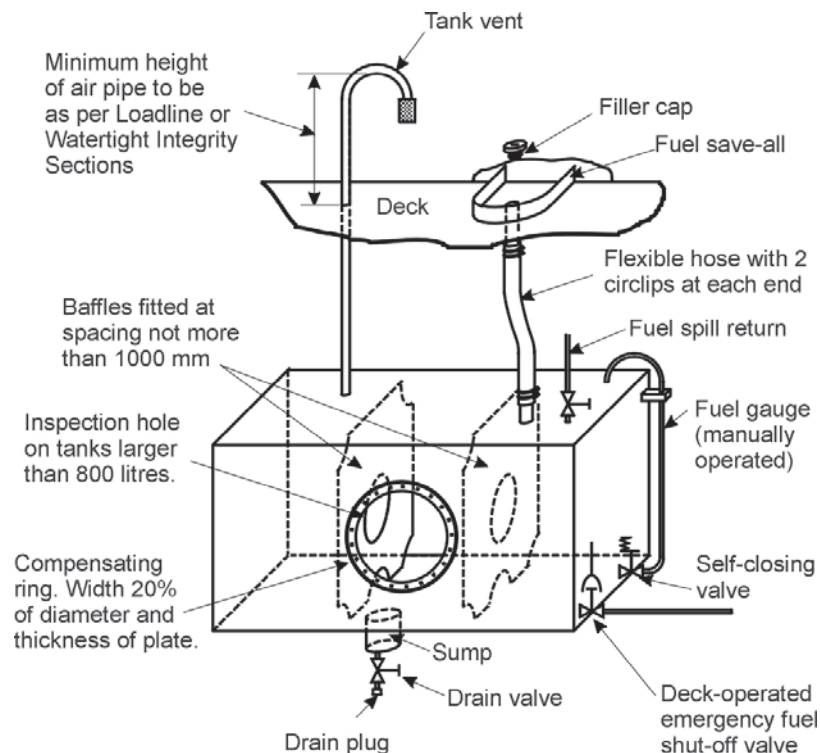


Figure 11 — Example of a freestanding non-portable fuel tank installation for fuel over 60°C flashpoint (informative)

4.9.5 Flexible fuel piping

Flexible fuel piping may be used in fuel systems for non-portable fuel tanks only—

- a) between the fuel shut-off valve or cock specified in Clause 4.7.1.5 and the main or auxiliary engine; and
- b) to conduct any fuel bypass back to the top of the fuel tank.

Flexible piping shall have a synthetic rubber inner tube with metal braided reinforcement. It shall be resistant to heat, salt water, petroleum products and shall be a component supplied for the purpose by the engine manufacturer or shall comply with a relevant national or international standard. It shall be installed so as to be readily visible and clear of the bilge, and shall be secured to prevent chafing. Hose fittings shall be in accordance with the hose manufacturer's recommendations for the particular application. Hose clamps should not be used.

Flexible piping should be located so as to permit regular inspection and periodic replacement.

NOTES:

1. Flexible fuel lines tend to degrade over time.
2. Compliance with relevant national or international standards include classification society approval, approval by a national marine authority (e.g. AMSA, US Coast Guard), certified compliance with a relevant standard (such as SAE 30R9-Fuel Injection Hose Medium-Pressure Coupled and Uncoupled Synthetic Rubber Tube and Cover). Compliance is only valid if the application is the same as that envisaged by the particular standard or authority, especially supply pipes to fuel injection pumps which are subjected to dynamic pulsing. Fuel returns may also be subjected to dynamic pulsing.

4.10 ADDITIONAL REQUIREMENTS FOR FUEL SYSTEMS IN VESSELS WITH NON-PORTABLE FUEL TANKS AND WHICH OPERATE ON FUEL WITH FLASHPOINT LESS THAN 60°C

Refer to Figure 12 and Figure 13.

NOTE: Petrol (gasoline) and liquefied petroleum gas (LPG) both have a flashpoint less than 60°C.

4.10.1 Application

The requirements of this Clause apply to fuel systems in vessels with non-portable fuel tanks and which operate on fuel with a flashpoint less than 60°C, with the exception of liquefied petroleum fuel systems. Liquefied petroleum fuel systems shall comply with Part C Subsection 5D (LPG Systems for Engines) of the NSCV.

4.10.2 Gravity feed fuel systems

Gravity feed fuel systems shall not be used on engines with non-portable fuel tanks of capacity exceeding 10 L.

4.10.3 Fuel tank capacity

Non-portable fuel tanks should be no larger than that necessary for the intended service of the vessel, but should be of sufficient capacity to prevent them having to be filled while in service.

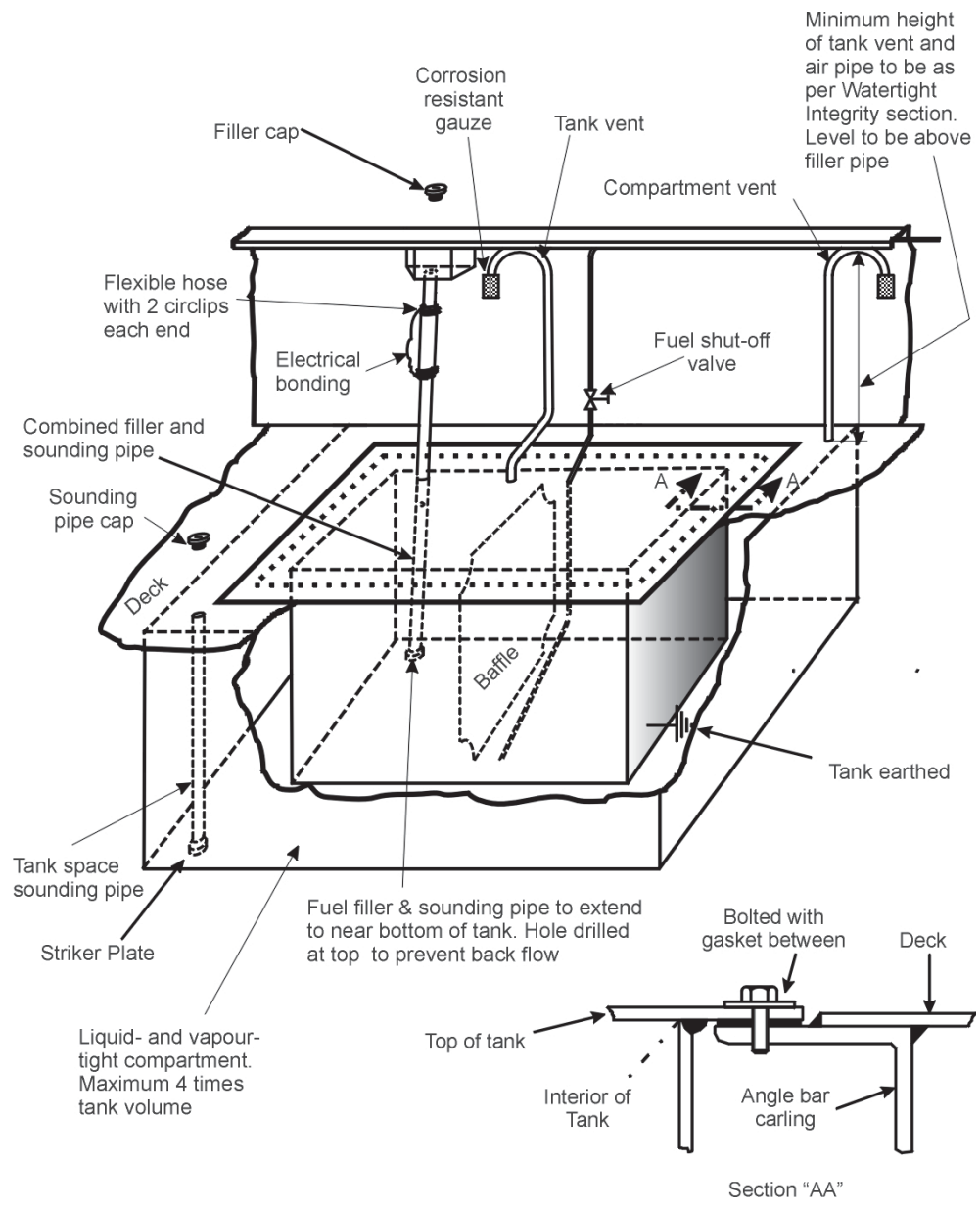


Figure 12 — Example of an under-floor fuel tank installation for fuel less than 60°C flash point (informative)

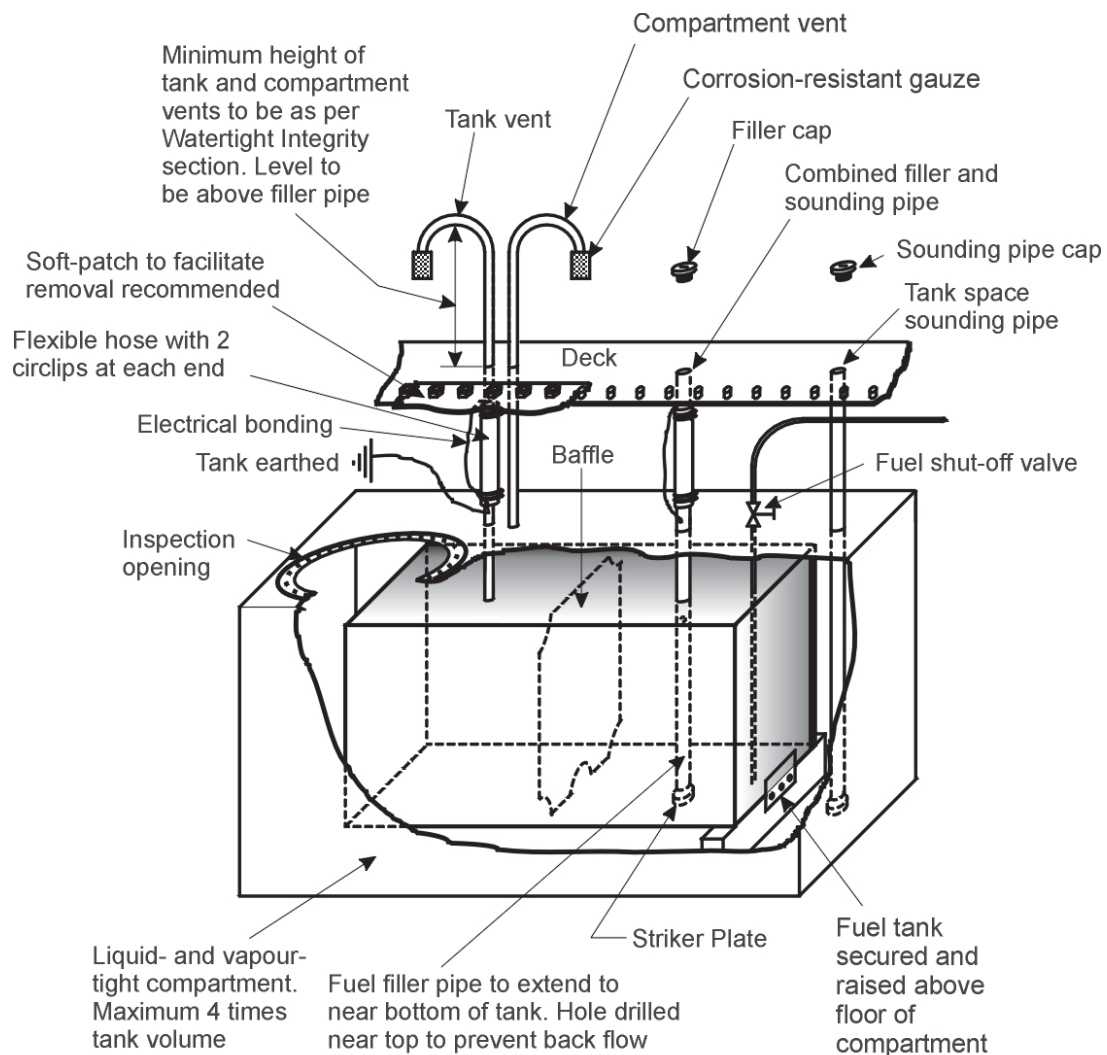


Figure 13 — Alternative example of an under-floor fuel tank installation for fuel less than 60°C flashpoint (informative)

4.10.4 Fuel tank contents measurement

Non-portable fuel tanks shall be fitted with a means for determining the amount of fuel contained in the tank. It shall not be possible for fuel to leak through the measurement device in the event of the tank being overfilled. The cap provided on the sounding pipe for the insertion of the sounding rod shall have a maximum clear opening of 15 mm diameter.

NOTE: The 15 mm limit on caps for sounding pipes is intended to prevent the risk of spillage where a sounding pipe not intended for use as a filling point is used for that purpose. It does not apply where the filling pipe is also designed for taking soundings.

4.10.5 Fuel tank location

Non-portable fuel tanks shall be securely installed in a location remote from the engine, exhaust pipes and other potential sources of ignition.

Fuel tanks located below the deck or within an enclosed space shall be in a compartment no greater than four times the volume of the tanks. The fuel tank compartment shall be liquid and vapour tight to all other compartments.

Such fuel tank compartments shall not be used for any purpose other than for housing the fuel tanks. Means to sound the fuel tank space shall be provided.

NOTE: The likelihood of fuel leaking from a tank is reduced when penetrations such as fuel take-offs, tank vents and inspection covers are arranged to pass through the top of the tank; e.g. refer to Figure 13 and Figure 14.

4.10.6 Fuel filler pipe

The fuel filler pipe for non-portable fuel tanks shall extend to a point close to the bottom of the tank.

NOTE: The purpose of this clause is to reduce the backflow of inflammable vapours through the filling pipe.

4.10.7 Inspection

Non-portable fuel tanks and associated fittings should be able to be inspected externally.

4.10.8 Ventilation

Spaces for non-portable fuel tanks that do not drain overboard shall be adequately ventilated. Venting shall be via a vent pipe to an open space where there is no risk of the escaping vapour igniting or posing any other hazard.

Each fuel tank shall also be fitted with a vent pipe, remote from the tank space vent, leading to a similar open space.

Vent pipes from tank spaces and fuel tanks shall comply with the relevant requirements of Part C Section 2: Watertight and Weathertight Integrity of the NSCV. They shall be separate and non-communicating, and shall be fitted with spark arresters (e.g. wire gauze diaphragms).

NOTE: Additional ventilation of the fuel tank space may be provided by a flameproof fan. Alternatively, a gas detector may be fitted, having an audible or visual alarm located at the control position. Guidance for the fitting of flameproof fans is provided in AS 1799.3 Chapter 5.

4.10.9 Electrical connections

Unless required for establishing the amount of fuel in a non-portable fuel tank, electrical connections or wiring shall not be fitted anywhere within the tank space.

4.10.10 Electrical bonding

Electrical bonding shall be provided to protect against the possibility of a spark arising from static charge causing an explosion. Each non-portable

metallic fuel tank and metal or metal-plated component of the fuel fill system that may come into contact with fuel shall be earthed so that resistance to earth is less than 10 ohms. When a fill or air pipe contains a non-conducting flexible section, a conductor shall join the metallic sections of the fill or air pipe to protect against a static charge arising during fuel filling.

4.10.11 Fuel piping

Unless provided for in Clause 4.10.12, piping in fuel systems for non-portable fuel tanks shall be of seamless heavy gauge metal. Pipe connections shall be made via flanged joints, metal to metal joints of the conical type or other suitable means, and shall be minimised. Pipe connections shall also be readily visible and accessible.

Where cone nipples are used, they shall be welded. Olive-type compression fittings shall not be used.

4.10.12 Flexible piping

A short length of flexible piping may be fitted in fuel systems for non-portable fuel tanks in the section of line between the engine bed and the fuel lift pump.

Flexible piping shall have a synthetic rubber inner tube with metal braided reinforcement. It shall be resistant to heat, salt water, petroleum products and vibration and shall comply with a relevant national or international standard (SAE J 30 or equivalent). It shall be installed so as to be readily visible and clear of the bilge, and shall be secured to prevent chafing.

4.10.13 Carburettor trays

Carburettors in fuel systems for non-portable fuel tanks (other than down-draught type carburettors) that can flood or overflow shall be fitted with a flame trap and a drip tray. The drip tray should—

- a) be made of copper or brass;
- b) be fuel-tight;
- c) have a corrosion-resistant wire gauze screen sweated into it not less than 13 mm below its lip;
- d) be of a size sufficient to impound any leak from the carburettor; and
- e) be readily removable.

4.10.14 Engine covers

Engine covers that might be fitted to protect the engine from the weather or salt spray shall be provided with adequate ventilation to prevent the accumulation of explosive fumes.

CHAPTER 5 FLUID SYSTEMS

5.1 SCOPE

This Chapter specifies requirements for installation and operation of seawater and bilge systems. It applies to vessels of less than 35 m in measured length.

NOTE: For vessels of 35 m or more in measured length, refer to Clause 1.2.1.

5.2 OBJECTIVE

The objective of this Chapter is to control the risks arising from seawater and bilge system installations within the vessel and to provide effective and reliable means for detecting and discharging water that may collect within the vessel.

NOTES:

1. Specific hazards associated with fluid system installations include the following: flooding of the vessel due to a failure of piping, flooding of the vessel due to back-flooding through piping, blockage of piping, inability to pump bilge water from one or more compartments (due to failure of bilge pumps, pipes drawing air or failure of piping), failure to detect flooding.
2. Consequences of these hazards include the following: foundering of the vessel through progressive down-flooding or capsizing, loss of propulsive power, loss of emergency systems.

REQUIRED OUTCOMES

5.3 MEANS FOR MONITORING LIQUID LEVELS

Means must be provided for readily ascertaining the quantity of liquid within any tank or watertight compartment.

5.4 WATERTIGHT INTEGRITY

Seawater and bilge systems must be designed and constructed to maintain the watertight integrity of the hull in normal and abnormal conditions.

Any reference to “sea” or “seawater” in Chapter 5 also applies to vessels operating in freshwater.

5.5 DRAINING OF SPACES WITHIN THE VESSEL

Means must be provided for draining the watertight spaces within a vessel in normal and abnormal conditions to—

- a) maintain the vessel's reserve buoyancy and stability;
- b) prolong the time before the reserve buoyancy or stability is lost;
- c) maintain the function of equipment essential to the safety of persons on board the vessel, or prolong the time before such equipment no longer functions; and
- d) prevent corrosion and degradation caused by moisture lying within the vessel.

5.6 RELIABILITY

Seawater and bilge systems essential to the safety of the vessel must provide a reliable means for fulfilling their specific functions.

DEEMED-TO-SATISFY SOLUTIONS

5.7 DISCHARGES INLETS AND SEAWATER PIPING

5.7.1 Compliance

For the purpose of this National Standard, discharges, inlets and seawater piping within a vessel shall be deemed to have satisfied the Required Outcomes in Clauses 5.4 and 5.6 if they comply with Clauses 5.7.2 to 5.7.4.

5.7.2 Discharge and inlets

5.7.2.1 *Seagoing Class 1 and Class 2 Vessels 24 m and more in measured length*

All discharges, inlets and scuppers on seagoing vessels that are required to be marked with a load line in accordance with Part C Subsection 2A (Watertight and Weathertight Integrity — Loadline Vessels) of the NSCV shall comply with the load line conditions of assignment for discharges, inlets and scuppers contained within that Subsection. Where there is conflict between the provisions of Clause 5.7.2 and those of Part C Subsection 2A, the latter shall prevail.

5.7.2.2 *Inlet and discharge valves*

All sea inlet and overboard discharge pipes (including sanitary discharges) shall be fitted with valves or cocks unless required otherwise by Clauses 5.7.2.3 or 5.7.2.4.

5.7.2.3 *Small discharges*

A small discharge may not be fitted with a valve provided that:

- a) the internal diameter of the discharge does not exceed 50 mm; and
- b) the lowest point of the discharge is not less than 225 mm above the deepest loaded water line.

5.7.2.4 *Scupper discharges*

A scupper discharge which passes through the vessel's side from a space above the bulkhead deck may be fitted with a non-return valve in lieu of a screw-down valve or cock.

5.7.2.5 *Valves and cocks*

Valves and cocks shall be manufactured from bronze, ductile cast steel or equivalent material. Where a valve with a screwed bonnet is a sea injection valve or a valve controlled by an extended spindle, the bonnet shall be secured so that it cannot slacken when the valve is operated.

5.7.2.5.1 *Fitting*

Valves and cocks shall be fitted such that they are readily accessible at all times. They shall be mounted on pads or flanges and secured to one of the following:

- a) The hull of the vessel.
- b) Water boxes.
- c) Standpipes.

Where secured to standpipes, the standpipes shall be as short as practicable.

5.7.2.5.2 *Types*

Valves and cocks with a bore greater than 50 mm shall be of the flanged type. Those with bores 50 mm or less shall either be of the flanged type or the screwed type (see Clause 5.7.2.5.3).

5.7.2.5.3 *Skin fittings and standpipes*

Valves and cocks shall be secured to the hull of the vessel by means of a metallic skin fitting or standpipe. The finished wall thickness of any such stand pipe shall be a minimum 1.25 times the calculated thickness for a hull of the same material as the standpipe.

5.7.2.5.4 *Gratings*

Gratings shall be fitted on the outside of the hull to all seawater inlets. The clear area through the grating shall be at least twice the area of the connected valve. Gratings should be removable to permit access.

5.7.3 **Pipe materials**

5.7.3.1 **General characteristics**

Material for seawater piping shall be suitable for its intended service taking into account the nature of fluid carried and the demands imposed by its location in the vessel. All piping that may come into contact with seawater shall be corrosion-resistant.

NOTE: Other characteristics that are relevant for pipes used for seawater applications include resistance to internal pressure, vacuum and external pressure, axial strength, operating temperature limitations, impact resistance, resistance to fatigue, ageing and erosion, fluid absorption, material compatibility, fire endurance and smoke generation upon combustion.

5.7.3.2 **Metallic piping**

5.7.3.2.1 *Material*

Metallic piping shall be copper, stainless steel, aluminium alloy of a grade suitable for long-term exposure to seawater or carbon steel which has been protected against corrosion (e.g. galvanising).

5.7.3.2.2 *Thickness*

The thickness of metallic piping shall be sufficient to withstand the likely maximum pressure with due allowance for corrosion and erosion that may

occur. In any case, the thickness of metallic piping shall not be less than the following:

$$t_p = 0.012 d_i + t_0$$

where

t_p = minimum pipe thickness, in millimetres

d_i = internal diameter, in millimetres

t_0 = 1.8 mm for carbon steel or aluminium

1.1 mm for copper

0.8 mm for stainless steel or copper alloy.

5.7.3.3 Rigid plastic piping

5.7.3.3.1 Application

Rigid plastic piping shall meet the requirements contained in IMO Resolution A.753(18), or the requirements of a Classification Society.

NOTE: IMO Resolution A.753(18) places limits on the extent to which rigid plastic piping can be used for essential services on board ship. In particular, fire endurance, reliability and the consequences of failure are important considerations.

5.7.3.3.2 Installation

Rigid plastic piping shall be arranged so that it is readily accessible for inspection and protected against mechanical damage and contact with hot surfaces.

Where acrylonitrile butadiene styrene (ABS) piping is used in pressure applications, it shall comply with AS 3518.1. Fittings for ABS piping shall comply with AS 3518.2.

NOTE: Plastic piping has a coefficient of linear expansion that is eight to ten times that of steel. Where plastic piping is used, design requirements over the range of service temperatures will have to be considered.

5.7.3.4 Flexible piping

5.7.3.4.1 General characteristics

Flexible piping shall be reinforced synthetic rubber. It shall comply with a relevant national or international standard and shall have the following performance characteristics:

- a) Resistance to water, petroleum products, heat and vibration.
- b) Capable of operation under suction without collapse and resultant reduction in effective cross-sectional area.
- c) Capable of withstanding internal pressure present within the system.

5.7.3.4.2 Application

Flexible piping shall be readily visible and located so as to prevent mechanical damage and contact with hot surfaces. Subject to Clause 5.8.4.4, flexible piping shall only be used in the following applications:

- a) In short lengths of no more than 760 mm for vibration damping or to accommodate relative movement of machinery.

- b) In vessels less than 12.5 m in length, provided that—
 - i) the length of piping does not exceed half the beam of the vessel;
 - ii) the run of the piping is as direct as practicable; and
 - iii) it is adequately supported.

5.7.3.4.3 *Method of securing*

The method of securing flexible piping to a rigid pipe or fitting shall be appropriate for the nature of fluid carried and the risks associated with leakage of that fluid.

Where clips are used to secure flexible piping of 25 mm internal diameter and above, at least two such clips shall be fitted at each end of the flexible pipe and the clips shall be of corrosion-resistant material.

5.7.3.5 *Pipe fittings—material*

Pipe fittings shall not be made of malleable iron.

5.7.4 **Fish tank pumping systems**

5.7.4.1 *Piping for filling or discharging fish cargo tanks*

Non-metallic piping may be used for filling or discharging fish cargo tanks provided that—

- a) the piping complies with Clause 5.7.3.3;
- b) bilge alarms are fitted in each compartment in which the piping is installed; and
- c) any penetration by the piping of a high fire risk space bulkhead, including the bulkhead of a machinery space, is via a valve.

5.7.4.2 *Valves for fish tank pumping systems*

A valve shall be provided at each connection to a fish tank. The valves shall either be readily accessible, or where not readily accessible the valves shall either be capable of being readily closed from a position above the bulkhead deck, or shall be non-return valves.

NOTE: Valves need not be provided on the pipe connections to a fish tank if a rupture of the pipe would not reduce the safety of the vessel. Factors to be considered include the effect of discharging the tank contents into the bilge of the vessel and the effect of the ruptured pipe on the vessel's weathertight integrity.

5.8 **BILGE PUMPING SYSTEMS**

5.8.1 **Compliance**

For the purpose of this National Standard, the means for draining of spaces within the vessel shall be deemed to have satisfied the Required Outcomes in Clauses 5.3 and 5.6 if it complies with Clauses 5.8.2 to 5.8.9.

5.8.2 **General**

5.8.2.1 *Capability of bilge pumping system*

Unless otherwise provided for in Clauses 5.8.2.2 or 5.8.2.3, a vessel shall be fitted with a pumping system capable of pumping from and draining any bilge or watertight compartment in the vessel.

NOTE: Australia is a party to MARPOL Annex 1. The discharge of oil or other pollutants (including oily bilge water) overboard may be subject to Commonwealth, State or Territory marine pollution legislation. For bilge systems, this may necessitate the fitting of oily bilge water holding tanks or oil separation equipment.

5.8.2.2 Alternative arrangements for small open vessels

Open vessels of measured length less than 5 m may be provided with a bailing bucket in lieu of a bilge system, provided there is ready access to the bilge for bailing.

5.8.2.3 Alternative arrangements for small compartments

A watertight compartment less than 7 per cent of the total under deck volume may be drained into an adjacent compartment by means of a self-closing valve or cock. The adjacent compartment shall itself be served by the bilge system. The valve or cock shall be fitted outside the compartment to be drained, and shall be operable from a readily accessible position.

NOTE: Other bilge pumping arrangements for small compartments are possible but would need to be considered as equivalent solutions (see Part B—General Requirements of the NSCV). For example, bilge pumping arrangements may not be needed on small vessels having numerous small compartments where it can be shown that the safety of the vessel is not materially reduced by the flooding of adjacent compartments. Key factors would include: the effectiveness of watertight boundaries; the flooded characteristics of the vessel; the effect on systems essential to the safety of the vessel; means for monitoring water levels within compartments; and arrangements to remove accumulated water in the bilge.

5.8.2.4 Location of bilge suction

Bilge suction shall be located to facilitate the drainage of water from within each compartment over a range of list not less than $\pm 5^\circ$. Limber holes or other arrangements shall be provided to allow water to drain past structural members to the bilge suction.

NOTE: Bilge suction is normally located at the lowest point of a compartment or, where no lowest point can be identified, at the after end of the compartment. More than one suction is normally provided in long compartments and on vessels with a flat bottom (rise of floor less than 5°), arranged so as to ensure the bilge pump will not lose suction in the event of one suction drawing air.

5.8.2.5 Back-flooding

The bilge system shall be arranged to prevent water back-flooding from the sea into watertight compartments or machinery. The bilge connection to any pump that also draws from the sea shall be either a screw down non-return valve, or a cock that cannot be opened at the same time to the bilge and to the sea.

5.8.2.6 Watertight integrity of compartments

The bilge system shall also be arranged to prevent water passing from a flooded watertight compartment into other compartments. Bilge pipes should be located a distance of at least 20 per cent of the breadth of the vessel inboard of the vessel sides to avoid damage in the event of a collision. Alternatively, bilge suction pipes may be provided with non-return valves or foot valves fitted within the space they serve.

5.8.2.7 Bilge distribution manifold

The bilge system in vessels of 25 m measured length and over shall be provided with a bilge distribution manifold located in an accessible position. Valves in bilge distribution manifolds shall be of non-return type.

NOTE: Various configurations may be used for bilge systems. A bilge system may have branch suction pipes from each compartment running to a centrally located bilge distribution manifold. Alternatively the branch suction lines may run into a main bilge line, which in turn passes through compartments to connect with the bilge pumps. In general, the former is recommended, and is required on larger vessels, because it allows for better control and monitoring of the bilge system.

5.8.2.8 Class 1B vessels of 15 m and over

In Class 1B vessels of 15 m in measured length and over, the bilge system shall permit pumping and draining from every space in the vessel while any one watertight compartment is flooded. This provision need not apply to flooding of the machinery space.

NOTE: This may necessitate the fitting of a bilge distribution manifold on vessels less than 25 m in measured length or the remote operation of bilge valves within compartments from a level above the bulkhead deck. While not mandatory, the locating of the two bilge pumps in two separate compartments is recommended.

5.8.3 Bilge pumps**5.8.3.1 Number and capacity of pumps**

Vessels shall be provided with bilge pumps in accordance with Table 5.

Table 5 — Bilge pump requirements

| Measured length of vessel (m) | Manual pumps | | Powered pumps | |
|----------------------------------|--------------|--|---------------|--|
| | Qty | Capacity per pump, as installed, in kL/h | Qty | Capacity per pump, as installed, in kL/h |
| Less than 7.5 | 1 | 4.0 | N/A | N/A |
| 7.5 and over but less than 10 | 2 | 4.0 | N/A | N/A |
| 10 and over but less than 12.5 | 1 | 5.5 | 1 | 5.5 |
| 12.5 and over but less than 17.5 | 1 | 5.5 | 1 | 11.0 |
| 17.5 and over but less than 20 | 1 | 8.0 | 1 | 11.0 |
| 20 and over but less than 25 | N/A | N/A | 2 | 11.0 |
| 25 and over but less than 35 | N/A | N/A | 2 | 15.0 |

NOTE: The installed capacity of a bilge pump is normally less than the nominal figure specified by the manufacturer due to the head of the discharge above the suction and losses through valves and piping.

5.8.3.2 Bilge pumping arrangements—general

The following bilge pumping arrangements apply to vessels fitted with pumps in accordance with Clause 5.8.3.1:

- a) A powered bilge pump may be substituted for a manually operated pump.

- b) A bilge pump shall be self-priming or shall be provided with a priming device.
- c) A powered bilge pump shall be driven by a main engine, an auxiliary engine or a low or medium-voltage electric motor.
- d) Bilge pumps may be fitted additional to those specified in Table 5 provided the pump together with its piping and electrical systems are arranged to ensure that the safety of the vessel is maintained.

NOTE: Sub-clause d) above applies to any extra-low voltage bilge pumps (under 50 V d.c) that may be fitted on a vessel.

5.8.3.3 Bilge pumping arrangements—vessels required to have two pumps

Where two pumps are required, the following shall apply:

- a) Each power pump shall not be dependent on the same source of power.
- b) The pumps and piping systems shall be arranged to enable simultaneous pumping of each machinery space bilge by both pumps on all vessels of 20 m and more in measured length.
- c) If both pumps are powered, the capacity of one pump may be less than that specified in Clause 5.8.3.1 by up to 20 per cent provided the total required pumping capacity is achieved.
- d) For vessels other than Class A, one of the two pumps may be a portable pump provided it can be operated at full capacity within 5 minutes of flooding becoming known. Where a portable pump is fitted, the portable pump and its attachments shall be of a type suitable for connection and operation over the range of conditions likely to be encountered by the vessel in normal and abnormal conditions. A means (e.g. lanyards) shall be provided for securing the portable pump when operating or when being relocated on vessels of Classes B, C or D.

5.8.4 Bilge piping

5.8.4.1 Materials

Bilge piping shall comply with the requirements of Clause 5.7.3.

5.8.4.2 Protection from mechanical damage

Bilge piping shall be protected from mechanical damage arising from the stowage or working of cargo and stores or from other causes.

5.8.4.3 Rigid plastic bilge piping—application

Rigid plastic bilge piping may only be used as follows:

- a) *Vessels less than 12.5 m in measured length*

In any location except where rigid plastic bilge piping passes through spaces which are high fire risk on vessels relying on subdivision unless the watertight integrity of adjacent bulkheads can be maintained by fitting the affected bilge suction pipes with non-return valves.

b) *Vessels 12.5 m and more in measured length*

In low fire risk spaces such as voids, cofferdams and water tanks. The application of rigid plastic bilge piping in other locations shall be subject to meeting the fire endurance requirements contained in IMO Resolution A 753(18) or the requirements of a Classification Society.

NOTE: Alternative arrangements may be acceptable where part of the bilge system is duplicated.

5.8.4.4 Flexible suction hose bilge systems (wandering hoses)

A flexible suction hose bilge pumping system may be fitted to service compartments in Class C, D or E vessels of measured length less than 12.5 metres. Subject to Clause 5.8.3.3 d), the pump or pumps shall be permanently mounted. The hose shall be of sufficient strength not to kink or collapse under suction. Compartments that are not void shall be fitted with a deck-mounted camlock fitting connected to a permanent bilge suction pipe within the compartment.

Where there is a risk of downflooding if hatches or other weathertight or watertight covers leading to a void compartment are opened, void compartments should also be provided with a deck-mounted camlock fitting connected to a suction pipe permanently mounted within the compartment.

5.8.5 Bilge pipe sizes

5.8.5.1 Vessels under 10 m in measured length

The minimum diameter of bilge piping in vessels less than 10 m in measured length shall not be less than 25 mm.

5.8.5.2 Vessels of 10 m measured length and over

The minimum diameters of bilge suction pipes in vessels of 10 m and over in measured length, which shall in no case be less than 32 mm, shall be determined by the following formulas:

- a) For main bilge suction pipes (pipes serving more than one compartment)—

$$d_m = 25 + 1.68\sqrt{L(B+D)}$$

- b) For branch suction pipes (pipes serving just a single compartment)—

$$d_b = 25 + 2.16\sqrt{C(B+D)}$$

where

d_m = internal diameter of the main bilge suction pipe, in millimetres

d_b = internal diameter of branch suction pipes, in millimetres, but not greater than d_m

L = the measured length of the vessel, in metres

B_H = the applicable breadth, in metres, as follows—

- a) for mono-hulled vessels, the breadth of the vessel

- b) For multi-hulled vessels—
 - i) For the main bilge suction pipe in the case of multi-hulled vessels having only a single main bilge line, the sum of the breadths of the hulls;
 - ii) for the main bilge suction pipe in the case of a multi-hulled vessels having a dedicated main bilge line in each hull, the breadth of the applicable hull; or
 - iii) for branch section lines, the breadth of the applicable hull.

D = depth of vessel, in metres

C = length of compartment, in metres.

5.8.6 Strainers

5.8.6.1 Vessels of 20 m in measured length and over

All bilge suction shall be fitted with a mudbox, strum box or strainer that is accessible for cleaning. Each bilge suction in a machinery space shall be fitted with a mudbox and metallic tail pipe.

5.8.6.2 Strainer holes

Strainer holes shall not be greater than 10 mm in diameter, and the aggregate area of the holes shall not be less than twice the area of the suction pipe.

5.8.7 Bilge level alarms

On decked vessels, a bilge level alarm shall be fitted—

- a) in the propulsion machinery space; and
- b) in all other compartments that contain seawater pumping systems.

The alarm shall be clearly audible at a continuously manned control position with the machinery operating under full power conditions.

NOTE: Additional bilge alarms may be required on certain vessels, see Clauses 2.19.9.6 and 5.7.4.1.

5.8.7.1 Power supply

The power supply for the bilge level alarm shall be available at all times there is a person on board.

5.8.8 Collision bulkhead piping

Where a pipe pierces a collision bulkhead, it shall be fitted with a suitable valve or cock at the bulkhead. The control mechanism for the valve or cock shall incorporate a means to indicate clearly whether the valve or cock is open or closed.

5.8.8.1 Means of control

Unless otherwise provided for in Clause 5.8.8.2, the valve or cock shall be controllable from the bulkhead deck.