Australian Transport Council

Uniform Shipping Laws Code

Section 9: Engineering

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ENGINEERING SECTION

PART 1—PRELIMINARY

1. This Section is divided into Parts as follows:

Part 1 Preliminary

Part 2 General

Part 3 Machinery

Part 4 Electrical

Part 5 Liquid Petroleum Gas Installation

Part 6 Cargo Refrigeration

Part 7 Personnel Protection

2. This Section should be read in conjunction with the Introduction, Definitions and General Requirements Section.

3. **Application**

3.1 Subject to sub-clause 3.2 these requirements shall be applicable to all classes of vessels less than 35 m in length.

3.2 Vessels of 35 m in length and over shall comply with Parts 2, 5 and 7 and clause 29 of Part 4 of this Section and shall otherwise be assessed under the Rules of a Classification Society. Additionally Class 1A vessels of 35 m and over and Class 2A vessels of 500 tons and over shall comply with the requirements of the Navigation (Construction) Regulations.

PART 2—GENERAL

4. In this Section the following general requirements shall apply:

4.1 Design—Corrosion and Abnormal Loadings

4.1.1 Where any item detailed in this Section is subject to rapid corrosion, other rapid form of deterioration or to abnormal loading, such item shall be subject to special consideration.

4.1.2 In any pipe system provision shall be made to avoid excessive stress in any part due to expansion and contraction resulting from variation in temperature or due to vibration and shall otherwise take account of the effects of corrosion and external mechanical damage.

4.2 Novel Design and Unusual Materials

Where any item detailed in this Section is novel in design, or involves the use of unusual materials, the owner or his agent shall submit full calculations and any other information required. He shall bear the cost of any special tests or examinations considered necessary by the Authority.

4.3 Astern Power

Where the shaft power available for propulsion exceeds 5 kW astern power shall be provided for adequate manoeuvrability under normal operating conditions.

4.4 Access to Machinery

The overall design of a machinery space shall be so arranged as to permit reasonable access to all items of the installation which may require attention in service.

4.5 Machinery Identification

4.5.1 All controls for operating the machinery, and all measuring devices, pumping systems, valves, cocks, air pipes, sounding pipes, switches etc. shall be permanently marked with appropriate inscriptions clearly showing their purpose. All hand-wheels for valves which are closed by turning anti-clockwise shall be marked to show the direction of turning

for closure. Where pipes are marked by colours to indicate their purpose the colours shall be in accordance with Australian Standard AS1345.

4.5.2 The provisions of this sub-clause need not apply if the surveyor considers it to be unnecessary owing to the simplicity of the installation.

4.6 Manufacturer's Recommendations

In all requirements of this Section due consideration shall be given to any specific recommendations of the manufacturer of any engine or item of ancillary equipment.

4.7 Other Sections

In addition to a requirement of this Section there may be associated requirements in the Load Lines, Construction, Fire Appliances, Life-saving Appliances and other Sections of these uniform requirements. Due regard shall therefore be paid to these requirements.

4.8 Communication

A vessel of 24.4 m and over shall be provided with a suitable means of communication between the wheelhouse and the machinery space except that this shall not apply in the case of a vessel having propulsion machinery which under normal operating conditions is started, controlled and stopped from the wheelhouse only.

PART 3—MACHINERY

5. Main Engines

5.1 Subject to the next succeeding sub-clause of this clause, a vessel shall be provided with a main engine or engines of a type designed and manufactured for marine use having regard to their intended purpose and shall operate on fuel having a closed flash point of not less than 60°C.

5.2 Engines which operate on fuel having a closed flash point of less than 60°C may only be used on vessels as follows:

(a) outboard engines in Classes 1C, 1D and 1E vessels; and

(b) inboard engines not located below decks or outboards engines in Classes 2C, 2D, 2E, 3C, 3D and 3E vessels.

(c) all outboard powered vessels for operation outside sheltered waters shall have at least two engines each capable of maintaining adequate directional control under normal weather conditions.

6. Machinery Seatings

6.1 General

Each item of machinery shall be securely bolted to a rigid seating. Fitted and/or clearance bolts may be used and suitable arrangements are to be provided to prevent the bolts from becoming slack.

6.2 Wood and Glass Reinforced Plastic (GRP)

Where the machinery seatings are of wood or GRP the upper face of recesses to accommodate the nuts and washers of the holding down bolts are to be located at a depth, below the upper face of the seating, sufficient to ensure ample material in compression when the bolts are tightened.

6.3 Resilient Mountings

When resilient mountings are fitted the output shaft is to be connected to a flexible coupling. Satisfactory arrangements are to be made to transmit thrust.

7. Instrumentation

7.1 Instruments—General

Instruments shall be suitable for marine use, capable of withstanding vibration and shock and be so installed and illuminated as to be readily visible.

7.2 Items Monitored

7.2.1 An engine essential for the safe operation of a vessel of 25 m in length and over shall be provided with an audible warning device to indicate a dangerous condition associated with:

(a) engine lubricating oil pressure;

(b) engine jacket cooling water outlet temperature; and

(c) engine gear box lubricating oil pressure.

7.2.2 All engines essential for the safe operation of the vessel shall, to the extent that the design and manufacture allows, be provided with instruments indicating the following:

(a) engine lubricating oil pressure;

(b) engine jacket cooling water outlet temperature;

(c) engine gear box lubricating oil pressure;

(d) charging rate of generator; and

(e) in the case of propulsion machinery, the rotational speed.

7.3 Unmanned Machinery Space

In the case of an unmanned machinery space the instruments as required by sub-paragraph 7.2.2 (a) (b) and (c) shall be located as to be clearly visible at each steering position. The instruments required by sub-paragraph 7.2.2 (d) and (e) shall only be necessary at the position at which the vessel is principally navigated.

8. Starting Arrangements

8.1 Methods

In all Class A, B and C vessels where the main engine or engines are not fitted with hand starting arrangements, provision shall be made for an alternative method of starting to be capable of being developed on board without external aid. If for this purpose:

(a) an electric generator or air compressor is required, the unit shall be power driven by a hand starting engine. A hand operated air compressor may be accepted and in the case of electric starting a standby set of batteries may be accepted.

(b) a hydraulic accumulator is required, then the accumulator shall be capable of being pressurised by hand.

8.2 Number of Starts

Air receivers or batteries used for starting main engines shall have sufficient capacity without recharging to provide:

(a) 6 consecutive starts for each non-reversible engine.

(b) 12 consecutive starts for each reversible engine.

8.3 Bars and Hand Cranks

Bars used on flywheels to turn machinery over by hand shall be so constructed as to facilitate easy withdrawal from the flywheel's recess if the engine should recoil. Hand cranks for engines shall be designed to disengage instantly when the engine starts.

9. Unfired Pressure Vessels

9.1 Unfired pressure vessels and their mountings shall be designed, constructed and tested in accordance with the requirements of Australian Standard AS 1210 or the requirements of a classification society.

10. Exhaust Systems

10.1 Gas Passage Area

No part of the exhaust gas passage shall have an area less than that of the outlet of the exhaust manifold. If the exhaust system is unusually long or the conditions

require bend, the internal cross sectional area of the piping shall be increased to prevent an increase of back pressure at the engine.

10.2 Separation

Exhaust pipes of several engines shall not be connected together but shall be run separately to the atmosphere unless arranged to prevent the return of gases to an idle engine.

10.3 Silencer

All internal combustion engines shall be effectively silenced.

10.4 Materials

Exhaust pipes and silencers shall be of steel, copper or other approved material.

The use of reinforced synthetic rubber hose may be permitted for exhaust pipes on engines having water cooled exhausts. Except for reinforced synthetic rubber hose enclosed in a gastight trunk as required by sub-clause 10.8, all of the hose shall be readily visible.

10.5 Thermal Protection

Exhaust piping and silencers are to be water cooled or efficiently lagged. The exhaust system is to be so installed as to prevent the transfer of heat to readily combustible materials.

10.6 Height of Discharge

Exhaust pipe discharges which are led through the hull below deck level are to be installed as high above the load water line as practicable and shall not be installed at a height less than the height required by the Load Line or Construction Sections of these uniform requirements, as is applicable. The arrangement shall otherwise comply with the relevant provisions of the Load Lines Section.

10.7 Back Flooding

The exhaust system shall be so designed and installed as to prevent sea water or exhaust cooling water entering the engine manifold.

10.8 Protection of Accommodation Space

An exhaust pipe which passes through an accommodation space shall be enclosed in a gas tight trunking.

10.9 Location of Discharge

Where an exhaust pipe is led above the deck it shall be installed well clear of space openings so as to limit the products of combustion passing back into any space in the vessel.

10.10 Layout-Support

Exhaust pipes shall be led to the point of escape with a minimum number of bends or elbows and be adequately supported.

11. Engine Cooling Systems

11.1 Air Cooling

11.1.1 In air cooled engines the cooling air discharge shall be separately trunked to the open air.

11.2 Water Cooling

11.2.1 In water cooled engines an adequate supply of sea water shall be provided for cooling purposes.

11.2.2 A cooling water pump may be driven by the engine it serves or be independently driven.

11.2.3 In vessels propelled by a single main engine exceeding 400 kW brake power provision is to be made for an emergency supply of cooling water from a separate power pump which may be driven by the engine.

12. Ventilation of Machinery Spaces

12.1 Aspiration

Adequate ventilation shall be provided in the engine room and all other enclosed machinery spaces. The volume of air provided shall be not less than that necessary for the efficient aspiration and efficient operation of the main engines and other machinery. Such ventilation shall be obtained with all access openings closed.

12.2 Ventilator Sizes for Natural Ventilation

The engine room shall be furnished with an inlet and exhaust ventilator each of which is to have a minimum size as follows:

vessels less than 10m in length	100 cm^2
vessels of 10 m and over but less than 15 m in length	160 cm^2
vessels of 15 m and over but less than 20 m in length	220 cm^2
vessels of 20 m and over but less than 25 m in length	280 cm^2
vessels of 25 m and over but less than 30 m in length	340 cm^2
vessels of 30 m and over but less than 35 m in length	400 cm^2

12.3 Area of Cowls or Scoops

Where cowls or scoops are provided on any ventilator, the free area of the cowl or scoop shall be not less than twice the required trunk area. Where the cowls or scoops are screened, the mouth area shall be increased to compensate for the area of the screen wire. Inlet and outlet openings shall not be located where the natural flow of air is obstructed. Outlet ventilators shall not discharge within one metre of a possible source of ignition. Ventilators shall be so located that exhaust air will not be taken into supply vents.

13. Gear Boxes

13.1 Gear boxes shall be of the marine type and suitably matched to the prime mover with which they are to be used. When coupled to the engine it shall not be possible to exceed the limiting power, torque, speed or thrust of any component of the gear box. Makers' certificates covering design, materials and manufacture may be accepted for this purpose.

14. Propeller and Intermediate Shafting

14.1 Intermediate Shaft Size

The diameter of the intermediate shafting shall not be less than that determined by the following formula:

$$d_i = akf\sqrt[3]{\frac{P}{N}}$$

where d_i = diameter of intermediate shafting in mm

a = 1.108 for vessels of Classes A, B and C

= 1.053 for vessels of Classes D and E

k = 89 for propulsion through reduction gears or flexible couplings

= coefficient given in table 14.1.A for propulsion by direct drive in line engines.

P = the greater of

(a) the maximum continuous brake power in kW; or

(b) the maximum brake power in kW the engine when installed will transmit irrespective of the time the engine manufacturer nominates the engine may be run at that power

N = shaft revolutions per minute

f = steel factor to be determined by formula

$$f = 1.01\sqrt[3]{\frac{400}{T}}$$

where T is the minumum ultimate tensile strength of the shaft material in MPa Note: Where test pieces are not submitted the value of T shall be the minumum ultimate tensile strength of the material as guaranteed by the manufacturer and for low carbon steel it shall be taken as 410 MPa; for 316 stainless steel 618 MPa and for 329 stainless steel 724 MPa;

Table 14.1.A

No. of cyclinders	*2 S.C.* *k*	*4 S.C.* *k*
1&2	110	110
3	107	109
4	102	109
5	99	105
6	96.5	102
7	95	101
8	93	99
9	90	98
10	90	94
11 and more	90	90

14.2 Propeller Shaft Size

The diameter of the propeller shaft shall not be less than that determined by the following formula:

$$d_p = \left(1.14d_i + \frac{d}{K}\right) f$$

where d_p = diameter of propeller shaft in mm

d_i = diameter of intermediate shaft in mm

(calculated for a material with a U.T.S. of 410 MPa)

d = propeller diameter in mm

K = 144 for shafts protected against corrosion by

(a) a continuous liner;

(b) a suitable oil gland;

(c) an appropriate coating of the shaft between bushes, if this coating can be examined at each dry docking, or

(d) the nature of the material of the shaft

K = 100 in all other cases.

f = steel factor to be determined by formula

where T is the minimum ultimate tensile strength of the shaft material in MPa

Note: Where test pieces are not submitted the value of T shall be the minimum ultimate tensile strength of the material as guaranteed by the manufactuer and

for low carbon steel it shall be taken as 410 MPa, for 316 stainless steel 618 MPa and for 329 stainless steel 724 MPa.

The part of the propeller shaft forward of the stern gland may be tapered down to a diameter calculated in accordance with the following formula:

$$\text{Reduced diameter} = 1.14 \left(d_i \times \frac{f_p}{f_i} \right)$$

where f_p is the steel factor used for calculating d_p and f_i is the steel factor used in calculating d_i. The reduction in diameter is to be as gradual as possible.

14.3 Hollow Shafting

Where hollow shafting is used, the proportions are to be such that the strength will be equivalent to that required for the corresponding solid shaft, except that a central hole not exceeding one third of the shaft diameter may be accepted without increase in shaft size.

14.4 Bearing Spacing

Any unsupported length of shafting shall not exceed that determined by the following formula:

$$S = 0.142\sqrt[3]{d^2}$$

where S = distance between bearings in m

d = diameter of shaft in mm.

The forward most bearing should preferably be at least 12 shaft diameters from the engine gear box or thrust block flange.

14.5 Propeller Shaft Overhang

The overhang of the propeller shaft between the forward face of the propeller boss and the after face of the adjoining shaft bearing shall not be more than the actual propeller shaft diameter. However an overhang greater than this amount may be permitted provided that the bending stress due to the additional overhang is considered in the calculation of the shaft diameter.

14.6 Material

14.6.1 Shafts shall be of

(a) salt water resistant stainless steel

(b) bronze

(c) monel metal

(d) fully killed carbon steel for diameters of 150 mms and over, or

(e) semi-killed carbon steel for diameters less than 150 mms.

The use of rimming or free cutting steel is not acceptable.

14.6.2 Shafts shall conform to the following minimum requirements:

(a) ultimate tensile strength (U.T.S.) 410 MPa

(b) yield point 230 MPa

(c) elongation

bronze 25%

carbon steel 23%

monel 20%

stainless steel 17%

The Authority shall be satisfied that the material is suitable for the purpose and where doubt exists may require physical and/or chemical tests to be conducted. Where tests are required to determine the U.T.S. and elongation they shall be determined on a 70 mm minimum gauge length by 14 mm diameter test piece.

Screw shafts and tube shafts of carbon or carbon manganese steel are in general to be restricted to a range of tensile strengths between 410 and 510 MPa.

Where it is proposed to use:

(a) a carbon or carbon manganese steel having a specified minimum tensile strength greater than 590 MPa, or

(b) a material other than carbon or carbon manganese steel having a minimum tensile strength greater than 724 MPa.

full details shall be submitted to the Authority for consideration.

14.7 Propeller Shaft Liner

14.7.1 Propeller shafts of carbon steel are to be protected by a continuous salt water resistant liner where exposed to sea water. Alternatively, the liner may be omitted provided the shaft runs in an oil lubricated stern tube with an approved sealing gland at the after end. Lengths of shafting between stern tubes and propeller brackets may be protected by suitable coatings.

14.7.2 The thickness of bronze liners fitted on propeller shafts or tube shafts in way of the bushes shall not be less than:

$$t = \frac{d_p + 230}{32}$$

where t = thickness of the liner in mm

d_p = diameter required for the propeller or tube shaft within the liner in mm

The thickness of a continuous liner at the part between the bushes shall not be less than 0.75 t. Liners shall be shrunk on or forced on to the shafts by hydraulic pressure. Securing pins shall not be fitted.

14.7.3 The thickness of stainless steel or mild steel liners fitted on propeller shafts or tube shafts in way of the bushes shall not be less than:

$$t = \frac{d_p + 120}{32}$$

where t = thickness of liner in mm

d_p = diameter required for the propeller or tube shaft within the line in mm

Liners shall be either shrunk on, or forced on to the shafts by hydraulic pressure. Securing pins shall not be fitted.

14.7.4 Effective means shall be provided to exclude water from the part of the shaft between the after end of the liner and the propeller boss. Any cavity between the liner and the shaft clear of the close fitting portions shall be filled with a suitable composition.

14.8 Propeller Shaft Taper

Propeller shafts are to be provided with an accurate taper fit in the propeller boss, particular attention being given to the fit at the large end of the taper. The taper shall be between the limits of 1 in 12 and 1 in 16 on the diameter. It is recommended that the 1 in 12 taper be employed wherever possible.

14.9 Keys and Keyways

14.9.1 Keyways are to be contained wholly within the length of the taper. The distance between the large end of the taper and the commencement of the keyway is to be not less than 0.2 of the nominal diameter of the propeller shaft. The depth of the keyway shall be half the required thickness of the key.

14.9.2 Keyways are to be provided with smooth fillets at the bottom and sharp edges at the top are to be removed. For shafts in excess of 150 mm nominal diameter, the radius of the fillet in the bottom corners of the keyway is to be at least 0.012 of the nominal diameter of the shaft.

14.9.3 Keys for propeller shafting are to be of the round ended or sled-runner type, and shall be of material similar to the shaft to which they are to be fitted.

Where keys of the sled-runner type are used provision should be made to prevent them from sliding in the keyway.

14.9.4 The dimensions of keys are to be determined in accordance with the following formula:

$$w = \frac{d_p}{4} \text{ mm}$$

t (for shafts less than 150 mm dia)

$= 0.633\,(w-8) + 6$ mm

t (for shafts equal to or greater than 150 mm dia) $= \frac{w}{2} + 6$ mm

where d_p = diameter of propeller shaft in mm

w = width of key in mm

t = thickness of key in mm.

The length of the key (L) in mm is to be not less than

$$L = \frac{d_p^2}{2.5w} \text{ mm}$$

Where d_p = nominal diameter of the propeller shaft in mm.

14.10 Propeller and Shaft Coupling Retaining Nuts

14.10.1 Retaining nuts which are of similar materials to the propeller or intermediate shafting to which they are to be fitted shall comply with the following:

(a) the outside diameter of the threads shall be not less than 0.75 of the diameter at the small end of the taper;

(b) the depth over which the nut is fully threaded shall not be less than 0.75 of the diameter of the thread; and

(c) the width across the flats or the effective outside diameter shall not be less than 1.5 times the diameter of the thread.

The nuts shall be fitted with effective locking devices. Propeller nuts fitted to low carbon steel shafts shall be cap nuts.

14.10.2 The pitch of the threads for shafts and nuts should be in accordance with the following:

(a) 2.5 mm pitch for diameters not exceeding 40 mm;

(b) 3.5 mm pitch for diameters of 40 mm and not exceeding 75 mm;

(c) 4 mm pitch for diameters of 75 mm and not exceeding 100 mm; and

(d) 6 mm pitch for diameters exceeding 100 mm.

The thread form should be U.N.C.

14.11 Coupling Materials

Couplings are to be of carbon steel or equivalent material. Ordinary grades of cast iron will not be accepted and higher grades will be subject to special consideration.

14.12 Coupling Types

Couplings shall be of the following types:

(a) Flange couplings with flanges formed by upsetting the ends of a shaft.

(b) Flange couplings with flanges of fabricated construction. Such couplings shall be suitably designed, prepared, and heat treated subsequent to welding and then machined. They shall be subjected to such testing as is deemed necessary.

(c) Coupling fitted on a taper, keyed and held in place with a nut.

(d) Couplings shrunk on a parallel shaft which do not employ a key, pin, dowel or similar item in way of the shrink fit provided that the design and manufacture are satisfactory and the couplings are not subject to removal in service.

(e) Oil injection couplings.

(f) Couplings of the split type, keyed and clamped to parallel shafts.

(g) Approved flexible couplings.

14.13 Coupling Dimensions

The thickness of a coupling flange shall be not less than 0.25 of the diameter of the intermediate shaft or shall be equal to the diameter of the coupling bolt whichever is the greater.

The ligament thickness outside the coupling bolt holes shall be not less than 0.6 of the coupling bolt diameter.

The fillet radius at the base of the flange is to be not less than 0.125 of the actual diameter of the shaft. The strength of the boss of a coupling shall be not less than the equivalent strength of the shaft.

14.14 Universal Joint Couplings

Universal joints may be incorporated in the propulsion shafting between the engine and thrust block.

The hollow shafting component of such a universal jointed propulsion shafting installation shall be equivalent to the requirements of the clause which relates to solid propeller shafting, and the flanged universal ends shall be equivalent to the requirements which relate to couplings.

The installation shall be such as to limit the stresses set up by cyclic irregularities.

Effective arrangements are to be provided to prevent damage to the hull or structure of the vessel due to the flailing of the shaft should the universal joint elements fail to service.

14.15 Shaft Coupling Bolts

14.15.1 The minimum diameter of the shaft coupling bolts is to be determined by the following formula:

$$d_b = 0.54 \sqrt{\frac{di^3}{Nr}}$$

where d_b = diameter of bolts at joint in mm

N = number of bolts fitted in one coupling

r = pitch circle radius of bolts in mm

d_i = required diameter of intermediate shaft in mm, using material having the same mechanical properties as the material of the coupling bolts.

14.15.2 Shaft coupling bolts shall be machine finished and neat fitting.

14.16 Bolts for Clamp Coupling

14.16.1 The diameter at the bottom of the threads of bolts in clamp couplings is not to be less than:

$$d_b = 0.33\sqrt{\frac{di^3}{Nr}}$$

where d_b = diameter of bolts in mm

N = number of clamp bolts at one of the shaft ends

r = distance in mm between the centre of the bolts and the centre line of the shaft

d_i = required diameter of the intermediate shaft in mm, using material having the same mechanical properties as the material of the coupling bolts.

14.16.2 A minimum of two bolts shall be let into the shaft for half their diameter, to take the astern thrust.

14.17 Stern Bearings

14.17.1 Grease lubricated white metal bearings, or water lubricated bearings which are lined with rubber composition or other suitable material, shall not be less in length than four times the diameter of the propeller shaft.

14.17.2 Oil lubricated white metal bearings shall be provided with a satisfactory type of oil sealing gland. The length of the bearing is to be sufficient to ensure that the bearing pressure resulting from the mass of the propeller and propeller shafting will not exceed 480 kPa. The length of the bearing shall not be less than 2‡ times the diameter of the propeller shaft.

14.18 Flexible Stern Gland

"In the case of a vessel in which the tailshaft diameter is not greater than 102mm (4 inches), a flexible stern seal of an approved type may be fitted."

14.19 Propeller Shaft Brackets

14.19.1 General

Unless otherwise provided, reference to diameter of propeller shaft in this sub-clause shall mean the diameter of the propeller shaft as provided for the vessel.

14.19.2 Boss

The length of the boss is to be not less than four times the diameter of the propeller shaft. The thickness of the boss is to be not less than one quarter of the diameter of the propeller shaft.

14.19.3 Brackets of 'V' Configuration of Carbon Steel

14.19.3.1 Width

The width of each leg is not to be less than that obtained from the following formula:

$$W = 2.27d$$

where

W = width of major axis in mm

d = diameter of propeller shaft in mm, calculated for a material having a U.T.S. of 410 MPa

14.19.3.2 Thickness

The thickness of each leg is not to be less than that obtained from the following formula:

$$t = 0.35d$$

where

t = thickness of leg (minor axis) in mm

d = diameter of propeller shaft in mm, calculated for a material having a U.T.S. of 410 MPa

Where the included angle between the legs is less than 45°, the scantlings are to be specially considered.

14.19.4 Brackets of 'I' Configuration of Carbon Steel

14.19.4.1 Width

The width of the leg is not to be less than that obtained from the following formula:

$$W_1 = 3.22d$$

where

W_1 = width of major axis in mm

d = diameter of propeller shaft in mm, calculated for a material having a U.T.S. of 410 MPa

14.19.4.2 Thickness

The thickness of the leg is not to be less than that obtained from whichever of the following formula is appropriate:

(a) where the bracket is a cantilever

$$t_1 = 0.515d; \text{ or}$$

(b) where the lower end of the bracket is attached to a shoe piece or skeg

$$t_1 = 0.36\,d$$

where

t_1 = thickness of the leg (minor axis) in mm

d = diameter of propeller shaft in mm, calculated for a material having a U.T.S. of 410 MPa

14.19.5 Propeller Shaft Brackets of Materials other than Carbon Steel

Where a material other than carbon steel is used, the Authority may allow the thickness of the legs to be determined from:

$$t_2 = t\sqrt{\frac{410}{T}}$$

where

t_2 = thickness of the leg of material other than carbon steel in mm

t = thickness of the leg determined in accordance with sub-paragraphs 14.19.3.2 or 14.19.4.2 whichever is appropriate

T = Ultimate tensile strength of material in MPa

14.19.6 Leg Length

The length of the longer leg of a V bracket or the leg of an I bracket measured from the outside perimeter of the boss to the outside of the shell plating is not to exceed 10.6 times the diameter of the propeller shaft. Where this length is exceeded the width and thickness of the legs or leg are to be increased and the bracket design will be given special consideration.

14.19.7 Where the bracket is a hollow section, the modulus of section is to be at least equal to the modulus of section of the solid bar as required by the preceding paragraphs.

15. Fuel Systems

15.1 Fuel Tanks Forming Part of the Hull Structure

Fuel tanks forming part of the vessel's hull structure shall comply with the relevant provisions of the Construction Section.

15.2 Free-Standing Non-Portable Metal Fuel Tanks

15.2.1 Free-standing non-portable metal fuel tanks shall be substantially constructed of carbon steel, stainless steel, copper or marine grade aluminium alloy. No part of the fuel tank shall depend on soft solder for tightness.

15.2.2 Where a dimension parallel to the longitudinal axis of a tank exceeds 1 m, baffles spaced not more than 1 m apart may be required.

15.2.3 The minimum thickness of carbon steel used in the construction of a fuel tank shall be determined using the dimensions of the largest unsupported panel but shall not be less than 3 mm. In assessing the largest unsupported panel account shall be taken of the support afforded by:

(a) tank boundaries;

(b) baffles, where the thickness of the baffle is not less than the thickness of the tank plating in way; and

(c) stiffeners, where

(i) the thickness of the stiffener is not less than the thickness of the tank plating in way, or 5 mm, whichever is the greater; and

(ii) the depth of the stiffener is not less than

$$\frac{12 + \text{breadth of the panel (mm)}}{10}$$

15.2.4 Where the depth from the top of the filling pipe to the bottom of the tank does not exceed 2.5 m the plate thickness shall be obtained from figure 15.2.4 which is developed from the formula:

$t = 0.024\,ac$

where t = thickness of plate in mm

a = width of panel (minor axis) in mm

c = numerical value as given below, where

b = length of panel (major axis) in mm

$\frac{b}{a}$	1	1.25	1.5	1.75	2 and over
c	0.226	0.258	0.275	0.284	0.288

15.2.5 Where the depth from the top of the filling pipe to the bottom of the tank exceeds 2.5 m the plate thickness shall be calculated from the formula:

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

where t, a, b, and c are as defined in paragraph 15.2.4 and h = distance from top of filling pipe to bottom of tank in m.

15.2.6 Where a material other than carbon steel is used, the Authority may allow the plate thickness to be determined from:

$$t_1 = t\sqrt{\frac{410}{T}}$$

where t_1 = late thickness of material other than carbon steel in mm

t = thickness of plate in mm determined in accordance with paragraph 15.2.4 or 15.2.5 as appropriate

T = ultimate tensile strength of material in MPa.

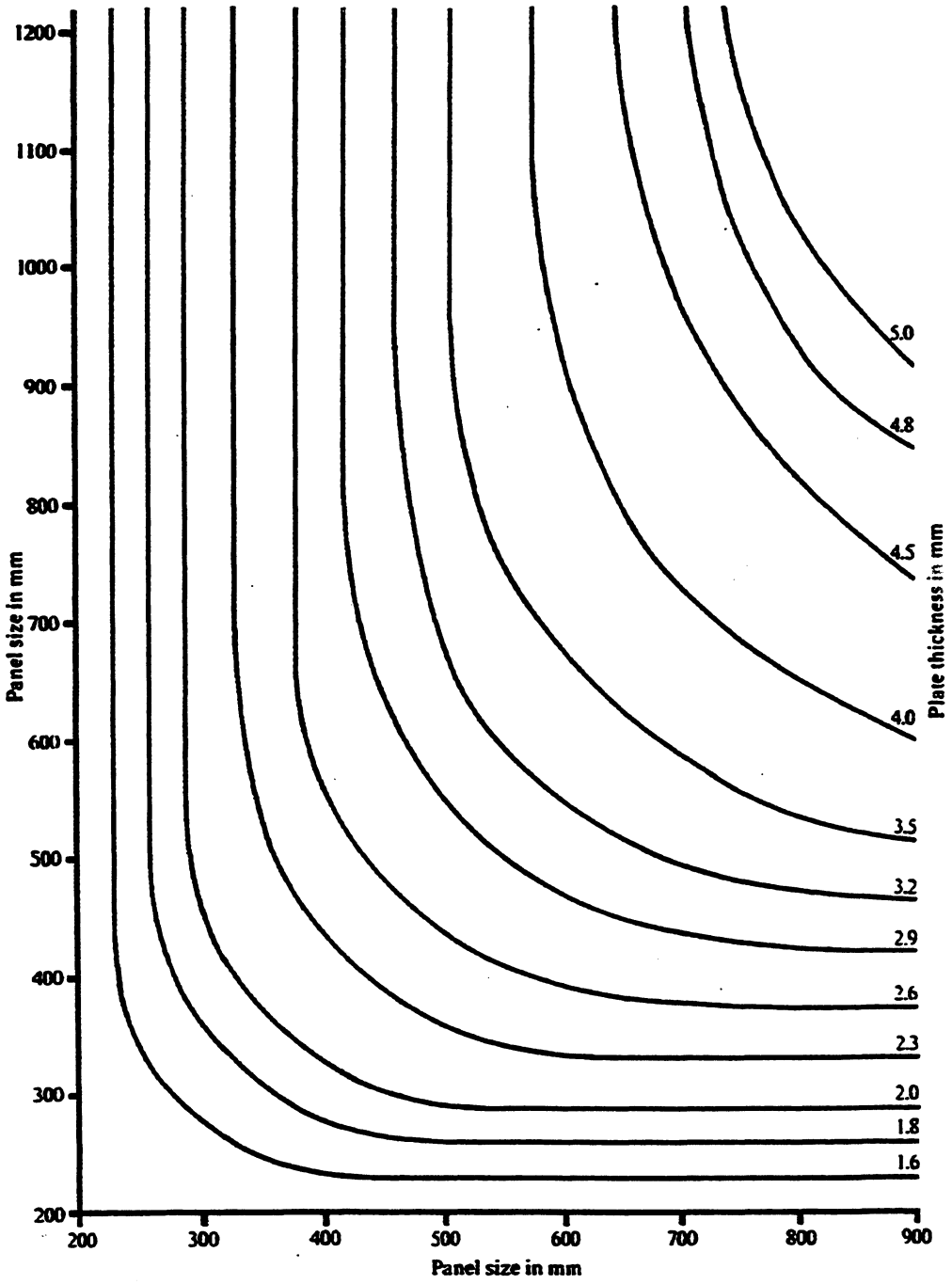
1200
1100
1000
900
800
700
600
500
400
300
200
Panel size in mm
200
300
400
500
600
700
800
900
Panel size in mm
5.0
4.8
4.5
4.0
3.5
3.2
2.9
2.6
2.3
2.0
1.8
1.6
Plate thickness in mm

Figure 15.2.4

15.2.7 The pressure test of a tank shall be carried out prior to its installation in the vessel.

15.3 Installations with Non-Portable Fuel Tanks

15.3.1 Fuel Tank Pressure Test

A fuel oil tank shall be subjected to a test equivalent to 2.5 m of fresh water above the top of the tank or to the maximum head to which the tank may be subject in service, whichever is the greater.

15.3.2 Fuel Tank Location

15.3.2.1 Taking account of the possibility of overflow, leakage or rupture, fuel storage tanks and piping should be arranged to minimize the possibility of fuel coming into contact with a hot surface or electrical components which may result in outbreak of fire.

15.3.2.2 Fuel tanks should not be fitted over stairways and ladders, hot surfaces and electrical equipment. However, where this is unavoidable, each tank shall be provided with a self draining save-all. The Authority may waive this requirement where the fuel tank is supplied as an integral part of the engine.

15.3.3 Fuel Tank Venting

The vent pipe for a fuel tank shall be of size sufficient to prevent generation of pressure. Where the tank filling is effected by pumping through the filling line, the area of air escape shall not be less than 1.25 times the area of the filling pipe.

The pipe shall terminate in a gooseneck, the top of the bend not being less than the height of the bulwark or the top of the guard rail. Where the pipe outlet exceeds 18 mm in diameter a corrosion resistent wire gauze screen shall be fitted. The open area of the screen shall be not less than the cross-sectional area of the vent pipe. Where the Authority considers the provision of a suitable vent pipe is not practicable it may permit a small vent hole in the filling cap.

15.3.4 Fuel Tank Inspection Opening

A suitable manhole or hand hole to facilitate cleaning and inspection shall be provided except that this requirement may be dispensed with in the case of free-standing non-portable tanks which have a capacity of less than 800 l.

15.3.5 Fuel Shut-off

15.3.5.1 A 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.

15.3.5.2 Means shall be provided outside a propulsion machinery space, in an accessible position not likely to be isolated by a fire in the space, to shut off the fuel to the main and auxiliary engines by means of a fire-safe valve or cock. Non-metallic piping and fittings shall not be fitted in the line between any fuel tank and this fuel shut-off.

15.4 Safety Devices for Power Operated Fuel Pumps and Motors

15.4.1 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.

15.4.2 Stop valves shall be provided on the suctions and deliveries of cargo oil, fuel transfer and fuel pressure pumps.

15.4.3 A fuel transfer or a cargo oil pump which is located below deck in a machinery space shall be provided with means to stop the pump from both inside and outside the space.

15.5 Fuel Filters

Filters manufactured of steel or an equivalent material may be fitted at any position in the fuel system. See-through glass or plastic filters shall be resistant to both mechanical impact and thermal shock and may only be fitted in a protected position.

15.6 Fuel Systems for Vessels Having Engines which Operate on Fuel with a Flashpoint of 60°C or More

15.6.1 Fuel Tank Filling

Each fuel oil tank shall be provided with a permanent filling pipe of suitable material led from the deck to the top of the tank. Where the Authority considers that a flexible section is necessary between the deck and tank fitting, the flexible section shall be of reinforced synthetic rubber piping which is resistant to fuel, salt water and vibrations. It shall be fastened to the deck fitting and tank fitting with corrosion resistent clips.

15.6.2 Fuel Tank Contents Measurement

Suitable means shall be provided for determining fuel tank contents and they shall be such that in the event of a tank being overfilled, spillage through them shall not occur.

Where a level indicating gauge glass is fitted on a fuel tank it shall be fitted with self-closing valves or cocks, provided that 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. Oil fuel tank soundings should not be located in crew accommodation but where in exceptional circumstances they are located in alleyways, flush deck screwed caps should be fitted.

15.6.3 Fuel Tank Drain

Each fuel service tank having a capacity of 400 litres or more shall be fitted with a drain valve or drain cock, the open end of which is blanked with a screwed plug. Tanks having a capacity less than 400 litres shall be fitted with a screwed drain plug.

15.6.4 Fuel Filling Stations

Oil fuel filling stations shall be situated outside machinery spaces and be so arranged that any overflow cannot come into contact with a hot surface.

15.6.5 Fuel Piping

Fuel piping shall be of seamless steel or heavy gauge copper. The piping shall be connected by flanged joints, metal to metal joints of the conical type or by other acceptable means.

Where cone nipples are used they are to be welded. Olive type compression fittings shall not be used. Connections in pipes shall be kept to a minimum and shall be so located as to be readily visible and accessible. Flexible piping may be fitted:

(a) between the fuel shut-off valve required under sub-paragraph 15.3.5.2 and the engine,

(b) to conduct any fuel by-pass back to the top of the fuel tank.

Flexible piping shall be of metal braided reinforced type having a synthetic rubber inner tube and must have a high resistance to salt water, petroleum products and vibration. It shall be capable of containing fuel after being exposed to free-burning kerosine for a period of $2^1/_2$ minutes. It must be so installed as to be readily visible, clear of the bilge and effectively secured to prevent chafing.

15.7 Fuel Systems for Vessels Having Engines which Operate on Fuel with a Flashpoint less than 60°C, but not Including Installations which Employ Portable Fuel Tanks

15.7.1 Gravity Feed Fuel System

Engines employing a gravity feed fuel system will not be permitted except that this requirement may be waived in the case of small engines with a tank not exceeding 10 l capacity.

15.7.2 Fuel Tank Capacity

Fuel tanks shall be no larger than necessary for the intended service of the vessel but shall be of sufficient capacity to prevent them having to be filled at sea. No loose cans of fuel shall be carried on board a vessel for this purpose. Suitable means shall be provided for gauging fuel tank contents and shall be such that in the event of a tank being overfilled spillage shall not occur via the gauging arrangements. Caps provided for the insertion of sounding rods shall have a maximum clear opening of 15 mm diameter to prevent them being used as a filling point.

15.7.3 Fuel Tank Location

Fuel tanks shall be securely installed in positions as remote from the engine and exhaust pipes as practicable in a compartment liquid and vapour tight to all other compartments no greater than four times the volume of the fuel tank(s). Fuel tank spaces which do not drain overboard and outboard shall be well ventilated and the Survey Authority may require gas detectors with audible or visual alarms at the control station. A flameproof extraction fan with a suction from the bottom of the space may be required. Provision is to be made to allow as far as practicable, the external inspection of the tanks and fittings.

No electrical connections or wiring shall be fitted within the fuel tank space apart from that necessary for task content gauges. The tank space shall not be used for any other purpose than housing the fuel tanks.

15.7.4 Fuel Tank Filling Pipe

Fuel tanks shall be provided with a filling pipe so arranged as to prevent fuel spillage entering the vessel. The filling pipe is to extend internally to near the bottom of the tank and shall be fitted with a watertight cover.

Where the Authority considers that a flexible section is necessary between the deck and tank fitting, the flexible section shall be of a reinforced type having a synthetic rubber inner tube and be resistant to fuel, salt water, and vibration. It shall be secured to deck and tank fittings with corrosion resistant metal clips.

15.7.5 Fuel Pump Suction

When a fuel pump is employed, the fuel shall be drawn from the tank by means of a pipe extending internally from the top of the tank to near the bottom of the tank. An anti-syphon device shall be provided in the line.

15.7.6 Fuel Tank Venting

A vent pipe shall be led from each tank and separately from each fuel tank space to an open position where no danger will arise from escaping vapour. Such air pipes shall comply with the construction section and have gauze diaphragms.

15.7.7 Fuel Piping

Fuel piping shall be of seamless steel or heavy gauge copper. The piping shall be connected by metal to metal joints of the conical type or by other acceptable means. Where cone nipples are used they are to be welded. Olive type compression fittings shall not be used. Connections in pipes shall be kept to a minimum and shall be so located as to be readily visible and accessible. A short length of flexible piping may be fitted in the section of line between the engine bed and the fuel lift pump. Such flexible piping shall be of metal braided reinforced type having a synthetic rubber inner tube and must have a high resistance to salt water, petroleum products and vibration. It shall be capable of containing fuel after being subject to a $2^{1}/_{2}$ minute exposure to free burning kerosene. It must be so installed as to be readily visible. Filters meeting the requirements of 15.5 which are not mounted in a position in which spillage of fuel would drain overboard shall be designed and installed so that their disassembly for cleaning purposes will result in minimum spillage.

15.7.8 Electric Bonding

All elements of the fuel installation shall be electrically bonded.

15.7.9 Carburettor Trays

Carburettors (other than the down draught type) which can be flooded or overflowed must be fitted with a copper or brass fuel tight drip tray. Such tray must have sweated into it not less than 13 mm below its lip, a corrosion resistant wire gauze screen. The tray shall be of a size sufficient to impound any leak from the carburettor and shall be readily removable for emptying.

The carburettor must be fitted with an efficient flame trap.

15.7.10 Engine Enclosure

Where a petrol engine is installed in an enclosure, the enclosure shall be well ventilated.

15.8 Fuel Systems for Vessels Having Engines which Operate on Fuel with a Flashpoint less than 60°C and which Employ Portable Fuel Tanks.

15.8.1 Portable fuel tanks shall:

(a) be not more than 30 l capacity,

(b) be designed and constructed to allow ease of handling and be provided with means for locating and securing against movement,

(c) be manufactured from metal which is corrosion resistant or coated to provide protection from corrosion and where necessary shall have mated parts that are galvanically compatible,

(d) have all service and vent openings above the full contents level,

(e) be fitted with a fuel contents gauge,

(f) have base areas in proportion to their height to minimise upsetting.

15.8.2 Where the 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 spillage of fuel from draining below the deck.

15.8.3 Where portable fuel tanks are fitted, the fuel lines shall be of heavy duty synthetic rubber fitted with bayonet type fittings which when disconnected will automatically shut off fuel from the tank.

16. Shipside Valves and Sea Water Piping

16.1 Inlet and Discharge Valves—General

All sea inlet and overboard discharge pipes shall be fitted with screwdown valves or cocks unless required otherwise by the Load Lines Section and except that:

(a) discharge valves or cocks shall not be required in the case of discharges (including sanitary discharges) having bore diameters not exceeding 50 mm, and the lowest points of which are not less than 230 mm above the load water line; and

(b) discharges which are led through the vessel's side from spaces above the bulkhead deck may be fitted with non-return valves in lieu of screw down valves or cocks.

16.2 Requirements for Valves and Cocks

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

16.2.2 Shipside valves and cocks with a bore greater than 50 mm shall be of the flanged type. Valves and cocks not greater than 50 mm bore may be of the screwed type.

16.3 Fitting of Valves and Cocks

16.3.1 Flanged valves and cocks shall be mounted on suitable pads or flanges which are secured to:

(a) the hull of the vessel;

(b) suitable water boxes; or

(c) standpipes which shall be as short as practicable.

16.3.2 Valves and cocks of the screwed type shall be secured to the hull of the vessel by means of a suitable skin fitting or standpipe. The finished wall thickness of any such fitting or stand pipe shall not be less than the thickness of the hull plating to which it is attached.

16.3.3 The valves or cocks must be so fitted that they are readily accessible at all times.

16.4 Gratings

Gratings shall be fitted on the outside of the hull, to all sea water inlets. The clear area through the grating shall be not less than twice the area of the valve connected.

16.5 Pipe Materials

All pipes that can be placed in communication with the sea are to be of heavy gauge copper or steel. Suitable reinforced synthetic rubber piping having a high resistance to salt water, fuel oil, heat and vibration, and capable of operation under suction without collapse and resultant reduction in effective area, may be used:

(a) in short lengths for vibration damping;

(b) in vessels of less than 15 m in length, provided that the length of piping does not exceed half the beam of the vessel, the run of piping is direct as practicable and it is adequately supported.

When installed the rubber piping shall be readily visible and protected against mechanical damage and contact with hot surfaces.

16.6 Securing of Flexible Pipe

The method of securing a flexible pipe to a rigid pipe or fitting shall be by corrosion resistant clips or pressed ferrules.

For flexible piping of 25 mm internal diameter and above not less than two clips shall be fitted at each end.

16.7 Material of Pipe Fittings

The material of pipe fittings shall not be of malleable iron.

17. Bilge Pumping Arrangements

17.1 General

17.1.1 Subject to paragraph 17.1.2 every vessel shall be provided with a pumping system capable of pumping from and draining any water tight compartment in the vessel.

17.1.2 A watertight compartment less than 7% of the total under deck volume may be drained into the adjacent compartment by means of a self-closing valve or cock. The valve or cock shall be fitted outside the compartment to be drained and shall be operable from a readily accessible position.

17.1.3 In the case of a vessel of Classes 1A and 1B of 15 m in length and over the system shall permit pumping and draining from every space in the vessel whilst any one watertight compartment is flooded.

17.2 Number and Capacity of Pumps

Vessels shall be provided with bilge pumps in accordance with the following table.

	Manual pumps discharge capacity as installed		*Power pumps discharge capacity as installed*	
Measured length of vessel in m	*No.*	*Capacity in kl/hr*	*No.*	*Capacity in kl/hr*
Less than 7.5	1	4.0		
7.5 and over but less than 10	2	4.0		
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			2	11.0
25 and over but less than 35			2	15.0

17.3 Pump Details

In any vessel:

(a) a power pump may be substituted for a manually operated pump;

(b) a power pump may be driven by a main engine, an auxiliary engine or by an electric motor. However, where 2 power pumps are required, each pump shall not be dependent on the same source of power;

(c) where a vessel is required by sub-clause 17.2 to be fitted with 2 power pumps and the capacity of one of those pumps is less than that specified by not more than 20%, the deficiency may be made good by an excess of capacity in the other power pump; and

(d) a bilge pump shall be of the self priming type or be provided with a suitable priming device.

17.4 Pipe Materials

17.4.1 All bilge piping shall be of steel or heavy gauge copper, except that non-metallic bilge piping may be used on vessels of Classes 1D, 2C, 3A,

3B and 3C which are less than 12.5 m in length and on vessels of Classes 1E, 2D, 2E, 3D and 3E which are less than 15 m in length.

17.4.2 Notwithstanding the provisions of 17.4.1 and subject to 17.5 reinforced synthetic rubber piping may be used as tail pipes.

17.4.3 Where non-metallic bilge piping is used it shall have a high resistance to salt water, fuel oil, heat and vibration and be capable of operating under suction without collapse and resultant reduction in effective area.

17.5 Strainers

17.5.1 On vessels of 20 m in length and over each bilge suction in a machinery space shall be fitted with a mudbox and metallic tail pipe. All other bilge suctions shall be fitted with a mudbox, strum box or strainer. The Authority may give special consideration to the aforementioned arrangements having regard to the accessibility of a bilge suction.

17.5.2 Strainer holes shall not be greater than 10 millimetres diameter and the aggregate area of the holes shall not be less than twice the area of the suction pipe.

17.6 Back Flooding

Bilge piping arrangements shall be so arranged as to prevent water passing from the sea into holds or machinery spaces, or where the length of a vessel is 25 m and over from one watertight compartment to another. The bilge connection to any pump which also draws from the sea shall be either a screw down non-return valve, or a cock which cannot be opened at the same time to the bilges and to the sea. Where the length of a vessel is 25 m and over valves in bilge distribution boxes shall be of a non-return type.

17.7 Pipe Sizes

17.7.1 In vessels of 10 m and over in length the diameter of bilge suction pipes is to be not less than that determined by the following:

(a) $d_m\ 5 + 1.68\sqrt{L\ (B + D)}$

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

where d_m = internal diameter of the main bilge suction pipe in mm

d_b = internal diameter of branch suction pipes in mm

L = the measured length of the vessel in m

B = breadth of vessel in m

D = depth of vessel in m

C = length of compartment in m.

No main or branch suction piping is to be less than 32 mm in diameter.

17.7.2 In vessels of less than 10 m in length, the diameter of the bilge piping shall not be less than 25 mm.

17.8 Bilge Level Alarm

In all decked vessels other than Class E vessels, the space in which the propulsion machinery is located shall be fitted with a bilge level device which is connected to an audible alarm located near the steering position. The power supply for the audible alarm shall be available at all times there is any person on board.

With the machinery operating under full power conditions the alarm shall, when operated, be clearly audible at the steering position.

18. Fish Tank Pumping Systems

18.1 Non-Metallic Piping

18.1.1 Non-metallic piping may be used for filling fish cargo tanks provided that:

(a) bilge alarms are fitted in each compartment in which the piping is installed;

(b) the sea suction valves can be readily closed from a position above the bulkhead deck;

(c) any penetration by the piping of a machinery space bulkhead is via a suitable valve; and

(d) All connections to the tanks are readily accessible and have valves attached directly to the tanks or to heavy guage metal piping attached directly to the tanks and provided that where the connections are not near the top of the tanks, the valves shall be capable of being readily closed from a position above the bulkhead deck or shall be non-return valves.

18.1.2 Non-metallic piping may be used for discharging fish cargo tanks subject to compliance with sub-paragraphs (a), (c) and (d) of paragraph 18.1.1.

19. Collision Bulkhead Valve

A pipe piercing a collision bulkhead shall be fitted with a screw down valve or cock at the bulkhead. The valve or cock shall be controllable from the bulkhead deck and an appropriate open/close indicator shall be provided. If the valve or cock is fitted on the after side of the bulkhead and is readily accessible under all service conditions, the remote control may be dispensed with.

20. Sounding Devices and Sounding Pipes

20.1 A suitable means shall be provided for determining the liquid content of:

(a) any watertight compartment, which is not part of the machinery space, including a cofferdam and a double bottom tank; and

(b) any cofferdam and double bottom tank which is located in the machinery space.

20.2 Where a sounding pipe is fitted it shall:

(a) for a pipe located outside of the machinery space, extend to a readily accessible position on deck;

(b) for a pipe located in a machinery space, extend to a readily accessible position. It shall extend to deck level or to a lesser height if the pipe is furnished with a cock having a parallel plug with a permanently secured handle so loaded that on being released it automatically closes the cock; and

(c) terminate in such a position that there is no danger of over flow spillage on to hot surfaces or electrical equipment.

20.3 The upper end of a sounding pipe shall be provided with means of closing to prevent the free entry of water.

20.4 A sounding pipe shall be as straight as practicable and if curved to suit the shape of the vessel, the curvature shall be sufficient to permit the passage of a sounding rod or a sounding chain.

20.5 A sounding pipe shall be of metal not less than 4.5 mm in thickness and be not less than 32 mm internal diameter.

20.6 A sounding pipe shall be protected against mechanical damage and where it passes through any refrigerated space shall be thermally insulated.

20.7 A striking plate shall be fitted under the lower end of a sounding pipe.

21. Steering Gear

21.1 Number of Means

All vessels except twin screw vessels shall be fitted with two effective independent means of steering, one of which may be a hand tiller, except that where the normal means of steering is a hand tiller an alternative means need not be provided. The secondary or emergency gear shall be capable of being brought speedily into action.

21.2 Design

21.2.1 The steering gear arrangement shall be of adequate strength and sufficient to steer the vessel at maximum speed. The steering gear shall be so designed that it is not damaged at maximum astern speed.

21.2.2 Components that transmit torque, tensile stresses or shock loads shall not be of ordinary cast iron or other similar non-ductile material.

21.2.3 Rudder movement should be 35° port and starboard and formulae indicated in clause 22 are based on these helm angles. Rudder movement less than or in excess of 35° shall only be permitted with the approval of the Authority and in such cases the Authority may allow a reduction or require an increase in the diameter of the rudder stock.

21.2.4 In a vessel of 12.5 m in length and over the steering gear shall be capable of putting the rudder over from 35° on one side to 30° on the other in 30 seconds when the vessel is at maximum ahead service speed with the rudder totally submerged, and, if normally operated shall be designed to prevent violent recoil of the steering wheel.

21.3 Hydraulic Systems

Hydraulic Steering Systems shall meet the requirements of clause 25 and otherwise comply with the following:

21.3.1 Means to facilitate a quick change over from the primary to the secondary steering shall be fitted.

21.3.2 In power systems a relief valve shall be installed and set to prevent mechanical damage to the steering gear.

21.3.3 Hydraulic piping shall be so arranged to avoid the possibility of damage.

21.4 Helmsman's View

The steering arrangement shall be such that the operator has a clear view ahead in the normal steering position.

21.5 Rudder Movement Direction

21.5.1 The trailing edge of the rudder blade of a vessel shall move in the same direction as the top spokes of the steering wheel.

21.5.2 In a vessel of 15 m and over fitted with power operated steering gear, a rudder position indicator shall be fitted. It shall be so placed as to be in full view of the helmsman whilst he is at the normal steering position.

21.6 Transmission Shaft Bearings

Steering gear transmission shafts shall be adequately supported in bearings spaced not more than 70 times the diameter of the transmission shaft, provided that bearing spacing adjacent to sprockets or gears is such that no undue bending load can be applied to the shaft.

21.7 Tiller Arm

21.7.1 The section modulus of a tiller arm just clear of the boss, or quadrant just clear of the boss, shall not be less than:

$$Z = \frac{0.15d^3\ (a - b)}{1000 \qquad a}$$

where Z = section modulus of quadrant or tiller in cm^3 about the vertical axis

d = required diameter of the upper rudder stock in mm

a = distance from the point of application of the load on the tiller or quadrant to the centre of the rudder stock in mm

b = distance between the section of tiller or quadrant just clear of the boss and centre of the rudder stock in mm

For tillers of rectangular section, the ratio between the breadth and thickness is not to be greater than 3.

(*Note:* This formula is based on the material of the tiller arm and upper rudder stock being carbon steel having a U.T.S. of 410 MPa.)

21.7.2 The section modulus at the point of application of the load is to be not less than one third of that required by paragraph 21.7.1.

21.7.3 The outside diameter of the tiller arm boss or quadrant boss is to be not less than 1.8 times the rudder stock diameter, and the depth is to be not less than the rudder stock diameter.

21.7.4 The distance from the tiller arm boss to the nearest bearing, gland or other support should not exceed 2.5 times the required diameter of the rudder stock.

22. Rudder and Rudder Stocks

22.1 Materials

22.1.1 Unless otherwise stated, rudder couplings, coupling bolts, gudgeons and similar parts subject to dynamic stress shall be manufactured from materials complying with the requirements of paragraph 14.6.2.

22.1.2 Unless otherwise stated rudder plating and stiffeners shall be of material complying with those requirements specified for hull material in the Construction Section (Steel Vessels).

22.2 Upper Stock Size

A rudder stock above the top pintle for an unbalanced rudder or above the neck bearing for a balanced rudder is to be not less than obtained from the formula:

$$d = C\sqrt[3]{RAV^2}$$

where d = diameter of upper stock in mm

R = distance in m from the centre line of stock to the centre of area of A

A = area of rudder in m^2

V = sea speed of vessel in knots with:

a minimun of 8 in vessels up to 30 m in length;

a minimum of 9 in vessels of 30 m in length and over.

C = for vessels up to 30 m in length:

= 21.66 where V = 8

= 19.2 where V = 14 or over.

For values of V between 8 and 14, C may be obtained by interpolation.

C = for vessels of 30 m in length and over:

= 21.66 where V = 9

= 19.20 where V = 15 and over.

For values of V between 9 and 15, C may be obtained by interpolation.

22.3 Unbalanced Rudder Main Piece Size

For an unbalanced rudder, the main piece shall be of the required diameter for the upper stock at the top arm of a single-plate rudder or the top of a built up rudder but the diameter may be gradually reduced until it is 0.75d at the bottom.

22.4 Balanced Rudder Lower Stock Size

22.4.1 For a balanced rudder, the stock in way of and below neck bearings shall have diameters not less than obtained from the following equation:

$$d_1 = C\sqrt[3]{RAV^2}$$

where d_1 = diameter of lower stock in mm

$R = 0.25\,(a + \sqrt{a^2 + 16b^2}$ for a balanced rudder which has efficient neck and bottom bearings

$R = a + \sqrt{a^2 + b^2}$ for a balanced rudder which has no bottom bearings

A = area of rudder in m^2

a = vertical distance from the bottom of the neck bearing to the centre of area of A in m

b = horizontal distance from the centre of the lower stock to the centre of area of A in metres

V = speed of vessel in knots with a minimum of 8 in vessels up to 30 m in length and a minimum of 9 in vessels of 30 m in length and over.

C shall be determined according to the following:

(a) where the speed of the vessel is not greater than $4\sqrt{\text{LWL}}$, LWL being the length of the vessel in m at the designed waterline, and the length of the vessel is less than 30 m.

C = 21.66 where V = 8

C = 19.20 where V = 14 and over

For values of V between 8 and 14, C may be obtained by interpolation;

(b) where the speed of the vessel is not greater than $4\sqrt{\text{LWL}}$, with LWL being the length of the vessel in m at the designed waterline, and the length of the vessel is 30 m in length and over

C = 21.66 where V = 9

C = 19.20 where V = 15 and over

For values of V between 9 and 15, C may be obtained by interpolation; or

(c) where the speed of the vessel is greater than $4\sqrt{\text{LWL}}$, LWL being the length of the vessel in m at the designed waterline.

C = 16

22.4.2 The mainpiece of a balanced rudder having efficient neck and bottom bearings is to be full diameter for at least 2/3 of the distance from the neck to the bottom bearing. The diameter may be gradually reduced below this point until it is $0.75d_1$ in the bottom bearing. The mainpiece is to extend into the bottom bearing for a distance not less than $0.7d_1$. Both bearings are to be bushed.

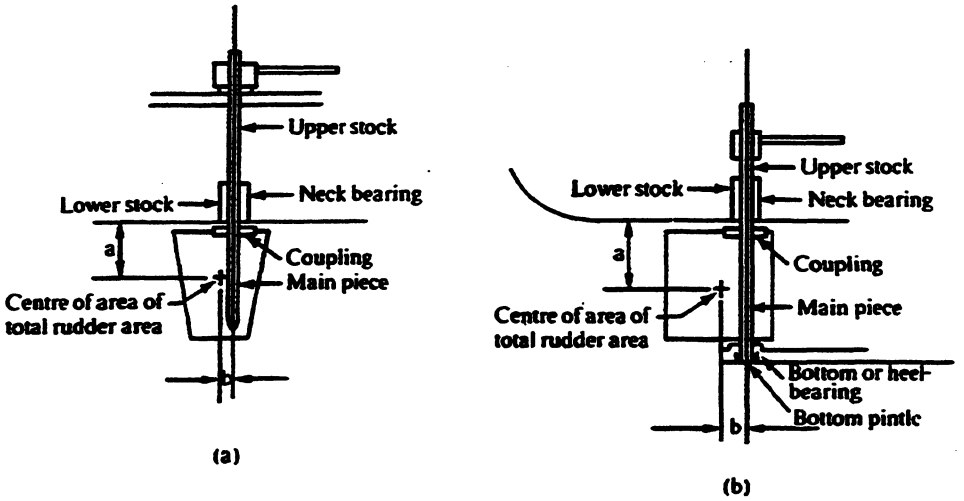

Figure 22.4

22.4.3 The stock of a balanced rudder having no bottom bearing is to be full diameter to the underside of the top rudder arm if a single plate rudder, or to the top of the rudder if a built-up rudder. The diameter may be gradually reduced below this point until it is $0.5d_1$ and the length of stock in way of the rudder shall not be less than 2/3 of the depth of the rudder at the centre line of the stock.

22.5 Rudder Stock Sizes of Material other than Carbon Steel

The diameter of a rudder stock or main piece of material other than carbon steel shall be:

$$d\sqrt[3]{\frac{410}{T}}$$

where d equals the diameter of the rudder stock in millimetres as required by sub-clause 22.2 and 22.4 and T equals the minimum ultimate tensile strength of the material in MPa.

22.6 Rudder Bearings and Pintles

22.6.1 The neck bearing for rudders shall be bushed, be of the type shown in Fig. 22.4 (b) and not be less in depth than 1.5 times the required stock diameter. For spade rudders of the type shown in Fig. 22.4 (a) the neck bearings shall not be less in depth than 4 times the required stock diameter unless an upper bearing is fitted. Bearings are to be adequately supported and housings effectively attached to the vessel's structure.

22.6.2 The diameter of rudder pintles shall not be less than 0.75 times the required diameter of the rudder stock, and the depth of pintle bearings shall not be less than the required diameter of the pintle.

22.6.3 Where more than one pintle is fitted the required diameter may be reduced by 10 per cent for each additional pintle fitted.

22.7 Coupling Types

Some acceptable forms of flanged rudder couplings are as follows:

(a) Couplings of fabricated construction, provided that they are suitably designed, prepared and heat treated subsequent to welding.

(b) Couplings formed by upsetting the end of the stock provided that there is no necking or narrowing of the stock.

(c) Couplings fitted on a taper, keyed and held in place by a nut.

22.8 Coupling Dimensions

The scantlings of rudder couplings are to be in accordance with the following:

22.8.1 The thickness of the flange shall be:

(a) for a rudder with a pintle or bottom bearing not less than 0.25 times the diameter of the rudder stock or equal to the required diameter of the coupling bolts whichever is the greater; and

(b) for a spade rudder not less than 0.32 times the diameter of the rudder stock or equal to the required diameter of the coupling bolts whichever is the greater.

22.8.2 The fillet radius at the base of the flange shall not be less than 0.125 times the diameter of the stock.

22.8.3 The ligament thickness outside the coupling bolt holes shall not be less than 0.6 times the diameter of the coupling bolt.

22.8.4 The pitch circle radius of bolts for couplings of the forged or welded flange type shall not be less than the diameter of the rudder stock, and for couplings keyed to the stock shall be not less than 1.25 times the diameter of the rudder stock.

22.8.5 Couplings keyed to the stock shall be provided with keys of the type specified in paragraph 14.9.3 and having width and thickness in accordance with paragraph 14.9.4 or 14.9.5 as appropriate.

22.8.6 The boss thickness of keyed couplings shall not be less than 1.5 times the required thickness of the key and the boss length shall not be less than 1.5 times the required diameter of the rudder stock.

22.8.7 Where a rudder stock is 150 mm or more in diameter at least 6 bolts are to be used in each coupling flange. Where the diameter is less than 150 mm, at least 4 bolts are to be used in each coupling flange. The total area of bolts is not to be less than that determined from the following formula:

$$A = \frac{0.3 \times d^3}{R}$$

where A = total bolt area in mm^2 at root of threads

R = pitch circle radius of bolts in mm

d = required diameter upper stock in mm.

22.8.8 Rudder coupling bolts shall be machine finished, neat fitting and the nuts shall be effectively locked.

22.9 Spade Rudders

Acceptable forms of spade rudder are as follows:

22.9.1 Fabricated or cast rudder blade with integral flange secured to a rudder stock with flange by fitted bolts. (With this type of rudder the sizes of the couplings and bolts are to be based on the required diameter of the lower rudder stock, but due regard shall also be given to the bending and tensile stresses to which they may be subject arising from the forces on the rudder.).

22.9.2 Fabricated or cast rudder blade attached to rudder stock by means of a taper with key and securing nut. (The length of the taper is not to be less than 1.5 times the required diameter of the lower rudder stock. The taper is to be between the limits of 1 in 12 and 1 in 16 on diameter, but should preferably be 1 in 12).

22.9.3 Fabricated rudder blade integral with rudder stock.

22.9.4 Fabricated or cast rudder blade shrunk on to a parallel rudder stock and additionally secured with dowells.

22.9.5 Rudders with the blade cast on to the rudder stock are subject to the approval of the Authority. The approval will be dependent upon the design and construction method and may also be dependent on the result of proof load testing.

22.9.6 Cast rudder blades shall be of ductile material.

22.9.7 The pressure on the rudder bearings should, in general, not exceed 3.9 MPa. For bearings with efficient lubrication a pressure of 5.9 MPa may be accepted.

For the determination of the pressure on the bearings the rudder force may be calculated from the following formula:

$F_p = 196AV^2$

where A = area of rudder in m^2

V = speed of vessel in kn

F_p = rudder force in N.

22.10 Single Plate Rudders

22.10.1 A single plate rudder with upper stock diameter measuring 75 mm or less shall have a plating thickness not less than obtained from the formula $t = 0.15d + 6$.

A single plate rudder with upper stock diameters d measuring more than 75 mm shall have a plating thickness not less than obtained from the formula $t = 0.04d + 14$

where t = thickness of rudder plate in mm.

d = required diameter of upper rudder stock in mm

Where speed of the vessel exceeds 15 kn, the required thickness of the rudder plate shall be increased at the rate of 1 mm/kn of excess speed.

Where distances between centres of rudder stiffeners are less than obtained from the formula in 22.10.2 the thickness of the rudder plating t, may be given special consideration.

22.10.2 The distance between centres of single plate rudder stiffeners is not to be greater than that obtained from the following formula:

where $h \times 2.5d + 952.5$

where h = vertical distance between the centres of stiffeners in mm

d = required diameter of upper rudder stock in mm.

The section modulus (Z) in way of the stiffeners immediately forward and aft of the stock is not to be less than that obtained from the following formula:

$Z = 0.8(d—51)\ cm^3$

The breadths 'b' of the stiffeners may be tapered forward and aft of the maximum breadths required to satisfy the above section modulus. However, the breadths at the leading and trailing edges of the rudder are not to be less than obtained from the following formula:

$b = 0.1d + 8$

where b = breadth of the stiffeners in mm.

22.10.3 The blade of a single plate rudder shall be attached to the main piece by a full penetration continuous weld. Stiffeners shall be attached to the main piece and blade by a double continuous fillet weld.

22.11 Double Plate Rudders

22.11.1 Double plate rudders are to have horizontal internal webs.

22.11.2 In the case of a vessel less than 20 metres in length the thickness of plating for a double plate rudder shall be in accordance with table 22.11.2.

TABLE 22.11.2

Diameter of rudder stock derived from formula in mm	*Plate thickness mm*		
	Spacing of webs in mm		
	300	*450*	*600*
(1)	*(2)*	*(3)*	*(4)*
less than 40	4.5	4.5	6.5
40 and over but less than 45	4.5	6.5	6.5
45 and over but less than 60	4.5	6.5	8.0
60 and over but less than 65	6.5	6.5	8.0
65 and over but less than 75	6.5	8.0	9.5

Horizontal and vertical webs in double plate rudders not replacing the main piece are to have the same thickness as the side plates. Plates forming the top and bottom of the rudders are not to be less than the thickness given in column (4).

22.11.3 Where the required rudder stock diameter exceeds 75 mm the thickness of the rudder side plating and webs is not to be less than obtained from the following formula:

$$t = 6.5 + 0.117\sqrt{A}$$

where:

t = plate thickness in mm

V = sea speed of vessel in kn with an 8 kn minimum with vessels less than 30 m in length and a 9 kn minimum with vessels of 30 m and over.

A = total area of rudder in m^2.

The distance between centres of the webs is not to be greater than obtained from the formula:

$$Sp = 585 + 2.41\sqrt{A}$$

where:

Sp = distance between centres in mm; and V & A are as defined above.

The thickness of the plating is to be increased at the rate of 0.015 mm for each mm of spacing greater than that given by the formula and may be reduced at the same rate for lesser spacing.

22.11.4 Special attention is to be given to the attachment of the rudder arms, pintle gudgeons and rudder coupling to the body of the rudder.

Horizontal and vertical stiffeners in double plate rudders are to be attached to the mainpiece by continuous double fillet welds and to the plating by fillet welds consisting of 75 mm increments spaced 150 mm between their centres. Where the interior of the rudder is inaccessible for welding the stiffeners shall be fitted with flat bars and the plating connected to these flat bars by continuous or slot welds.

22.11.5 Double plate rudders are to be watertight. Means for draining the rudder shall be provided.

Double plate rudders are to be tested by a head of water of 2.5 m or equivalent.

22.12 Wooden Rudders and Steering Nozzles

The construction and scantlings of wooden rudders and steering nozzles shall be specially considered.

22.13 G.R.P. Rudders

G.R.P. rudders are to incorporate a substantial steel spider formed by perforated plate arms, approximately half the rudder width in length and welded to the rudder main piece. The main piece is to be continuous through the rudder but where this is not possible owing to the design at the rudder, suitable arrangements are to be made to ensure continuity of strength and alignment. The blade is to be moulded from mats with or without woven rovings, and is to be bonded with epoxy or polyester resins. The rudder is to be filled with a suitable material such as a resin/glass dough or a micro-balloon mixture.

22.14 Rudder Support

The weight of a rudder is to be suitably supported at the heel pintle or by a suitable carrier bearing. The structure in way of a carrier bearing is to be adequately strengthened for that purpose.

22.15 Rudder Stops

22.15.1 Effective means shall be provided to limit vertical movement of the rudder.

22.15.2 Effective stops to prevent the rudder coming into contact with the propeller or hull shall be provided.

23. Windlass

23.1 A mechanical lifting device provided in a vessel to meet the requirements of the Miscellaneous Equipment Section shall constitute a windlass or capstan. Cable stoppers, claws or similar fastenings shall be provided as necessary between the windlass or capstan and the hawse pipe. The windlass or capstan is to be designed for immediate dropping of the anchor and with an efficient brake.

23.2 For an anchor mass of less than 50 kg, the windlass or capstan may be hand operated provided that the applied effort shall not exceed 155 N when lifting the anchor and total length of cable fitted.

23.3 For an anchor mass of 50 kg and above a power operated windlass or capstan shall be provided. It shall be capable of lifting one anchor and 35 m of its chain cable plus a 20 per cent overload at a speed of not less than 7.5 m per minute.

24. Air Compressors

A compressor for the supply of compressed air for purposes other than breathing apparatus shall be in accordance with the following.

24.1 An air compressor shall be provided with a relief valve of such size and so set that when the compressor discharge valve is closed and the compressor is running normally, the maximum accumulation pressure will not exceed the working pressure by 10 per cent.

24.2 The casing of an air cooler of an air compressor shall be fitted with a relief valve or a safety diaphragm to provide protection against an air tube bursting.

24.3 An air compressor shall be provided with means for draining water and oil from the inter and final discharge stages.

24.4 The air intake for a compressor shall be so located to minimise the induction of oil vapours.

24.5 An air compressor shall be so designed and installed that the temperature of the air delivered from the after cooler does not exceed 93°C.

24.6 A pressure gauge shall be fitted between the after cooler and the compressor H.P. discharge.

25. Hydraulic Power Systems

25.1 Hydraulic pumps shall have pressure relief protection on the discharge side which shall operate in closed circuit.

25.2 The materials of hydraulic pumps, motors and accessories shall be compatible with the working fluid. Hydraulic fluid shall be non-flammable or shall have a flash point of 157°C or over.

25.3 Hydraulic hose shall comply with Australian Standard B 226. Installation and fittings shall be in accordance with the manufacturer's requirements .

26. Pressure Pipes

26.1 General

26.1.1 Unless specified elsewhere in this Section the requirements of this clause shall apply to pipes the working pressure of which is 700kPa and over.

26.1.2 The design of steel pipe work shall comply with Australian Standard CB18.

26.2 Copper

Copper and copper alloy pipes shall be of seamless construction. When pipes other than those of seamless construction are proposed, they will be specially considered by the Authority.

26.3 Copper Pipe Thickness

26.3.1 The minimum thickness of copper and copper alloy pipes shall be determined by the following formula:

$$t = \frac{WP \times d}{200f + WP} + c$$

where t = wall thickness in mm

WP = working pressure in kPa

d = outside diameter of the tube in mm

f = maximum permissable stress in MPa at the appropriate working temperature (see Table 26.3).

c = 0.75 mm

TABLE 26.3

Material	*Minimum tensile strength M Pa*	*0.5% Proof stress M Pa*	*Permissible stress MPa*										
			50°C	*75°C*	*100°C*	*125°C*	*150°C*	*175°C*	*200°C*	*225°C*	*250°C*	*275°C*	*300°C*
Copper	215	62	41	40.5	40	38	26.5	21.5	..	..	..	..	..
Aluminium Brass	325	120	69	68.5	67	65	62	42.5	24	..	..	..	..
Copper Nickel 95/5 & 0/10	275	135	69	68.5	67	65	63.5	60	56	50	43.5	38	..
Copper Nickel 70/30	390	135	83	80.5	76	72.5	68.5	66	63.5	61.5	59	56.5	54

26.3.2 Where copper and copper alloy pipes are to be bent, the thickness as obtained in paragraph 26.3.1 shall be increased by 10 per cent to allow for thinning at the bend. In no case shall the radius of curvature at the centre line of the pipe be less than twice the external diameter of the pipe.

26.4 Copper Pipe Heat Treatment

Copper pipes shall be annealed and copper alloy pipes heat treated in accordance with the manufacturer's recommendation.

26.5 Reducing Valves

Where a pressure pipe or fitting may receive supply from any source at a higher pressure than that for which the pipe or fitting is designed, an efficient reducing valve shall be fitted. An efficient relief valve of sufficient size together with a pressure gauge shall be fitted on the low pressure side of the reducing valve.

TABLE 27.2.2a

Conductor		Maximum Current Ratings											
		Heat resisting Polyvinyl chloride			Ethylene propylene rubber cross-linked Polyethylene chlorosulphonated Polythylene			Silicone rubber			Mineral insulated metal sheathed		
Standing	Cross section mm^2	1 core	2 core	3 & 4 core	1 core	2 core	3 & 4 core	1 core	2 core	3 & 4 core	1 core	2 core	3 & 4 core
7/0.4	1	14	11	9	16	13	11	20	17	14	20	17	14
7/0.5	1.5	19	16	13	22	18	15	24	20	17	24	20	17
7/0.67	2.5	25	21	17	28	23	19	32	27	22	32	27	22
7/0.85	4	32	27	22	37	31	25	42	36	29	42	36	29
7/1.05	6	42	35	29	48	40	33	53	45	37	53	45	37
7/1.35	10	58	49	40	67	57	47	73	62	51	73	62	51
7/1.70	16	78	66	54	89	75	62	98	83	69	98	83	69
19/1.35	25	100	86	71	115	99	82	130	110	91	130	110	91
19/1.53	35	120	105	88	145	120	100	165	140	115	165	140	115
29/1.73	50	155	135	110	180	155	125	200	175	145	200	175	145
19/2.14	70	195	165	135	220	185	155	250	215	175	250	215	175
37/1.78	95	235	200	160	270	220	190	310	265	215	310	265	215
37/2.03	120	270	230	190	310	265	215	360	305	250	360	305	250
37/2.25	150	310	265	215	355	305	250	420	355	290	420	355	290
37/2.52	185	355	300	250	405	345	235	485	410	340	485	410	340
61/2.25	240	415	355	290	475	405	330	570	485	400	570	485	400
61/2.52	300	470	410	335	540	465	380	660	560	460	660	560	460
61/2.85	400	570	485	400	650	550	455	..	..	..	..	..	..
61/3.20	500	650	550	455	740	630	520	..	..	..	..	..	..
127/2.52	630	740	630	520	..	..	..	..	..	..	..	..	..

Notes: Correction Factors for Current Ratings.

(i) Where more than six cables are bunched together a derating correction factor of 0.85 is to be applied to the current rating of the cable shown in Table 27.2.2a.

(ii) When it is known that the ambient temperature is other than 45°C the current rating is to be multiplied by the appropriate correction factor as shown in Table 27.2.2c.

(iii) Where the load is intermittent the correction factors shown in Table 27.2.2d are to be multiplied by the current rating of the cable shown in Table 27.2.2a. In no case is a shorter rating than a one half hour rating to be used.

PART 4—ELECTRICAL

27. Electrical Equipment Extra Low Voltage

27.1 General

27.1.1 This clause shall apply where the electrical supply does not exceed 32 volts D.C.

27.1.2 Details of electrical power supply arrangements for radio shall comply with requirements of the Radio Equipment Section.

27.1.3 In every installation all necessary precautions shall be taken to limit electrical equipment from affecting navigational aids.

27.1.4 Electrical installations associated with an engine using fuel having a closed flash point of less than 60°C, shall be specially considered by the Authority.

27.2 Distribution

27.2.1 The distribution of electrical power shall be by the two wire insulated system. The use of a hull return for lighting or power distribution is not permitted.

27.2.2 The voltage drop in any circuit shall not exceed 10% of the design voltage. Maximum permissible current ratings shall be in accordance with:

(a) the cable manufacturer's recommendations; or

(b) Tables 27.2.2 (A), (B), (C) and (D) or (E) whichever of (A) and (B) gives the least rating.

27.2.3 Circuits supplying two or more final sub-circuits are to be rated in accordance with the total connected load subject, where justified, to the application of a diversity factor. Where space ways are provided on a main or sub-switchboard or distribution board an allowance for future increases of load is to be added to the total connected load before application of any diversity factor. The diversity factor may be applied to the calculation for size of cable and rating of switch gear and fuse gear.

27.2.4 Final Sub-Circuits

The number of points that may be connected to a final sub-circuit is limited only by the connected load. In determining the connected load, the loading is to be determined as follows:

(a) the loading of lamp holders is to be taken as:

(i) 60 watts or the wattage of the largest lamp which could be inserted, whichever is the greater;

(ii) in the case of a fluorescent lamp, the wattage of that lamp;

(b) the loading of the plug sockets is to be taken as 160 watts or the actual wattage of the appliance to be connected, whichever is the greater;

(c) the loading of permanently connected appliances is to be taken as the actual wattage of the appliance.

The connected load so determined is not to exceed the rating of the fuse or fuses required to protect the conductors.

Where protection of the final sub-circuit is by a circuit breaker having a fixed over current setting there is no limit to the number of points that may be connected to the circuit having regard both to the suitability of the circuit breaker setting and the maximum permissible current carrying capacity of the cable. Where circuit breakers having adjustable load setting are used, the above limitations of this paragraph shall apply. A separate final sub-circuit is to be provided for every motor required for an essential service.

27.3 Switchboards

27.3.1 Switchboards shall be constructed using an insulating material that is mechanically strong, non-hygroscopic and non-flammable.

27.3.2 Switchboards should be placed in accessible, adequately ventilated positions, free from flammable gases and acid fumes, and where they are not exposed to the risk of mechanical injury or damage from water.

27.3.3 Switch gear and accessories on main switchboards, sub-switchboards or distribution panels shall be provided with efficient means of identification.

27.4 Protection

27.4.1 All conductors, switchgear and accessories are to be of such size and construction as to be suitable for the purpose intended, and capable of carrying, without their respective ratings being exceeded, the maximum in service current.

27.4.2 Enclosures for switchgear and fuse gear, if of a combustible material, shall be lined with non-hygroscopic fire resistant material.

27.4.3 The active conductor or conductors of each individual circuit shall be fitted with overload protection by means of a fuse or circuit breaker.

27.4.4 In a vessel with a metal hull which has overload protection provided in both conductors, the installation shall be provided with lamps or suitable equipment to indicate earth faults.

Table 27.2.2B

INSULATION TEMPERATURE RATINGS

Insulating Material	*Maximum Rated Conducted Temp °C*
Heat Resisting Polyvinyl Chloride	75
Ethylene Polylene Rubber	85
Cross Linked Polyethylene	85
Chlorosulphonated Polyethene	85
Silicone Rubber	95
Mineral Insulated Metal Sheathed	75

Table 27.2.2C

Insulation	*Correction Factor for Anbient Temperature*			
	40°	*45°*	*50°*	*55°*
Polyvinyl Chloride (Heat resisting)	1.08	1.00	0.91	0.82
Silicone Rubber	1.05	1.00	0.95	0.89
Mineral insulated metal sheathed	1.05	1.00	0.95	0.89
Ethylene Polyethene Rubber	1.06	1.00	0.94	0.87
Cross Linked Polythene				
Chlorosulphonated Polythene				

Table 27.2.2D

CORRECTION FACTOR FOR INTERMITTENT SERVICE

Correction Factor	*One Half Hour Rating*		*One Hour Rating*	
	With Metalic Sheath	*Without Metalic-Sheath*	*With Metalic-Sheath*	*Without Metalic-Sheath*
1.0	Up to 20mm^2	Up to 75mm^2	Up to 67mm^2	Up to 230mm^2
1.1	21mm^2-40mm^2	76mm^2-125mm^2	68mm^2-170mm^2	231mm^2-400mm^2

Table 27.2.2E

AUTOMOTIVE CABLES COMPLYING WITH AUSTRALIAN STANDARD 2218—CONDUCTOR DETAILS

Area mm^2	*Gauge*	*Meteric standing*	*Rating*
0.85	18	11/0.32	5 amps
1.00	16	14/0.32	10 amps
1.25	16	16/0.32	10 amps
2.00	14	26/0.32	15 amps
3.00	12	41/0.32	20 amps
5.00	10	65/0.32	25 amps

27.4.5 All electrical equipment should be located in dry, accessible and well ventilated positions and all nuts and screws used in connection with current carrying parts and working parts are to be effectively locked.

27.5 Conductors, Cables and Wiring

27.5.1 All conductors of cables between the source of supply and final sub-circuits, with the exception of mineral insulated and metal sheathed cables, and control and instrumentation wiring, are to be of annealed copper of stranded type constructed in accordance with Australian Standard 1125.

27.5.2 Conductors may be insulated by one of the following materials, having regard to the temperature of the space through which they pass:

(a) Polyvinyl Chloride Compound (P.V.C.) complying with Australian Standards AS 1695 or AS 3147;

(b) Chlorosulphonated Polyethylene complying with Australian Standard AS 3116;

(c) Ethylene Propylene Rubber complying with Australian Standards AS 1168 or AS 3116; and

(d) Mineral complying with Australian Standard AS 3157.

(e) Silicone Rubber complying with Australian Standard AS 3178; and

(f) Crosslinked Polyethylene (XLPE) complying with Australian Standard AS 3198.

27.5.3 All cables unless run in conduit are to have an impervious sheath over the insulating material which may be one of the following:

(a) Polyvinyl Chloride Compound (P.V.C.) complying with Australian Standards AS 1695 or AS 3147;

(b) Polychloroprene (P.C.P.) complying with Australian Standards AS 1168 or AS 3116;

(c) Chlorosulphonated Polyethlene complying with Australian Standard AS 1168; or

(d) Copper sheath for mineral insulated cable complying with Australian Standard AS 3187.

27.5.4 Flexible cord complying with Australian Standard AS 3191 may be used as fixed wiring subject to compliance with the following:

(a) the current carrying capacity shall not be less than the current rating or setting of the circuit protective device;

(b) the insulation shall have a total thickness at least equivalent to that of an insulated cable of equivalent cross-sectional area;

(c) the insulation rating shall be not less than 75°C; and

(d) installation shall be in accordance with Table 27.5.4 and provisions 27.6 and 27.11.

27.5.5 The mininum internal radius of bend of cable when installed shall be in accordance with the following:

(a) 6 times the cable diameter for elastomer and PVC sheathed cables exceeding 25mm overall diameter (without metal covering);

(b) 4 times the cable diameter for elastomer and PVC sheathed cable exceeding 9.5 mm and up to 25 mm overall diameter (without metal covering); and

(c) 4 times the cable diameter for mineral insulated metal sheathed cable of any diameter.

TABLE 27.5.4

Type of flexible cord	*Nominal cross section of conductor*	*Additional installation requirements*
Braided overall	Not smaller than 1 mm^2	(1) Further enclosure (2) Not permitted for enclosure within appliances
Sheathed, screened and sheathed overall	Not smaller than 1 mm^2	Nil
Light duty sheathed	Not smaller than 1 mm^2	(1) Further enclosure (2) Not permitted for enclosure within appliances
Ordinary duty sheathed	Not smaller than 1 mm^2	Further enclosure
Heavy duty sheathed	Not smaller than 1 mm^2	Nil
Single core unsheathed	Not smaller than 1 mm^2	Further enclosure

27.5.6 Engine starting cables shall be protected against mechanical damage and kept as short as is compatible with the safe stowage arrangements for the batteries. The cables are not to be placed where they will come into contact with lubricating oil or fuel unless sheathed with an impervious material. Conductors of adequate size shall be taken directly to the starter via the starting relay contacts. The relay is to be mounted directly on the starter or adjacent to it.

27.6 Cable Fittings

27.6.1 Trays, cable clips, saddles and fixing screws for the support of cables shall be of corrosion resistant material or be suitably corrosion inhibited

before installation. The distance between supports is to be in accordance with the requirements of Table 27.6.1 having regard to the type of cable being supported.

27.6.2 When a watertight bulkhead or deck is penetrated the watertight integrity of the bulkhead or deck shall be maintained.

Table 27.6.1

MAXIMUM SPACING OF CABLE SUPPORTS

External diameter of cable in mm	*Spacing in mm*	
	Non-armoured cables	*Armoured cables*
Less than 8	200	250
Eight and over but less than 13	250	300
13 and over but less than 20	300	350
20 and over but less than 30	350	400
30 and over	400	450

27.6.3 Where conductors or cables pass through conduits or ducts or through openings formed in metal work, the openings are to be of ample size and provided with effective bushes.

27.6.4 Materials used for glands and bushes are to be corrosion resistant.

27.6.5 Where P.V.C. conduit is exposed to risk of mechanical damage effective arrangements are to be provided for its protection.

27.7 Navigation Lights

Each navigation light shall be protected in each active conductor by a fuse or circuit breaker. Switches and protective devices for these lights shall be located in the wheel house.

27.8 Battery Charging Equipment

There shall be fitted suitable control equipment for generators and batteries including ammeters, isolating switches, voltage regulators, cut outs and fuses or circuit breakers.

27.9 Fittings in Exposed Positions

Plugs and sockets in exposed positions shall be weathertight and sockets are to be provided with blank caps. External sockets shall be at least 300 mm above the deck and be combined with a tube of compatible material to enclose cables passing through the deck.

27.10 Insulation Resistance

The insulation resistance between conductors, or conductors and earth, either of the complete installation or any part thereof, measured with all fuse elements in place and all switches closed, shall not be less than 100,000 ohms. This value shall be obtained using a test voltage of not less than twice the supply voltage and not more than 250 volts with appliances, lamps and other consuming devices disconnected. Electronic equipment, which may be damaged during such tests, shall be disconnected.

27.11 Installation in Refrigerated Spaces

27.11.1 Cables installed in refrigerated spaces shall have a watertight and impervious sheath and be protected where necessary against mechanical damage.

27.11.2 PVC conduit shall not be installed in a space where the temperature is likely to fall below –15°C. If metallic conduit is installed it shall be provided with drainage and shall be sealed by a non-setting compound where it passes from the refrigerated to the non-refrigerated space.

27.11.3 Cables entering a refrigerated space should pass directly through the walls or lagging. They shall be protected by a tube of compatible material sealed at each end. Alternatively, cables may be passed through solid door frames, the necessary holes being sealed at each end. Sealing compound shall be resilient after setting.

27.12 Batteries and Battery Installation

27.12.1 Provision shall be made to electrically isolate the batteries.

27.12.2 Batteries shall be securely mounted so as to prevent movement due to the motion of the vessel. Starting batteries should be located as near as practicable to the engine served and in the case of a propulsion engine not below the level of the starting motor. If installed outside of the machinery space batteries shall be located in a suitable compartment.

27.12.3 Lead acid batteries are to be installed in liquid tight trays not less than 100 mm deep and lined with GRP or other acid resisting material. Alkaline batteries shall be installed on suitable insulating supports and where metal cell containers are used these are to be protected against conducting materials that can cause short circuiting between container and container, and between container and the metal structure. Provision shall be made for effective protection of the casings and terminals against the risk of mechanical damage, damage from water or short circuit.

27.12.4 All spaces used for the storage of batteries shall be ventilated to avoid accumulation of flammable gas.

27.12.5 A battery located on the open deck shall be protected from the weather.

27.12.6 All battery terminal connections are to be resistant to the electrolyte. Cable ends at terminals shall be sealed in such a manner as to prevent the entrance of electrolyte.

27.12.7 The ignition and starting system shall be so installed as to minimize the dangers arising from sparking and to eliminate the effects of moisture. In particular starter motor and solenoid terminals shall be covered and protected.

28. Electrical Equipment—Low and Medium Voltage

In every installation which is AC or where the DC voltage exceeds 32 the electrical equipment and installation shall be such that the vessel and all persons on board are protected against electrical hazards and shall conform with the relevant provisions of the Regulations for the Electrical and Electronic Equipment of Ships issued by the Institution of Electrical Engineers of the United Kingdom or the relevant provisions of a classification society. All work shall be carried out by electricians recognised by the Authority.

29. Emergency Electrical Installation

29.1 General

An emergency source of electrical power shall be self contained.

29.2 Location

29.2.1 Except as provided by paragraph 29.4.2 the emergency source of power including any fuel supply shall be situated outside of the propulsion machinery casing, not forward of the collision bulkhead and be above the uppermost continuous deck.

29.2.2 Subject to the provisions of paragraph 29.4.2 an emergency source of electrical power including any fuel supply shall be so situated within the

vessel in relation to the main source of electrical power, that a fire or other casualty occurring in the propulsion machinery space will not interfere with the supply or distribution of emergency power outside that space.

29.3 Operation

The emergency generator and its prime-mover and any emergency accumulator battery shall be so arranged as to ensure that it will operate at full rated power when it is upright and when inclined at any angle of list up to and including 22° either way or up to and including 10° inclination either way in the fore and aft direction, or is in any combination of angles within those limits.

29.4 Type of Power Source

29.4.1 An emergency source of electrical power shall be:

(a) an accumulator battery; or

(b) a generator driven by a compression ignition engine.

29.4.2 The emergency source of electrical power in vessels of Classes 1C, 2A less than 50 m in length and less than 500 tons, 2B less than 50 m in length and less than 500 tons, 2C, 3A less than 50 m in length and less than 500 tons, 3B less than 50 m in length and less than 500 tons, and 3C may be the main engine starting batteries.

29.5 Battery

29.5.1 An accumulator battery shall be capable of carrying the total emergency load without recharging or excessive voltage drop for the time specified in the Life-saving Appliances and Radio Equipment Sections, as appropriate for the class and size of vessel.

29.5.2 An accumulator battery shall comply with sub-clause 27.12 where applicable.

29.5.3 Where a Class 1A or a Class 1B vessel has an emergency source of power from an accumulator battery only, then in the event of failure of the main electrical supply the emergency lighting shall automatically come into operation.

29.6 Internal Combustion Engine Prime Mover

29.6.1 Fuel for an internal combustion engine shall:

(a) have a flash point of not less than 60°C; and

(b) be sufficient for the time specified in the Life-saving Appliances Section, as appropriate for the class and size of vessel and in addition, where an emergency fire pump is supplied with power from an emergency generator, be sufficient for 12 hours full rated operation of the pump.

29.6.2 An emergency generator shall be installed in a space affording protection from the weather and such space shall be adequately ventilated to allow the generator to operate at full power.

29.6.3 Starting arrangements shall comply with the following:

(a) An engine may be hand started;

(b) Where an engine is not hand started, the starting equipment shall be capable of effecting 12 consecutive cold starts in a period of not more than 30 minutes and where the emergency generator supplies power to an emergency fire pump shall also be capable of effecting 4 cold starts in a period of not more than 10 minutes;

(c) The consecutive starts required by the preceding sub-paragraph shall be obtained independently of any machinery wiring or other equipment situated:

(i) below the bulkhead deck in the case of a passenger vessel or below the uppermost continuous deck in the case of a cargo vessel;

(ii) forward of the collision bulkhead;

(iii) in the space containing the main source of electrical power; and

(iv) in a space which would be rendered inaccessible or uninhabitable by a fire or other casualty in the space containing the main source of electrical power; and

(d) Where compressed air is used as the sole means of starting an engine then a manually operated air compressor or manual start mechanically driven air compressor unit shall be provided. If only a manual operated compressor is fitted a small air bottle which will provide one start of the engine shall be fitted in addition to the main air receiver for the engine and both shall be capable of being supplied from the vessel's main compressed air system. Where an air receiver for an emergency generator has a supply from the main or auxiliary compressed air system then the air supply line shall be fitted with a non-return valve and the non-return valve shall be located in the emergency generator space.

29.7 Temporary Source of Emergency Power

29.7.1 Where a Class 1A or a Class 1B vessel is provided with a generator as an emergency power source then a temporary source of emergency power shall be provided consisting of an accumulator battery of sufficient capacity:

(a) to supply emergency lighting continuously for half an hour;

(b) to close the water tight doors (if electrically operated) but not necessarily to close them all simultaneously;

(c) to operate the indicators (if electrically operated) which give warning that power operated watertight doors are about to close; and

(d) to operate the sound signals (if electrically operated) which give warning that power operated watertight doors are about to close.

29.7.2 The temporary source of emergency power shall come into operation automatically in the event of failure of the main electrical supply.

29.8 Emergency Switchboard

29.8.1 An emergency switchboard forming part of the emergency electrical installation shall be installed as near as practicable to the source of emergency power except that:

(a) Where a generator is provided as the emergency source of electrical power then the emergency switchboard shall be located in the same space as the generator, unless the operation of the emergency switchboard would be impaired; and

(b) Where an accumulator battery is provided as the emergency source of electrical power then the battery shall not be installed in the same space as the emergency switchboard.

29.8.2 An emergency switchboard may be supplied from the main switchboard in normal operation.

29.9 Items Supplied With Emergency Power

29.9.1 Items required by the Life-saving Appliances Section to be supplied with emergency power are as follows:

(a) An emergency bilge pump where electrically operated on Class 1A and Class 1B vessels;

(b) A watertight door where electrically operated on Class 1A and Class 1B vessels;

(c) An indicator which shows whether a power operated door is open or closed and the sound signals which give warning that a power operated door is about to close on Class 1A and Class 1B vessels;

(d) A fire protection system which requires electrical power on Class 1A and Class 1B vessels;

(e) Emergency lighting for vessels of: Class 1A, Class 1B, Class 2A 50 m or over, Class 2A less than 50 m but not less than 500 tons, Class 2B 50 m or over, Class 2B less than 50 m but not less than 500 tons, Class 3A 50 metres and over, Class 3A less than 50 m but not less than 500 tons, Class 3B 50 m and over and Class 3B less than 50 m but not less than 500 tons;

(f) Emergency signals on Class 1A and Class 1B vessels;

(g) The Navigation lights on vessels of Class 1A, Class 1B, Class 1C, Class 2A, Class 2B, Class 2C, Class 3A, Class 3B and Class 3C;

(h) The communication equipment on vessels of Class 1A, Class 1B, Class 1C, Class 2A, Class 2B, Class 2C, Class 3A, Class 3B and Class 3C;

(i) A day light signalling lamp on vessels of Class 1C, Class 2A less than 50 m and less than 500 tons, Class 2B less than 50 m and less than 500 tons, Class 2C, Class 3A less than 50 m and less than 500 tons, Class 3B less than 50 m and less than 500 tons and Class 3C; and

(j) Alarm signal on vessels of Class 2A 50 m and over, Class 2A less than 50 m but not less than 500 tons, Class 2B 50 m and over, Class 2B less than 50 m but not less than 500 tons, Class 3A 50 m and over, Class 3A less than 50 m but not less than 500 tons, Class 3B 50 m and over and Class 3B less than 500 tons.

29.9.2 Items required by the Fire Appliance Section to be supplied with emergency power are as follows:

(a) A fire protection system, fitted on any passenger vessel, in compliance with the Section; and

(b) An audible gas release alarm fitted to any vessel fitted with a fixed smothering gas installation.

29.9.3 Where a vessel is fitted with an automatic sprinkler system for the protection of an accommodation space, then the sprinkler pump shall be capable of being operated by the emergency supply.

29.10 Emergency Lighting

Emergency lighting as required by sub-paragraph 29.9.1 (e) shall be so situated to illuminate:

(a) service and accommodation alleyways, stairways and exits and personnel lift cars;

(b) the trunks of personnel lifts, where the lifts are not for use by passengers;

(c) the machinery spaces and main generating stations including their control positions;

(d) control stations and all machinery control rooms;

(e) the stowage positions for firemen's outfits;

(f) the steering gear;

(g) sprinkler pumps, emergency fire pumps, emergency bilge pumps and the starting position for the motors of these pumps;

(h) life boat stations on deck;

(i) life boats and their launching gear during preparation for and the process of launching, and the water into which the life boats are launched, until the process of launching is completed;

(j) stowage positions of life rafts for which launching devices are not provided; and

(k) life rafts and the launching devices for the life rafts during the preparation for and the process of launching and the water into which the life rafts are launched until the process of launching is completed.

29.11 Lifts

A lift for use by crew or passengers, that is not arranged such that in the event of a main power failure the lift car will come to rest at a normal or emergency exit point, shall be supplied from an emergency source of power which would allow the loaded lift car to be brought abreast of an exit point and the lift car doors to be opened.

PART 5—LIQUEFIED PETROLEUM GAS INSTALLATION

30. Liquefied Petroleum Gas Installation

30.1 Definitions

The following definitions shall apply in this clause.

30.1.1 Liquefied petroleum gas (L.P. gas) is a material which is composed predominantly of any of the following hydrocarbons or mixtures of all of or any of them: propane (C_3 H_8), propylene (C_3 H_6), butane (C_4 H_{10}) or butylene (C_4 H_8).

30.1.2 High pressure stage is that part of the installation between the valve of the container and the inlet of the pressure regulator.

30.1.3 Low pressure stage is that part of the installation between the outlet of the pressure regulator and the inlet of the appliance, at a pressure not exceeding 3.5 kPa.

30.1.4 Cylinder is a welded or brazed steel vessel complying with Australian Standard AS 2030 but not exceeding 500 l water capacity and used for the storage and transfer of L.P. gas.

30.1.5 Pressure regulator is a means for maintaining a constant outlet pressure.

30.1.6 Space heater is a self contained sealed combustion gas burning appliance for heating air by secondary conduction of heat from the flue gas through metal to the air.

30.1.7 Pilot is a small flame which is utilised to ignite the gas at the main burner or burners of an appliance.

30.1.8 An L.P. gas appliance is a device which consumes gas for any purpose.

30.2 Appliance Approval

An L.P. gas appliance shall be approved by the Australian Gas Association.

30.3 Installation and Testing

L.P. gas installations and their testing shall be undertaken in accordance with the Australian Gas Association or the Australian Liquefied Petroleum Gas Association Installation Code for Gas Burning Appliances and Equipment, modified where necessary, in accordance with the requirements of this Part, by approved persons.

30.4 Piping and Fittings

Piping and fittings shall meet the appropriate requirements of Australian Standard AS 1596 for copper alloy pipes and fittings.

30.5 Cylinder Protection and Fittings

The cylinder shall be hot dipped galvanised and be provided with a safety relief device and manually operated stop valve. The operating wheel or handle shall be attached at all times to the stop valve on the cylinder.

30.6 Low Pressure Regulators

30.6.1 All systems shall be provided with a regulating device so adjusted as to release gas to the distributing tubing at a pressure not in excess of 3.5 kPa.

30.6.2 A low pressure relief valve shall be integral with the regulator; it shall be set to start to discharge at not less than 2 times and not more than 3 times the delivery pressure.

30.7 Cylinder and Fittings Installation

30.7.1 General

Cylinders, cylinder valves, the high pressure stage and regulating equipment comprising a complete system shall be:

(a) designed and constructed to withstand a load on the securing devices in any direction equal to 4 times the weight of the cylinder when full;

(b) installed with the pressure regulator as close as practicable to the cylinder.

The regulator may be mounted on the cylinder valve. If it is not mounted on the cylinder, it shall be fastened firmly to the cylinder supports or otherwise firmly mounted on to the vessel's structure and provision shall be made for ample flexibility in the connection between the cylinder and regulator by means of a loop or loops in the connecting pipe, or by a flexible connection;

(c) installed so that there is ample flexibility between the regulator and adjacent structure. This shall be achieved by the provision of a loop or loops in the connecting pipe or by the use of a flexible connection where the regulator is mounted directly on the cylinder or cylinder supports.

30.7.2 Internal Installation

A cylinder shall not be installed or stored, even temporarily, inside a deckhouse or below decks except:

(a) for a cylinder which is an integral part of a portable appliance set, provided that the total gas storage capacity of the set does not exceed 4.5 kg; and

(b) that in partially decked or open boats the Authority may permit cylinders, regulators and associated equipment to be installed in a locker which complies with paragraph 30.7.4.

30.7.3 External Installation

Apart from cylinders located internally as provided for by paragraph 30.7.2, cylinders, cylinder valves, the high pressure stage and regulating equipment, comprising a complete system shall be:

(a) substantially secured in a position with the valves uppermost, on the open deck or deckhouse top, outside of enclosures and at a distance of not less than one metre measured horizontally from any opening leading below decks; and

(b) protected from climatic extremes and if housed, vented to the open air at the top and bottom.

30.7.4 Locker Construction

The construction requirements for a locker referred to in paragraph 30.7.2 shall:

(a) be vapour tight to the interior of the vessel and located above the waterline;

(b) be lined with fire resistant material;

(c) be accessible from the top only, and be provided with a vapour tight cover which can be conveniently and quickly opened for operation of cylinder valves and testing of the system for leakage;

(d) be vented at the bottom by a pipe at least 13 mm inside diameter led directly overboard through the hull to a point lower than the container but not closer than 230 mm to the designed waterline;

(e) not have electrical connections or wiring within; and

(f) not be used for any other purpose than housing gas cylinders and regulators.

30.8 Piping Arrangement

30.8.1 Pipe work of the low pressure stage shall be of such size that the pressure drop from the regulator to any appliance shall not exceed 250 Pa with all appliances alight at full gas rate.

30.8.2 The minimum size of pipe used in a low pressure stage shall be 4.75 mm outside diameter and 1.0 mm wall thickness.

30.8.3 Where practicable, pipe work shall be continuous and shall enter the vessel's structure directly below or adjacent to the appliance. Branch tees shall be in the main run of pipe and outside the space housing the appliance. Piping shall not go through sleeping accommodation.

30.8.4 No part of an L.P. gas installation shall be installed in or pass through any space containing machinery, explosives or highly combustible substances.

30.8.5 The number of pipe fittings shall be kept to a minimum and sharp changes of direction shall be avoided. All unions, joints, sectional cocks and valves shall be readily accessible.

30.8.6 All piping in the low pressure stage of the system shall be secured against vibration and chafing by non-ferrous clips, peferably of the same material as the pipe. Such clips shall be spaced in accordance with the following table:

MAXIMUM SPACING OF PIPE CLIPS AND SUPPORTS

Nominal dia. of pipe	*Spacing for vertical runs*	*Spacing for horizontal runs*
mm	*m*	*m*
less than 6.5	1	0.4
6.5 and over	1.25	0.6

In addition, a support shall be provided between 100 mm and 150 mm from any elbow, tee or branch fitting and adequate support shall be provided on pipe bends as close as practicable to each end of the bend.

30.8.7 Where piping passes through a bulkhead or structural member it shall be protected to prevent chafing.

30.8.8 Runs of piping shall be separated from runs of electrical cable and associated fittings. The distance of separation shall, wherever practicable, not be less than 50 mm.

30.9 Flame Failure Shut Off

An Appliance shall be fitted with a device which provides an automatic complete shut off of the gas when a pilot light or main burner flame failure occurs. Such

appliance shall not be installed below the weather deck without the approval of the Authority.

30.10 Ventilation

30.10.1 Spaces containing a gas consuming appliance shall be provided with ventilation openings both top and bottom which cannot be readily closed. The system of ventilation shall provide for the introduction of fresh air and removal of any gas leakage. The minimum area of each ventilation opening shall be 250 mm^2 for each MJ hourly gas consumption rating of the appliance.

30.10.2 Where mechanical ventilation is fitted to any space in which gas containers or gas consuming appliances are situated, the material and design of the fan shall be such as to eliminate incendive sparking due to friction or impact of the fan impeller with the casing. Electric motors driving fans shall be situated outside the space, outside the ventilation trunking and clear of outlets. Alternatively suitably certified flameproof motors may be used if this cannot be achieved. Ventilation outlets shall be in a safe area free from ignition hazard. Mechanical exhaust ventilation trunking shall be led down to the lower part of the space and adjacent to the appliance.

30.10.3 Any gas-consuming appliance shall be so sited in relation to the ventilation system that air turbulence does not bring about the extinction of gas flames.

30.11 Cooking Stoves

Cooking stoves may, with the approval of the Authority, be installed below weather deck level and such appliances shall:

(a) be permanently and securely fastened to a non-flammable and non-porous base;

(b) be installed in positions which are protected from draughts;

(c) be installed not less than 300 mm from any combustible construction material, unless the surface of that material is protected with sheet asbestos at least 6.5 mm thick covered with sheet metal and with an air space of at least 6.5 mm between the protected material and the asbestos board; and

(d) have a minimum clearance above the burners of not less than 750 mm.

30.12 Refrigerators

A refrigerator shall have a minimum clearance of 50 mm at the back and 300 mm clearance above the appliance unless specifically instructed otherwise by the manufacturer.

30.13 Heaters

Space heaters and water heaters with the exception of small single point sink heaters of less than 42 MJ hourly gas consumption shall be of the fully flued type, vented to the outside atmosphere.

30.14 Flues

30.14.1 Where flues pass through the sides or top of a space they shall be fitted with a protective sleeve of 6.5 mm asbestos sheeting. Where the structure includes combustible material, a minimum clearance between sleeve and the combustible material of 25 mm shall be provided.

30.14.2 Every flue pipe shall be fitted with a cowl or other suitable means which prevents the ingress of rain. The effective cross sectional area of the flue pipe shall not be less than that of the outlet of the appliance. A flue pipe shall not be fitted with a damper.

30.14.3 Where a manufacturer requires the fitting of a draught diverter to a flued appliance it shall be installed in accordance with his requirements.

30.15 Means of Escape

An appliance shall be so located in a space that a fire at the appliance shall not restrict the exit of persons from the space.

30.16 Instruction Plate

An instruction plate shall be affixed in a conspicuous position near to one of the appliances. The wording on the instruction plate shall be:

(a) All appliances must be turned off and cylinder valves closed when vessel is not in use or while refuelling operations are in progress.

(b) Cylinder valves shall be immediately closed in an emergency.

(c) Close appliance cocks before opening the cylinder valve.

(d) Check connections at appliances, regulators and cylinders periodically for leaks with soapy water or its equivalent.

(e) Never use a match or flame when checking for leaks.

(f) In the event of a gas leak, immediately stop all engines, shut off all gas appliances and close cylinder valves. Then ventiliate the vessel until the air is clear.

(g) Do not stow empty cylinders in the machinery space.

(h) In the event of fire, immediately close the cylinder valve.

(i) Close valve and fit sealing plugs to all spare cylinders not connected, whether full or empty.

(j) No additions or alterations to the L.P. gas system shall be made without permission from the Authority.

(k) Crew should familiarise themselves with the odour of unburnt L.P. gas to assist in the early detection of leaks.

(l) All permanent ventilators, flues and vents should be regularly checked to ensure that they are clear.

PART 6—CARGO REFRIGERATION

31. Cargo Refrigeration

31.1 General

31.1.1 Refrigeration units should be of the ammonia or freon compression type. Where it is proposed to use other refrigerants full details shall be submitted. Methyl Chloride shall not be used as a refrigerant. Ammonia shall not be used as a refrigerant on a Class I vessel.

31.1.2 A freon plant may be installed in a manned or unmanned machinery space. An ammonia plant shall not be installed in a manned machinery space.

31.1.3 A refrigerated space which a person may be required to enter shall be provided with:

(a) an alarm which is audible outside the space and which can only be activated and cancelled from within the space;

(b) means inside the space for locating the exit door, should lights in the space be switched off or fail; and

(c) means to open every door from both outside and inside the space.

31.2 Cargo Refrigeration

31.2.1 Where a refrigeration machinery space has a boundary common with sleeping accommodation the boundary shall be permanently gastight. Piping shall be arranged so that there can be no direct leakage of refrigerant into an accommodation space.

31.2.2 Each space containing refrigeration machinery shall be provided with ventilation to the outside air, either by natural or mechanical means. Where natural ventilation is used the free opening area shall be determined as follows:

$$F = 0.14\sqrt{G}$$

where F = Free opening area (in m^2)

G = Mass of the refrigerant charge (in Kg)

Where mechanical ventilation is used the rate of air removal shall be determined as follows:

$$F = 13.9\sqrt[3]{G}$$

where Q = the airflow (in l/s)

G = mass of the refrigerant charge (in Kg)

31.2.3 Unless a vessel with a refrigeration installation carries a breathing apparatus in accordance with the Fire Appliances Section and the apparatus is located in a position unlikely to become inaccessible in the event of leakage of gas, the vessel shall comply with the following sub-paragraphs.

31.2.3.1 A vessel of 25 m in length and over in which refrigeration machinery is installed shall be provided with a breathing apparatus which complies with the requirements of the Fire Appliances Section and the apparatus shall be placed in a convenient position not likely to become inaccessible in the event of leakage of gas.

31.2.3.2 A vessel of less than 25 m in length in which ammonia refrigeration machinery is installed shall be provided with a cannister respirator which complies with the requirements of SAA Z18 and the respirator shall be placed in a convenient position not likely to become inaccessible in the event of leakage of gas.

31.2.4 Unless otherwise specified in this Part a refrigeration system shall be designed, constructed and tested in accordance with the appropriate provisions of Australian Standard AS1677.

31.2.5 Every pressure vessel shall be hydrostatically tested and stamped with identification and other marks.

31.2.6 The tests required by paragraphs 31.2.4 and 31.2.5 shall be carried out to the satisfaction of a person recognized by the Authority.

31.2.7 In addition to the requirements of Australian Standard AS1210 with regard to pressure vessel supports, no pressure vessel is to be used as a support for other pressure vessels and/or machinery or piping, except with the approval of the Authority.

31.2.8 An ammonia refrigeration installation shall comply with the following sub-paragraphs.

31.2.8.1 All electrical equipment on or adjacent to the installation shall conform to the requirements prescribed in Australian Standard AS3000, Part 1 for electrical installations in hazardous locations.

31.2.8.2 Flame producing devices and hot surfaces above 400°C shall be located as remotely as practicable from the installation.

31.2.8.3 Unless the space containing the refrigeration installation is protected in accordance with the provisions of Australian Standard AS1482, equipment shall be surrounded by fixed water sprays directed at all potential leak sources such as pipe connections, flanges and compressors. Supply of water to the sprays shall be controllable from outside the space containing the equipment.

31.2.8.4 A purge valve shall be fitted which is operable from outside the machinery space and discharges to the sea.

PART 7—PERSONNEL PROTECTION

32. Machinery Space Safeguards

32.1 General

Machinery shall be so arranged and protected as to safeguard personnel from hazard.

32.2 Passage Widths

In the engine room of a vessel of 20 m in length and over, passages of not less than 600 mm, should be provided between engines and auxiliary machinery or switchboards.

32.3 Gratings and Floor Plates

32.3.1 Gratings in a machinery space shall be provided with a handrail and guard rail where necessary. Toe boards approximately 60 mm high should be fixed to the edge of all gratings where appropriate.

Floor plates shall be properly fitted and secured in place and have a non-slip surface.

32.3.2 Openings to machinery space bilges shall be guarded where necessary.

32.4 Ladders

Machinery space ladders shall be fitted with rungs or non-slip treads and have adequate hand rails.

32.5 Moving Machinery Guarding

Engines, electric motors, gearing, chain and belt drives, friction clutches and shafting which may cause injury to personnel shall be fitted with guards where necessary.

32.6 Thermal Protection

Exhaust piping and other hot surfaces shall be properly insulated or otherwise protected where necessary.

Ethylene propylene rubber
cross-linked Polyethylene
chlorosulphonated
Polythylene