MACHINERY AND SYSTEMS
EQUIPMENT AND OPERATION

Piping Systems

JANUARY 2011

This chapter has been amended since the main revision (January 2011), most recently in July 2011.
See “Changes” on page 3.
FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

The Rules lay down technical and procedural requirements related to obtaining and retaining a Class Certificate. It is used as a contractual document and includes both requirements and acceptance criteria.
CHANGES

General
As of October 2010 all DNV service documents are primarily published electronically.
In order to ensure a practical transition from the “print” scheme to the “electronic” scheme, all rule chapters having incorporated amendments and corrections more recent than the date of the latest printed issue, have been given the date January 2011.
An overview of DNV service documents, their update status and historical “amendments and corrections” may be found through http://www.dnv.com/resources/rules_standards/.

Amendments July 2011

• General
  — The restricted use legal clause found in Pt.1 Ch.1 Sec.4 has been added also on the front page.

Main changes
Since the previous edition (January 2002) this chapter has been amended, most recently in July 2008. All changes previously found in Pt.0 Ch.1 Sec.3 have been incorporated and a new date (January 2011) has been given as explained under “General”.
In addition, the layout has been changed to one column in order to improve electronic readability.
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SECTION 1
GENERAL REQUIREMENTS

A. Classification

A 100 Application
101 The rules in this chapter apply to piping for the assignment of class notation LC and HSLC.
102 Compliance with the rules is required for installations and equipment necessary for performing the main functions given in Pt.1 Ch.1 Sec.2.
103 The rules give system requirements and prescribe minimum requirements for materials, design, manufacture, inspection and testing.
104 Text quoted from the International Code of Safety for High-Speed Craft (2000 HSC Code) is printed in italics.
105 For the application of these rules, wherever the term Administration is quoted, this is to be read as the Society.

B. Definitions

B 100 Terms
101 Piping is defined to include the following components:
— pipes
— flanges with gaskets and bolts and other pipe connections
— expansion elements
— valves, including hydraulic and pneumatic actuators, and fittings
— hangers and supports
— flexible hoses
— pump housings.
102 A piping system is defined to include piping, as well as components in direct connection to the piping such as pumps, heat exchangers, evaporators, independent tanks, etc. with the exception of main components such as steam and gas turbines, diesel engines, reduction gears and boilers.

For components which are subject to internal pressure and are not included in the piping, the design requirements in Ch.7 apply.

C. Documentation

C 100 Plans and particulars
101 Plans showing machinery arrangement are to be submitted for information.
These are to show layout of machinery components such as engines, fans, heat exchangers, generators, switchboards, pumps, purifiers, filters etc. but excluding pipes, valves and accessories.
102 Diagrammatic plans for the following systems and arrangements are to be submitted in triplicate for approval:
— bilge pumping and drainage systems
— ballast system
— air, overflow, sounding and filling pipes
— scuppers and discharges
— fittings on sides and bottom
— tank arrangement for fuel and other flammable fluids
— fuel oil systems and piping conveying fuel or other flammable fluids
— lubricating oil systems
— cooling water systems
— starting systems
— exhaust piping
— machinery space ventilation
— arrangement of hydraulic and pneumatic systems for:
— windlasses
— starting of engines
— remote control of valves and watertight doors.

103 The diagrammatic plans are to include the following particulars:
— outside diameter and wall thickness of pipes
— materials to be used in pipes, valve bodies and fittings
— pump type and capacity
— type of flexible hoses and expansion elements
— maximum working pressure if exceeding 7 bar
— maximum temperature if exceeding 60°C.

104 Analyses of reliability and availability are to be submitted upon request when considered necessary by the Society.

These analyses are to include information on possible numerical background material.

105 Documentation for the control and monitoring system for valves and pumps for systems listed in 102 shall be submitted for approval, if arranged. For requirements for documentation types, see Ch.9.

D. Signboards

D 100 General

101 Signboards provide information or certain conditions to be complied with for the safe handling of machinery components and systems.

Some signboards are required by the rules, others may be required by the Society in each particular case.

In Sec.1 of each chapter a summary of the signboards required by the rules in that chapter is introduced.
SECTION 2
MATERIALS

A. Piping Systems

A 100 General

101 The materials to be used in piping systems are to be suitable for the medium and service for which the system is intended. Unless specifically mentioned all metallic materials with melting point above 900°C may be used.

Guidance note:
Stainless steel is generally not considered suitable for use in seawater systems.

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A 200 Copper and copper alloys

Copper and copper alloys are in general not to be used for media having temperature above the following limits:

— copper and aluminium brass: 200°C
— copper nickel: 300°C.

Special bronze suitable for high temperature service may be used for media having temperature up to 260°C.

201 Pipes for starting air are not to be of copper or copper alloys when the outer diameter exceeds 44.5 mm.

A 300 Non-metallic materials

Pipes made from non-metallic materials may be used in piping systems with the following exceptions:

— systems conveying flammable fluids
— systems with design pressure above 16 bar
— fire extinguishing systems.

301 Pipes for non-essential services may be of a recognized standard for domestic water services.

A 400 Aluminium

401 Pipes made from aluminium may be used for services mentioned in 301.

In addition, air, sounding and filling pipes for aluminium tanks may be made from the same material, provided these pipes are located outside fire hazard areas.
SECTION 3
DESIGN PRINCIPLES

A. Arrangement

A 100 Piping systems

101 Piping systems are normally to be made of rigid pipes. The use of flexible hoses of approved type suitable for their intended use may be accepted in lieu of rigid piping upon special consideration. Pipes and fittings are to be supported in such a way that their weight is not taken by connected machinery or that heavy valves and fittings do not cause large additional stresses in adjacent pipes.

102 Axial forces due to internal pressure, change in direction or cross-sectional area and movement of the craft are to be taken into consideration when mounting the piping system.

103 The support of the piping system is to be such that detrimental vibrations will not arise in the system.

104 Metallic pipes are to be connected by welding or brazing in accordance with the requirements in Sec.7 B or by detachable connections of approved type.

105 Plastic pipes are to be connected by an approved method e.g. welding, gluing or cementing, or by approved detachable connections.

106 Installation of pipes for water or oil, behind or above electric switchboards is to be avoided as far as possible. If this is impracticable, all detachable pipe joints and valves are to be at a safe distance from the switchboard or well shielded from it.

107 Water pipes and air and sounding pipes through freezing chambers are to be avoided.

A 200 Operation of valves

201 Sea suction and discharge valves, bilge valves and valves on the fuel oil and lubricating oil tanks which are situated higher than the double bottom tanks, are to be arranged for local mechanical manual operation. The change over to manual operation from possible remote control arrangement is to be simple to execute.

202 For remotely controlled valves failure in power supply is not to cause:

— opening of closed valves
— closing of open valves on fuel oil tanks and in cooling water system for propulsion and power generating machinery.

203 Remotely controlled valves are to be provided with indications for open and closed valve positions at the control station.

In cases where possibility of direct manual operation is required in addition to the remote control, means of observing the valve position at the valve location is to be provided.
SECTION 4
CRAFT PIPING SYSTEMS

A. Bilge Pumping, Drainage, Air, Sounding and Filling Pipes

A 100 Bilge pumping and drainage systems

101 Arrangements shall be made for draining any watertight compartment other than the compartments intended for permanent storage of liquid. Where, in relation to particular compartments, drainage is not considered necessary, drainage arrangements may be omitted, but it shall be demonstrated that the safety of the craft will not be impaired.

(HSC Code 10.3.1)

102 Bilge pumping arrangements shall be provided to allow every watertight compartment other than those intended for permanent storage of liquid to be drained. The capacity or position of any such compartment shall be such that flooding thereof could not affect the safety of the craft.

(HSC Code 10.3.2)

103 The bilge pumping system shall be capable of operation under all possible values of list and trim after the craft has sustained the postulated damage in 2.6.5 to 2.6.8. The bilge pumping system shall be so designed as to prevent water flowing from one compartment to another. The necessary valves for controlling the bilge suction shall be capable of being operated from above the datum. All distribution boxes and manually operated valves in connection with the bilge pumping arrangements shall be in positions which are accessible under ordinary circumstances.

(HSC Code 10.3.3)

104 The power-operated self-priming bilge pumps may be used for other duties such as fire fighting or general service but not for pumping fuel or other flammable liquids.

(HSC Code 10.3.4)

105 Each power bilge pump shall be capable of pumping water through the required bilge pipe at a speed of not less than 2 m/s.

(HSC Code 10.3.5)

106 The diameter \(d\) of the bilge main shall be calculated according to the following formula, except that the actual internal diameter of the bilge main may be rounded off to the nearest size of a recognized standard:

\[
d = 25 + 1.68 (L (B + D))^{0.5}
\]

where:

- \(d\) is the internal diameter of the bilge main (mm);
- \(L\) is the length of the craft (m) as defined in chapter 1 (Pt.0 Ch.6);
- \(B\) is for monohull craft, the breadth of the craft in m as defined in chapter 1 (Pt.0 Ch.6) and, for multihull craft, the breadth of a hull at or below the design waterline (m); and
- \(D\) is the moulded depth of the craft to the datum (m).

(HSC Code 10.3.6)

Guidance note:
Reference is given to Ch.1 Sec.1 A306 regarding the definition of the word *datum*.

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107 Internal diameters of suction branches shall meet the requirements of the Administration but shall not be less than 25 mm. Suction branches shall be fitted with effective strainers.

(HSC Code 10.3.7)

108 An emergency bilge suction shall be provided for each machinery space containing a propulsion prime mover. This suction shall be fed to the largest available power pump other than a bilge pump, propulsion pump or oil pump.

(HSC Code 10.3.8)

109 The spindles of the sea inlet valves shall extend well above the machinery space floor plates.

(HSC Code 10.3.9)

110 All bilge suction piping up to the connection to the pumps shall be independent of other piping.

(HSC Code 10.3.10)
Spaces situated above the water level in the worst anticipated damage conditions may be drained directly overboard through scuppers fitted with non-return valves.

(HSC Code 10.3.11)

Any unattended space for which bilge pumping arrangements are required shall be provided with a bilge alarm.

(HSC Code 10.3.12)

For craft with individual bilge pumps, the total capacity \( Q \) of the bilge pumps for each hull shall not be less than 2.4 times the capacity of the pump defined in 10.3.5 (105) and 10.3.6 (106).

(HSC Code 10.3.13)

In bilge pumping arrangements where a bilge main is not provided, then, with the exception of the spaces forward of public spaces and crew accommodation, at least one fixed submersible pump shall be provided for each space. In addition, at least one portable pump shall be provided supplied from the emergency supply, if electric, for use on individual spaces. The capacity of each submersible pump \( Q_n \) shall not be less than:

\[
Q_n = \frac{Q}{(N-1)} \text{ tonne/h with a minimum of 8 tonnes/h}
\]

where:

- \( N \) number of submersible pumps
- \( Q \) total capacity as defined in 10.3.13 (214).

(HSC Code 10.3.14)

Non-return valves shall be fitted in the following components:

1. bilge valve distribution manifolds;
2. bilge suction hose connections where fitted directly to the pump or to the main bilge suction pipe; and
3. direct bilge suction pipes and bilge pump connections to main bilge suction pipe.

(HSC Code 10.3.15)

Two non-return valves in series shall be arranged between sea or ballast system and bilge suction in compartments. This is applicable also for bilge pump discharges located above the waterline. For emergency bilge suction in machinery spaces, one non-return valve will be acceptable.

Requirements for passenger craft (HSC Code 10.9) are quoted in Pt.5 Ch.1 Sec.6 B100.

Requirements for cargo craft (HSC Code 10.10) are quoted in Pt.5 Ch.3 Sec.4 C200.

Air, sounding and filling pipes

All compartments and tanks arranged with filling and/or drainage arrangement are to have air pipe and means for ascertaining the level of liquid.

All tanks containing flammable liquids or which can be pumped up or filled from the sea are to have air pipe extending above the weather deck.

Air pipes from fuel oil and lubricating oil systems are to be carried up to a position where water cannot enter and so arranged that vapour or overflow cannot be ignited.

Air pipes from lubricating oil storage tanks may terminate in the machinery space, provided that the open ends are so located that issuing oil cannot come into contact with electronic equipment or heated surface.

All air pipes outlets are to have approved automatic means preventing ingress of water and such arrangement are to be so that the tanks are not exposed to vacuum or pressure exceeding the design pressure or vacuum.

All air pipes carried up to the open air are to extend at least 760 mm above the freeboard deck and 450 mm above the superstructure deck or where carried out through the side of the craft such outlet are wherever practicable to be at least 2300 mm above the waterline. Where these heights may interfere with the operation of the craft, a lower height may be approved by the Society on the condition that satisfactory closing arrangement and other circumstances justify a lower height.

All tanks containing flammable liquids or which can be pumped up or filled from the sea are to have sounding pipe carried up to the open air fitted with screw cap or equivalent. Other approved level indicator or remote sounding arrangement may replace sounding pipe.

Filling pipes to tanks containing flammable liquids shall terminate on the weather deck and shall be so arranged that possible spill cannot escape to the inside of the vessel, but will be collected inside a suitably arranged coaming.
208 All filling pipes to fuel oil and lubricating oil tanks are to have screw caps, plugs or similar arrangement preventing water from entering such tanks.

209 Overflow pipes are to have sectional area not less than 125% of the filling pipes. The same requirement applies to air pipes on tanks not fitted with overflow pipes.

A 300 Scuppers and discharges

301 A sufficient number of scuppers, arranged to provide effective drainage, is to be fitted to all decks.

302 Scuppers on weather portions of decks and scuppers leading from superstructures or deckhouses not provided with closing appliances, are usually to be led overboard.

303 Scuppers led through the deck or shell are to comply with requirements to material and thickness as given in 403.

304 Scupper pipes are to be well stayed to prevent any vibrations. However, sufficient possibility for expansion of the pipes to be provided when necessary.

305 Scuppers from spaces below the freeboard deck or spaces within closed superstructures may be led to bilges.

306 Scuppers leading overboard from spaces mentioned in 305 are to comply with the requirements given in 307 for discharges. Scuppers from exposed superstructure deck, led through the ship’s sides and not having closeable valves, are to have strength as required in 403.

307 Discharges led through the shell either from spaces below the freeboard deck or from spaces within superstructures and deckhouses on the freeboard deck, fitted with doors as required in Pt.3 Ch.6 Sec.1, are to be provided with efficient means for preventing water from passing inboard.

Such means may be two non-return valves in series, one of which may be closed from a readily accessible position.

A 400 Fittings on sides and bottom

401 All sea inlets and discharges are to have easily operable valves of an approved type connected to the side or bottom of the craft by a substantial flange connection or equivalent. The valves are to be of lug type, so that piping inboard of the valves may be disconnected without interfering with the watertight integrity of the shell.

402 The choice of material combination, dimensioning and corrosion protection of the sea inlet and discharge valves connection to the sides and bottom of the craft is to be so arranged that flooding as a reason of damage of such fitting is avoided. Such valves are not to be made from grey cast iron.

403 The thickness and diameter of piping between hull plating and closeable or non-return valve are to be chosen so as to achieve equivalent strength as the surrounding hull structure.

Due regard to be taken to the corrosion resistance of the piping material.

404 All sea inlet valves and outlet valves fitted below the waterline are to be arranged for direct mechanical closing with the manoeuvring handle situated easily accessible and visible above the waterline. Valve position indicator is to be visible at the manoeuvring stand.
SECTION 5
MACHINERY PIPING SYSTEMS AND VENTILATION

A. General

A 100 Tank arrangement for fuel oil or other flammable fluids

101 The requirements in this section apply to fuel oil or other flammable fluids with a flash point not lower than 43°C. However, fuel oil with a lower flash point but not lower than 35°C may be used provided suitable precautions are taken against the risk of fire and explosion as described in 500.

102 Fuel oil tanks for emergency diesel engines are to be located on or above the weather deck and preferably in the same compartment as the emergency diesel engine.

103 Fuel oil tanks or tanks containing other flammable fluids, are not to be located in or adjacent to machinery spaces or other fire hazard areas, except as permitted in 104.

104 Tanks as mentioned in 103 may be located in machinery spaces or other fire hazard areas, provided the following conditions are met:

— the tank is made from steel or other equivalent material
— the tank content has a flash point not lower than 60°C
— the tank is a daily service tank or a double bottom tank.

105 Tanks containing fuel oil or other flammable fluids are to be designed to withstand the maximum head to which they may be subjected in service taking into account the dynamic forces encountered.

106 Tanks for fuel oil or other flammable fluids not forming part of the craft’s structure are to be securely fastened and are to be arranged so as to be readily inspected or movable for inspection.

107 Tanks as mentioned in 106 are to be so installed as to provide a free circulation of air around the tanks.

108 All tanks containing fuel oil or other flammable fluids are to be separated from passenger, crew and baggage compartments by cofferdams or equivalent.

109 Tanks containing fuel oil or other flammable fluids having connections below the highest tank liquid level are to have spill tray so arranged that any spill can be collected and led to a collecting tank or equivalent in order to prevent leakage or spillage to the bilge from detachable piping connections.

110 No tubular gauge glasses are to be fitted to tanks containing fuel oil or other flammable fluids. Level gauges of approved type may be used in place of sounding pipes, provided such gauges require no penetrations below the top of the tank and their failure or overfilling of the tank will not permit release of fuel oil or other flammable fluids.

111 Small test-cocks may be fitted to tanks containing fuel oil or other flammable fluids, provided the cocks are of self-closing type and are located above drip trays.

112 Provision shall be made to prevent overpressure in tanks containing fuel oil or other flammable fluids.

A 200 Piping conveying fuel or other flammable fluids

201 Piping conveying fuel oil or other flammable fluids is to be adequately screened or otherwise protected to avoid oil leakage onto hot surfaces, electrical equipment, or other sources of ignition. As far as practicable, all parts of the piping system is to be so located that defects and leakages can readily be observed. The number of detachable pipe connections is to be kept to a minimum.

Guidance note:
See MSC/Circ.647, ”Guidelines to Minimize Leakages from Flammable Liquid Systems for Improving Reliability and Reducing Risk of Fire”.

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202 Piping conveying fuel oil or other flammable fluids is to be accessible, protected from mechanical damage, be effectively secured against excessive movements and vibration. Flexible pipes are to have suitable connections, be resistant to salt, water, oil and vibration, be visible, easily accessible and are not to penetrate watertight bulkheads. The number of flexible pipes is to be kept a minimum.

203 Filling, air, overflow and drain lines to or from tanks containing fuel oil or other flammable fluids are to be of adequate size and terminate in a manner that will not constitute a hazard.

204 Piping conveying fuel oil or other flammable fluids is not to be carried through passenger, crew and baggage compartments.
Inlet and outlet pipes of tanks containing fuel oil or other flammable fluids are to be fitted with shut-off valves located on the tank itself if the pipes are connected to the tank below the tank top (or below the outlet of the overflow pipe if fitted).

All valves mentioned in 205 and which are open during normal operation are to be arranged for remote shut-off. The operation is to be carried out from a position outside the space concerned. For filling valves, non-return valves may be accepted as an alternative to remote operation. Valves on tanks below 0.5 m³ need not be arranged for remote shut-off.

The use of hydraulic or pneumatic systems for keeping quick-acting shut-off valves in open position will not be accepted.

**A 300 Lubricating oil arrangements**

301 The arrangements for the storage, distribution and utilisation of lubrication oil are in general to comply with the provisions in 100 and 200, except that:

— sight-flow glasses may be permitted, provided they are shown by test to have a suitable degree of fire resistance
— short sounding pipes may be permitted in machinery spaces, provided the pipes are fitted with appropriate means of closure and terminate in safe distance from ignition hazards.

**A 400 Arrangements for heated fuel oil tanks and equipment for fuel oil treatment**

401 Where daily service fuel oil tanks or settling tanks are fitted with heating arrangements, a high temperature alarm shall be provided if the flashpoint of the oil can be reached due to failure of the thermostatic control.

402 Equipment that treats flammable liquids automatically, such as fuel oil purifiers which, whenever practicable shall be installed in a special space reserved for purifiers and their heaters, shall have arrangements to prevent overflow spillage.

**A 500 Arrangement for fuel oil with flashpoint below 43°C**

501 Fuel with a flashpoint below 35°C shall not be used. In every craft in which fuel with a flashpoint below 43°C is used, the arrangements for the storage, distribution and utilization of the fuel shall be such that, having regard to the hazard of fire and explosion which the use of such fuel may entail, the safety of the craft and of persons on board is preserved. The arrangements shall comply, in addition to the requirements of 7.5.1 to 7.5.5 (Ch.10 Sec.3 C101 to C102, with the following provisions:

.1 tanks for the storage of such fuel shall be located outside any machinery space and at a distance of not less than 760 mm inboard from the shell side and bottom plating and from decks and bulkheads;
.2 arrangements shall be made to prevent overpressure in any fuel tank or in any part of the oil fuel system, including the filling pipes. Any relief valves and air or overflow pipes shall discharge to a position which, in the opinion of the Administration, is safe;
.3 the spaces in which fuel tanks are located shall be mechanically ventilated using exhaust fans providing not less than six air changes per hour. The fans shall be such as to avoid the possibility of ignition of flammable gas-air mixtures. Suitable wire mesh guards shall be fitted over inlet and outlet ventilation openings. The outlets for such exhausts shall be discharged to a position which, in the opinion of the Administration, is safe. 'No Smoking' signs shall be posted at the entrances to such spaces;
.4 earthed electrical distribution systems shall not be used, with the exception of earthed intrinsically safe circuits;
.5 suitable certified safe type electrical equipment shall be used in all spaces where fuel leakages could occur, including the ventilation system. Only electrical equipment and fittings essential for operational purposes shall be fitted in such spaces;

Guidance note:
See Recommendations published by the International Electrotechnical Commission and, in particular, publication 92 - Electrical Installations in Ships.
permitted if such means do not require penetration below the top of the tank, and providing their failure or overfilling of the tank will not permit the release of fuel;

.9 during bunkering operations no passenger shall be on board the craft or in the vicinity of the bunkering station, and adequate ‘No Smoking’ and ‘No Naked Lights’ signs shall be posted. Vessel-to-shore fuel connections shall be of closed type and suitably earthed during bunkering operations;

.10 the provision of fire-detection and extinguishing systems in spaces where non-integral fuel tanks are located shall be in accordance with paragraphs 7.7.1 to 7.7.4 (Ch.10 Sec.5 and Sec.6), and

.11 refuelling of the craft shall be done at the approved refuelling facilities, detailed in the route operational manual, at which the following fire appliances are provided:

.11.1 suitable foam applicator system consisting of monitors and foam making branch pipes capable of delivering foam solution at a rate of not less than 500 l/min for not less than 10 min;

.11.2 dry powder extinguishers of total capacity not less than 50 kg; and

.11.3 carbon dioxide extinguishers of total capacity not less than 16 kg.

(HSC Code 7.5.6)

502 Air pipes from tanks containing fuel oil with flash point less below 43°C are to be fitted with flame arresters.

Guidance note:
See MSC/Circ.677 "Revised Standards for the Design, Testing and Locating of Devices to Prevent the Passage of Flame into Cargo Tanks".

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B. Other Systems

B 100 Ballast systems

101 Water ballast shall not in general be carried in tanks intended for oil fuel. In craft in which it is not practicable to avoid putting water in oil fuel tanks, oily-water separating equipment shall be fitted, or other alternative means such as discharge to shore facilities shall be provided for disposing of the oily-water ballast. The provisions of this paragraph are without prejudice to the provisions of the International Convention for the Prevention of Pollution from Ships in force.

(HSC Code 10.4.1)

102 Where a fuel-transfer system is used for ballast purposes, the system shall be isolated from any water ballast system and meet the requirements for fuel systems and the International Convention for the Prevention of Pollution from Ships in force.

(HSC Code 10.4.2)

B 200 Cooling systems

201 The cooling arrangements provided shall be adequate to maintain all lubricating and hydraulic fluid temperatures within manufacturers’ recommended limits during all operations for which the craft is to be certificated.

(HSC Code 10.5)

B 300 Starting systems

301 Propulsion and generator engines are to be equipped with starting arrangement of sufficient capacity which can be easily operated without external aid.

302 Starting arrangements are to have total capacity for starting the propulsion engine at least 6 times, and each generator engine at least 3 times without recharging. For multi-engine propulsion plants, capacity of the system is to be sufficient for 3 starts per engine. However, the total capacity is not to be less than 12 starts and need not exceed 18 starts.

303 Equipment for recharging of the engine starting power capacities as required in 302 is to be available onboard the craft. In the case of pneumatic starting arrangements such recharging is to be possible within one hour. For other types of starting arrangements required recharging time will be considered case by case.

B 400 Exhaust systems

401 All engines exhaust systems shall be adequate to assure the correct functioning of the machinery and that safe operation of the craft is not put at risk.

(HSC Code 10.8.1)
402 Exhaust systems shall be so arranged as to minimize the intake of exhaust gases into manned spaces, air-conditioning systems, and engine intakes. Exhaust systems shall not discharge into air-cushion intakes. (HSC Code 10.8.2)

403 Pipes through which exhaust gases are discharged through the hull in the vicinity of the waterline shall be fitted with erosion-/corrosion-resistant shut-off flaps or other devices on the shell or pipe end and acceptable arrangements made to prevent water flooding the space or entering the engine exhaust manifold. (HSC Code 10.8.3)

Guidance note: Other devices than a shut-off flap may be a gate valve that can be closed, or a loop extending sufficiently high above the waterline.

404 Gas turbine engine exhausts shall be arranged so that hot exhaust gases are directed away from areas to which personnel have access, either on board the craft or in the vicinity of the craft when berthed. (HSC Code 10.8.4)

405 Drainage is to be arranged where needed.

406 Above S.W.L. the wall thickness of exhaust piping of stainless steel is not to be less than 2.0 mm. Below S.W.L. and in the seawater cooled part of the exhaust pipe the stainless steel is to be of low-carbon grade with chromium and nickel above 20% and molybdenum above 3%. Thickness requirements are as given in Table B1.

Guidance note: Examples of stainless steels are UNS S312254 and DIN 2.4856. These steels require a special welding procedure.

Table B1 Stainless steel pipe thickness

<table>
<thead>
<tr>
<th>Exhaust pipe diameter (mm)</th>
<th>Minimum wall thickness (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D &lt; 76.1</td>
<td>2.0</td>
</tr>
<tr>
<td>76.1 &lt; D &lt; 108.0</td>
<td>2.25</td>
</tr>
<tr>
<td>108.0 &lt; D &lt; 159.0</td>
<td>2.5</td>
</tr>
<tr>
<td>159.0 &lt; D &lt; 267.0</td>
<td>3.0</td>
</tr>
<tr>
<td>267.0 &lt; D &lt; 457.0</td>
<td>4.0</td>
</tr>
<tr>
<td>457 &lt; D</td>
<td>4.5</td>
</tr>
</tbody>
</table>

For other material than stainless steel the wall thickness will be especially considered.

407 Exhaust pipes led through bulkheads or hull are to be thermally insulated from the bulkhead and hull.

Guidance note: Maximum continuous operating temperature in sandwich construction is 80°C. The susceptibility to exfoliation corrosion and stress corrosion cracking of 5000 series aluminium alloys containing more than about 3% magnesium may increase when subject to long term exposure to temperatures exceeding 65°C.

408 Exhaust pipes with expansion bellows are to be adequately adjusted, aligned and clamped. Sufficient distance to other structures are in general to be provided, and in particular when this is of GRP and or aluminium.

409 Exhaust pipes, bellows and flanges are to be insulated.

410 Aluminium alloys should not be subject to long term exposure to temperatures exceeding 150°C due to reduced mechanical properties.

B 500 Engine air intake systems

501 Arrangements shall provide sufficient air to the engine and shall give adequate protection against damage, as distinct from deterioration, due to ingress of foreign matter. (HSC Code 10.6)

502 Air intakes are to be positioned or provided with equipment to reduce the salt spray to the engines.

B 600 Machinery space ventilation

601 Ventilation systems

Machinery spaces shall be adequately ventilated so as to ensure that when machinery therein is operating at full power in all weather conditions, including heavy weather, an adequate supply of air is maintained to the
spaces for the safety and comfort of personnel and the operation of the machinery. Auxiliary machinery spaces shall be adequately ventilated appropriate for the purpose of those spaces. The ventilation arrangements shall be adequate to ensure that the safe operation of the craft is not put at risk.

(HSC Code 10.7)

602 A mechanical ventilation system with suitable weather deck inlets and outlets including dampers is to be provided for the machinery space.

603 Calculated air quantity required is to be based on the sum of the air demanded for diesel engines and boilers as well as the requirements for exhaustion of heat emitted from diesel engines, electrical equipment, boilers, exhaust pipes and tanks etc. However, in no case is air supply to be less than total sum of needed combustion air plus 50%.

604 The air ventilation system is to be designed so as to keep a slight positive air pressure in the machinery space while operating at normal condition.

605 The temperature rise (maximum difference between exhaust and supply air) is normally not to exceed 10°C assuming maximum ambient air temperature.

606 The air system is to be distributed and balanced in such way as to provide an atmosphere which is agreeable to the personnel, machinery and equipment throughout the space.

607 Air is not to discharge directly on insulated piping or electrical equipment nor should it be necessary that air be directed at any equipment in order for it to function properly.

608 Fire dampers are to be fitted to all inlets and outlets.

B 700 Pneumatic equipment

701 Components requiring extremely clean air are not to be used. Extremely small openings in air passages are to be avoided.

702 Main pipes are to be inclined relative to the horizontal, and drainage is to be arranged.

703 For air supply the redundancy requirement applies for compressors, pressure reduction units, filters and air treatment units (lubricator or oil mist injector and dehumidifier).

704 Air to instrumentation equipment is to be free from oil, moisture and other contamination. Condensation is not to occur at relevant pressures and temperatures. For air flowing in pipes which are located entirely inside the machinery space and accommodation, the dew point is to be more than 10°C below ambient temperature, but need normally not be lower than 5°C. The dew point of air flowing in pipes on open deck is to be below -25°C.

705 Reduction valves and filters are to be duplicated when serving more than one function (e.g. more than one control loop).
SECTION 6
PIPES, PUMPS, VALVES, FLEXIBLE HOSES
AND DETACHABLE PIPE CONNECTIONS

A. Pipes

A 100 General

101 The wall thicknesses of pipes are to comply with the requirements in this section.

102 For special applications and in cases where the pipes may be subject to excessive external loads or are inaccessible during service, greater wall thicknesses than given in the following may be required.

A 200 Minimum wall thicknesses of metallic pipes

201 The nominal wall thickness is generally not to be less than given in Table A1 for pipes of copper and copper alloys and in Table A2 for steel pipes and aluminium pipes.

<p>| Table A1 Minimum nominal wall thickness for pipes of copper and copper alloys, titanium and stainless steel |
|-------------------------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th>External pipe diameter $D$ (mm)</th>
<th>Minimum nominal wall thickness $W$ (mm) 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D \leq 10$</td>
<td>1</td>
</tr>
<tr>
<td>$10 &lt; D \leq 20$</td>
<td>1.2</td>
</tr>
<tr>
<td>$20 &lt; D \leq 44.5$</td>
<td>1.5</td>
</tr>
<tr>
<td>$44.5 &lt; D \leq 76.1$</td>
<td>2</td>
</tr>
<tr>
<td>$76.1 &lt; D \leq 108$</td>
<td>2.5</td>
</tr>
<tr>
<td>$108 &lt; D \leq 159$</td>
<td>3</td>
</tr>
<tr>
<td>$159 &lt; D \leq 267$</td>
<td>3.5</td>
</tr>
<tr>
<td>$267 &lt; D \leq 457$</td>
<td>4</td>
</tr>
<tr>
<td>470</td>
<td>4</td>
</tr>
<tr>
<td>508</td>
<td>4.5</td>
</tr>
</tbody>
</table>

1) The wall thickness of pipes within ballast tanks in systems for remote control of valves is not to be less than:

- 3 mm for Al-Brass
- 2 mm for Cu-Ni and stainless steel

<p>| Table A2 Minimum nominal wall thickness for steel pipes and aluminium pipes |
|-------------------------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th>External diameter $D$ (mm)</th>
<th>Minimum nominal wall thickness $W$ (mm) 1) 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2–12</td>
<td>1.6</td>
</tr>
<tr>
<td>13.5–17.2</td>
<td>1.8</td>
</tr>
<tr>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>21.3–25</td>
<td>2</td>
</tr>
<tr>
<td>26.9–33.7</td>
<td>2</td>
</tr>
<tr>
<td>38–44.5</td>
<td>2</td>
</tr>
<tr>
<td>48.3</td>
<td>2.3</td>
</tr>
<tr>
<td>51–63.5</td>
<td>2.3</td>
</tr>
<tr>
<td>70</td>
<td>2.6</td>
</tr>
<tr>
<td>76.1–82.5</td>
<td>2.6</td>
</tr>
<tr>
<td>88.9–108</td>
<td>2.9</td>
</tr>
<tr>
<td>114.3–127</td>
<td>3.2</td>
</tr>
<tr>
<td>133–139.7</td>
<td>3.6</td>
</tr>
<tr>
<td>152.4–168.3</td>
<td>4</td>
</tr>
<tr>
<td>177.8</td>
<td>4.5</td>
</tr>
</tbody>
</table>

1) For pipes efficiently protected against corrosion, the thickness may be reduced by an amount up to not more than 1 mm.

2) For threaded pipes, where allowed, the minimum wall thickness is to be measured at the bottom of the thread.

202 The outer diameters and wall thicknesses given in the tables are in accordance with ISO-standards. For pipes covered by other standards thicknesses slightly less may be accepted.

A 300 Plastic pipes

301 Minimum wall thicknesses and acceptable internal pressure of plastic pipes are determined by long term testing of hydraulic pressure strength according to an approved specification.
302 Evaluation of vacuum and external pressure resistance is necessary for plastic piping. Due to low elasticity modulus the buckling stability may be critical in pipe systems where vacuum or external pressures are to be expected.

303 Temperature limits and pressure reductions are indicated in Tables A3 and A4. The limits may be extended on basis of acceptable documentation from the pipe manufacturer. The permissible temperatures are stated for long term service. Short periods of marginally higher temperatures may be accepted by case to case considerations.

304 The tables are related to water service only. Use for other media shall be considered case by case.

305 If thermoplastic pipes are to be installed in external areas, the pipes shall either be particularly approved for external use or be protected against ultraviolet radiation.

306 Plastic pipes are normally made of electrically insulating materials and are as such not acceptable for service in gas hazardous areas. Special qualities can be permitted if they are documented to be electrically conductive (antistatic) according to an approved specification.

307 The need for expansion elements must be specially considered with respect to the large thermal expansion coefficient of the plastic materials.

308 Glassfibre reinforced epoxy and polyester pipes are considerably more exposed to damage from impact and local overloading than steel pipes. This must be duly taken into consideration by handling, installation and inspection.
B. Pumps

B 100 General

101 The following pumps are to be delivered with the Society’s certificate:

— sea-water cooling pumps for main engine
— fresh-water cooling pumps for main engine
— fuel oil service pumps
— fuel injection valve cooling pumps
— lubricating oil pumps for main engine and main reduction gear
— bilge pumps
— ballast pumps
— fire pumps and emergency fire pumps
— other pumps considered necessary for performing of the main functions listed in Pt.1 Ch.1 Sec.2 A300.

Guidance note:
The control and monitoring system for valves and pumps for systems listed in Sec.1 C102 is not required to be delivered with NV product certificate.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

B 200 Relief valves

201 Displacement pumps are to be fitted with relief valves. For pumps transporting flammable liquids, the discharge from the relief valve is normally to be led back to suction side of the pump.

B 300 Hydrostatic tests

301 Pump housings are to be hydrostatically tested at a pressure of 1.5 times the maximum working pressure. However, the test pressure need not exceed the maximum working pressure by more than 70 bar.

For centrifugal pumps the maximum pressure is to be the maximum pressure head on the head-capacity curve. For displacement pumps the maximum working pressure is not to be taken less than the relief valve opening pressure.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

<table>
<thead>
<tr>
<th>Material</th>
<th>Nominal pressure</th>
<th>Permissible working pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) bar</td>
<td>20°C 30°C 40°C 50°C 60°C 70°C 80°C</td>
</tr>
<tr>
<td>PVC</td>
<td>10</td>
<td>7.5   12   9   6</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>7.5   12   9   6</td>
</tr>
<tr>
<td>ABS</td>
<td>10</td>
<td>7.5   12   7   6</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>10.5  12  9   7.5</td>
</tr>
<tr>
<td>HDPE</td>
<td>10</td>
<td>7.5   12   6</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>9.5   6</td>
</tr>
</tbody>
</table>

1) According to recognized standards for water supply on shore.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

# Table A3 Thermoplastic pipes. Permissible pressures and temperature limits

<table>
<thead>
<tr>
<th>Material</th>
<th>Nominal pressure</th>
<th>Permissible working pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) bar</td>
<td>-20 to 0°C</td>
</tr>
<tr>
<td>PVC</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>ABS</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>10.5</td>
</tr>
<tr>
<td>HDPE</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

<table>
<thead>
<tr>
<th>Minimum heat distortion temperature of resin ISO 75 Method A</th>
<th>Nominal pressure 2) PN (bar)</th>
<th>Permissible working pressure (bar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>10</td>
<td>-50 to 30°C 40°C 50°C 60°C 70°C 80°C</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10 9 7.5 6</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
<td>10 14 12 9.5</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>10 16 16 15</td>
</tr>
<tr>
<td>100</td>
<td>16</td>
<td>10 10 9.5 8.5</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10 16 15 13.5</td>
</tr>
<tr>
<td>16</td>
<td>10</td>
<td>10 16 16 16</td>
</tr>
<tr>
<td>25</td>
<td>10</td>
<td>10 16 16 16</td>
</tr>
<tr>
<td>135</td>
<td>10</td>
<td>10 10 10 9.5</td>
</tr>
<tr>
<td>16</td>
<td>10</td>
<td>10 16 16 16</td>
</tr>
<tr>
<td>25</td>
<td>16</td>
<td>16 16 16 16</td>
</tr>
</tbody>
</table>

1) Minimum heat distortion temperature 135°C.
2) According to recognized standards for marine use.
**B 400 Capacity tests**

401 Pump capacities are to be checked with the pump running at design condition (rated speed and pressure head, viscosity, etc.)

Capacity test may be dispensed with for pumps produced in series when previous satisfactory tests have been carried out on similar pumps.

For centrifugal pumps having capacities less than 1 000 m³/h, the pump characteristic (head-capacity curve) is to be determined for each type of pump. For centrifugal pumps having capacities equal to or greater than 1 000 m³/h, the pump characteristic is to be determined over a suitable range on each side of the design point, for each pump.

402 Special survey arrangement for testing of pumps may be agreed upon.

**C. Valves**

**C 100 Valve design**

101 Drawings and specifications are to be submitted for approval for valves of new type or unconventional design and for valves of welded construction fitted on ship’s side and bottom.

102 Pressure-temperature ratings for valves are to be in accordance with a recognized national standard.

103 Screwed-on valve bonnets are not to be used for valves on craft’s side and bottom and for valves in systems for flammable fluids.

104 Screwed-on valve bonnets are to be secured against loosening when the valve is operated.

105 Valves are normally to be closed by turning the handwheel clockwise.

106 Indicators are to be provided to show the open and closed position of the valve, unless this can be observed in some other way, e.g. by a distinctly rising valve stem.

107 Handles on cocks are to be removable only when the cocks are in closed position.

108 Welded necks of valve bodies are to be sufficiently long to ensure that the valves are not distorted as result of welding and subsequent heat treatment of the joints.

**C 200 Hydrostatic tests**

201 All valve bodies are to be subjected by the manufacturer to a hydrostatic test at a pressure equal to 1.5 times the nominal pressure (the nominal pressure is the maximum allowable working pressure at room temperature). The test pressure need not be more than 70 bar in excess of the nominal pressure.

For valves fitted on craft’s side and bottom the test pressure is not to be less than 5 bar.

202 Butterfly valves fitted on craft’s side and bottom are also to be hydrostatically tested at a pressure equal to 5 bar applied independently on each side of the closed disc.

203 For valves fitted on craft’s side and bottom, the hydrostatic test is to be carried out in the presence of the surveyor or according to a special agreement (MSA).

204 For valves other than those mentioned in 203, the manufacturer’s certificate for hydrostatic testing will be accepted.

**D. Flexible Hoses**

**D 100 General**

101 Flexible hoses with couplings are to be of DNV approved type.

102 Hoses of non-metallic materials used in systems containing flammable fluids or sea water are to have at least one ply internal wire braid.

103 In fresh cooling water lines for diesel engines and compressors the requirements in 101 and 102 may be dispensed with provided each engine is arranged with an independent cooling system. Short rubber hoses with internal textile reinforcement fitted by means of hose clamps may be accepted.

104 Every hose is to be hydrostatically tested at a hydrostatic pressure of 1.5 times the working pressure.

**D 200 Installation**

201 Flexible hoses are to be accessible for inspection.
Flexible hoses except for short lengths are to be continuously supported along their length.

E. Detachable Pipe Connections

E 100 Flange connections

101 Flanges with their pressure-temperature ratings in accordance with a recognized national standard will normally be accepted.

E 200 Screwed pipe couplings

201 Bite and compression type couplings and couplings with brazing (only for copper and copper alloys) and welding cones according to a recognized standard may be used for pipes with an outer diameter 51 mm and less.

202 Threaded joints may be used for pipes with an outer diameter 60.3 mm and less with the exclusion of pipes containing flammable fluids and pipes in systems with design pressure above 16 bar.

Guidance note:
Threaded joint is defined as a joint where packed threads perform the sealing.

---e-n-d---of---G-u-i-d-a-n-c-e---n-o-t-e---

E 300 Expansion joints and bellows

301 Expansion joints and bellows are subject to approval for their intended use. The joints and bellows are to be so designed and installed that pulling or blowing out is prevented.

The pipeline in which an expansion joint or bellow is to be fitted, is to be adequately adjusted, aligned and clamped. When found necessary, protection against mechanical damage of the expansion joints may be required.

302 The positions of expansion joints and bellows are to be clearly shown in the drawing of the piping systems.

303 Expansion joints and bellows are in general only to be used in readily accessible spaces. Exceptions to the above are ballast tanks and pipe tunnels.
SECTION 7
MANUFACTURE, WORKMANSHIP, INSPECTION AND TESTING

A. Joining of Plastic Pipes

A 100 General

101 Joining of plastic pipes by welding, gluing, cementing, lamination or similar methods is to be carried out by qualified personnel certified by the pipe manufacturer.

102 Satisfactory education and training is to be documented by a certificate issued by the pipe manufacturer. The certificate is to contain:

— the name of the holder
— a statement confirming that the holder is considered qualified for a specified type of joining
— reference to the pipe manufacturer’s joining procedure
— date of issue and validity period
— piping manufacturer’s stamp and signature of responsible person.

103 Prior to installation each operator is to, at the location, make at least one test joint representative of the joints to be used in the system. The ends of the joined pipe section are to be closed by flanges if such are included in the pipe system. The joined pipe section is to be exposed to an inside destructive hydrostatic pressure test of 5 times the design pressure of the pipe system, but not lower than 30 bars, for minimum 5 minutes. There is to be no visual crazing, cracking or leakage. Special care is to be taken to inspect for «weeping» (sweating of water through the pipe wall). The procedure test is to be surveyed and approved by the Society.

B. Welding and Brazing

B 100 General

101 Welding of joints is to be carried out by qualified welders using approved welding procedures and welding consumables.

102 Brazing of joints is to be carried out by qualified brazers using approved brazing procedures.

C. Hydrostatic Tests of Piping

C 100 Hydrostatic testing after assembly on board

101 The piping is to be hydrostatically tested in the presence of the surveyor after installation on board, according to Table C1.

<table>
<thead>
<tr>
<th>Piping system</th>
<th>Test pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel oil piping</td>
<td></td>
</tr>
<tr>
<td>Heating coils in tanks</td>
<td>1.5 x maximum working pressure, minimum 4 bar</td>
</tr>
<tr>
<td>Bilge pipes</td>
<td></td>
</tr>
<tr>
<td>Steam pipes, compressed air pipes and feed pipes</td>
<td>1.5 x maximum working pressure</td>
</tr>
<tr>
<td>Hydraulic piping</td>
<td>The test pressure need not exceed the working pressure by more than 70 bar</td>
</tr>
<tr>
<td>Piping systems made from non metallic material (plastic)</td>
<td>1.5 x maximum working pressure</td>
</tr>
<tr>
<td></td>
<td>Minimum 6 bar</td>
</tr>
<tr>
<td></td>
<td>Minimum duration 1 hour</td>
</tr>
</tbody>
</table>

D. Functional Testing

D 100 General

101 All piping systems are to be properly flushed, checked for leakage and functionally tested under working conditions to the satisfaction of the surveyor.
E. Non-Destructive Testing

E 100 General

101 In general, the welded joints including the inside wherever possible shall be visually examined. Non-destructive tests will be required for pipes with outer diameter greater than 76.1 mm as indicated below:

*Butt welded joints*

For pipes containing flammable fluids or steam with design pressure above 7 bar, or other media with design pressure above 16 bar, at least 10% random radiographic testing.

*Fillet welds*

For pipes containing flammable fluids or steam with design pressure above 7 bar, or other media with design pressure above 16 bar, at least 10% random magnetic particle testing.