FOREWORD

DNV GL rules for classification contain procedural and technical requirements related to obtaining and retaining a class certificate. The rules represent all requirements adopted by the Society as basis for classification.

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# CHANGES – CURRENT

This document supersedes the January 2018 edition of DNVGL-RU-SHIP Pt.4 Ch.6. Changes in this document are highlighted in red colour. However, if the changes involve a whole chapter, section or subsection, normally only the title will be in red colour.

## Changes July 2018, entering into force 1 January 2019

<table>
<thead>
<tr>
<th>Topic</th>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bypass damper design for NOx and SOx systems</strong></td>
<td>Sec.8 [2.3.9]</td>
<td>Changed to refer to Sec.8 [3.3.10].</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [3.3.10]</td>
<td>Updated the rule to clarify what valves are required to be fitted with double barrier, and guidance on the acceptable means to achieve this requirement.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 Table 3</td>
<td>Added alarm for loss of sealing air or underpressure, as applicable in accordance with new requirement in Sec.8 [3.3.10].</td>
</tr>
<tr>
<td><strong>Excessive requirements for inline scrubbers</strong></td>
<td>Sec.8 [3.2.8]</td>
<td>Clarified the requirement and changed the list to state that the manufacture of the unit shall be according to requirements for class III piping, while the NDT scope for relevant welded joints shall be according to class II requirements. Also we have added a guidance note for what potential failures should be evaluated.</td>
</tr>
<tr>
<td><strong>General maintenance/internal alignment/clarifications</strong></td>
<td>Sec.8 [2.4.1]</td>
<td>Added tank vent piping to the requirement in line with UR M77.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.6]</td>
<td>Added exemption for tank vent heads.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.5.5]</td>
<td>Updated guidance note cross reference for R717 systems.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 Table 3</td>
<td>Added SH for NaOH leakage in accordance with Sec.8 [3.6.8] and Sec.8 [3.6.10], including footnote 14.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [3.3.9]</td>
<td>Added drainage for drain pots.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [3.6.6]</td>
<td>Added exemption for drip tray drain lines.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [3.4.11]</td>
<td>Updated to clarify that an additional level detector is still required for engine room.</td>
</tr>
<tr>
<td><strong>Material requirement for SCR mixing tube</strong></td>
<td>Sec.8 [2.3.13]</td>
<td>Added to the guidance note for requirement Sec.8 [2.3.13] that &quot;the requirement for stainless steel may be waived if the exhaust line after the injector is not arranged with bends for the distance specified by the manufacturer&quot;.</td>
</tr>
<tr>
<td><strong>Soot cleaning for NOx and SOx bypass valves</strong></td>
<td>Sec.8 [2.3.10]</td>
<td>Changed to refer to Sec.8 [3.3.11].</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [3.3.11]</td>
<td>Updated requirement to clarify what valves are required to be fitted with soot cleaning, and guidance on the acceptable means for such soot cleaning.</td>
</tr>
<tr>
<td><strong>Temperature sensitive scrubber material to be accepted</strong></td>
<td>Sec.8 [3.2.1]</td>
<td>Updated requirement to outline the criteria for allowing heat sensitive scrubber unit material.</td>
</tr>
<tr>
<td><strong>Unclear criteria in bypass requirement</strong></td>
<td>Sec.8 [2.3.2]</td>
<td>Updated rule with guidance on the required means for ensuring unrestricted flow and no risk of failure leading to shutdown.</td>
</tr>
</tbody>
</table>
Editorial corrections

In addition to the above stated changes, editorial corrections may have been made.
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SECTION 1 GENERAL

1 Classification

1.1 Application

1.1.1 The rules in this chapter apply to piping systems for ships and barges for the assignment of main class.

1.1.2 The rules of this chapter shall be applied to all installations and equipment required to be approved according to Table 2, covering:
1) Installations and equipment necessary for performing the main functions given in Pt.1 Ch.1 Sec.1 [1.2]
2) Specifically identified installations and equipment supporting non-main functions.
For other installations and equipment, not specified in Table 2, see Ch.1.

1.1.3 For installations and equipment not listed in Table 2, the requirements of this chapter shall be applied as required by Ch.1.

1.2 Scope
The rules in this chapter give system requirements and prescribe minimum requirements for materials, design, manufacture, inspection and testing.

2 Definitions

2.1 Terms

2.1.1 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.

2.1.2 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.

2.1.3 Pipe tunnel indicates a space that can be entered via doors or hatches and shall be ventilated.

2.1.4 Pipe duct is a space which is normally not entered, but can be entered via manholes and is provided with air pipes.

2.1.5 Classes of piping systems. For the purpose of testing, type of joint to be adopted, heat treatment and welding procedure, piping is subdivided into three classes as indicated in Table 1.
Table 1 Classes of piping systems

<table>
<thead>
<tr>
<th>Piping system for</th>
<th>Class I 1)</th>
<th>Class II 1)</th>
<th>Class III 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$p$ (bar)</td>
<td>$t$ (°C)</td>
<td>$p$ (bar)</td>
</tr>
<tr>
<td>Steam</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$&gt; 16$ or $&gt; 300$</td>
<td>$\le 16$ and $\le 300$</td>
<td>$\le 7$ and $\le 170$</td>
</tr>
<tr>
<td>Thermal oil</td>
<td>$&gt; 16$ or $&gt; 300$</td>
<td>$\le 16$ and $\le 300$</td>
<td>$\le 7$ and $\le 150$</td>
</tr>
<tr>
<td>Fuel oil, lubricating oil, flammable hydraulic oil</td>
<td>$&gt; 16$ or $&gt; 150$</td>
<td>$\le 16$ and $\le 150$</td>
<td>$\le 7$ and $\le 60$</td>
</tr>
<tr>
<td>Other media 2)</td>
<td>$&gt; 40$ or $&gt; 300$</td>
<td>$\le 40$ and $\le 300$</td>
<td>$\le 16$ and $\le 200$</td>
</tr>
</tbody>
</table>

$p$ = design pressure, as defined in Sec.9 [1.3.3]

$t$ = design temperature, as defined in Sec.9 [1.3.4]

1) For class II and III piping both specified conditions shall be met, for class I piping one condition only is sufficient.
2) Cargo oil pipes on oil carriers and open ended pipes (drains, overflows, vents, boiler escape pipes, etc.), independently of the pressure and temperature, are pertaining to class III.
3) Cargo piping systems for flammable liquids on offshore supply vessels are pertaining to the same pipe class as fuel oil systems.
4) Outside machinery spaces of category A, class II piping is sufficient.

Note:
Cargo piping for chemicals or liquified gases are not covered by the table. Requirements for these piping systems are given in Pt.5 Ch.6 and Pt.5 Ch.7.

2.1.6 Independent operation of a component is when the function of the component and the power supply of the component is independent of main engine.

3 Documentation

3.1 Documentation requirements

3.1.1 Documentation shall be submitted as required by Table 2 and Table 3. Table 3 is applicable only when the Society is authorised to issue IAPP certificates.

3.1.2 For general requirements to documentation, including definition of the info codes, see Pt.1 Ch.3 Sec.2.

3.1.3 For a full definition of the documentation types, see Pt.1 Ch.3 Sec.3.

Table 2 Documentation requirements

<table>
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<tr>
<th>Object</th>
<th>Documentation type</th>
<th>Additional description</th>
<th>Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bilge handling systems</td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td>AP</td>
</tr>
<tr>
<td></td>
<td>S030 – Capacity analysis</td>
<td>Pump capacity and size of bilge pipes. For passenger ships the bilge pump numeral shall be included. See SOLAS Ch. II-1 Reg. 35-1.</td>
<td>AP</td>
</tr>
<tr>
<td></td>
<td>I200 - Control and monitoring system documentation</td>
<td>Control and monitoring system for valves and pump.</td>
<td>AP</td>
</tr>
<tr>
<td>System</td>
<td>Diagram/Documentation</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
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<td>-----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Ballast system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I200 - Control and monitoring system documentation</td>
<td>Control and monitoring system for valves and pumps.</td>
<td></td>
</tr>
<tr>
<td><strong>Sounding systems</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Air pipes</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>S020 – Pressure drop analysis</td>
<td>Back pressure in tank when overfilling with largest available pump.</td>
<td></td>
</tr>
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<td><strong>Overflow system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Internal drain system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
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<tr>
<td><strong>External drain system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Propulsion steam piping system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td>Pipes conveying steam with a temperature exceeding 400°C, the plans shall show particulars of flanges and bolts and details of welded joints with specification of welding procedure and filler metals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S080 – Thermal stress analysis</td>
<td>Only for pipes conveying steam with a temperature exceeding 400°C. See also Sec.9 [1.4].</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I200 - Control and monitoring system documentation</td>
<td>Control and monitoring system for valves and pumps.</td>
<td></td>
</tr>
<tr>
<td><strong>Propulsion feed water system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Propulsion condensate piping system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td></td>
<td></td>
</tr>
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<td>S010 – Piping diagram (PD)</td>
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<tr>
<td><strong>Auxiliary steam piping system</strong></td>
<td>S010 – Piping diagram (PD)</td>
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<td></td>
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<tr>
<td><strong>Auxiliary condensate system</strong></td>
<td>S010 – Piping diagram (PD)</td>
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<td></td>
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<td><strong>Lubrication oil system</strong></td>
<td>S010 – Piping diagram (PD)</td>
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<tr>
<td></td>
<td>I200 - Control and monitoring system documentation</td>
<td>Control and monitoring system for valves and pumps.</td>
<td></td>
</tr>
<tr>
<td><strong>Fuel oil system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td>Including all fittings on settling and daily service tanks.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I200 - Control and monitoring system documentation</td>
<td>Control and monitoring system for valves and pumps.</td>
<td></td>
</tr>
<tr>
<td><strong>Fresh water system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td>Cooling system.</td>
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<tr>
<td></td>
<td>I200 - Control and monitoring system documentation</td>
<td>Control and monitoring system for valves and pumps.</td>
<td></td>
</tr>
<tr>
<td><strong>Sea water system</strong></td>
<td>S010 – Piping diagram (PD)</td>
<td>Cooling system.</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- AP: Applicable
- FI: For Internal Drain System only

---

Rules for classification: Ships — DNVGL-RU-SHIP Pt.4 Ch.6. Edition July 2018

Piping systems

DNV GL AS
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>File(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed air systems</td>
<td>Control and monitoring system for valves and pumps.</td>
<td>S010 – Piping diagram (PD) AP</td>
</tr>
<tr>
<td>Quick closing arrangement</td>
<td>Oil tank valves.</td>
<td>S010 – Piping diagram (PD) AP</td>
</tr>
<tr>
<td>Sea water inlets</td>
<td>Arrangement of sea water inlets and discharges.</td>
<td>S050 – Connections to the shell and to the sea chests AP</td>
</tr>
<tr>
<td>Anchor windlasses hydraulic system</td>
<td>Oil tank valves.</td>
<td>S010 – Piping diagram (PD) AP</td>
</tr>
<tr>
<td>Valve control hydraulic system</td>
<td>Oil tank valves.</td>
<td>S010 – Piping diagram (PD) AP</td>
</tr>
<tr>
<td>Internal watertight doors / ramps hydraulic system</td>
<td>Oil tank valves.</td>
<td>S010 – Piping diagram (PD) AP</td>
</tr>
<tr>
<td>Sludge handling arrangement</td>
<td>Sludge tanks.</td>
<td>S010 – Piping diagram AP</td>
</tr>
<tr>
<td>Engine rooms</td>
<td>Shall show layout of machinery components such as engines, boilers, fans,</td>
<td>Z030 – Arrangement plan FI</td>
</tr>
<tr>
<td></td>
<td>heat exchangers, generators, switchboards, pumps, purifiers, filters, etc.,</td>
<td>Z090 – Equipment list FI</td>
</tr>
<tr>
<td></td>
<td>but excluding pipes, valves and accessories.</td>
<td></td>
</tr>
<tr>
<td>Exhaust gas systems</td>
<td>Arrangement of exhaust system with outlet through ship side or stern is</td>
<td>S010 – Piping diagram FI</td>
</tr>
<tr>
<td></td>
<td>subject to approval.</td>
<td></td>
</tr>
<tr>
<td>Refrigeration systems</td>
<td>Refrigeration machinery room including access and exits.</td>
<td>Z030 - Arrangement plan AP</td>
</tr>
<tr>
<td></td>
<td>Personnel protection appliances. In case refrigerant R717 is used, include</td>
<td>Z030 - Arrangement plan AP</td>
</tr>
<tr>
<td></td>
<td>water curtains, number and location of gas masks.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control and monitoring system, including location of refrigerant leakage</td>
<td>Z030 - Arrangement plan AP</td>
</tr>
<tr>
<td></td>
<td>detectors.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Refrigerant and brine circuits.</td>
<td>S011 - Piping and instrumentation diagram (P &amp; ID) AP</td>
</tr>
<tr>
<td></td>
<td>For pressure relief valves, including calculation of back pressure in</td>
<td>I200 - Control and monitoring system documentation AP</td>
</tr>
<tr>
<td></td>
<td>vent lines.</td>
<td>S030 - Capacity analysis AP</td>
</tr>
<tr>
<td>Refrigerated sea water system</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Documentation for refrigeration systems covered by Sec.6**

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>File(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigeration systems</td>
<td>Refrigeration machinery room including access and exits.</td>
<td>Z030 - Arrangement plan AP</td>
</tr>
<tr>
<td></td>
<td>Personnel protection appliances. In case refrigerant R717 is used, include</td>
<td>Z030 - Arrangement plan AP</td>
</tr>
<tr>
<td></td>
<td>water curtains, number and location of gas masks.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control and monitoring system, including location of refrigerant leakage</td>
<td>Z030 - Arrangement plan AP</td>
</tr>
<tr>
<td></td>
<td>detectors.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Refrigerant and brine circuits.</td>
<td>S011 - Piping and instrumentation diagram (P &amp; ID) AP</td>
</tr>
<tr>
<td></td>
<td>For pressure relief valves, including calculation of back pressure in</td>
<td>I200 - Control and monitoring system documentation AP</td>
</tr>
<tr>
<td></td>
<td>vent lines.</td>
<td>S030 - Capacity analysis AP</td>
</tr>
<tr>
<td>Refrigerated sea water system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Object</td>
<td>Documentation type</td>
<td>Additional description</td>
</tr>
<tr>
<td>-----------------------------------------</td>
<td>--------------------</td>
<td>----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Piping systems</td>
<td>S012 - Ducting diagram (DD)</td>
<td>In refrigeration machinery room, including specification of fan capacities.</td>
</tr>
<tr>
<td>Bilge water system</td>
<td>S010 - Piping diagram (PD)</td>
<td>In refrigeration machinery room.</td>
</tr>
</tbody>
</table>

**Documentation for ozone ship installations covered by Sec.7**

<table>
<thead>
<tr>
<th>Object</th>
<th>Documentation type</th>
<th>Additional description</th>
<th>Info</th>
</tr>
</thead>
</table>
| Ozone system                             | S010 - Piping diagram (PD) | Including:  
- oxygen generator  
- nitrogen disposal, if applicable  
- oxygen storage  
- ozone generator  
- ozone injection point  
- ozone purging or destruction, if applicable. | AP   |
|                                          | Z030 - Arrangement plan | Including:  
- components and pipes  
- ventilation openings  
- access and escape routes  
- personal protective equipment. | FI   |
|                                          | G130 - Cause and effect diagram | Covering all safety functions and interfaces to other safety and control systems. | AP   |
|                                          | I200 - Control and monitoring system documentation |  | AP   |
|                                          | Z161 - Operation manual | See Sec.7 [2.5]. | AP   |
|                                          | Z265 - Calculation report | Leakage calculations. As applicable according to Sec.7 [2.2] or Sec.7 [1.1]. | FI   |
| Ventilation systems                      | S012 - Ducting diagram (DD) | For spaces containing ozone piping, as applicable according to Sec.7 [2.2]. | AP   |

**Additional required documentation for ships provided with exhaust gas cleaning systems**

<table>
<thead>
<tr>
<th>Object</th>
<th>Documentation type</th>
<th>Additional description</th>
<th>Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhaust gas NOx cleaning systems</td>
<td>S011 - Piping and instrumentation diagram (P &amp; ID)</td>
<td>Including exhaust gas treatment fluid systems.</td>
<td>AP</td>
</tr>
<tr>
<td></td>
<td>S011 - Piping and instrumentation diagram (P &amp; ID)</td>
<td>Arrangement and details of by-pass valve/dampers.</td>
<td>AP</td>
</tr>
<tr>
<td></td>
<td>S020 – Pressure drop Analysis</td>
<td>Back pressure calculation as per Sec.8 [2.3.7].</td>
<td>FI</td>
</tr>
<tr>
<td></td>
<td>I200 – Control and monitoring system documentation</td>
<td>Covering cleaning unit control and safety systems.</td>
<td>AP</td>
</tr>
<tr>
<td></td>
<td>Z161 – Operation manual</td>
<td></td>
<td>FI</td>
</tr>
</tbody>
</table>
### Exhaust gas SO\textsubscript{x} cleaning systems

<table>
<thead>
<tr>
<th>Object</th>
<th>Documentation type</th>
<th>Additional description</th>
<th>Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z161 - Operation manual</td>
<td>SO\textsubscript{x} emission compliance plan (SECP).</td>
<td></td>
<td>AP</td>
</tr>
<tr>
<td>Z161 - Operation manual</td>
<td>Exhaust gas cleaning system technical manual (ETM). Scheme A or B as applicable.</td>
<td></td>
<td>AP</td>
</tr>
<tr>
<td>Z161 - Operation manual</td>
<td>Onboard monitoring manual (OMM).</td>
<td></td>
<td>AP</td>
</tr>
<tr>
<td>Z270 - Record</td>
<td>EGC record book or electronic logging system.</td>
<td></td>
<td>AP</td>
</tr>
<tr>
<td>Z253 - Test procedure for quay and sea trial</td>
<td>According to the requirements of MEPC 259(68).</td>
<td></td>
<td>AP</td>
</tr>
<tr>
<td>I200 - Control and monitoring system documentation</td>
<td>Covering environmental measurements, analysers and recording devices.</td>
<td></td>
<td>AP</td>
</tr>
</tbody>
</table>

**Table 3 Additional required documentation for ships provided with exhaust gas cleaning systems for SO\textsubscript{x} where the Society is authorized to issue the IAPP certificates**

**Object** | **Documentation type** | **Additional description** | **Info**
---|---|---|---
Exhaust gas SO\textsubscript{x} cleaning systems | Z161 - Operation manual | SO\textsubscript{x} emission compliance plan (SECP). | AP |
Exhaust gas SO\textsubscript{x} cleaning systems | Z161 - Operation manual | Exhaust gas cleaning system technical manual (ETM). Scheme A or B as applicable. | AP |
Exhaust gas SO\textsubscript{x} cleaning systems | Z161 - Operation manual | Onboard monitoring manual (OMM). | AP |
Exhaust gas SO\textsubscript{x} cleaning systems | Z270 - Record | EGC record book or electronic logging system. | AP |
Exhaust gas SO\textsubscript{x} cleaning systems | Z253 - Test procedure for quay and sea trial | According to the requirements of MEPC 259(68). | AP |
Exhaust gas SO\textsubscript{x} cleaning systems | I200 - Control and monitoring system documentation | Covering environmental measurements, analysers and recording devices. | AP |

AP = for approval, FI = for information
### 3.2 Certification requirements

#### 3.2.1 Certification required for piping components are summarised in Table 4.

#### Table 4 Certification requirements – piping components

<table>
<thead>
<tr>
<th>Object</th>
<th>Certificate type</th>
<th>Issued by</th>
<th>Additional description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pumps</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sea-water cooling pumps</td>
<td>PC</td>
<td>Society</td>
<td>For propulsion drivers.</td>
</tr>
<tr>
<td>Fresh-water cooling pumps</td>
<td>PC</td>
<td>Society</td>
<td>For propulsion drivers.</td>
</tr>
<tr>
<td>Circulating pumps</td>
<td>PC</td>
<td>Society</td>
<td>For boilers with forced circulation and main condenser.</td>
</tr>
<tr>
<td>Air pumps</td>
<td>PC</td>
<td>Society</td>
<td>For main condenser.</td>
</tr>
<tr>
<td>Feed water pumps</td>
<td>PC</td>
<td>Society</td>
<td></td>
</tr>
<tr>
<td>Condensate pumps</td>
<td>PC</td>
<td>Society</td>
<td>For main condenser.</td>
</tr>
<tr>
<td>Fuel oil pumps</td>
<td>PC</td>
<td>Society</td>
<td>Transfer, booster, service and fuel injection valve cooling pumps.</td>
</tr>
<tr>
<td>Lubricating oil pumps</td>
<td>PC</td>
<td>Society</td>
<td>Propulsion driver and reduction gear.</td>
</tr>
<tr>
<td>Bilge pumps</td>
<td>PC</td>
<td>Society</td>
<td>Bilge pumps additional to the ones required by these rules need not be certified.</td>
</tr>
<tr>
<td>Ballast pumps</td>
<td>PC</td>
<td>Society</td>
<td></td>
</tr>
<tr>
<td>Fire pumps</td>
<td>PC</td>
<td>Society</td>
<td>Main and emergency.</td>
</tr>
<tr>
<td>Hydraulic pumps</td>
<td>PC</td>
<td>Society</td>
<td>For gears, windlasses, variable pitch propellers, side thrusters, and hydraulically operated valves.</td>
</tr>
<tr>
<td>Thermal oil circulation pumps</td>
<td>PC</td>
<td>Society</td>
<td></td>
</tr>
<tr>
<td>Cargo pumps</td>
<td>PC</td>
<td>Society</td>
<td>Not applicable for non-flammable liquids on offshore supply vessels.</td>
</tr>
<tr>
<td>Other pumps considered necessary for performing of the main functions</td>
<td>PC</td>
<td>Society</td>
<td>Main functions defined in Pt.1 Ch.1.</td>
</tr>
<tr>
<td><strong>Fans</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Force draft fans</td>
<td>PC</td>
<td>Society</td>
<td>Propulsion boilers</td>
</tr>
<tr>
<td>Ventilation fans</td>
<td>PC</td>
<td>Society</td>
<td>Serving hazardous spaces. For battery rooms, paint stores and gas bottle stores, a certificate from a notified body, showing compliance with EN 13463-1, EN 13463-5 and EN14986, together with manufacturers works certificate may replace a Society product certificate.</td>
</tr>
<tr>
<td><strong>Valves</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Piping systems

<table>
<thead>
<tr>
<th>Component</th>
<th>Approval Body</th>
<th>Nominal Diameter and Design Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valves</td>
<td>PC Society</td>
<td>Nominal diameter $&gt; 100$ mm and design pressure $\geq 16$ bar.</td>
</tr>
<tr>
<td>Ship side valves</td>
<td>PC Society</td>
<td>Nominal diameter $&gt; 100$.</td>
</tr>
<tr>
<td>Other valves</td>
<td>PC Manufacturer</td>
<td></td>
</tr>
<tr>
<td>Vent heads</td>
<td>TA Society</td>
<td></td>
</tr>
</tbody>
</table>

#### Hydraulic cylinders

<table>
<thead>
<tr>
<th>Component</th>
<th>Approval Body</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic cylinders</td>
<td>PC Society</td>
<td>Only cylinders where $pD &gt; 20 000$ [bar] [mm]. The cylinders shall be certified according to DNVGL-CG-0194 Hydraulic cylinders.</td>
</tr>
<tr>
<td>Hydraulic cylinders for cleating and manoeuvring of watertight doors and hatches</td>
<td>PC Society</td>
<td>All cylinders regardless of pressure and size. The cylinders shall be certified according to DNVGL-CG-0194 Hydraulic cylinders.</td>
</tr>
<tr>
<td>Cleating cylinders where the locking mechanism is placed inside the cylinder</td>
<td>TA Society</td>
<td>All cylinders regardless of pressure and size. The cylinders shall be type approved according to DNVGL-CG-0194 Hydraulic cylinders.</td>
</tr>
</tbody>
</table>

#### Flexible hoses

<table>
<thead>
<tr>
<th>Component</th>
<th>Approval Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible hoses with couplings</td>
<td>TA Society</td>
</tr>
<tr>
<td>Plastic piping</td>
<td>TA Society</td>
</tr>
</tbody>
</table>

#### Pipe couplings

<table>
<thead>
<tr>
<th>Component</th>
<th>Approval Body</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe couplings</td>
<td>TA Society</td>
<td>Other than flanges.</td>
</tr>
<tr>
<td>Expansion bellows</td>
<td>TA Society</td>
<td>For rubber compensators, see class programme DNVGL-CP-0183 [3.5].</td>
</tr>
</tbody>
</table>

#### Exhaust gas cleaning systems for NO\(_X\)

<table>
<thead>
<tr>
<th>Component</th>
<th>Approval Body</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment fluid pumps</td>
<td>PC Society</td>
<td>$\geq 1$ m(^3)/h.</td>
</tr>
<tr>
<td>Control and monitoring systems</td>
<td>PC Society</td>
<td>See Ch.9.</td>
</tr>
</tbody>
</table>

#### Exhaust gas cleaning systems for NO\(_X\) applicable when the Society is authorised to issue IAPP Certificates

<table>
<thead>
<tr>
<th>Component</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exhaust gas cleaning system components</td>
<td>See MARPOL Annex VI Regulation 13/NO(_X) Technical Code.</td>
</tr>
<tr>
<td>Environmental monitoring systems</td>
<td>See MARPOL Annex VI Regulation 13/NO(_X) Technical Code.</td>
</tr>
</tbody>
</table>

#### Exhaust gas cleaning systems for SO\(_X\)

<table>
<thead>
<tr>
<th>Component</th>
<th>Approval Body</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pumps</td>
<td>PC Society</td>
<td>$\geq 50$ m(^3)/h.</td>
</tr>
<tr>
<td></td>
<td>PC Manufacturer</td>
<td>$&lt; 50$ m(^3)/h.</td>
</tr>
<tr>
<td>Treatment fluid pumps</td>
<td>PC</td>
<td>Society</td>
</tr>
<tr>
<td>------------------------</td>
<td>----</td>
<td>---------</td>
</tr>
<tr>
<td>Control and monitoring systems</td>
<td>PC</td>
<td>Manufacturer</td>
</tr>
<tr>
<td><strong>Exhaust gas cleaning systems for SOₓ</strong> applicable when the Society is authorised to issue IAPP Certificates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust gas cleaning system components</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental monitoring systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Refrigeration systems</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety and monitoring system</td>
<td>PC</td>
<td>Society</td>
</tr>
</tbody>
</table>

3.2.2 For general certification requirements, see Pt.1 Ch.3 Sec.4.

3.2.3 For a definition of the certification types, see Pt.1 Ch.3 Sec.5.

4 **Signboards**

4.1 General

4.1.1 Signboards provide information or certain conditions to be complied with for the safe handling of engine installations and systems.
Some signboards are required by the rules, others may be required by the Society in each particular case.

4.2 References

4.2.1 Signboards are required by the rules in Sec.4 [11.3.3] oil overflow.
SECTION 2 MATERIALS

1 Piping systems

1.1 General

1.1.1 The materials to be used in piping systems shall be suitable for the medium and service for which the system is intended.

Guidance note:
The traditional stainless steels, including type 316 or 316L, should not be considered suitable for use in seawater systems. However, certain stainless steels with higher contents of chromium, molybdenum and nitrogen have improved resistance to localised corrosion. These include high molybdenum austenitic steels and ferritic-austenitic (duplex) steels. Even these steels cannot be considered immune to attack under all situations; avoidance of stagnant seawater conditions and removal of welding oxides are some of the important factors to the successful use.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

1.1.2 Non-ferrous metallic materials with melting points higher than 925°C may be accepted in piping systems as an alternative to steel except where specific limitations are given elsewhere in the rules. Non-ferrous metallic materials with melting point lower than 925°C may be used under the same restrictions as for plastic pipes. See [1.7].

1.2 Carbon and low alloy steels

1.2.1 Steel pipes for classes I and II shall be seamless drawn or fabricated by a welding method considered equivalent to seamless pipes. See Pt.2 Ch.2 Sec.5.

1.2.2 Steel pipes, valves and fittings may be used within the temperature limits given in Sec.9.

1.3 Copper and copper alloys

1.3.1 Copper and copper alloy pipes for classes I and II shall be seamless drawn.

1.3.2 Copper and copper alloys shall not 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.

1.3.3 Pipes for starting air shall not be of copper or copper alloys when the outer diameter exceeds 44.5 mm.

1.4 Grey cast iron

1.4.1 Grey cast iron shall not to be used for piping subject to pressure shock, excessive strains and vibration.

1.4.2 Grey cast iron shall not be used for class I and II piping with the following exceptions:
— components in hydraulic piping systems where failure would not render the system inoperative or introduce a fire risk
— pump and filter housings in fuel and lubrication oil systems where the design temperature does not exceed 120°C.

1.4.3 Grey cast iron may be used for class III piping, with the following exceptions:
— pipes and valves fitted on ship sides and bottom and on sea chests
— valves fitted on collision bulkhead
— valves under static head fitted on the external wall of fuel tanks, lub. oil tanks and tanks for other flammable oils
— valves for fluids with temperatures in excess of 120°C.

1.5 Nodular cast iron of the ferritic type

1.5.1 Nodular cast iron of the ferritic type, with specified minimum elongation of 12%, may be used in class II and III piping and in pipes and valves located on the ship's side and bottom and valves on the collision bulkhead. The use of nodular cast iron in class I piping shall be subject to consideration for approval in each case.

1.5.2 Nodular cast iron shall not be used for media having a temperature exceeding 350°C.

1.5.3 The use of nodular cast iron for media having a temperature below 0°C shall be considered in each particular case.

1.6 Nodular cast iron of the ferritic/pearlitic and pearlitic type

1.6.1 Nodular cast iron of the ferritic/pearlitic and pearlitic type shall be subject to the limitation of use as grey cast iron as specified in [1.4].

1.7 Plastic pipes

1.7.1 Plastic pipes used in systems and locations according to Table 1 shall meet the fire endurance requirements specified therein. The permitted use and the requirements for the piping are in conformance with IMO Resolution A.753(18) Guidelines for the Application of Plastic Pipes on Ships, except for the requirements for smoke generation and toxicity.

All pipes, except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead, shall have low surface flame spread characteristics not exceeding average values listed in IMO Resolution A.753(18) Appendix 3. Surface flame spread characteristics shall also be determined using the test procedures given in ASTM D635, or in other national equivalent standards.

1.7.2 Where a fire protective coating of pipes and fittings is necessary for achieving the fire endurance level required, it shall meet the following requirements:

a) The pipes shall be delivered from the manufacturer with the protective coating on.

b) The fire protection properties of the coating shall not be diminished when exposed to salt water, oil or bilge slops. It shall be demonstrated that the coating is resistant to products likely to come into contact with the piping.

c) In considering fire protection coatings, such characteristics as thermal expansion, resistance against vibrations, and elasticity shall be taken into account.

d) The fire protection coatings shall have sufficient resistance to impact to retain their integrity.
1.7.3 In addition to the use permitted by Table 1, plastic pipes may be used for pipes for pneumatic and hydraulic instrumentation systems within control cabinets located in control rooms or engine rooms with the following exceptions:

- systems for steering gear
- systems for remote control of:
  - seawater valves
  - valves on fuel oil service tanks
  - valves in bilge and fuel oil systems
  - fire extinguishing.

1.7.4 Plastic pipes used in refrigerated seawater (RSW) systems do not need to be type approved by the Society if used outside machinery spaces of category A.

Remote control capable of being operated from a location outside the machinery space, shall be installed for valves fitted on the ship's sides and leading through the shell, as well as at RSW-tank penetrations.

1.7.5 Plastic pipes used in piping systems subject to classification shall be type approved and tested to an approved specification observing the requirements in Sec.9 [1.7]. Plastic pipes used in air bubbling systems for sounding of tanks are subject to classification and is therefore required to be type approved in accordance with the above.

### Table 1 Fire endurance requirements matrix

<table>
<thead>
<tr>
<th>Piping systems</th>
<th>Location</th>
<th>Location</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>Machinery spaces of category A</td>
<td>NA</td>
<td>NA</td>
<td>L1</td>
</tr>
<tr>
<td>Other machinery spaces</td>
<td>NA</td>
<td>NA</td>
<td>L1</td>
</tr>
<tr>
<td>Cargo pump rooms</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Ro/Ro cargo holds</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Other dry cargo holds</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Cargo tanks</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Fuel oil tanks</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Ballast water tanks</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Cofferdams, void spaces, pipe tunnel and ducts</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Accommodation service and control spaces</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Open decks</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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</tbody>
</table>

**Flammable cargo (flash point ≤ 60°C)**

<table>
<thead>
<tr>
<th>1</th>
<th>Cargo lines</th>
<th>NA</th>
<th>NA</th>
<th>L1</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>0</th>
<th>L1</th>
<th>2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Crude oil washing lines</td>
<td>NA</td>
<td>NA</td>
<td>L1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>L1</td>
</tr>
<tr>
<td>3</td>
<td>Vent lines</td>
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<td>NA</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>NA</td>
<td>X</td>
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</table>

**Inert gas**

<table>
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<tr>
<th>4</th>
<th>Water seal effluent line</th>
<th>NA</th>
<th>NA</th>
<th>0</th>
<th>NA</th>
<th>NA</th>
<th>0</th>
<th>0</th>
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<tr>
<td>5</td>
<td>Scrubber effluent line</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
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<tr>
<td>6</td>
<td>Main line</td>
<td>0</td>
<td>0</td>
<td>L1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
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<tr>
<td></td>
<td>Distribution lines</td>
<td>NA</td>
<td>NA</td>
<td>L1</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
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<td>----</td>
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<td>---</td>
</tr>
<tr>
<td><strong>Flammable liquids (flash point &gt; 60°C)</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td>Cargo lines</td>
<td>X</td>
<td>X</td>
<td>L1</td>
<td>X</td>
<td>X</td>
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<td>9</td>
<td>Fuel oil</td>
<td>X</td>
<td>X</td>
<td>L1</td>
<td>X</td>
<td>X</td>
<td>NA</td>
<td>3)</td>
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<tr>
<td>10</td>
<td>Lubricating oil</td>
<td>X</td>
<td>X</td>
<td>L1</td>
<td>X</td>
<td>X</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>11</td>
<td>Hydraulic oil</td>
<td>X</td>
<td>X</td>
<td>L1</td>
<td>X</td>
<td>X</td>
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<tr>
<td><strong>Seawater</strong></td>
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<tr>
<td>12</td>
<td>Bilge main and branches</td>
<td>L1</td>
<td>L1</td>
<td>L1</td>
<td>X</td>
<td>X</td>
<td>NA</td>
<td>0</td>
<td>0</td>
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<td>13</td>
<td>Fire main and water spray</td>
<td>L1</td>
<td>L1</td>
<td>L1</td>
<td>X</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>14</td>
<td>Foam system</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>15</td>
<td>Sprinkler system</td>
<td>L1W</td>
<td>L1W</td>
<td>L3</td>
<td>X</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>16</td>
<td>Ballast</td>
<td>L3</td>
<td>L3</td>
<td>L3</td>
<td>L3</td>
<td>X</td>
<td>0</td>
<td>10)</td>
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<tr>
<td>17</td>
<td>Cooling water, essential services</td>
<td>L3</td>
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<td>Tank cleaning services, fixed machines</td>
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<td>20</td>
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<td>L3</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
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<td>21</td>
<td>Condensate return</td>
<td>L3</td>
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<td>NA</td>
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<td>0</td>
<td>NA</td>
<td>0</td>
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<tr>
<td><strong>Sanitary and drains and scuppers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>23</td>
<td>Deck drains (internal)</td>
<td>L1W</td>
<td>L1W</td>
<td>NA</td>
<td>L1W</td>
<td>NA</td>
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<td>0</td>
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<td>0</td>
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<td>24</td>
<td>Sanitary drains (internal)</td>
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<td>NA</td>
<td>0</td>
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<td>25</td>
<td>Scuppers and discharges (overboard)</td>
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<td>1)8</td>
<td>0</td>
<td>1)8</td>
<td>0</td>
<td>1)8</td>
<td>0</td>
<td>1)8</td>
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<tr>
<td><strong>Sounding and air</strong></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Water tanks or dry spaces</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10)</td>
<td>0</td>
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</tr>
</tbody>
</table>
### Table 2 Abbreviations and footnotes in Table 1

#### Abbreviations

- **L1** = Fire endurance test in dry conditions, 60 minutes, Appendix 1 of IMO Res. A.753(18)
- **L2** = Fire endurance test in dry conditions, 30 minutes, Appendix 1 of IMO Res. A.753(18)
- **L3** = Fire endurance test in wet conditions, 30 minutes, Appendix 2 of IMO Res. A.753(18)
- **0** = No fire endurance test required
- **NA** = Not applicable
- **X** = Metallic materials having a melting point greater than 925°C
- **W** = Negligible leakage is accepted, i.e. not exceeding 5% flow loss.

#### Footnotes:

1. Where non-metallic piping is used, remotely controlled valves to be provided at ship's side (valve shall be controlled from outside space).
2. Remote closing valves to be provided at the cargo tanks.
3. When cargo tanks contain flammable liquids with flash point > 60°C, 0 may replace NA or X.
4. For drains serving only the space concerned, 0 may replace L1.
5. When controlling functions are not required by statutory requirements or guidelines, 0 may replace L1.
6. For pipe between machinery space and deck water seal, 0 may replace L1.
7. For passenger vessels, X shall replace L1.
8. Scuppers serving open decks in positions 1 and 2, as defined in regulation 13 of the International Convention on Load Lines, 1966, shall be X throughout unless fitted at the upper end with the means of closing capable of being operated from a position above the freeboard deck in order to prevent down-flooding.
9. For essential services, such as fuel oil tank heating and ship's whistle, X shall replace 0.
10. For tankers where compliance with paragraph 3.6 of regulation 19 of Annex I of MARPOL 73/78 is required, NA shall replace 0.

#### Location definitions

<table>
<thead>
<tr>
<th>Location</th>
<th>Definition</th>
</tr>
</thead>
</table>
Rules for classification: Ships — DNVGL-RU-SHIP Pt.4 Ch.6. Edition July 2018

1.8 Material certificates

1.8.1 The materials used in piping systems shall be certified and documented according to Table 3. For definitions related to the various types of documentation of material certification, see Pt.1 Ch.1 Sec.4.

The requirements for material certification and documentation concerning piping systems for chemical carriers and liquefied gas carriers can be found in Pt.5 Ch.6 Sec.1 [4] and Pt.5 Ch.7 Sec.1 [5], respectively.

Guidance note:
The control and monitoring system for valves and pumps for systems listed in Sec.1 [3.1.3] is not required to be delivered with a product certificate issued by the Society.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

Table 3 Material certificates

<table>
<thead>
<tr>
<th>Component</th>
<th>Material</th>
<th>Class of piping system</th>
<th>Nominal diameter (mm)</th>
<th>Design temperature (°C)</th>
<th>Certificate type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipelines</td>
<td>I</td>
<td>&gt; 50</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>II, III</td>
<td>&gt; 50</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>I, II, III</td>
<td>≤ 50</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flanges and bolts</td>
<td>&gt; 400</td>
<td>x</td>
<td>≤ 400</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Component</td>
<td>Material</td>
<td>Class of piping system</td>
<td>Nominal diameter (mm)</td>
<td>Design temperature (°C)</td>
<td>Certificate type</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------</td>
<td>-----------------------</td>
<td>-------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Bodies of valves and fittings 1), source materials of steel expansion bellows, other pressure containing components not considered as pressure vessels</td>
<td>Steel 2)</td>
<td>I</td>
<td>&gt; 100</td>
<td>&gt; 400</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>≤ 100</td>
<td>&gt; 400</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Steel or nodular cast iron</td>
<td>I, II</td>
<td>&gt; 100</td>
<td>≤ 400</td>
<td>x</td>
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<td></td>
<td></td>
<td></td>
<td>≤ 100</td>
<td>≤ 400</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Cast iron</td>
<td>III</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Copper alloys 2)</td>
<td>I, II</td>
<td>&gt; 50</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>≤ 50</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Pump housings</td>
<td></td>
<td>I</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II, III</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) Pipes and bodies of valves fitted on ship's side and bottom and bodies of valves fitted on collision bulkhead shall be provided with documentation as required for class II piping systems.
2) When fittings are made from plates or pipes, the certification requirements for pipes shall be applied also for pipe fittings.
3) Not applicable for exhaust gas systems.
SECTION 3 DESIGN PRINCIPLES

1 Arrangement

1.1 Piping systems

1.1.1 Piping systems shall consist of permanently installed pipes and fittings 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.

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

1.1.3 The support of the piping system shall be such that detrimental vibrations shall not arise in the system.

1.1.4 Metallic pipes shall be connected by welding or brazing in accordance with Sec.10 [1] and Sec.10 [2] or by detachable connections in accordance with Sec.9 [5].

1.1.5 Plastic pipes shall be connected by welding, gluing, cementing, lamination or similar methods in accordance with Sec.10 [4] or by approved detachable connections in accordance with Sec.9 [5].

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

1.1.7 Water pipes and air and sounding pipes through freezing chambers shall be avoided.

Guidance note:
For special requirements regarding air, sounding and water pipes penetrating insulated tank tops, see Pt.6 Ch.4 Sec.10 [4.4.3].

1.1.8 Piping systems shall be adequately identified according to their purpose. Valves shall be permanently and clearly marked.

1.2 Operation of valves

1.2.1 Where valves are required by the rules to be readily accessible, their controls shall be located in a space entered without using tools; and shall be protected from obstructions, moving equipment and hot surfaces that prevent (hinder) operation or servicing.

1.2.2 Where remotely operated valves are required by the rules to also be arranged for local manual operation, the changeover to manual operation shall be simple to execute. This implies that there shall be no need to use additional tools for removal of covers or similar to get access to operate the valve manually.

1.2.3 Sea suction and discharge valves located in dry compartments, bilge valves and valves on the fuel oil and lubricating oil tanks which are situated higher than the double bottom tanks, shall be arranged for local manual operation.

Guidance note:
Where hydraulically actuated sea suction and discharge valves are located in the engine room, a hand pump ready for use fitted to each actuator is considered acceptable as local manual operation.
1.2.4 For remotely operated valves, failure in valve control system shall not cause:
— opening of closed valves
— closing of valves that need to remain open to maintain propulsion and power generation.

1.2.5 All valves in cargo and ballast tanks which are hydraulically or pneumatically controlled are also to be arranged for manual operation, e.g. with a hand pump connected to the control system.

1.2.6 Spindles of sea suction valves, discharge valves below the load line, emergency bilge valves in engine rooms and blow down discharge valves shall extend above the floor plates or by other means be easily accessible and visible.

For vessels with class notation **E0** see also: Pt.3 Ch.12.

1.2.7 Remotely controlled valves shall be provided with indications for open and closed valve positions at the control station.

In cases where possibility of local manual operation is required in addition to the remote control, means of observing the valve position at the valve location shall be provided.

1.3 Valves on ship's sides and bottom

1.3.1 All sea inlet and overboard discharge pipes shall be fitted with easily accessible valves or cocks secured direct to the shell or sea chest.

Scuppers and sanitary discharges shall be arranged in accordance with Pt.3 Ch.12 Sec.9, as applicable.

1.3.2 If it is impractical to fit the valves or cocks directly to the shell or sea chest, distance pieces of steel may be accepted. These shall be made as short, rigid constructions, and shall not be of a thickness less than given in Pt.3 Ch.12 Sec.9. The distance piece shall extend through the shell plating or sea chest, and shall be welded on both sides or with full penetration welding.

If valves are bolted to pads on the ship side, the pads shall be welded to the ship side as described for distance pieces above.

1.3.3 For vessels with double side and/or bottom, the following requirements apply:

a) The valve may be fitted to the inboard tank boundary.

b) The pipe wall thickness between side and bottom and inner boundary shall be minimum 11 mm, regardless of pipe diameter and regardless the shell plating thickness.

c) Due attention shall be paid to the detail design to avoid high stresses being introduced at pipe fixations, as e.g. where the outer and inner boundary are connected by a short and straight pipe.

d) Outlet- or inlet-pipes passing through heated fuel oil tanks or lubricating oil tanks shall be surrounded by cofferdams.

1.3.4 All outlets and sea inlet valves shall be fitted to the shell in such a way that piping inboard of the valves may be disconnected without interfering with the watertight integrity of the shell.

1.3.5 Valves and cocks for blow down of boilers shall have a protection ring fitted on the outside of the shell plating through which the spigot shall be carried. The spigot shall terminate flush with the outer side of the ring.

1.3.6 Suction and discharge valves of steel and sea chests and distance pieces shall be protected against corrosion by an efficient coating or equivalent.

1.3.7 All suction and discharge pipes shall be adequately protected where they are liable to be damaged by cargo, etc.
1.3.8 Sea inlets shall be so designed and arranged as to limit turbulence and to avoid entry of air due to the ship’s movements.

1.3.9 Sea suction and discharge valves for ships having additional class notation for navigation in ice see Pt.6 Ch.6.

1.3.10 Sea inlets and discharge valves for systems where plastic piping is used shall be arranged with approved remote closing arrangement.

1.4 Fittings on watertight bulkheads

1.4.1 Drain cocks shall not be fitted to collision bulkhead, nor are other openings to be cut in same.

1.4.2 The collision bulkhead may be penetrated below the bulkhead deck by one pipe for pumping fluid in the forepeak tank, and where the forepeak is divided into two tanks, two pipe penetrations may be accepted for same purpose on following conditions:
   — a valve is fitted directly on the collision bulkhead inside the forepeak
   — the valve is operable from above the bulkhead deck.

1.4.3 The collision bulkhead valve may be fitted on the after side of the collision bulkhead provided that the valve is readily accessible under all service conditions and the space in which it is located is not a cargo space. Local operation of the valve shall be acceptable.

1.4.4 No drain valve or cock shall be fitted to watertight bulkheads unless it is accessible at all times and capable of being closed from above the deep load line. Alternatively the valve shall be of the self-closing type. Indication of open and closed position of the valves and cocks shall be provided.

1.4.5 The fastening of fittings, pipes, etc. to bulkheads or tunnel plating by using bolts passing through clearing holes in the plating shall not be accepted.

1.4.6 Pipe penetrations through watertight bulkheads or decks as well as through fire divisions shall be Type Approved unless the pipe is welded into the bulkhead/deck.

1.4.7 When a plastic pipe penetrates a bulkhead or deck which is also a fire division and a fire may cause flooding of watertight compartments, a metallic shut-off valve shall be fitted at the bulkhead or deck. The operation of this valve shall be provided for from above the freeboard deck.
SECTION 4 SHIP PIPING SYSTEMS

1 General

1.1 Application

1.1.1 The rules in this section apply to ship piping systems for all ships to be assigned main class. Additional requirements for piping systems for cargo handling are given in Pt.5 Ch.5, Pt.5 Ch.6 and Pt.5 Ch.7. Requirements for sanitary discharges and scuppers, see Pt.3 Ch.12 Sec.9. For additional requirements for drainage and piping systems in passenger ships and ferries, see Pt.5 Ch.4, and for fishing vessels, see Pt.5 Ch.12. For requirements for availability of drainage from forward spaces on bulk carriers, see Pt.5 Ch.1.

1.1.2 Passenger ships additionally to the requirements in this section shall comply with SOLAS requirements [II-1, Reg.35-1(3)]. Exemption may be granted for vessels not engaged in international trades subject to acceptance from the flag administration.

1.1.3 Cargo systems in vessels intended for supply services to offshore installations shall comply with the requirements given in Pt.5 Ch.9.

2 Basic requirements for drainage of compartments and tanks

2.1 General

2.1.1 An efficient drainage system shall be provided for all tanks and watertight compartments. Void spaces without piping installations may be drained by portable equipment.

2.1.2 For dry compartments the drainage system shall be so arranged that effective drainage through at least one suction is achieved even if the ship has a list of 5° when otherwise on an even keel. For this purpose, wing suctions shall be necessary, except in short, narrow compartments where one suction can provide effective drainage under the above conditions.

2.1.3 The arrangement of the drainage system shall be so that no sea water can unintentionally enter dry compartments or pass from one compartment to another.

2.2 Prevention of unintentional ingress of water into compartments or between compartments

2.2.1 Two non-return valves in series shall be installed between sea or ballast system and bilge suctions in compartments.

2.2.2 For direct and emergency bilge suctions in the machinery space one non-return valve between sea or ballast system and these suctions may be acceptable.

2.2.3 Bilge distribution chest valves shall be screw-down non-return valves.

2.2.4 All direct bilge suctions, and branch suctions not leading to a bilge distribution chest shall be fitted with screw-down non-return valves.
2.2.5 If ejectors are used for drainage of cargo holds the requirement in [2.2.1] may be dispensed with provided the arrangement gives equivalent safety against ingress of water.

2.2.6 Bilge pipes through deep tanks, see [8.5.2].

3 Drainage of cargo holds

3.1 General

3.1.1 One bilge suction shall be fitted to each side of each cargo hold. Where the rise of the cargo hold floor is more than 5° one suction near the centre line may be accepted.

3.1.2 Ships with one cargo hold shall have suctions as required in [3.1.1] both in fore and after ends of the cargo hold. This also applies to ships having two or more cargo holds with length greater than 0.2 \( L \) if these are longer than 35 m.

3.1.3 For cargo holds with double bottom the bilge suctions shall be led from bilge wells with a capacity of at least 0.15 m\(^3\) each. Wells of less capacity may be accepted for small compartments.

3.1.4 Cargo holds for dry cargo in bulk shall be provided with arrangement giving satisfactory drainage when bulk cargoes are carried. Drainage arrangement for fishing vessels built for carrying fish in bulk, see Pt. 5 Ch. 12.

3.1.5 Drainage from refrigerated cargo spaces shall comply with the requirements for vessels with additional class notation RM, see Pt. 6 Ch. 4 Sec. 9.

3.2 Cargo holds carrying alternately liquid cargo, ballast and dry cargo

3.2.1 One centre suction may be accepted and the wing suctions may be omitted, if the inner bottom is sloping towards the centre line with an angle of slope of minimum 1.5°.

3.2.2 For such tanks, the filling and suction pipes for liquid cargo and ballast shall be arranged for blank flanging. Bilge suction pipes are also to be arranged for blank flanging at the tank bulkhead.

**Guidance note:**
An instruction for transfer between liquid cargo and dry cargo service should be made in the appendix to the classification certificate.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4 Drainage of cargo deck spaces

4.1 General

4.1.1 All cargo decks shall have an appropriate number of drainage openings on each side of the vessel, for the drainage of small leaks.

4.1.2 Cargo decks with a length of less than 70 m shall have minimum one drainage on each side in the forward and aft end. For cargo decks with length above 70 m one additional drainage on each side within the middle 50% of the length shall be arranged.
4.1.3 The total drainage capacity of each part of the deck as defined in [4.2] shall have a capacity greater than the quantity of water supplied from two nozzles (four nozzles from cargo spaces intended for carriage of dangerous goods).

4.1.4 Where the sill of any cargo or service door is below the uppermost load line, see Pt.3 Ch.12 Sec.2.

4.1.5 The cross sectional area of each drainage opening shall not be less than that corresponding to a pipe diameter of 125 mm. Each opening shall have a strain off grating with total area of openings not less than 4 times that of the drainage opening.

4.1.6 The outlets may be led overboard if the drainage openings in the deck shall not be lower than the waterline when the vessel is loaded to the summer load waterline and has a list of 5°. If the drainage openings in the deck will be lower than the waterline at a list of 5°, the outlets shall be led down to bilge wells in the inner bottom or to a separate bilge water tank.

4.1.7 Each drainage opening shall comply with the requirements in Pt.3 Ch.12. For vessels where requirements for damage stability apply, see also Ch.1.

4.1.8 Drainage pipes from different watertight subdivisions leading to a common bilge water tank shall have automatic non-return valves.

4.1.9 The bilge water tank shall be connected to the vessel's bilge system. The suction pipe from the tank shall have a diameter not less than that of the main bilge line.

4.1.10 The bilge tank volume shall correspond to not less than 1/3 of the total drainage capacity per hour of each part of the deck(s).

4.1.11 Air pipes from the bilge tank shall be led to open air above the bulkhead deck.

4.1.12 Bilge water tanks and bilge wells collecting drainage water from cargo spaces as specified in [4.1] and [4.2] shall be arranged with alarm to the bridge indicating ingress of water.

4.1.13 Drainage from a cargo deck for dangerous goods into bilge wells in a lower space is only permitted if that space satisfies the same requirements as the cargo deck above.

4.1.14 From vehicle, special category and ro-ro spaces, scuppers shall not be led to machinery spaces or other spaces where sources of ignition may be present.

4.2 Additional requirements for cargo spaces with fixed water-spraying system or high-expansion foam system

4.2.1 Where cargo spaces are protected against fire by a pressure water-spraying system or a high-expansion foam system, drainage openings shall be arranged as follows:

The cargo deck area shall be divided into four areas, two on each side of the ship. One area shall cover the forward half of the deck length, and the other shall cover the aft half of the deck length. Each of the four cargo deck areas shall have two or more drainage openings with a combined capacity at least equal to the total capacity of the water-spraying system or the high-expansion foam system. For the latter, the total capacity of the drainage openings shall be determined considering the water content of the high-expansion foam only.

However, the drainage capacity shall in no case be less than that given in [4.1.3].
4.2.2 The diameter \( d \) of each drainage opening shall not be less than calculated by the following formula:

\[
d = 12\sqrt[4]{\frac{Q}{nh - 0.6}} \quad [\text{mm}]
\]

where:

\( n \) = number of drains in the deck area on each side of the compartment, where drainage capacity \( Q \) is required

\( h \) = the lesser of the vertical distance in m from the drained deck to outlet of the drain pipe or to the waterline

\( Q \) = total capacity in m\(^3\)/hour of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles.

4.2.3 Where the water is discharged by means of pumps pumping directly from bilge wells or bilge tanks, the capacity of the bilge pumps shall be at least 125% of the combined capacity of both the water-spraying system pumps and the required number of fire hose nozzles.

4.2.4 The drainage system valves shall be operable from outside the protected space at a position in the vicinity of the extinguishing system controls.

4.2.5 An easily removable grating, screen or other means shall be installed over each drain opening in the protected spaces to prevent debris from blocking the drain. The total open area ratio of the grating to the attached drain pipe shall be at least 6:1. The grating shall be raised above the deck or installed at an angle to prevent large objects from blocking the drain. No dimension of the individual openings in the grating shall be more than 25 mm.

5 Drainage of dry compartments other than machinery spaces of category A and cargo holds

5.1 General

5.1.1 Dry compartments shall be connected to the bilge system or to be drained by separate bilge pumps. For small compartments hand pumps may be accepted.

5.1.2 Alternatively, the compartments may be arranged with drain pipes leading to a bilge well in the main bilge system.

5.1.3 Where an open drain pipe is carried through a watertight bulkhead or deck, it shall be fitted with an easily accessible self-closing valve at the bulkhead or deck, or a valve that can be closed from above the deep load line. The valve shall have an indication for the open and the closed position.

5.1.4 Pipe and shaft tunnels of length greater than 35 m shall have suctions in fore and after ends.

5.1.5 Exhaust lines and silencers shall be provided with suitable drains of adequate size.

5.2 Spaces other than cargo spaces fitted with automatic water sprinkler systems

5.2.1 Spaces fitted with automatic sprinkler systems shall be provided with drainage arrangements with a capacity at least equal to the sprinkler system assuming all nozzles in the space are in operation.
5.2.2 The requirement in [5.2.1] may be exempted from upon considerations of stability.

6 Drainage of machinery spaces of category A

6.1 General

6.1.1 The bilge drainage arrangements in the machinery space shall comply with requirements given in [2]. It shall be possible to pump out any water entering the compartment through at least two bilge suctions when the ship is on an even keel, and is either upright or has a list of not more than 5°. One of these suctions shall be a branch bilge suction, i.e. a suction connected to the main bilge line, and the other shall be a direct bilge suction, i.e. a suction led directly to an independent power pump.

To obtain this the bilge suctions shall be arranged as specified in [6.2], [6.3] and [6.4].

6.2 Branch bilge suctions

6.2.1 At least three branch bilge suctions shall be fitted. The suctions shall be arranged forward and aft at both sides of the engine room.

6.2.2 Where the rise of the bottom of the room is more than 5° one branch suction near the centre line may be acceptable.

6.2.3 In ships propelled by electrical machinery, special means shall be provided to prevent the accumulation of bilge water under the main propulsion generators and motors.

6.3 Direct bilge suctions

6.3.1 Separate bilge suctions shall be lead directly to the bilge pumps from each side of the engine room in addition to the branch bilge suctions.

6.3.2 If an emergency bilge suction is arranged to a self-priming pump (as required by SOLAS for passenger vessels), the direct bilge suction may be omitted on the side where the emergency suction is fitted.

6.3.3 Where the rise of the bottom of the room is more than 5°, one direct suction from near the centre line may be accepted.

6.4 Divided and specially formed machinery spaces

6.4.1 Where the machinery space is divided into compartments separated by watertight bulkheads, the number and position of the branch bilge suctions in boiler rooms, auxiliary engine rooms etc shall be the same as for cargo holds. In addition a direct bilge suction shall be arranged for each compartment to an independent pump.

6.4.2 Specially formed parts of the machinery space, e.g. flywheel wells and hot well of main condensers shall be fitted with branch suctions, with internal diameter not less than 50 mm.
7 Drainage of barges and pontoons

7.1 General

7.1.1 Barges and pontoons shall be provided with means for drainage of cargo holds, engine rooms and watertight compartments and tanks which give major contribution to the vessel's buoyancy and floatability.

7.1.2 As far as applicable and with the exemptions specified in the following, the rules and principles for drainage of ship with propulsion machinery shall be complied with.

7.2 Barges

7.2.1 Manned barges shall be provided with a permanently installed bilge system with power bilge pumps. The bilge system shall have suctions in rooms mentioned in [7.1.1].

An additional emergency bilge suction shall be provided in engine rooms.

Dry compartments in fore- and after peaks may be drained by effective hand pumps.

Rooms situated on deck may be drained directly overboard.

7.2.2 Manned barges for unlimited service shall be equipped with two permanently installed bilge pumps.

Manned barges with restricted service shall have one bilge pump.

Ballast pumps may be used as bilge pumps. Where only one permanently installed bilge pump is installed, this pump shall not serve as fire pump.

7.2.3 Ballast systems shall comply with the requirements for ballast systems in ships. However, one ballast pump may be accepted.

Alternative methods for emptying ballast tanks, e.g. by means of compressed air and bottom valves, may be accepted upon consideration in each case.

7.2.4 Unmanned barges shall be provided with drainage facilities for rooms mentioned in [7.1.1].

For cargo holds the facilities shall be so arranged that drainage can be performed in loaded conditions, for instance by arranging ducts for portable pumps to bilge wells or piping from the connection point of the bilge pump to the bilge wells.

Other rooms which shall be drained by portable equipment, shall be provided with suitable access openings for such equipment.

Any engine room or pump room shall have bilge suctions to available pumps.

7.2.5 Unmanned barges may have portable bilge pumping equipment only, arranged with their own power supply.

For barges for unlimited service such equipment shall be delivered with the barge.

For barges for restricted service the rules are based on the assumption that suitable bilge pumping equipment is carried on board the barge or on board the tug.

This assumption shall be included in the appendix to the classification certificate for the barge.

7.3 Pontoons

7.3.1 Manned pontoons shall be provided with bilge or ballast system as specified for manned barges in [7.2].
7.3.2 Unmanned pontoons may be drained by portable bilge pumping equipment carried on board the tug. Suitable access hatches for the pumping equipment shall be provided for each tank or compartment. The assumption that suitable bilge pumping equipment is carried on board the tug, shall be included in the appendix to the classification certificate for the pontoon. Where an engine room or pump room is arranged below deck, bilge suctions shall be provided to an available pump.

7.3.3 Ballast connections to closed compartments which are assumed to be empty in loaded condition, shall be fitted with means to prevent unintentional ingress of water to the compartments, e.g. blank flanges, etc.

8 Bilge pumping and piping

8.1 General

8.1.1 At least two bilge pumping units shall be provided. For ships with length 90 m and less, one of these may be driven by the main engine. In larger ships, both units shall be independently driven.

8.1.2 Each pumping unit may consist of one or more pumps connected to the main bilge line, provided their combined capacity is sufficiently large.

8.1.3 One of the bilge pumps may be a bilge ejector if there is a separate pump delivering sufficient water for operating the ejector.

8.1.4 The bilge pumping units may be connected to other systems for service duties of an intermittent nature provided a redundancy type 2 according to Ch.1 is established.

8.1.5 In vessels arranged with inboard drainage of cargo deck spaces which have access openings in the shell plating or which have fixed water-spraying fire fighting systems, one of the bilge pumping units shall not be connected to more than one additional system in which the number and capacity of pumping units already satisfy the rules.

8.1.6 For ships of less than 100 gross tonnage with the service area restriction notations R0, R1, R2, R3 or R4, one bilge pump driven by the main engine and one manual pump of sufficient capacity may be accepted. This arrangement presumes that the main engine can be disconnected from the propeller shafting, and the cooling water pumps driven by the main engine shall be able to drain directly from the engine room.

8.1.7 For ships intended exclusively for the carriage of containers in cargo holds with non-weathertight hatch covers additional requirements to bilge pumping arrangement is given in Pt.6 Ch.5 Sec.2. For ships carrying dangerous goods in cargo holds requirements to bilge pumping arrangement in Pt.6 Ch.5 Sec.10 may be applicable.

8.2 Capacity and types of bilge pumping units

8.2.1 Each bilge-pumping unit shall be capable of giving a water velocity of at least 2 m/s through a rule size main bilge pipe.

8.2.2 Where the capacity of one bilge pumping unit is somewhat less than required, the deficiency may be made up for by the other bilge pumping unit. However, the capacity of the smaller bilge-pumping unit shall not be less than one third of the combined pumping capacity.

8.2.3 Pumping unit capacity determined from pipe diameter given in [8.4] is specified in Table 1.
The pump capacity $Q$ in $\text{m}^3/\text{hour}$ may also be determined from the formula:

$$Q = \frac{5.75d^2}{10^3}$$

where:

$d$ = bore of bilge pipe in mm according to [8.4.1] or [8.4.2].

For ships with spaces protected by water sprinkler systems see also [4.2.3].

8.2.4 Bilge pumps of centrifugal type are either to be of the self-priming type or connected to a central priming system.

Guidance note:
It is advised that at least one of the bilge pumps be of the reciprocating type.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

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8.2.5 Where large centrifugal pumps are being used for bilge drainage, the pump characteristics together with calculations of the pressure losses in the pipe system shall be submitted for approval in those cases where the water velocity in the main bilge line may exceed 5 m/s. Arrangement plans of systems for air evacuation, cooling of bearings, etc. shall be submitted for approval.

Guidance note:
Centrifugal pumps much larger than specified by Table 1 (for a given bilge main diameter) should preferably not be used as bilge pumps.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
8.3 Bilge pumping arrangement

8.3.1 All bilge pump connections to the main bilge line shall be fitted with stop valves.

8.3.2 The bilge pumps shall be so arranged that either can be used while the other is being overhauled.

8.3.3 The direct bilge suctions from machinery spaces shall be so arranged that they can be used at the same time as the other bilge pumping unit is drawing from the main bilge line.

8.3.4 Centrifugal bilge pumps shall be located as low as possible in the ship.

8.3.5 Centrifugal bilge pumps shall be arranged in such a way that any suction line is not led through more than two non-return valves, preferably not more than one.

8.4 Sizes of bilge suctions

8.4.1 The internal diameter of the main bilge suction line shall not be less than given by the following formula, to the nearest 5 mm:

\[ d = 1.68 \sqrt{L(B + D)} + 25 \text{ [mm]} \]

where:

- \(L\) = length of ship [m]
- \(B\) = breadth of ship [m]
- \(D\) = depth of ship to bulkhead deck [m].

as defined in Pt.3 Ch.1 Sec.4 [3.1].

8.4.2 For ships where the pumps in the machinery space are not used for bilge drainage outside the machinery space, the size of the main bilge suction line may be less than stipulated in [8.4.1]. In no case, however, is the cross-sectional area of the pipe to be less than twice the area required for branch bilge suction pipes in engine rooms, see [8.4.3].

8.4.3 The internal diameter of branch bilge suctions to cargo holds, machinery and boiler spaces shall not be less than stipulated by the following formula, to the nearest 5 mm:

\[ d_1 = 2.15 \sqrt{l(B + D)} + 25 \text{ [mm]} \]

where:

- \(l\) = length of compartment [m].
- \(B\) and \(D\) as given in [8.4.1].

The internal diameter of any branch suction shall not be less than 50 mm.

8.4.4 Direct bilge suctions shall have an internal diameter of not less than 1.4 \(d_1\) but need not exceed the diameter given in [8.4.1].

If an emergency suction is fitted, the diameter shall be taken equal to that of the suction side of the pump, but need not exceed 400 mm.
8.4.5 The sizes of direct bilge suctions in smaller separated machinery spaces shall be considered in each case.

8.4.6 The sectional area of a suction pipe from a bilge distribution chest shall not be less than the combined area of the two largest branch bilge suctions connected to that chest, but it need not exceed that required above for the main bilge line.

8.4.7 The internal diameter of the bilge suction pipes to the fore and after peaks and to the tunnel well shall not be less than 63 mm for ships exceeding 61 m in length and 50 mm for ships under 61 m.

8.5 Bilge pipes through tanks and holds

8.5.1 Bilge suction pipes are, as far as practicable, not to be carried through double bottom tanks. Where this cannot be avoided, the pipe wall thickness shall be as given in Sec.9 Table 2, column 3.

8.5.2 In deep tanks used for water ballast or fuel oil the bilge pipes shall be led through pipe ducts or made of steel with a wall thickness according to Sec.9 Table 2. If possible they should consist of a single pipe length or be welded together. Expansion bends shall be fitted to the bilge pipes within the tanks. The open ends of these suction pipes in the cargo holds shall be provided with non-return valves.

8.5.3 Where bilge pipes are led through cargo holds, they shall be efficiently protected by covers or to be built in.

8.6 Bilge wells, mud boxes, valves etc.

8.6.1 The bilge wells shall have a capacity of at least 0.15 m³.

8.6.2 Branch bilge pipes for drainage of machinery spaces and shaft tunnels shall be led to mud boxes. The mud boxes shall have straight tail pipes to the bilges and shall be arranged for easy inspection and cleaning. Strums or rose boxes shall not be fitted to the lower end of these pipes or to direct or emergency bilge suctions.

8.6.3 Strums or rose boxes shall be fitted to the ends of bilge suction pipes in cargo holds, and arranged for easy inspection and cleaning. The open area shall be at least twice the internal sectional area of the pipe. The diameter of the holes shall be approximately 10 mm.

8.6.4 The distance between the open ends of the bilge suction pipes and the bottom of the bilge or wells shall be adequate to allow a full flow of water and to facilitate cleaning.

8.6.5 Valves, cocks and mud boxes shall be located in readily accessible positions above or on the same level as the floor plates. Where this is not practicable, they may be placed immediately below, provided that the floor plates in question can easily be removed and are fitted with a name plate which indicates the presence of these fittings.

9 Ballast system and drainage of tanks

9.1 Drainage of ballast tanks

9.1.1 All ballast tanks shall be connected to at least two drainage pumps. For drainage of top wing tanks see Pt.3 Ch.12 Sec.9.
9.1.2 For ballast tanks with flat bottoms and width exceeding half of the vessel's beam wing suctions are required.

9.1.3 The dimensions of pipes are at least to be as specified for branch bilge pipes in [8.4.3].

9.2 Filling of ballast tanks

9.2.1 Permanent ballast tanks may be filled by pumping or by opening inlet valves to sea.

9.3 Ballast water management systems

9.3.1 Ships with ballast water treatment systems installed in order for ships to meet the requirements of the ballast water management convention shall follow the requirements of Pt. 6 Ch. 7 Sec. 1.

9.4 Anti-heeling arrangements

9.4.1 Anti-heeling arrangements, which may counteract heeling angles of more than 10°, shall be designed as follows:

— A shut-off device shall be provided in the cross channel between the tanks destined for this purpose before and after the anti-heeling pump.
— These shut-off devices and the pump shall be remotely operated. The control devices shall be arranged in one control stand.
— At least one of the arranged remote controlled shut-off devices shall automatically shut-down in the case of power supply failure.
— The position closed on the shut-off devices shall be indicated on the control stand by end position indicators.

10 Remotely controlled bilge and ballast systems

10.1 Arrangement

10.1.1 If a main bilge line for the cargo holds is arranged, this shall be placed in a pipe tunnel or duct, and the branch bilge suctions from the main shall be fitted with remotely controlled valves. The main line shall be dimensioned as the machinery space main bilge line, and it shall be placed as high as possible in the pipe tunnel/duct.

10.1.2 As alternatives for locating the main bilge line in a pipe tunnel or pipe duct, the following alternatives may be accepted:

1) Main bilge line through double bottom ballast tanks with the branch line valves located in accessible dry compartments.
2) Two main bilge lines with branch line valves located in double bottom ballast tanks. Each cargo hold has branch suctions connected to main lines, i.e. two bilge suctions per hold.

10.1.3 The main bilge line for cargo holds shall be fitted with a shut-off valve in the machinery space.

10.2 Pumps

10.2.1 Remotely controlled bilge and ballast pumps shall be provided with operating indications at the remote manoeuvring panel.
11 Air, overflow and sounding pipes

11.1 Air pipes

11.1.1 Air pipes shall be fitted to all tanks, cofferdams, shaft tunnels and pipe tunnels. For small dry compartments without piping installations the requirement for fitting air pipes may be waived.

11.1.2 Air pipes shall not be fitted with valves that may impair the venting function.

11.1.3 Tank air pipes shall be placed at the highest part of the tank and as far away as possible from the filling pipes.

Where the tank top is unusual or of irregular profile or of great length, the number and positions of the air pipes shall be decided in each case. For tanks with width exceeding half of the vessel's beam, air pipes on each side shall be required.

11.1.4 Pipe ducts of great length shall be fitted with air pipes in the fore and after ends. The shaft ducts shall be provided with an air pipe at the after end.

11.1.5 Tanks with anodes for cathodic protection shall have air pipes fitted forward and aft, alternatively a single air pipe provided with a flame screen may be accepted.

11.1.6 Air pipes from tanks which can be filled from the sea, air pipes from double bottom tanks, shaft tunnels, pipe ducts and air pipes from sea chests shall be carried up to above the bulkhead deck.

11.1.7 Air pipes from fuel oil tanks, heated lubrication oil tanks, cofferdams and all tanks which can be pumped up, shall be carried above the bulkhead deck up to the open air.

11.1.8 Air pipes from lubricating oil and hydraulic 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 electrical equipment or heated surfaces.

11.1.9 Air pipes from fuel oil daily service tanks and settling tanks shall be so arranged that possible ingress of seawater or rainwater through a broken pipe does not reach the fuel oil service tanks. If lubrication oil service tanks have air pipes extending to the open deck, the same requirements as for fuel oil apply.

Guidance note:

Arrangements utilising common venting through an overflow tank, or a drain pot in the air pipe with automatic drainage to a suitable tank should comply with the above.

---end---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

11.1.10 Air pipes from fuel oil draining tanks with a volume less than 2 m³ and which cannot be pumped up, may terminate in the engine room.

11.1.11 For height and wall thickness of air pipes above deck, see Pt.3 Ch.12 Sec.7 [3].

11.1.12 The ends of the air pipes shall be so designed or so located that ingress of water is prevented. Where automatic vent heads with ball floats or similar devices are fitted, they shall be type approved.

11.1.13 Air pipes for tanks containing heated fuel shall comply with Sec.5 [4.1].

11.1.14 Where only one air pipe is fitted, it shall not be used as a filling pipe.

11.1.15 All air pipes shall be clearly marked at the upper end.
11.1.16 Air pipes shall be self-draining under normal conditions of trim.

11.1.17 Air pipes for tanks shall not be used as primary means for sounding.

11.2 Sectional area of air pipes

11.2.1 For tanks which can be pumped up and for which overflow pipes are not arranged, the sectional area of air pipes shall be dimensioned such that the structure is able to withstand the pressure if the tank is over-pumped with the largest available pump.

Documentation of calculated pressure drops in air pipes for water overflow is required in cases where the capacity of the ballast pump is large compared to the cross-sectional area of the air pipes. The calculations shall verify that the dynamic pressure increase during water overflow does not exceed 25 kN/m². Alternatively, arrangements for prevention of over-pumping of tanks may be accepted.

The sectional area of the air pipes shall in no case be taken less than 125% of the sectional area of the filling pipe.

Guidance note:

Automatic stop of ballast pumps or automatic closing of valve in the ballast filling line may be accepted as arrangement for prevention of over-pumping of tanks. Such means should be activated by a remote level gauging system or equivalent. In addition an independent visual and audible high level or high-pressure alarm should be required. The alarm should be activated prior to stop of pumps or closing of valve. Arrangements for functional testing of the automatic stop or closing and alarm systems should be provided.

For short air pipes of the gooseneck type a maximum water velocity of 4 m/s may be acceptable. If an automatic type airvent head is fitted, the flow resistance is increased and the water velocity should be lower.

11.2.2 For tanks that are filled from installations outside the vessel (e.g. bunker fuel tanks) and not fitted with overflow pipes, the sectional area of air pipes shall not be less than 125% of the sectional area of the filling pipe.

11.2.3 Air pipes shall have an internal diameter not less than 50 mm. However, for tanks of volume less than 0.5 m³ smaller diameters may be considered for air pipes of short length.

11.2.4 Shaft ducts and pipe ducts shall be fitted with an air pipe with an internal diameter not less than 75 mm.

11.3 Overflow pipes

11.3.1 The requirements in [11.3.2] to [11.4.1] are applicable to any overflow system when fitted.

11.3.2 The overflow tanks shall have a capacity large enough to take an overflow of ten minutes at the normal rate of filling.

11.3.3 Where a storage tank is used for overflow purposes a signboard shall be fitted to signify that sufficient volume for overflow is ensured. The use of a fuel storage tank as overflow also requires installation of a high level alarm and an air pipe with 1.25 times the cross-sectional area of the main bunkering line.

11.3.4 The overflow system shall be fitted with an alarm device or a sight glass, easily visible from the place where the transfer pump can be stopped.

11.3.5 The overflow system shall be so arranged that water from the sea cannot enter through the overflow main line into other tanks in case of any tanks being damaged.
Guidance note:
This requirement applies if any fuel tank or overflow tank connected to a common overflow line or air vent tank is bounded by bottom shell plating or ship’s side plating below the waterline. In such cases the common overflow line or air vent tank should be located higher than the deepest waterline, alternatively individual tank overflow lines should be arranged with loops extending above the waterline.

Ships subject to damage stability requirements:
Routing of the pipe lines in the overflow system should take account of the deepest waterline derived from the damage stability calculations. The deepest waterline in this context should be taken from the cases where any tank connected to the system are damaged and should correspond to the equilibrium angle after damage + the required range of positive stability (residual stability).

---End of Guidance note---

11.3.6 The overflow pipes shall be self-draining under normal conditions of trim and ambient temperature.

11.4 Sectional area of overflow pipes

11.4.1 The sectional area of overflow pipes shall be dimensioned in accordance with the requirements in [11.2.1].

11.5 Sounding pipes

11.5.1 All tanks, cofferdams and pipe tunnels and ducts shall be provided with sounding pipes or other approved means for ascertaining the level of liquid in the tanks. Spaces which are not always accessible, shall be provided with sounding pipes. In cargo holds, sounding pipes shall be fitted to the bilges on each side and as near the suction pipe rose boxes as practicable.

11.5.2 Sounding pipes shall be readily accessible at any time and clearly marked.

11.5.3 Sounding pipes shall be led to the bulkhead deck. Sounding pipes from tanks that can be pumped up and contains flammable liquids shall be carried to the open air (except as provided for in [11.5.5]). Sounding pipes to tanks containing liquids which have a flash point below 60°C (closed cup), are always to be carried up to the open air. The sounding rod of these tanks shall be of spark proof material and no gauge glasses shall be fitted to these tanks if located in machinery spaces. The sounding pipes shall be fitted with efficient closing appliances.

11.5.4 Sounding pipes on tanks shall be provided with holes for equalising the pressure close to the top of the tank.

11.5.5 Readily accessible short sounding pipes may be fitted to the top of tanks in machinery spaces and shaft tunnels. If the tanks contain fuel oil or other flammable liquids the following conditions shall be met:

a) A closed type level gauging system is fitted for all passenger ships and cargo ships of 500 gross tonnage and above.
b) The sounding pipes terminate in safe distance from ignition hazards. If not, other arrangements shall be made to prevent oil from coming into contact with a source of ignition.
c) The terminations of sounding pipes shall be fitted with self-closing cocks having cylindrical plugs with weight-loaded levers permanently attached.
d) Small test cocks are fitted below the self-closing cocks. For fuel oil tanks above double bottom short sounding pipes may be permitted on the same conditions provided that in addition the tanks are fitted with an approved oil level gauge.

11.5.6 Short sounding pipes to tanks not intended for oil may be fitted with a screw cap attached by chain to the pipe or with shut-off cocks.
Such arrangement may also be accepted for lubrication oil tanks and hydraulic oil tanks which cannot be pumped up and for fuel oil drain tanks less than 2 $m^3$ which cannot be pumped up.

11.6 Other level indicating devices

11.6.1 Oil level indicating devices of approved type may be installed in lieu of sounding pipes, provided adequate means to prevent release of oil in case of failure or overfilling are fitted.

11.6.2 Flat glass type gauge glasses or magnetic level indicators can be installed as a means of level indication for tanks containing flammable fluids. They shall be fitted with a self-closing valve at each end, and shall be protected against mechanical damage.

11.6.3 Other oil level indicating devices and level switches, which penetrate below the tank top, may be used, provided they are contained in a steel enclosure or other enclosures not being capable of being destroyed by fire.

11.6.4 In passenger ships, no oil level indicating devices requiring penetrations below the top of the tank are permitted.

11.6.5 Open sounding system shall not be allowed for oil fuel tanks which can be heated up to above 50°C.

11.6.6 Remote sounding system of approved type may replace ordinary sounding pipes or gauges as follows:

a) For tanks easily accessible for checking of level through for example manholes, one remote sounding system may be accepted.

b) For tanks not always accessible for checking of level, two independent remote sounding systems are required. In the case of remote sounding based on the air-bubble principle, two air bubble lines per tank may be accepted.

11.7 Sectional area of sounding pipes

11.7.1 The internal diameter of sounding pipes shall not be less than 32 mm. For heavy fuel oil tanks the internal diameter shall not be less than 50 mm.

11.8 Air and sounding pipes through refrigerated spaces

11.8.1 Air and sounding pipes through refrigerated cargo spaces, see Pt.6 Ch.4 Sec.9.

11.9 Air and sounding pipes for barges and pontoons

11.9.1 Closed compartments and tanks shall be provided with air and sounding pipes. Air and sounding pipes may not be required for dedicated dry voids which are permanently preserved and closed, and do not contain piping.

Access shall be arranged for detecting possible water ingress and enable use of portable bilge pumps.

11.9.2 Air pipes for unmanned barges and pontoons shall be fitted with automatic operating closing appliances.

11.9.3 Manned barges and barges for unlimited service shall be provided with sounding pipes to the cargo holds.
11.9.4 Where air pipes of full height may cause difficulties in operation of the vessel, a lower height may be approved, provided the national maritime authorities in question are satisfied that the closing arrangements and other circumstances justify a lower height.

11.9.5 Where the presence of air pipes may cause particular difficulties in operation of the vessel, the requirement to air pipes may be dispensed with after consideration in each case. Such compartments and tanks are, however, to have alternative means for expansion.

11.9.6 Ballast tanks which have been approved without air pipes according to [11.9.5], shall be arranged with suitable hatch arrangement for opening during pumping of ballast.

12 Tanks for liquid cargoes other than mineral oils with flash point above 60°C (closed cup)

12.1 General

12.1.1 Air and sounding pipes shall satisfy the requirements for fuel oil tanks, see [11].

12.1.2 On tanks carrying latex, air pipes fitted with pressure vacuum valves shall be provided if the remaining air and filling pipes are kept closed.

12.1.3 Pipes for vegetable oils and other liquid cargoes shall not be led through fuel oil tanks. In addition, fuel oil pipes shall not be led through tanks for vegetable oil or other liquid cargoes.

12.1.4 It shall be possible to blank flange bilge and ballast piping terminating in tanks which can be used for vegetable oils or other liquid cargoes. See also [3.2.2].

12.1.5 For hydraulic testing of pipes in tanks, see Sec.10 [5].

12.1.6 Requirements for transport of mineral oils with flash point below 60°C, see Pt.5 Ch.5.
SECTION 5 MACHINERY PIPING SYSTEMS

1 General

1.1 Redundancy and capacity

1.1.1 For definition of redundancy, see Ch.1.

1.1.2 Redundancy shall be arranged as specified in Ch.1, and capacity of redundant components shall be as specified in the requirements for the different systems.

Applied to piping systems this implies that more than one pump unit shall be installed when failure of such a unit will result in loss of a main function specified in Pt.1 Ch.1 Sec.1 [1.2].

The capacity shall cover demands at maximum continuous load on the component served when any pump unit is out of service.

1.1.3 For propulsion plants with one engine with output less than 400 kW and with pumps driven directly by the unit it serves, redundancy type 3 may be accepted. I.e. an easily removable pump of each type may be approved as a standby pump.

1.2 Drip trays

1.2.1 All oil tanks in machinery spaces over double bottom tanks shall be equipped with drip trays of sufficient capacity and height for collecting any leakage of oil that may occur from valves, fittings etc. Drip trays shall be fitted under those parts of the oil systems which are often opened up for cleaning such as burners, purifiers, filters, pumps, etc.

1.2.2 Precautions shall be taken against overflow of oil from the lowest situated drip trays. Drainpipes led to double bottom tanks shall be provided with means for prevention of backflow.

1.2.3 The drip trays shall be drained to a closed waste tank not forming part of an overflow system. For drip trays intended for small leakages and located far away from the nearest drain tank, other solutions may be considered.

1.3 Oil filters

1.3.1 Uninterrupted supply of filtered fuel oil and lubrication oil to main and auxiliary engines, and any other machinery used for main functions shall be ensured during cleaning of the filtering equipment. In case of automatic back-flushing filters, it shall be ensured that a failure of the automatic back-flushing shall not lead to a total loss of filtration.

1.3.2 Back-flushing intervals of automatic back-flushing filters provided for intermittent back-flushing shall be monitored and frequent flushing shall be alarmed.

1.3.3 Where blocking of fuel oil and lubrication oil filters may lead to loss of propulsion or power generation, they shall be fitted with differential pressure monitoring. On engines provided for operation with gas oil only, differential pressure monitoring is not required.

1.3.4 Duplex filters used in systems for flammable liquids shall be arranged with means for preventing opening of a filter under pressure and for venting when put into operation. It shall be clearly visible, which chamber is in and which is out of operation.
2 Cooling systems

2.1 General

2.1.1 Centrifugal sea-water cooling pumps shall be installed as low as possible in the ship or other means shall be provided to prevent, as far as practicable, that the pumps lose water in a seaway.

2.1.2 For systems using fuel oil as a cooling agent, requirements in [4] are also applicable.

2.1.3 Shut-off valves shall be provided at the inlet and outlet of all heat exchangers.

2.1.4 Every heat exchanger and cooler shall be provided with a vent and a drain.

2.1.5 For heat exchangers attached to smaller engines (or other small installations), the requirements of [2.1.3] and [2.1.4] may be dispensed with, provided that the engine is fitted with such shutoff valves and drains.

2.2 Cooling water supply

2.2.1 For propulsion systems with an output of 400 kW or less, engine-driven bilge pumps can be used as standby cooling water pumps.

2.2.2 For auxiliary engines with engine-driven sea water cooling pumps a complete spare pump ready for mounting shall be delivered with the ship. If at least 3 auxiliary engines are installed, each with sufficient output for normal operation at sea, the requirement regarding a spare pump is waived.

2.2.3 For steam-driven propulsion plants the cooling water pumps for the main condenser shall be arranged with built in redundancy, to at least 30% capacity.

2.2.4 For condenser installations with scoop cooling, a standby cooling water pump with at least 30% capacity shall be installed. In addition the largest of the remaining sea water pumps in the machinery shall be arranged for emergency supply of cooling water to the main condenser.

2.2.5 If cooling water is used for heating of oil, the system shall be arranged to avoid contamination of the cooling water. For this purpose the heating coils shall be located on the pressure side of the cooling pumps. Alternatively a primary and secondary system arrangement may be used. In the case of direct heating the heating coils shall be all welded with no detachable connections where mixing of oil and water may occur.

2.3 Sea inlets for cooling water pumps

2.3.1 Sea-water cooling systems for the main and auxiliary machinery shall be connected to at least two cooling water inlets, preferably on opposite sides of the ship.

**Guidance note:**
The inlets may be arranged as high and low suctions.

2.3.2 Strums shall be fitted to all sea chest openings in the shell plating. The total area of the strum holes shall be at least twice the total flow area in the sea water inlet valves.

2.3.3 Where sea water is used for cooling the main engines or auxiliary engines, the cooling water, suction lines shall be provided with strainers which can be cleaned without interrupting the cooling water supply.
2.3.4 Regarding sea inlets see Sec. 3 [1.3].

2.3.5 Regarding sea chest arrangements for ships having additional class notations for navigation in ice, see Pt.6 Ch.6 Sec.5.

3 Lubricating oil system

3.1 General

3.1.1 Lubricating oil systems shall be separated from other systems. This requirement does not apply to hydraulic governing and manoeuvring systems for main and auxiliary engines.

3.1.2 For ships where a double bottom is required, the minimum distance between shell and circulating lubricating oil tank shall not be less than 500 mm. See also SOLAS Ch. II-1, Reg. 9.3.

3.1.3 Lubricating oil drain pipes from the engine sump to the drain tank shall be submerged at their outlet ends.

3.2 Lubricating oil pre-treatment arrangement

3.2.1 In systems where the lubricating oil circulates under pressure, efficient filtering shall be arranged.

3.2.2 For non-redundant units it shall be possible to clean the filters without interrupting the oil supply. If automatic cleaning filters are used, means shall be provided to ensure the oil supply in case of failure in the automatic cleaning and change over system.

Guidance note:
A manual back-wash function for emergency purpose is accepted as a means to ensure oil supply when automatic back-wash type filter is installed.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.2.3 For diesel engines burning residual oil fuel, cleaning of the lubrication oil by means of purifiers shall be arranged. These means are additional to the filters required in [3.2.1].

3.3 Lubricating oil supply

3.3.1 Each auxiliary engine or turbine shall be supplied with at least one lubricating oil pump of sufficient capacity for the maximum output of the engine.

3.4 Emergency supply of lubricating oil to main machinery

3.4.1 Main machinery installations with long roll-out times such as steam turbines shall be provided with a satisfactory emergency supply of lubricating oil in case of low oil pressure. This emergency supply shall be independent of power from the main switchboard. The emergency supply may be taken from a gravity tank containing sufficient oil to maintain adequate lubrication until the engines come to rest.
3.5 Remote shut-off arrangement for lubricating oil tanks

3.5.1 Valves on lubricating oil tanks shall be arranged with quick-acting shut-off valves as outlined in [4.5.1] if all conditions below are in place:

— the tanks are situated in machinery spaces above the double bottom
— the valves are open during normal service
— the valves are located below top of the tank or overflow outlet.

This requirement may be exempted from upon consideration in each case, for small tanks with volume less than 0.5 m³ and tanks, for which an unintended closing of the valves may result in loss of main function specified in Pt.1 Ch.1 Sec.1 [1.2].

4 Fuel oil systems

4.1 Flash point of fuel oil

4.1.1 Oil fuels with a flash point of less than 60°C (closed cup) are not permitted, except for the following:

— ships certified for restricted service within areas having climate ensuring that ambient temperatures of spaces where such fuel oil is stored shall not rise to temperatures within 10°C below the flash point of the fuel, may use fuel oil with flash point below 60°C but not less than 43°C.
— installation specially approved for the use of crude oil as fuel.

The use of gas as fuel is permitted in gas carriers as given in Pt.5 Ch.7 Sec.16 and in other ships as given in Pt.6 Ch.2.

4.1.2 Heating of oil fuel in storage tanks shall be limited to a temperature 10°C below the flash point of the fuel except that for heated tanks in the supply system when arranged in compliance with the following:

— temperature of the vapour at the outlet of the air pipes shall be below 60°C when the outlet is within 3 m from a source of ignition
— the air pipes shall be fitted with flame screens
— no openings from the vapour space of the fuel tanks shall have outlet into machinery spaces
— enclosed spaces shall not be located directly over such fuel tanks, except for well-ventilated cofferdams
— electrical equipment shall not be fitted in the vapour space of the tanks, unless it is certified intrinsically safe.

4.1.3 Liquids for specific purposes and whose flash point is lower than 43°C are preferably to be stored outside the machinery space. If tanks for such liquids are installed in the engine room, installation drawings shall be submitted for approval in each case.

4.2 Fuel oil tanks

4.2.1 Two fuel oil service tanks for each type of fuel used on board necessary for propulsion and vital systems or equivalent arrangements shall be provided. Each tank shall have a capacity sufficient for continuous rating of the propulsion plant and normal operating load at sea of the generator plant for a period of not less than 8 hours.

4.2.2 Settling tanks for heavy fuel oil shall be provided. Settling tanks shall have sufficiently dimensioned heating systems and be provided with drains, emptying arrangements and temperature measuring instruments.
4.2.3 Where fuel oil tanks are situated near to boilers or other hot surfaces, the tanks shall be well insulated. In order to keep the oil temperature well below the flash point, care shall be taken that the free air circulation is not impeded.

4.2.4 The plate thickness in free standing fuel oil tanks shall not be less than 5 mm. For very small tanks, however, the plate thickness may be reduced to 3 mm. Sides and bottom of the tanks shall be well stiffened. Large tanks shall be fitted with wash bulkheads.

4.2.5 Outlets for fuel oil centrifuges, if fitted, shall be taken from the lowest point of the tank bottom.

4.2.6 The use of free standing fuel tanks is prohibited for passenger vessels.

4.3 Fuel oil piping

4.3.1 Piping conveying flammable liquids under pressure in the engine room and boiler room shall be laid in well-lit places, in order that the piping may be kept under observation.

4.3.2 All detachable pipe connections and valves in oil fuel pressure piping shall be at a safe distance from boilers, exhaust pipes or other heated surfaces and electrical appliances.

4.3.3 The number of detachable pipe connections shall be limited to those which are necessary for mounting and dismantling.

4.3.4 Fuel lines shall not pass through tanks containing feed water, drinking water, lubricating oil or thermal oil.

4.3.5 For tanks that can be used for both fuel oil and water ballast (allowable in special cases only) separate valve chests shall be provided for fuel oil and water ballast. The piping arrangement shall be such that the same tank cannot be connected to both valve chests at the same time.

4.3.6 Piping arrangements for deep tanks carrying alternately dry cargo, fuel oil and water ballast, see Sec.4 [3.2.2].

4.3.7 The arrangement of piping and valves shall be such that oil cannot enter tanks not intended for this purpose.

4.3.8 The design pressure for fuel oil systems with a working pressure above 7 bar and a working temperature above 60°C shall be minimum 14 bar. Other fuel oil systems shall have a minimum design pressure of 3 bar.

(IACS UR P1.2.7)

4.3.9 Where electrical power is required for operation of propulsion machinery, the requirements are also applicable for machinery for power generation when such machinery is supplied by common fuel supply pumps.

4.4 Arrangement of valves, cocks and fittings

4.4.1 Every fuel oil inlet or outlet pipe from any fuel oil tank, that would allow fuel oil to escape from the tank if damaged, shall be provided with a shut-off valve directly on the tank.

For a tank situated above the double bottom, the valve shall be secured to the tank itself. Short distance pieces of rigid construction are acceptable in places where valves are required to be fitted directly on tanks.
4.4.2 All valves and cocks on oil tanks shall be mounted and protected in such a way that they cannot be damaged as the result of an accident. The positioning of valves shall be such that any possible leakage shall not lead to oil spray on boilers, exhaust pipes or other hot surfaces of the machinery, or on electric motors and appliances.

4.4.3 In multi-engine installations, which are supplied from the same fuel source, means of isolating the fuel supply and spill piping to individual engines shall be provided. The means of isolation shall not affect the operation of the other engines, and shall be operable from a position not rendered inaccessible by a fire on any of the engines.

4.4.4 All valves in the fuel oil system shall be controllable from positions above the floor plates.

4.5 Remotely controlled shut-off arrangement for fuel oil tanks

4.5.1 Oil fuel pipes, which, if damaged, would allow oil to escape from a storage, settling or daily service tank having a capacity of 500 l and above and situated above the double bottom, shall be fitted with a cock or valve directly on the tank capable of being closed from a safe position outside the space concerned.

4.5.2 In machinery spaces, fuel oil valves on tanks shall be arranged as quick-acting shut-off valves with remote operation. This remote operation shall be carried out from a central position outside the space itself, and at a safe distance from openings to the engine and boiler rooms.

4.5.3 Oil fuel pipes, which are led into the engine room from tanks situated above the double bottom outside this space, are also to be fitted with quick-acting shut-off valves in the engine room close to the bulkhead. This is not applicable where the valve on the tank is arranged for quick acting shut-off.

4.5.4 The requirement for remote shut-off is not applicable for valves closed during normal service, valves on double bottom tanks or valves on tanks less than 0.5 m³. For valves on filling lines connected below the liquid level, remote shut-off may be omitted if non-return valves are used.

4.5.5 The means used to operate the quick acting shut-off valves shall be independent of any power sources located in the same space as the valves. For a pneumatically operated system, the air supply may be from a source located within the same space as the valves provided that an air receiver complying with the following is located outside the space:
— sufficient capacity to close all connected valves twice
— fitted with low air pressure alarm
— fitted with a non-return valve adjacent to the air receiver in the air supply line.

Materials readily rendered ineffective by heat shall not be used in the construction of the valves or the closure mechanism.

4.5.6 The controls for remote shut-off for emergency generator and emergency fire pump shall be located separately from the controls of the other valves in order to avoid erroneous operation.

4.5.7 The arrangement shall be such that paint, corrosion etc. shall not impair the efficiency of the remote operation of the valves.

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

4.6 Fuel supply through stand pipes and mixing tanks

4.6.1 Where the capacity of stand pipes exceeds 500 l, the outlet pipe shall be fitted with a remote controlled quick-closing valve operated from outside the engine room. Stand pipes shall be equipped with air/
gas vents and with self-closing connections for emptying and draining. Stand pipes shall be fitted with a local
temperature indicator.

4.6.2 Atmospheric stand pipes shall be so located and arranged that in any operational configuration
sufficient free space for degasification is available inside the stand pipes.

4.6.3 Pressurised stand-pipes (mixing tanks) shall be designed as pressure vessels and shall be fitted with
the following equipment:
— a non-return valve in the recirculating lines from the engines
— an automatic degasser or a gas blanket monitor with manual degasser
— a drain/emptying device, which shall be locked in the closed position.

4.7 Fuel oil pre-treatment arrangement

4.7.1 Filters shall be fitted in the supply lines to the main and auxiliary machinery. These shall be arranged
in such a way that they can be cleaned without interrupting the supply of fuel oil.

4.7.2 For auxiliary engines one single fuel oil filter for each engine may be approved.

4.7.3 Fuel supply for diesel engines burning residual oil fuel (heavy fuel) or mixtures containing such oils
shall be provided with suitable means for removal of harmful contaminants. These means are additional to
the filters required in [4.7.1].
If centrifuges are used for the above purpose the arrangement shall have adequate built in redundancy.

4.8 Fuel oil pre-heaters

4.8.1 If pre-heating of the fuel in the fuel oil service system is required, two pre-heaters shall be provided.
The arrangement of only one pre-heater may be accepted where temporary operation with fuel oil that does
not need pre-heating can be ensured.

4.8.2 A by-pass with shut-off valve shall be provided.

4.8.3 For electric oil heaters, see Ch.8.

4.9 Viscosity control

4.9.1 Where main and auxiliary engines are operated on heavy fuel oil, automatic viscosity control shall be
provided.

4.9.2 Viscosity regulators shall be fitted with a local temperature indicator.

4.9.3 The following local control devices shall be fitted directly before the engine
— a gauge for operating pressure
— an indicator for the operating temperature.

4.10 Various requirements

4.10.1 Settling tanks and daily service tanks shall be fitted with means for draining of water from the bottom
of the tanks.
4.10.2 Open drains for removing water from oil tanks shall be fitted with self-closing valves or cocks, and means shall be provided for collecting all waste oil in closed tanks.

4.10.3 The inlet connections of suction lines for service and settling tanks shall be arranged such as to avoid that water and impurities which have settled out from entering the fuel supply system.

4.10.4 Where the overflow pipe of a heavy fuel oil service tank is terminated in the settling tanks, suitable means shall be provided to ensure that no untreated fuel oil can penetrate into the daily service tank in case of overfilling of a settling tank.

4.10.5 Fuel oil booster units shall be protected against pressure peaks, e.g. by using adequate dampers.

Guidance note:
Dampers may be dispensed with if adequate damping is confirmed by the engine manufacturer or engine licenser.

4.10.6 For propulsion plants less than 400 kW a hand pump can be accepted as second means for pumping up the daily service tank.

4.10.7 The oil burners shall be so arranged that they cannot be withdrawn unless the oil supply to the burners is cut off.

4.10.8 For auxiliary boilers where the installation of two separate burner units is impossible, the use of one unit may be accepted on the condition that necessary spare parts are provided.

4.10.9 Flow-meters of positive displacement type shall be fitted with means preventing immediate loss of fuel supply in case of blockage if this will lead to loss of propulsion plant or auxiliary power.

5 Thermal-oil installations

5.1 Installation of thermal oil plants

5.1.1 If oil fired thermal-oil heaters are not located in separate rooms, they shall be surrounded by coamings of height not less than 150 mm and with drainage to a closed tank.

5.1.2 If oil fired thermal oil heaters are installed in a separate room, the room shall have mechanical ventilation, automatic fire detection and an approved fixed fire-extinguishing system, operated from an easily accessible place outside the room. Stop of ventilation, oil-burner and oil-booster pumps shall to be placed outside the room. Ventilating ducts shall have closing flaps.

5.1.3 Oil piping in the exhaust fired thermal-oil heater area shall be so arranged that spray or drip from detachable pipe and valve connections can neither reach the heater and exhaust ducts nor flow to the engine room below.

5.1.4 Thermal-oil piping shall be installed to provide sufficient flexibility to accommodate thermal expansion. In cases where bellows are required due to thermal expansion, these may be accepted on a case-by-case basis, in direct connection with pumps. They shall be provided with shielding which totally encloses the bellow, and a drain from the enclosure shall be lead to a closed tank.

5.1.5 Thermal-oil pipes shall have welded connections, with the exception of flange connections required for servicing system components. The requirements for non-destructive testing (NDT) of welded joints for thermal oil piping can be found in Sec.10 [1.5].
5.1.6 Pipe penetrations through bulkheads and decks shall be insulated against heat conduction to the bulkhead.

5.2 Thermal oil tanks

5.2.1 An expansion vessel shall be placed at a high level in the system. The space provided for expansion shall be such that volume increase of the thermal oil at the maximum thermal oil temperature can be safely accommodated.

The following shall be regarded as minimum requirements: 1.5 times the increase in volume for volumes up to 1000 litres, and 1.3 times the increase for volumes over 1000 litres. The volume is the total quantity of thermal oil contained in the system up to the lowest liquid level in the expansion vessel.

5.2.2 A drainage tank shall be located at the lowest point of the system. The capacity shall be sufficient to hold the volume of the largest isolatable system section.

5.2.3 A separate storage tank shall be provided to compensate loss of oil. The stock of thermal oil shall be at least 40% of the capacity of the system.

5.2.4 If drainage tank and the storage tank are combined, it shall be dimensioned in a way that in addition to the stock of thermal oil, there is volume for the content of the largest isolatable system section.

5.2.5 All air pipes shall be led to open deck and shall be arranged with drainable water traps at the lowest points.

5.2.6 System tanks and vessels where water may accumulate shall be arranged with drain cocks.

5.3 Thermal oil expansion tank arrangement

5.3.1 The equipment on the expansion vessel shall be suitable for use at thermal oil systems and on ships.

5.3.2 The alarms and the activation of the limiters shall create optical and acoustic fault signals at the thermal oil system control panel.

5.3.3 The expansion tank shall be equipped with a liquid level gauge with a mark indicating the lowest allowable liquid level.

5.3.4 Level gauges made from glass or plastic are not permitted.

5.3.5 A level switch shall be fitted which shuts down and interlocks the oil burner and switches off the circulating pumps if the liquid level in the expansion tank falls below the allowable minimum.

5.3.6 An independent level switch shall be installed to give an alarm for low liquid level in the expansion tank (e.g. in the event of a leakage).

5.3.7 An alarm shall be provided for the maximum liquid level.

5.4 Quick drainage valves and emergency shut-off valves

5.4.1 A quick drainage valve shall be fitted directly to the expansion tank with remote control from outside the space in which the equipment is installed.

5.4.2 Automatic means shall be provided to ensure sufficient air supply to the expansion vessel when the quick drainage valve is operated.
5.4.3 Where the expansion tank is installed outside the engine room, the quick drainage valve may be replaced by an emergency shut-off device (quick closing valve).

5.4.4 The opening of the quick drainage valve or the actuation of the emergency shut-off device shall activate an alarm. At the same time the oil fired heater shall automatically be shut-down.

5.4.5 The dimensions of the drainage and air pipes shall be applied according to Table 1.

**Table 1 Dimension of drainage and air pipes**

<table>
<thead>
<tr>
<th>Heater output [kW]</th>
<th>Expansion and overflow pipes</th>
<th>Drainage and venting pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal diameter DN</td>
<td>Nominal diameter DN</td>
</tr>
<tr>
<td>≤ 600</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>≤ 900</td>
<td>32</td>
<td>40</td>
</tr>
<tr>
<td>≤ 1200</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>≤ 2400</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>≤ 6000</td>
<td>65</td>
<td>80</td>
</tr>
</tbody>
</table>

5.5 Expansion tank connection lines

5.5.1 A safety expansion line shall connect the system to the expansion vessel. It shall be installed with a continuous positive gradient and be dimensioned such that a pressure increase of more than 10% above the maximum allowable working pressure in the system is avoided.

5.5.2 The expansion vessel shall be provided with an overflow line leading to the drainage tank.

5.5.3 All parts of the system in which thermal oil can expand due to the absorption of heat from outside, shall be safeguarded against excessive pressure. Any thermal oil emitted shall be safely drained off.

5.5.4 The dimensions of the expansion and overflow pipes shall be applied according to Table 1.

5.6 Pre-pressurised thermal oil systems

5.6.1 Pre-pressurised systems shall be equipped with an expansion vessel which content is blanketed with an inert gas.

5.6.2 The pressure in the expansion vessel shall be locally indicated and safeguarded against overpressure.

5.6.3 A high pressure alarm and a shutdown of the oil burner, at set pressures below the set-pressure of the safety valve, shall be provided for the expansion vessel.

5.7 Thermal oil circulation system

5.7.1 Arrangements shall be made to ensure a minimum circulation through the heater in case consumers are shut-off. Such arrangements shall be automatically operated.
5.7.2 Each circulation system shall have a minimum of two circulation pumps. One pump shall be in continuous operation, the other in auto stand-by. Starting of the stand-by pump shall be initiated by the dropping out of the contactor for the pump in operation.

5.7.3 A transfer pump shall be installed for filling the expansion vessel and for draining the system.

5.7.4 For heating of liquid cargoes with flashpoint below 60°C, see the Pt.5 Ch.5 Sec.4.

5.8 Valves in thermal oil systems

5.8.1 Valves shall be designed for a nominal pressure of PN 16.

5.8.2 Valves shall be mounted in accessible positions.

5.8.3 Non-return valves shall be fitted in the pressure lines of the pumps.

5.8.4 Valves in return pipes shall be secured in the open position.

Guidance note:
Bellow sealed valves should be used.

---end---of---guidance---note---

5.9 Equipment

5.9.1 The outlets of the circulating pumps shall be equipped with pressure gauges.

5.9.2 It shall be possible to stop the circulating pumps by an emergency switch from a position outside the room in which they are installed.

5.9.3 Devices for safe sampling shall be provided in the thermal oil circuit.

5.9.4 Means of de-aeration of the system shall be provided at the highest points of isolatable sections of the thermal oil system and drainage devices at the lowest points. Venting and drainage via open funnels are not permitted.

5.9.5 Drip trays with drains to a waste oil tank shall be arranged under all plant components, e.g. pumps, filters, etc., where leakage may occur.

5.10 Insulation and shielding

5.10.1 All insulation shall be covered with an outer barrier which shall be impervious to liquid. In areas and locations where pipes are exposed to mechanical impact, the outer barrier shall be made of galvanised steel plates or aluminium plates of sufficient impact strength to resist deformations from normal wear and strain.

5.10.2 The arrangement of pipes and components shall provide sufficient space for satisfactory insulation installations. Flanged pipe connections shall have installed effective detachable shielding, which shall prevent oil leakage from reaching potential danger areas.

5.11 Test equipment and signboards

5.11.1 Cocks or valves for taking thermal-oil samples in a safe manner shall be arranged.
6 Feed water and condensate systems

6.1 Feed water pumps

6.1.1 Feed water pumps installed to meet the rule requirements to redundancy shall be independently driven.

6.2 Feed water piping

6.2.1 If feed water preheaters are fitted in feed water lines by-pass arrangements shall be provided enabling repair of a heater without interrupting the feed water supply.

6.2.2 Feed water piping shall be fitted with valves at the boiler inlet, as stated in Ch.7 Sec.5 [3.1.1].

6.3 Feed water heating

6.3.1 For steam boilers with design pressure above 7 bar arrangements for preheating and deaeration of the feed water before entering the boiler shall be provided.

The preheating arrangement shall be capable of maintaining the temperature above 80°C when boilers are operated at maximum load during normal seagoing service.

6.4 Feed water tanks

6.4.1 Reserve feed water tanks shall be provided, with a capacity corresponding to at least twice the hourly evaporation rate of the main boilers.

6.4.2 Feed water tanks in the double bottom shall be separated from oil tanks by cofferdams.

6.4.3 Piping for feed tanks shall be so arranged that the water cannot be contaminated by oil or oily water.

6.5 Condensate from steam heating of tanks

6.5.1 Where fuel or lubricating oil tanks, heaters or purifiers are heated by steam in pipe coils, the condensate shall be led into an observation tank. This tank shall be placed in an easily accessible, well ventilated and well illuminated position where it can easily be observed whether the condensate is free from oil or not.

6.6 Evaporators

6.6.1 For main boilers, evaporators shall be installed with a capacity sufficient to cover normal loss in the system even when one of the evaporators is out of order.

Guidance note:

Normal loss in the system is expected to be in the range of 1 to 2% of the boiler evaporation. The upper part of the range applies for smaller plants.

---end of guidance note---
7 Steam systems

7.1 Steam piping

7.1.1 Water pockets in the steam flow lines shall be avoided as far as practicable in order to prevent water hammer in the system. If this cannot be avoided, drain cocks or valves shall be fitted in such places so that the pipes may be efficiently drained while in operation.

7.1.2 Steam pipes shall not be led through cargo holds unless the arrangement is specially approved. Where the pipes are led through shaft tunnels they shall be insulated in such a way that the lagging surface temperature does not exceed 60°C.

Uninsulated steam pipes shall not be led through spaces or tanks without satisfactory possibilities for removal of the heat.

Guidance note:
Regarding steam heating of double bottom fuel oil tanks below insulated reefer cargo chambers, see Pt.6 Ch.4 Sec.9.

7.1.3 For pipes conveying steam at temperatures exceeding 450°C an arrangement may be required (calibrated gauge lengths) for checking of creep in highly stressed areas.

7.1.4 For analysis of thermal expansion stresses see Sec.9 [1].

7.2 Steam supply to auxiliary machinery

7.2.1 Steam supply to the steering gear, feed water pumps and machines operating electrical generators shall not be interrupted if steam supply to the propulsion machinery or cargo oil pumps is shut off.

7.3 Shut-off valves

7.3.1 If two or more boilers are connected to a common header or steam manifold the steam connection to each boiler shall be provided with two shut-off valves with a free blowing drain in between. This requirement does not apply to exhaust gas economisers with forced circulation.

7.3.2 Where blow-downs from two or more boilers are connected to a common discharge, two valves shall be fitted to each discharge.

7.3.3 Heating coils in tanks containing oil residues or fuel, e.g. sludge tanks, leak oil tanks and bilge water tanks, shall be provided with shut-off valves at the inlet and outlet of the tank. In addition, a testing device shall be fitted at the outlet of the tank.

7.4 Safety valves

7.4.1 The discharge from safety valves shall be to a point where hazard is not created, see Ch.7 Sec.6.

7.5 Blow down valves on ship's side

7.5.1 The blowdown valve on the ship's side shall be fitted in a readily accessible position. It shall be located above the level of the floor in such a way that it is easy to verify whether it is open or shut. The cock handle
shall not be removable unless the cock is shut, and if a valve is fitted, the wheel shall be fixed to the spindle. (See also Sec.3 and Ch.7 Sec.5.)

8 Hydraulic systems

8.1 General

8.1.1 The redundancy requirement in [1.1.2] applies to pumps, filters and pressure reduction units.

8.1.2 Hydraulic systems shall be separated from other piping systems except lubricating oil systems as specified in [3.1.1].

8.1.3 The hydraulic fluid shall not corrode or attack chemically the components in the system. It shall have a flash point not lower than 150°C and shall be suitable for operation at all temperatures to which the system may be subjected.

8.1.4 Means for filtration and cooling of the fluid and for deflation of entrapped gases shall be incorporated in the system where found necessary.

8.1.5 Excessive pressure surges and pulses generated by pumps and valve operations shall be avoided. When necessary, pulsation dampers shall be fitted, preferably connected directly to the source of vibrations. Design of the system shall be such that laminar flow is obtained.

8.1.6 Detachable pipe connections and valves in hydraulic pressure piping shall be at a safe distance from electrical appliances, boilers, exhaust pipes and other sources of ignition.

8.1.7 Air pipes from hydraulic oil circulation tanks and expansion tanks shall be lead to safe locations so that any escaping oil does not reach possible sources of ignition.

8.1.8 Oil circulation tanks or expansion tanks in engine rooms shall be provided with arrangements preventing overflow of oil (e.g. from generation of vapour due to moisture in the hydraulic oil). The following alternative arrangements may be accepted:

a) The free volume of the circulation tanks is sufficient for accumulating all the hydraulic oil in the system. A high level alarm is fitted in the tank at a level leaving sufficient free volume for containing the oil in the system.

b) The circulation tank or expansion tank is provided with an overflow pipe leading to a collecting tank. The cross sectional area of the overflow pipe is twice that of the return oil pipe.

c) The air pipe from the tank is lead to a safe position outside machinery space. The cross sectional area of the air pipe is twice that of the return oil pipe.

8.2 Hydraulic power supply

8.2.1 Requirements for hydraulic power supply to steering gears are given in Ch.10 Sec.1.

8.2.2 Anchor windlasses may be approved with one power unit provided the anchor(s) can be lowered independent of the hydraulic system.

8.2.3 Windlasses arranged for remote control are in addition to be arranged for local manual control.
8.3 Hydraulic cylinders

8.3.1 Hydraulic cylinders shall be certified as specified in Sec.1 Table 4.

8.4 Accumulators

8.4.1 Hydraulic accumulators of the gas or hydraulic fluid type having

\[ pV > 1.5 \]

where:

\[ p = \text{design pressure in bar} \]
\[ V = \text{volume in m}^3 \]

shall comply with Ch.7, while requirements to smaller accumulators are as for piping.

8.4.2 For hydraulic accumulators of the gas or hydraulic fluid type the two media shall be suitably separated if their mixture would be dangerous or would result in the contamination of the hydraulic fluid and/or loss of gas through absorption.

8.4.3 Each accumulator shall be protected on both gas and hydraulic fluid side by a safety device such as relief valve, fuse plug or rupture disc to prevent excess pressure if overheated. When the accumulator is an integral part of a system with such a safety device, the accumulator itself need not be supplied with a safety device.

8.4.4 The gas bottles for charging accumulators shall be in accordance with Ch.7. Such bottles shall be clearly marked to prevent mixing up with other types of gas bottles on board.

8.4.5 Cast accumulators shall have an inside coating.

8.5 Hydraulic equipment

8.5.1 System components and arrangement shall satisfy the requirements in [8.1] to [8.4].

8.5.2 Piping and tubing to actuators and between actuators and local accumulators shall be hydrostatically tested to 1.5 times the system design pressure for 15 minutes.

Guidance note:
This requirement may be waived by the surveyor on a case-by-case basis. Aspects to be considered are maximum operating pressure compared to design pressure. Experience with workmanship may also influence the decision.

8.5.3 Local accumulators used as backup power supply for essential systems shall be designed and located or protected to minimise the possibility of inadvertent isolation or mechanical damage which could prevent correct operation on demand.

8.5.4 Piping, tubing and components in systems required to operate in a fire scenario shall have adequate fire resistance properties to ensure correct system operation. This is particularly important for systems where hydraulic energy is required to activate or maintain control over the system. The Society may request fire test certificates for such system components.
8.5.5 Piping and tubing shall be flushed and cleaned before being connected to control systems.

8.5.6 Hydraulic oil return lines shall be designed with capacity to allow the maximum return flow during extreme conditions without reducing overall system performance. Care shall be taken to avoid the possibility of blockages at filters, vents or by mechanical damage or inadvertent operation of valves.

9 Pneumatic systems

9.1 General

9.1.1 The redundancy requirement in [1.1.2] applies for compressors, filters, pressure reduction units, when supplying more than one important consumer, and air treatment units (lubricator or oil mist injector and dehumidifier).

9.1.2 Air intakes for the compressors shall be so located as to minimise the intake of oil or water contaminated air.

9.1.3 Pipes between the compressors and pressure vessels shall not have connections to other machinery.

9.1.4 Pressure lines connected to air compressors shall be fitted with non-return valves at the compressor outlet.

9.1.5 Valves on the air receivers shall be designed such that detrimental pressure shock does not arise in the pipes when the valves are opened.

9.1.6 Pipes from air compressors with automatic start shall be fitted with a separator or similar device to prevent condensate from draining into the compressors.

9.1.7 If the ship has a pneumatic auxiliary steering gear, two starting air compressors with a total capacity sufficient for normal operation of the auxiliary steering gear shall be provided.

9.1.8 Air driven whistles shall be supplied from at least two compressed air receivers.

9.2 Pneumatic equipment

9.2.1 Components requiring extremely clean air shall not be used. Extremely small openings in air passages shall be avoided.

9.2.2 Main pipes shall be inclined relative to the horizontal as far as possible, and drainage shall be arranged at the lowest point.

9.2.3 Pipes and other equipment made of plastic materials are accepted if they have satisfactory mechanical strength, low thermoplasticity, high oil resistance, and are flame retardant. For application, see Sec.2 [1.7].

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

9.3.1 For diesel engine starting systems, see also Ch.3. For starting up from dead ship, see Ch.1. Electrical starting systems are described in Ch.8.

9.3.2 Starting systems for internal combustion engines and gas turbines shall have capacity for a number of starts specified in Table 2 without reloading of air receivers.
The capacity shall be divided between at least two air receivers of approximately same size.

Table 2 Capacity for number of starts

<table>
<thead>
<tr>
<th>Duty of engines</th>
<th>Number of starts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propulsion engines, reversible</td>
<td>12 starts</td>
</tr>
<tr>
<td>Propulsion engines, non-reversible</td>
<td>6 starts</td>
</tr>
<tr>
<td>Engines for driving electric generators and emergency generators, and engines for other purposes</td>
<td>3 starts each</td>
</tr>
</tbody>
</table>

9.3.3 If a starting system serves two or more of the above specified purposes, the capacity of the system shall be the sum of the capacity requirements.

9.3.4 For multi-engine propulsion plants the capacity of the starting air receivers shall be sufficient for three (3) starts per engine. However, the total capacity shall not be less than 12 starts and need not exceed 18 starts.

9.3.5 Two or more compressors shall be installed with a total capacity sufficient for charging the air receivers from atmospheric to full pressure in the course of one (1) hour.
The capacity shall be approximately equally shared between the compressors. At least one of the compressors shall be independently driven.

9.3.6 If the emergency generator is arranged for pneumatic starting, the air supply shall be from a separate air receiver.

9.3.7 The emergency starting air receiver shall not be connected to other pneumatic systems, except for the starting system in the engine room. If such a connection is arranged, then the pipeline shall be provided with a screw-down non-return valve in the emergency generator room.
SECTION 6 REFRIGERATION SYSTEMS

1 General

1.1 Application

1.1.1 The rules in this section apply to refrigerating plants using group 2 refrigerants and R744(CO2). For other group 1 refrigerants the rules apply for plants with a total prime mover effect of 100 kW and above.

1.2 References

1.2.1 For ships with additional class notation RM see Pt.6 Ch.4 Sec.9.
1.2.2 For ships with class notation Tanker for liquefied gas see Pt.5 Ch.7.
1.2.3 For ships with class notation Fishing vessel with refrigerated spaces see Pt.5 Ch.12.

2 Materials

2.1 Materials

2.1.1 The materials shall comply with the requirements specified in Pt.2 Ch.2 Sec.2 and Ch.7 Sec.2. Other suitable material specifications shall be considered for approval in each individual case. The materials shall be tested in accordance with the regulations for material testing given in Pt.2.

For a closed refrigerating circuit using refrigerants of group 1, or R717 and with a lowest design evaporating temperature of -41°C or warmer:
— rolled steel plates shall be accepted in accordance with Pt.2 Ch.2 Sec.2 [2]. A grade impact tested at 0°C (or colder) shall be selected
— steel pipes and fittings shall be accepted in accordance with Pt.2 Ch.2 Sec.5 [4].

In such systems for lower design evaporating temperatures and for or other group 2 refrigerants rolled steel plates and steel pipes and fittings shall comply with Pt.5 Ch.7.

Possible sub-cooling of the liquid in connection with accidental blow down need not be taken into account when deciding the design temperature.

For refrigerating systems on gas carriers where the cargo is used as refrigerant the materials and the design temperature shall be in accordance with Pt.5 Ch.7.

2.1.2 The materials shall be corrosion-resistant to the refrigerant and the compressor oil and to the combination of the two.

Piping located in areas where exposure to high humidity or water splashing is expected, e.g. fish processing spaces, shall be of corrosion resistant material, e.g. stainless steel.

2.1.3 The following materials and refrigerants shall not be combined:
1) copper with ammonia
2) magnesium with fluorinated hydrocarbons
3) zinc with ammonia and fluorinated hydrocarbons.
2.1.4 Thermal insulation of organic foams shall be of a flame-retarding quality, i.e. low ignitability and low flame-spread properties. Testing shall be carried out in accordance with a recognized standard, e.g. DIN 4102.1B2, or equivalent. The test method chosen shall be suitable for the type of foam in question.

### 3 Design criteria

#### 3.1 Refrigerants

**Group 1:**
Refrigerants in this group are normally nonpoisonous, but all of them, except R744, can be poisonous when decomposed by a flame or by a hot surface. These refrigerants are heavier than air, give no odour warning and will give a dangerous atmosphere by displacement of air. The lack of odour and the high density make these refrigerants particularly dangerous with regard to suffocation.

**Table 1 Group 1 refrigerants**

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R22 (monochlorodifluoromethane)</td>
<td>CHF₂Cl</td>
</tr>
<tr>
<td>R134a (1,1,1,2-tetrafluoroethan)</td>
<td>CH₃F-CF₃</td>
</tr>
<tr>
<td>R404A</td>
<td>hydrofluorocarbon mix</td>
</tr>
<tr>
<td>R407A</td>
<td>hydrofluorocarbon mix</td>
</tr>
<tr>
<td>R407B</td>
<td>hydrofluorocarbon mix</td>
</tr>
<tr>
<td>R407C</td>
<td>hydrofluorocarbon mix</td>
</tr>
<tr>
<td>R410</td>
<td>hydrofluorocarbon mix</td>
</tr>
<tr>
<td>R507</td>
<td>hydrofluorocarbon mix</td>
</tr>
<tr>
<td>R744 (carbon dioxide)</td>
<td>CO₂</td>
</tr>
</tbody>
</table>

**Group 2:**
Refrigerants in this group are particularly poisonous. R717 is lighter than air and is flammable in very high mixing ratios with air. A very high ignition energy is then required to start a fire.

Group 2 refrigerants shall not be used in air conditioning systems with direct expansion.

**Table 2 Group 2 refrigerants**

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R717 (ammonia)</td>
<td>NH₃</td>
</tr>
</tbody>
</table>

The use of other refrigerants shall be given special consideration.

#### 3.2 Design pressures

The scantlings of the various parts of the refrigerating plant shall be based on the pressures specified in Table 3.
Table 3 Design pressures for refrigerating plant

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Minimum design pressure bar</th>
<th>HP side of system</th>
<th>LP side of system</th>
</tr>
</thead>
<tbody>
<tr>
<td>R22</td>
<td></td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>R134a</td>
<td></td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>R717</td>
<td></td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>R404A</td>
<td></td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>R407A</td>
<td></td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>R407B</td>
<td></td>
<td>27</td>
<td>21</td>
</tr>
<tr>
<td>R407C</td>
<td></td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>R410</td>
<td></td>
<td>34</td>
<td>27</td>
</tr>
<tr>
<td>R507</td>
<td></td>
<td>26</td>
<td>20</td>
</tr>
<tr>
<td>R744 (CO2)</td>
<td></td>
<td>1)</td>
<td>1)</td>
</tr>
</tbody>
</table>

Design pressure to be specified by the designer.

If refrigerants other than those specified in Table 3 are used, the design pressure shall be subject to approval in each individual case. It may be assumed to be equal to the vapour saturation pressure of the refrigerant at 55°C and 45°C on the HP and LP sides, respectively. Low pressure side shall be considered as all parts of the refrigerating plant subjected to evaporation pressure of the refrigerant, however parts of the low pressure side that can be exposed to high pressure (e.g. during hot gas defrosting) shall be considered as high pressure side with regards to design pressure.

4 Design

4.1 Refrigeration machinery

4.1.1 All parts of the machinery shall be easily accessible for inspection and overhauling. Sufficient space for cleaning and replacing the tubes in the brine and RSW coolers and condensers shall be available.

4.1.2 If the refrigerating plant is located in a separate room outside the machinery space, this room shall be equipped with effective ventilation for cooling the refrigerating machinery. The mechanical ventilation shall have two main controls, one of which shall be operable from a place outside the room.

4.1.3 Except as permitted in [4.1.5] and [4.2.1], refrigeration systems using refrigerant R717 or R744 shall have the complete refrigerant circuit located within a separate machinery room surrounded by steel decks and bulkheads and fitted with self-closing doors opening outwards and with a sill height of at least 300 mm but not less than sufficient to prevent overflow of refrigerant in case 80% of the total refrigerant quantity of the largest unit is released while the ship is within normal range of trim and with a list not exceeding 15°. Decks and bulkheads shall be without openings and pipe and cable penetrations etc. shall be sufficiently tight to prevent leaked refrigerant from entering other rooms and spaces. Special glands of approved type need, however, not be used.

The refrigerating machinery room shall be located as high as reasonable within the ship. The refrigerating machinery room is subject to approval with regard to its location and arrangement within the ship and with regard to accesses and emergency escapes. Except for small refrigerating machinery rooms, at least two access doors shall be provided.
Thin-plate ventilation ducts for other spaces shall not be lead through the refrigerating machinery room. Air coolers for air conditioning plants shall not be located within the refrigerating machinery room.

The ventilation system for the refrigerating machinery room shall be separated from other ventilation systems, shall be of the exhaust type and to give minimum 30 air changes per hour. If the refrigerant is lighter than air the ventilation exhaust shall be from the top of the refrigerating machinery room.

All ventilation outlets from the refrigerating machinery room shall be at safe locations with regard to:

— the hazards of possibly leaked refrigerant in the ventilation air
— intake of ventilation air into other ventilation systems on the ship
— recycling between the ventilation outlets and intakes for the refrigerating machinery room.

**Guidance note:**
In case of R744, refrigerating machinery rooms surrounded by decks and bulkheads constructed of other materials than steel may be accepted upon special considerations.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

4.1.4 For refrigerants of group 2 the refrigerating machinery room shall additionally be equipped with effective mechanical catastrophe ventilation. For R717 the capacity shall be the larger of the values calculated by:

— $7.2 \text{ m}^3/\text{h}$ for each kg refrigerant up to 500 kg plus $3.0 \text{ m}^3/\text{h}$ for each kg refrigerant above 500 kg. In case the refrigerant is contained in completely separated refrigerant circuits, only the circuit with the largest quantity need be considered; or
— $300 \text{ m}^3/\text{h}$ for each m$^2$ deck area of the refrigerating machinery room. Special considerations shall be made in case the deck is thermally insulated to reduce evaporation of leaked refrigerant or the wet area is minimised by the deck shape or construction. If the refrigeration compressor/condenser skid is provided with spill coamings of min. 100 mm height, the area inside the coamings may be taken as the deck area for the purpose of capacity calculations.

For other refrigerants the required capacity shall be corrected according to the evaporating heat of the refrigerant at atmospheric pressure and the acceptable concentration in the ventilation exhaust air.

In order that under pressure in the room shall not make opening of exit doors difficult, a push button for temporary stop of ventilation shall be located close to the door(s) inside the room.

The normal and the catastrophe ventilation shall be arranged such that a single failure cannot cause a complete ventilation failure for the refrigerating machinery room.

Areas on open deck within a distance of 1 m from inlet ventilation openings, and within a distance of 3 m from outlet ventilation openings of refrigerating machinery rooms with R717 (both normal and catastrophe ventilation) shall be classified as hazardous zone 2, as specified in Ch.8 Sec.11.

4.1.5 On ships of less than 65 m of length (as defined in Pt.3 Ch.1 Sec.4) R717 or R744 refrigerating systems with less than 25 kg filling may be located within the engine room or another suitable space not including accommodation spaces. All parts of such refrigerating systems shall be located together. A secondary refrigerant or a heat transfer fluid shall be used in the air coolers in provision stores, air conditioning systems etc. connected to such refrigerating systems. The area where the refrigerating system is installed shall be fitted with a hood with a negative ventilation system and with a water spray system. The outlet from the ventilation system shall be arranged in accordance with [4.1.3].

R744 systems may be accepted with more than 25 kg filling if it can be proven that leakage of the complete refrigerant charge from the system will not result in oxygen concentration below 19% by volume.

4.1.6 If R717 is used as refrigerant the required separate refrigerating machinery room shall comply with the following:

— bilge wells shall be as small as practicable, e.g. not more than 25 litres
— the deck plating shall be arranged for easy cleaning and drying. Separate floor plating above the deck plating of the refrigerating machinery room shall not be fitted.
— bilge drainage system shall be separate for the room. Drain piping to bilge systems/bilge wells/bilges in other parts of the ship are not be arranged unless they are fitted with self-closing valves
— all non-Ex protected electrical equipment within the refrigerating machinery room shall be automatically de-energised in case an R717 concentration above 5 000 PPM is detected. Additionally, all non-EX protected electrical equipment shall be capable of being de-energised independently by a central switch located outside of the room. The normal and catastrophe ventilation systems shall be arranged with Ex protected motors and non-sparking fans
— ex protected (emergency) lighting fixtures shall be fitted in the refrigerating machinery room
— access doors and emergency escapes shall be provided with external water screens and eye washes with constantly available water supply.

Separate refrigerating machinery rooms for R717 systems with less than 25 kg filling shall be specially considered.

4.1.7 Access doors and -hatches shall either be operable from both sides or be fitted with catches to prevent inadvertent closing. All chambers and air cooler rooms shall each be fitted with at least one conveniently located alarm call button.

4.2 Refrigerant circuit

4.2.1 R717 or R744 may be used for direct expansion in cooling/freezing equipment located outside the refrigerating machinery room and within normally manned spaces such as production areas and cooled/frozen product cargo chambers on fishing vessels and fish factory ships. The refrigerant piping shall not be located within the crew accommodation spaces, the navigating bridge and the main engine room or such that all accesses to the main engine room will be blocked in case of pipe rupture.

Vessels not having class notations Fishing vessel or Stern trawler, and are fitted with fish processing decks or refrigerated cargo chambers with direct expansion refrigeration systems shall comply with the requirements given in Pt.5 Ch.12 Sec.3 [4].

4.2.2 Where R717 or R744 is used as refrigerant for direct expansion within production areas and cargo chambers, quick closing valves shall be fitted in the delivery lines (liquid and hot gas) and return within the refrigerating machinery room. The return lines shall be fitted with a valve arrangement providing a non-return function allowing flow towards the low pressure side within the refrigerating machinery room. Activation shall be possible from the refrigerating machinery room, the production area and from a suitably located emergency station outside these rooms.

4.2.3 The low-pressure side of the compressor or the plant shall be so constructed that liquid refrigerant or oil cannot be sucked into the compressor in harmful quantities.

4.2.4 Safety valves shall be located on the high-pressure side of the compressor ahead of the shutoff valve. The outlet may lead back to the suction side of the compressor.

Guidance note:
Bottles containing spare refrigerant should be stored in well ventilated spaces specially prepared for that purpose. Storage in refrigerating machinery spaces may be accepted based on special consideration with regards to quantity of stored refrigerant and location of refrigerating machinery space.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
5 Refrigeration system components

5.1 Pipes and tubes

5.1.1 Copper tubes and systems may be accepted with minimum wall thicknesses in accordance with Sec.9 Table 1. Welding of steel pipes shall be carried out according to an approved procedure. Grip type pipe couplings shall not be used.

5.1.2 Flexible hoses shall be of approved type. New types of flexible hoses, with couplings, shall be subjected to a prototype test. The bursting pressure shall be at least four (4) times the design pressure for the system, unless class I is applicable.

5.1.3 The complete refrigerant circuit, including both low- and high pressure sides, shall be considered as pertaining to class II piping systems except R744 (CO2) with design pressure above 40 bar which shall pertain to class I.

5.1.4 Soldered connections shall be able to withstand a temperature of at least 425°C if refrigerants of group 2 are used.

5.1.5 When tin soldering, the solder shall be of a type which does not decompose.

5.1.6 Any insulation of refrigerant and brine pipes shall be efficiently protected against the diffusion of moisture.

**Guidance note:**
Insulation and water vapour barriers should preferably be led continuously through the fastening arrangements.

---end---of---g-u-i-d-a-n-c-e---n-o-t-e---

5.2 Pressure vessels and heat exchangers

5.2.1 Pressure vessels, heat exchangers and coolers shall be constructed in accordance with Ch.7 as per Pt.6 Ch.4 Sec.9 [1.4.2]. Pressure vessels for refrigerant of group 2 shall comply with the requirements for class I pressure vessels. Requirements for thermal stress relief of pressure vessels with fluids liable to cause stress corrosion cracking (e.g. ammonia, R717) are given in Ch.7 Sec.7 [3.1.1].

5.2.2 Pressure vessels in closed refrigerating circuits may be accepted without inspection openings.

5.2.3 Condenser cooling water tubes shall be made of materials with high resistance to corrosion and erosion.

**Guidance note:**
The water velocity should not exceed:
- 2.5 m/s for aluminium brass pipes
- 2.5 m/s for 90/10 copper/nickel pipes
- 1.5 m/s for steel pipes.

---end---of---g-u-i-d-a-n-c-e---n-o-t-e---

For sea water cooled R717 condensers the condenser tubes and tube-plates shall be made of materials resistant to both sea water and ammonia corrosion. Use of coating or lining systems shall not be accepted in lieu of corrosion resistant materials.

5.2.4 Liquid level indicators constructed of glass tubes are not permitted.
Liquid level indicators with long glass plates shall be fitted with self closing valves in lower and upper connections.

5.3 Safety valves and discharge system

5.3.1 The refrigerant circuit(s) shall be protected against excessive pressure by safety relief valves, or equivalent arrangements.

5.3.2 If a shut-off valve is located between the pressure vessel and the safety valve, it shall be sealed in open position, and shall be closed only during repairs. A signboard stating this requirement shall be fitted.

5.3.3 Vessels with shut-off valves which contain liquid refrigerant shall be protected by a safety valve. For refrigerants of group 1, a safety disc which is corrosion-resistant, may be substituted for the safety valve.

5.3.4 The safety valve and safety disc shall be located above the surface of the liquid. They shall open at a pressure not less than the design pressure and shall be fully effective at a pressure which is maximum 10% higher.

5.3.5 The safety valve shall have a minimum capacity determined from the following formula (Ref. EN 13136:2013):

\[ Q_{md} = \frac{\varphi \times A_{surf}}{h_{vap}} \text{ [kg/s]} \]

where:

- \( A_{surf} \) = surface area of the vessel
- \( Q_{md} \) = minimum required discharge capacity
- \( h_{vap} \) = heat of vaporization at the relieving conditions [kJ/kg]
- \( \varphi \) = density of heat flow rate, assumed to be 10 kW/m\(^2\) for normal cases.

If the pressure vessel has a thermal insulation with thickness more than 0.04 m and the insulation material is fire retardant e.g. class D or better acc. To EN 13501-1, a reduced density of heat flow rate may be used as follows:

\[ \varphi_{red} = \varphi \times \frac{0.04}{s} \text{ [kW/m}\(^2\)] \]

where:

- \( s \) = thickness of insulation [m].

5.3.6 The discharge piping system from the relief devices shall have sufficient capacity to ensure critical flow through the relief devices.

5.3.7 A pipe with outlet opening at a position which is not considered dangerous for the ship or the surroundings of the ship, shall be led from the safety valve.

If led to the atmosphere the outlet opening shall be protected against rain and snow and shall be fitted with a protection net made of corrosion resistant material to prevent ingress of foreign objects.

5.3.8 When R717 is used as refrigerant the outlet shall be at a safe location as high as possible on the ship e.g. top of funnel or top of mast. The outlet shall be directed upwards.
6 Brine system

6.1 Brine piping system and vessels

6.1.1 Special consideration shall be given to corrosion resistance of materials.

Guidance note:
A corrosion-reducing agent consisting of 2.0 kg sodium dichromate + 0.54 kg caustic soda for each m³ of the solution should be added to calcium chloride. The pH value should be about 8. It is advised that a closed brine system be installed.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

6.1.2 If internally galvanized vessels or pipes are used with a closed system, and if the brine attacks zinc, the vessels shall be vented to a safe place in open air. At the outlet, the pipes shall be equipped with safety equipment against back flaming.

6.1.3 With an open system, the rooms where internally galvanized brine tanks are located shall be effectively ventilated, and brine, which generates gases with flash point lower than 30°C, shall not be used.

6.1.4 The thickness of the brine pipes from the bottom of the threads shall not be less than 2.5 mm.

7 Refrigeration system instrumentation

7.1 Instrumentation

7.1.1 A refrigerant leakage detection system with alarm covering all spaces with refrigerating machinery, the outlet piping from safety relief devices if R717 is the refrigerant and, in case of direct expansion, all refrigerated chambers shall be installed.

7.1.2 For plants using group 1 refrigerants except R744, monitoring for oxygen deficiency is an acceptable alternative to refrigerant gas detection. For R744 alarm shall be given if the concentration exceeds 2000 ppm. The sensors shall be located with due regard to the relative density of the refrigerant in gas form as well as to the ventilation flow.

7.1.3 The acoustic and optical alarm signals shall be given at such locations that crew members attending to an alarm shall not be led to entering a space possibly filled with refrigerant.

7.1.4 For provision and air condition refrigeration plants using group 1 refrigerants located in the engine room, leakage detection systems need not be fitted if the ventilation arrangement is considered sufficient to eliminate the risk of suffocation.

7.1.5 When R717 is used leakage detectors covering compartments with refrigerating machinery (including process vessels) shall give audible alarm within the compartment.

7.1.6 When R717 is used, refrigerant leakage in the refrigerating machinery room shall be detected at three (3) different consecutive levels with set points not higher than:
   a) 150 PPM Initial detection of leakage
   b) 350 PPM Access dangerous. Automatic shutdown of refrigerant circulation pump
   c) 5000 PPM De-energising of non-Ex protected electrical equipment. Automatic start of mechanical catastrophe ventilation.
Guidance note:
One processing unit for all three levels may be accepted if sensor for level a) is separate from sensor for levels b) and c).

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

7.1.7 For plants using R744, a low pressure alarm with set point well above the triple point pressure (abt. 5.2 bar) shall be fitted in the low pressure liquid part of the system.

8 Personnel protective equipment

8.1 Personnel protection equipment

8.1.1 At least two sets of air breathing apparatuses with spare air bottles shall be available onboard. The breathing apparatuses may be the same as those required for other purposes, e.g. SOLAS, provided the ship is equipped with an air compressor for recharging the air bottles.

8.1.2 In case R717 is the refrigerant, refrigerant gas masks and hermetically sealed filters shall be available in a transparent door case located immediately outside each entrance to the space where the refrigerating machinery is located. Additionally at least two sets of suitable protective clothing including also gloves and boots shall be available onboard and located in the vicinity of the space for the refrigerating machinery. In case any one refrigerant circuit contains more than 25 kg refrigerant the two sets of protective clothing shall be gas tight suits with permanently attached boots and gloves and suitable for use in combination with the air breathing apparatuses.
SECTION 7 OZONE SHIP INSTALLATIONS

1 General

1.1 Application
The rules are applicable for ozone piping systems on ships where the worst case leakage in an enclosed space may result in ozone concentrations of above 0.1 ppm.
Other safety measures that provide an equivalent level of safety may be accepted upon special consideration.

1.2 Definitions

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ozone leakage sources</td>
<td>ozone generator, flanges, valves, welds etc.</td>
</tr>
<tr>
<td>primary containment</td>
<td>a space containing ozone, i.e. ozone pipes and ozone generator</td>
</tr>
<tr>
<td>secondary containment</td>
<td>a space containing ozone piping, e.g. an ozone production room or the annular space in double walled piping</td>
</tr>
</tbody>
</table>

1.3 Signboards

1.3.1 A signboard shall be permanently fitted on doors or other access points to spaces containing ozone warning that an ozone system is installed.

1.3.2 A signboard shall be permanently fitted in the space containing ozone piping stating that heavy lifting, implying danger of damage to the ozone pipes, shall not be done during ozone operation.

1.4 Protective and medical equipment

1.4.1 At least two sets of air breathing apparatuses with spare air bottles shall be available onboard. The breathing apparatuses may be the same as those required for other purposes, provided the ship is equipped with an air compressor for recharging the air bottles.

1.4.2 At least one resuscitator shall be kept on board for medical treatment.

1.4.3 Personal protective equipment shall be stored outside entrances to spaces containing ozone piping.

2 Requirements

2.1 Materials

2.1.1 Ozone piping shall be of austenitic stainless steel or of a material with similar corrosion resistant properties. Special consideration shall be given to connections between stainless steel ozone piping and mild steel piping.
2.2 Arrangement and system design

Leakage from the primary containment shall not directly lead to intoxication of personnel.

The following safety measures are accepted to satisfy this functional requirement. A combination of the three different alternatives may be accepted for different parts of the piping system.

Alternative 1:

a) The ozone piping shall be designed with a dedicated secondary containment.

   **Guidance note:**
   
   Alternative 1 is typically for ozone piping with over pressure compared to adjacent spaces, the ozone generator or pressurized ozone supply piping.

b) The secondary containment shall be gas-tight towards other enclosed or partly enclosed ship spaces.

c) The ventilation system for the secondary containment space shall be separated from other ventilation systems.

d) All ventilation outlets from the secondary containment space shall be at safe locations with regard to air intakes for other ventilation systems on the ship.

e) Ventilation openings in the secondary containment space shall be strategically located in order to ensure an efficient air flow in the space.

f) The secondary containment space shall not be designed for passing between other ship spaces.

g) If there are doors for entering a secondary containment space, they shall be self-closing.

Alternative 2:

h) Ozone piping with over pressure compared to adjacent spaces may be designed without a secondary containment. The main condition is that it can be shown by calculation that the worst case leakage scenario does not cause ozone concentrations above 1 ppm.

i) The calculation shall as a minimum take into consideration the worst case leakage rate, the volume of the enclosed space, the ventilation capacity and time delays related to leakage detection and automatic shutdown. Calculations that assume even distribution of leaked ozone may be accepted for small and well ventilated spaces. More advanced are required for large spaces or spaces of irregular shape or layout.

j) Loss of ventilation in the space containing the ozone system shall lead to automatic shutdown of the ozone system.

Alternative 3:

k) The ozone piping system shall be designed in such a way that the ozone is under-pressurized compared to adjacent spaces.

l) Loss of under pressure shall lead to automatic shutdown of the ozone system.

2.3 Ozone piping and generation system

2.3.1 Ozone pipes shall not pass through accommodation or service spaces.

2.3.2 Ozone piping systems shall be located in safe locations with regards to mechanical damage from dropped or rolling objects.

2.3.3 Ozone pipes shall be marked to visually separate them from other piping systems.
2.3.4 The extent of ozone piping shall be minimized as far as possible in order to reduce the possible leakage points.

2.3.5 Flange connections on ozone piping shall be minimized as far as possible in order to reduce the possible leakage points.

2.3.6 It shall be possible to safely gas-free the ozone and oxygen system prior to opening the containment.

2.3.7 Outlets for purging of the ozone system shall be at safe locations with regard to air intakes for other ventilation systems on the ship.

2.3.8 Purging or venting of the ozone piping systems shall not lead to hazardous ozone concentrations on deck or in enclosed spaces.

Guidance note:
Hazardous concentrations may be avoided by diluting the ozone or installing an ozone destructor.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.3.9 Safety measures shall be in place to prevent supply of ozone to empty water systems.

2.3.10 Nitrogen rich waste stream shall be vented to open air. Disposal of nitrogen to an enclosed space may be accepted if it can be shown by calculation that the amount of disposed nitrogen does not affect the health of present personnel.

2.4 Instrumentation and control systems

2.4.1 All possible leakage sources in the ozone piping system shall be covered by a minimum of two independent means of ozone leakage detection.

Guidance note:
Fixed ozone gas detectors close to possible leakage sources and pressure monitoring are accepted methods for leakage detection.
A combination of the two methods is accepted.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

2.4.2 Fixed ozone gas detectors shall cover all possible leakage sources. Gas detectors shall as a minimum be placed close to the ozone generator and the ozone injection point.

2.4.3 The sensors or sampling suction points for ozone gas detectors shall be located where an ozone leakage is most likely to be sensed first.
Due regard shall be taken to the relative density of the gas as well as to the ventilation flow.

2.4.4 If double walled ozone piping is installed, fixed ozone gas detectors shall be located at the ventilation outlet from the annular space in the double walled piping.

2.4.5 Ozone gas detectors shall have a set point of 0.1 ppm ozone.

2.4.6 Ozone piping systems shall be fitted with automatic shut-off and purging functions.

2.4.7 An emergency stop button shall be located where the ozone system is operated as well as locally within and outside the accessible spaces containing ozone piping.

2.4.8 The alarm shall be both acoustic and optical and the signals shall be given within the accessible spaces containing ozone piping and at such locations that crew members attending to an alarm shall not be led to entering a space possibly containing leaked ozone.
2.4.9 The following signals shall lead to alarm, automatic shutdown and purging of the ozone system:
   a) ozone leakage detection
   b) emergency stop buttons
   c) failure of ventilation system. Applicable according to [2.2] alternative 2
   d) failure of connected water system to which the ozone is injected. Applicable according to [2.2].

2.4.10 Portable ozone and oxygen gas detection shall be provided. Oxygen gas detection is not required on systems where worst case leakage of oxygen, nitrogen or ozone cannot lead to hazardous concentrations with regards to suffocation.

2.5 Operational instructions

2.5.1 An operational manual for the ozone system shall be prepared and is subject to approval. The manual shall be kept on board the ship and shall as a minimum contain the following:
   a) general description of the system
   b) ozone generation and supply system piping and instrumentation diagram
   c) procedures for starting up the system
   d) procedures for shutting down and gas freeing the system
   e) procedures for opening of containment
   f) entry and evacuation procedures for the spaces containing ozone piping systems
   g) procedures for calibration or changing of sensors
   h) procedures for periodic inspections and tightness testing
   i) use of personal protective equipment
   j) medical treatment procedures for intoxication and suffocation.

2.6 Manufacture and testing

2.6.1 The ozone piping shall be tightness tested in the presence of the surveyor after installation on board.

2.6.2 All required functions of the safety and control system shall be tested in the presence of the surveyor after installation on board.
SECTION 8 POLLUTION PREVENTION

1 Oil Pollution prevention

1.1 Application

1.1.1 The following requirements apply to arrangements and equipment for handling and disposal of oily water and oil residues except when originating from cargo handling on tankers.

1.2 Ships of 400 gross tonnage and above

1.2.1 Forepeak tanks and other tanks forward of the collision bulkhead shall not be arranged for carriage of oil.

1.2.2 Combined fuel oil and ballast water tanks shall not be permitted.

1.2.3 Collecting tank(s) for oil residues including sludge, waste oil, drain oil, etc. shall be arranged with a minimum aggregate capacity of:

\[ V = K C D \, [m^3] \]

- \( K = 0.015 \) for ships where heavy fuel oil is purified for main engine use, or
- \( K = 0.005 \) for ships using diesel oil or heavy fuel oil which does not require purification before use

\( C \) = daily fuel oil consumption \([m^3]\)

\( D \) = length of voyage in days, but not less than 30 days unless restricted service notation.

1.2.4 Where heavy fuel oil is purified onboard, at least 80% of the capacity given in [1.2.3] shall be in tank(s) suitable for sludge from the fuel oil purifiers.

1.2.5 Tanks for oil residues shall be arranged with suitable access possibilities to facilitate cleaning.

1.2.6 Tanks for sludge from heavy fuel oil purifiers shall be fitted with heating arrangements.

1.2.7 Arrangements for transferring oil residues and oily bilge water to reception facilities shall be provided. The reception facility connection flange(s) shall be suitably located and with dimensions as given in Table 1. The oil residue handling system shall have no connections to the bilge water system except for:

- a possible common line leading to a common reception facility connection flange fitted with a screw-down non-return valve, and
- connections for draining settled water from sludge tanks to bilge water holding tanks or bilge wells provided fitted with manually operated self-closing valves or equivalent arrangements.

Table 1 Standard dimensions of flanges for discharge connections

<table>
<thead>
<tr>
<th>Description</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outside diameter</td>
<td>215 mm</td>
</tr>
<tr>
<td>Inner diameter</td>
<td>According to pipe outside diameter</td>
</tr>
<tr>
<td>Bolt circle diameter</td>
<td>183 mm</td>
</tr>
</tbody>
</table>
### Rules for classification: Ships — DNVGL-RU-SHIP Pt.4 Ch.6. Edition July 2018

<table>
<thead>
<tr>
<th>Description</th>
<th>Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slots in flange</td>
<td>6 holes 22 mm in diameter equidistantly placed on a bolt circle of the above diameter, slotted to the flange periphery. The slot width to be 22 mm</td>
</tr>
<tr>
<td>Flange thickness</td>
<td>20 mm</td>
</tr>
<tr>
<td>Bolts and nuts quantity, diameter:</td>
<td>6, each of 20 mm in diameter and of suitable length</td>
</tr>
</tbody>
</table>

The flange is designed to accept pipes up to a maximum internal diameter of 125 mm and shall be of steel or other equivalent material having a flat face. This flange, together with a gasket of oilproof material, shall be suitable for a service pressure of 6 bar.

### 1.2.8 The oil residue handling system shall have no direct overboard connection other than the reception facility connection flange.

### 1.2.9 An oily-water separating/oil filtering equipment capable of producing an effluent with oil content of less than 15 ppm shall be installed for the purpose of processing oil contaminated discharges.

**Guidance note:**
Excessive oil content in the water fed to the oily-water separating or filtering equipment could frequently cause malfunction of this equipment. It is recommended that a bilge water holding tank is arranged for pre-separation of oily water and with facilities for transfer of the oil-on-top in this tank to the oil sludge or waste oil tanks. Unless used for discharge to shore, bilge water holding tanks should not be connected to the suction side of the bilge pumps. The holding tank should be emptied through the bilge water separator.

### 1.2.10 For ships above 10 000 gross tonnage an oil content detecting device which shall sound an alarm if the oil content of the effluent exceeds 15 ppm shall be fitted. In addition to activating acoustic and visual alarm, the oil content detecting device shall automatically stop the discharge of oily water overboard, and instead direct it to bilge holding tank or bilge well.

Ships having combined fuel oil tanks and ballast tanks are required to comply with these requirements regardless of tonnage.

**Guidance note:**
In order to permit discharge of bilge water within special areas as defined in MARPOL 73/78 Annex I Reg. 10(1) (Baltic Sea, Mediterranean Sea, Black Sea, Red Sea, Gulfs, Gulf of Aden and Antarctic areas), alarm and automatic stop of the overboard discharge when oil content in the effluent exceeds 15 ppm, is required also for vessels less than 10 000 gross tonnage.

### 1.2.11 Where the bilge separator pump is arranged for automatic start, the oil content detecting device shall initiate automatic stop of the overboard discharge when the oil content in the effluent exceeds 15 ppm.

### 1.2.12 Oily-water separating/oil filtering equipment and oil content detecting device, if fitted, shall comply with MARPOL 73/78 Annex I.

### 1.2.13 The discharge lines of oily-water separators shall be fitted with a reverse flow protecting valve at the ship's side.

### 1.2.14 For vessels in dedicated trades the requirements in [1.2.9] and [1.2.10] may be dispensed with subject to acceptance of the flag administration and port state administrations, involved.

### 1.3 Ships below 400 gross tonnage

### 1.3.1 Suitable arrangements for collecting, handling and transfer to reception facilities of oily water and oil residues shall be available.
2 Exhaust gas cleaning systems for the reduction of NO\textsubscript{x}

2.1 General

2.1.1 The requirements in this rule section apply to all exhaust gas cleaning systems installed onboard for the purpose of reducing NO\textsubscript{x} emissions.

Guidance note:
Novel designs or design principles not previously known to the Society are subject to special consideration based on the principles outlined below.

---end of guidance note---

2.1.2 The paragraphs listed below shall only be applicable when the Society is authorised to issue the IAPP certificate. (the Society is recognised organisation for MARPOL Annex VI)
— [2.1.3], [2.6.2] and [2.7.3].

2.1.3 If exhaust gas cleaning systems (SCR system) for the reduction of NO\textsubscript{x} are considered necessary to comply with MARPOL Annex VI Regulation 13, the installed systems are considered mandatory installations.

Guidance note:
Where the Society is authorised to issue the IAPP certificate under MARPOL Annex VI, the environmental performance of the system in accordance with MARPOL Annex VI Regulation 13 / NO\textsubscript{x} Technical Code is considered to fall within the scope of the society and documents and manuals specified in MARPOL Annex VI Regulation 13 / NO\textsubscript{x} Technical Code are subject to approval.

---end of guidance note---

2.1.4 For ships designed to comply with the rules for redundant propulsion or dynamic positioning, the exhaust gas cleaning units and associated systems shall be designed not to interfere with the principles of Pt.6 Ch.2 Sec.7, Pt.6 Ch.3 Sec.2 or Pt.6 Ch.3 Sec.1. For notations requiring fully separated engine rooms (e.g. DYNPOS(AUTRO), DPS(3), RP(3, x)), each side shall be provided with a separate cleaning unit and any common piping shall have isolation valves at the bulkhead on both sides.

Guidance note:
The exhaust gas cleaning function need not be arranged for availability according to these principles.

---end of guidance note---

2.1.5 Stability calculations and stability manual shall take the exhaust cleaning system installation into account in accordance with the Society’s rules and IMO requirements.

Guidance note:
Although the exhaust gas cleaning units are subject to assessment of risk of failure (e.g. clogging) they should not be considered an active component provided arranged in accordance with [2.3.1].

---end of guidance note---

2.2 Component and system design

2.2.1 The materials used in exhaust gas cleaning components and systems shall be made of materials with a melting point above 925°C.

2.2.2 Exhaust gas cleaning components shall be certified as required by Sec.1 Table 4.
2.2.3 Interfaces to other ship systems shall be arranged to prevent the backflow of fluids or exhaust gas into such systems. Steam or compressed air supply valves for soot cleaning arrangements are considered normally closed and not covered by this requirement.

2.2.4 Where the design of the exhaust gas cleaning system is considered to require additional means for cleaning (e.g. due to soot build up), such arrangements are subject to approval. The system shall be automatically operated.

2.2.5 Systems for cleaning of soot build up shall be provided where engines shall be operated on heavy fuel oil.

2.2.6 By-pass valves and other valves arranged for remote or automatic operation shall be provided with position indication (both local and remote).

2.3 Exhaust gas systems

2.3.1 Exhaust pipes from multiple engine installations (i.e. main engines for propulsion, aux. engines for power generation, boilers etc.) shall not be connected, but shall have separate outlets, unless arranged with bypass according to these rules or other precautions are taken to prevent the loss of main function in the event of failure and to prevent the return of exhaust gases to a stopped engine installation.

2.3.2 Bypass shall be arranged for exhaust gas cleaning systems installed on vessels with a single main propulsion unit and where failure may lead to loss of any main function. This may be dispensed with if unrestricted flow is ensured and no risk of failure leading to shut down of engine is demonstrated. Acceptable means for ensuring no risk of failure leading to shutdown shall in such case include:

— soot cleaning arrangements per [2.2.4] regardless of fuel type
— temperature control for treatment fluid injection (set point is determined requirements for fuel type)
— active and/or passive thermal regeneration in case of soot build up shall be confirmed by SCR and engine manufacturer (functionality and temperature-/back pressure tolerance)
— propulsion systems with HFO fuelled main engine(s) shall be able to manoeuvre on MGO or MDO in case of increased build up of residues on catalysts (e.g. poor fuel quality). The ECA(SOx-A) class notation may serve as basis for evaluation of the fuel system capabilities.

2.3.3 The bypass valves shall be remotely operated from the control station for the exhaust gas cleaning system. The valves shall fail to safe mode upon loss of power supply or a failure in the pneumatic supply to the actuator(s).

2.3.4 The bypass arrangement shall be provided with interlock logic ensuring that the bypass valve is confirmed open before closing / blocking exhaust gas to the NO\textsubscript{X} reduction unit.

2.3.5 The bypass arrangement shall automatically open to bypass mode in case of a cleaning system shutdown or an increase of back-pressure that may affect the engine served.

2.3.6 The exhaust outlets from engine installations solely used for emergency operations are not required to comply with MARPOL Annex VI Reg.13 (e.g. emergency fire pump engines, emergency generator engines) and shall have independent exhaust outlets.

2.3.7 It shall be documented that the pressure drop in the exhaust gas cleaning system does not exceed the maximum allowable according to the engine and machinery component manufacturers. The pressure drop assessment shall be performed from the exhaust outlet of the engine installations to the exhaust outlet to open air. It shall include pressure drop from pipes and fittings as well as other components that contribute to pressure drop (e.g. silencers, exhaust gas boilers, SO\textsubscript{X} reduction units etc.). For cleaning systems where multiple exhaust sources are coupled to the same cleaning unit, the total pressure drop for all connected units shall be calculated.
The pressure drop shall take into account the exhaust gas flow corresponding to maximum specified operating load of the engine installations.

2.3.8 Exhaust gas piping shall be arranged so as to prevent ingress of treatment fluids into the engine installations served. This shall be prevented by placing the treatment fluid injection nozzle(s) after the exhaust drain pot usually fitted in the exhaust pipes to collect condensation/water from exhaust pipes. Exhaust collecting pipes/drain pots shall be provided with a drainage system that is capable of draining when the unit is in operation. The drainage for non-UREA based systems shall be led to a tank of suitable size.

**Guidance note:**
Placing the injection nozzle before the drain pot (i.e. between drain pot and engine) may be accepted if the injection control system prevents injection when the engine installation is not running and when the exhaust temperature is below SCR operating temperature. In such case the injection control system is subject for class approval.

---end-of-guidance-note---

2.3.9 Valves in the exhaust line shall be arranged as per [3.3.10].

2.3.10 Cleaning of valves in the exhaust line shall be arranged as per [3.3.11].

2.3.11 If exhaust gas fans for the prevention of excessive back-pressure is needed the cleaning system shall be arranged with a bypass. Fans shall be arranged with redundancy if deemed necessary for safety of the system (control of pressure).

2.3.12 Bypass systems shall be designed for the maximum exhaust flow in the system.

2.3.13 Where the treatment fluid has significant corrosive properties at elevated temperatures, the exhaust piping and associated valves and fittings shall be of stainless steel from the point where the treatment fluid is injected into the exhaust gas and until it is fully vaporized.

**Guidance note:**
Applies to UREA and similar types of treatment fluids. The requirement for stainless steel may be waived if the exhaust line after the injector is not arranged with bends for the distance specified by the manufacturer.

---end-of-guidance-note---

2.4 Urea solution based treatment fluid systems

2.4.1 The treatment fluid supply and tank vent system shall be separated from other piping systems onboard and shall be classed as per "other media" in Sec.1 [2.1.5].

2.4.2 If located in a high fire risk space, the tanks shall be stainless steel or equivalent material with a melting point above 925 °C. Materials shall be suitable for storage and transportation of the treatment fluid or mixtures thereof (ref. IACS UR M77).

**Guidance note:**
Steel tanks with an efficient corrosion protection system, either free standing tanks or structural tanks, are also considered suitable for this use.

---end-of-guidance-note---

2.4.3 Piping systems for urea shall be stainless steel or equivalent material with a melting point above 925 °C. Plastic piping may be used subject to the requirements of Sec.2 if the tank valves are quick acting shutoff valves arranged as for fuel oil systems or the tank valves are fail-to-closed type.

2.4.4 Air and sounding pipes shall be led to open air. Air pipes shall be arranged to prevent entrance of water to the urea tanks and shall terminate in a safe location with respect to the possible urea fumes in case of a
fire near the storage tank(s). Short sounding pipes may be accepted if arranged as for fuel tanks according to Sec.4 [11].

2.4.5 Tanks and piping systems shall be located in a well-ventilated space and piping shall not be led through accommodation, service spaces or control stations. If located in a separate space, the area shall be served by a ventilation system separate from accommodation, service spaces and control stations, providing not less than 6 air changes per hour (see IACS UR M77).

2.4.6 Drip trays shall be fitted under those parts of the urea systems which are often opened up for cleaning such as filters, pumps, etc. All urea tanks shall be equipped with drip trays of sufficient capacity and height for collecting any leakage of urea that may occur from valves, fittings etc (see IACS UR M77). Tank vent heads are not required to be fitted with spill trays.

2.4.7 The storage tank(s) shall be maintained within the correct temperature range applicable to the particular concentration of the solution. Where urea tanks are situated near to boilers or other hot surfaces, the tanks shall be well insulated (see IACS UR M77).

Guidance note:
Depending on the operational area of the ship, this may necessitate the fitting of heating and/or cooling systems. The physical conditions recommended by applicable recognized standards (such as ISO 18611-3) should be taken into account to avoid any impairment of the urea solution during storage

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2.4.8 Urea tanks shall not be located adjacent to, and urea piping shall not pass through, tanks for feed water, drinking water fuel oil (see IACS UR M77).

2.4.9 Every urea inlet or outlet pipe, that would allow urea to escape from the tank if damaged, shall be provided with a shut-off valve directly on the tank. Short distance pieces of rigid construction are acceptable (see IACS UR M77).

2.4.10 Where a common supply system is serving multiple engine installations, the isolation arrangements for idle engines shall be so designed so that leaking isolation valves cannot result in ingress of treatment fluid into idle engines.

Guidance note:
This may be achieved by arranging the injection valve with a double block and bleed arrangement (or similar). If the injection nozzle is placed after a suitably sized and arranged drain pot with automatic drainage, i.e. between drain pot and catalyst, such arrangements may be dispensed with.

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2.4.11 The following protective equipment shall be provided in the vicinity of, but in a safe distance from, the bunker station and treatment pumps: Appropriate chemical resistant protective gloves, respiratory protection if mist or dust may occur, tight fitting protective goggles or face shield, and fixed or portable eye wash equipment.

2.4.12 Treatment systems involving processes that may lead to generation of vapours that are flammable or hazardous to crew are subject to special considerations. See Pt.6 Ch.7 Sec.1 [3.4.2].

2.4.13 Systems and arrangements for pre-decomposition of urea prior to injection into the exhaust stream are subject to special considerations according to the requirements for non-urea based treatment fluid systems.

2.4.14 Where selective catalytic reduction (SCR) type exhaust gas cleaning systems are applied, excessive slip shall be prevented.
Guidance note:
The method for preventing excessive slip is subject to case by case approval. Monitoring of urea injection flow relative to engine load or other relevant load characteristics may be an acceptable solution.

---end---of---guidance---note---

2.5 Non-urea based treatment fluid systems

2.5.1 The treatment fluid supply system shall be separate from other piping systems onboard.

2.5.2 The exhaust gas cleaning system shall be supplied by pumps of sufficient capacity for supplying the system at maximum load without interfering with any essential service on the ship.

2.5.3 Treatment fluids considered to represent a hazard to personnel, pertain to class I piping systems regardless of design pressure (see IACS UR P2).

2.5.4 Treatment fluids with flashpoint below 60°C shall not be accepted. Anhydrous ammonia and aqueous ammonia shall not be used as a reductant in an SCR except where it can be demonstrated that it is not practicable to use a urea based reductant.

2.5.5 Tanks (including buffer tanks for water and treatment fluid mixes) and piping systems for treatment fluids that have corrosive properties or are considered to represent a hazard to personnel shall be designed in accordance with the requirements to fuel oil systems in Sec.5 [4] with the following additional requirements:

a) Materials in tanks and piping systems shall be suitable for storage and transportation of the treatment fluid or mixtures thereof.

b) Air and sounding pipes to tanks shall be led to open air and shall terminate in such a location that possible spray does not represent a hazard to personnel.

c) Tanks and piping systems shall be located in a well-ventilated space and shall not be led through accommodation, service spaces or control stations. If located in a separate space, ventilation capacities and leakage detection systems may be specially considered.

d) Piping systems shall have all welded connections, except in way of valves or connections to equipment.

e) Leakage sources shall be provided with spill trays leading to a closed tank. This also applies to bunker stations for treatment fluids. Leakage sources shall be screened so that possible spray does not endanger personnel.

Guidance note:
Treatment fluids are subject to assessment of hazards and location of tanks and piping may be subject to special considerations.

2.5.6 Where a common supply system is serving multiple engine installations, the isolation arrangements for idle engines shall be so designed that leaking isolation valves cannot result in ingress of treatment fluid into idle engines.

Guidance note:
This may be achieved by arranging the injection valve with a double block and bleed arrangement (or similar). If the injection nozzle is placed after a suitably sized and arranged drain pot with automatic drainage, i.e. between drain pot and catalyst, such arrangements may be dispensed with.
2.5.7 If treatment fluids are considered to represent a hazard to personnel, the following protective measures shall be provided:

— Eye wash and showers shall be provided in the vicinity of the treatment fluid bunker manifold as well as in the vicinity of, but in a safe distance from, treatment fluid pumps.
— Three (3) sets of protective equipment, covering all skin so that no part of the body is unprotected (large aprons, special gloves with long sleeves, suitable footwear, coveralls of chemical resistant material, tight-fitting goggles or face shields or both). The equipment shall be resistant to the treatment fluid in question. The equipment shall be used by personnel during bunkering and in operations which may entail danger to personnel.
— The protective equipment shall be provided in easily accessible lockers outside the accommodation.

2.5.8 Piping systems and tanks for residues/sludge generated by the exhaust gas cleaning system shall be separate from bilge water systems and the normal engine room bilge and sludge system, except for a common discharge piping to deck manifold.

2.5.9 Treatment systems involving processes that may lead to generation of vapours that are flammable or hazardous to crew are subject to special considerations. See Pt.6 Ch.7 Sec.1 [3.4.2].

2.5.10 Where selective catalytic reduction (SCR) type exhaust gas cleaning systems are applied, excessive slip shall be prevented.

Guidance note:
The method for preventing excessive slip is subject to case by case approval. Monitoring of urea injection flow relative to engine load or other relevant load characteristics may be an acceptable solution.

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2.6 Control and monitoring systems

2.6.1 The control and monitoring system shall comply with, and be documented according to, the requirements of Ch.9.

Guidance note:
The exhaust gas cleaning control and monitoring system is considered to be an important control system in the context of Ch.9.

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2.6.2 Control and monitoring systems as specified in MARPOL Annex VI Regulation 13 / NOx Technical Code related to performance are subject to verification when the Society is authorised to issue the IAPP certificate under MARPOL Annex VI.

2.6.3 For ships with class notation E0 (periodically unattended machinery space), any alarm and or shut-down condition in the exhaust gas cleaning system shall be relayed to the vessels extension alarm system.

2.6.4 Exhaust gas cleaning units shall be monitored as listed in Table 2. Indicators and alarms shall be provided at the control station for the exhaust gas cleaning unit:

Table 2 Control and monitoring

<table>
<thead>
<tr>
<th>System</th>
<th>Item</th>
<th>Gr 1 Indication and Alarm</th>
<th>Gr 2 Shut down with alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build-up of liquid in exhaust gas cleaning system</td>
<td>Level high</td>
<td>HA</td>
<td>SH</td>
</tr>
<tr>
<td>Treatment fluid supply system</td>
<td>Supply pressure</td>
<td>IR, LA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply temperature</td>
<td>HA, LA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tank level</td>
<td>IR, HA, LA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tank temperature</td>
<td>IR, HA, LA</td>
<td></td>
</tr>
<tr>
<td>Exhaust gas system</td>
<td>Pressure drop across unit</td>
<td>HA, SH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature before unit</td>
<td>IR, HA, LA</td>
<td>SH 6(10)</td>
</tr>
<tr>
<td></td>
<td>Temperature after unit</td>
<td>IR, HA</td>
<td>SH 1(10)</td>
</tr>
<tr>
<td>Ammonia slip</td>
<td>Ammonia slip</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td>Control / alarm/ monitoring / safety</td>
<td>Power failure</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

Gr 1 = Sensor(s) for indication, alarm (common sensor permitted).
Gr 2 = Sensor for shut down.
IR = Remote indication (presentation of values), in engine control room or another centralized control station.
A = Alarm activated for logical value.
LA = Alarm for low value.
HA = Alarm for high value.
SH = Shut down and opening of bypass with corresponding alarm.

1) If required by [2.2.1], the system shall give alarm before the tolerance temperature of internal components is reached and trigger automatic bypass if the temperature is exceeded. Alternatively a separate cooling system for the components may be fitted if arranged with low supply pressure alarm and redundancy.
2) If such build up is possible within the system (includes intermediate tanks), shall give alarm if treatment fluids enters the machinery it serves. Not applicable for urea solution based SCR systems.
3) Treatment fluid supply temperature monitoring may be replaced by tank temperature monitoring if heat tracing is not fitted.
4) Includes intermediate tanks if installed.
5) Alarm shall be activated before the backpressure exceeds the maximum allowable for the engine installations served.
6) For system where exhaust gas inlet temperature is essential. SHD at low-low AND high-high level. Not applicable for urea solution based SCR systems where urea is not injected at temperatures outside the SCR system operating temperature range.
7) Indication of soot fire.
8) If fans are installed. Indication of operational status.
9) Ref MEPC.198(62) - 3.3.1 Measures to prevent ammonia slip shall be provided. See also guidance note for [2.5.10].
10) Separate shutdown sensor is not required for urea solution based SCR systems.

2.6.5 All alarms related to the cleaning system installation shall be routed to a permanently manned location, and be presented as individual alarms or alarm groups.

2.6.6 The exhaust gas cleaning unit system shall be arranged for emergency stop from the control station of the exhaust gas cleaning unit. Activation of emergency stop shall cause immediate stop of all active components in the exhaust gas cleaning system and shall not lead to stop of the engine installations served. The emergency stop signals may be implemented in the cleaning unit safety system, and shall comply with the requirements in Ch.8.
2.7 Surveys and testing

2.7.1 Testing of piping systems shall be performed in accordance with Sec.10.

2.7.2 The exhaust gas cleaning system is subject to a function and safety test after installation onboard. The test shall include control and monitoring systems as well as the electrical power supply. The test shall be performed with all engine installations served in operation and in all relevant load conditions, including manoeuvring.

2.7.3 The exhaust gas cleaning system shall also be surveyed and tested in accordance with the requirements of MARPOL Annex VI Regulation 13/NO_x Technical as applicable.

Guidance note:
Where the Society is authorised to issue the IAPP certificate under MARPOL Annex VI, testing of the environmental performance of the system in accordance with MARPOL Annex VI Regulation 13/NO_x Technical Code is also considered to fall within the scope of the Society.

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3 Exhaust gas cleaning systems for the reduction of SO_x

3.1 General

3.1.1 The requirements in this rule section apply to all exhaust gas cleaning systems installed on board for the purpose of reducing SO_x emissions.

3.1.2 The paragraphs listed below shall only be applicable when the Society is authorised to issue the IAPP certificate. (the Society is recognised organisation for MARPOL Annex VI)
— [3.1.3], [3.8.1], [3.9.2], [3.9.4] and [3.10.3].

3.1.3 If needed to comply with MARPOL Regulations, the installed exhaust gas cleaning systems for the reduction of SO_x are considered mandatory installations for ships operating within emission control areas as defined by Annex VI to MARPOL 73/78, or using exhaust gas cleaning for compliance with world-wide requirements as defined by Annex VI to MARPOL 73/78.

Guidance note:
Where the Society is authorised to issue the IAPP certificate under MARPOL Annex VI, the environmental performance of the system in accordance with IMO Res. MEPC.259(68) is considered to fall within the scope of the Society and documents and manuals specified in IMO Res. MEPC.259(68) are subject to approval.

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3.1.4 For ships designed to comply with the rules for redundant propulsion or dynamic positioning, the exhaust gas cleaning units and associated systems shall be designed not to interfere with the principles of Pt.6 Ch.2 Sec.7, Pt.6 Ch.3 Sec.2 or Pt.6 Ch.3 Sec.1. For notations requiring fully separated engine rooms (e.g. DYNPOS(AUTRO), DPS(3), RP(3, x)), each side shall be provided with a separate cleaning unit and any common piping shall have isolation valves at the bulkhead on both sides.

Guidance note:
The exhaust gas cleaning function need not be arranged for availability according to these principles.

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3.1.5 For ships designed to comply with the rules for navigation in ice, the exhaust gas cleaning seawater inlets and outlets shall be designed in accordance with the principles of Pt.6 Ch.6.
Guidance note:

If the cleaning system requires a large flow (relative to the machinery cooling water flow) of seawater for operation, this may adversely affect the function of the ice sea chest. In such case it should be considered to increase the dimensioning of the ice sea chest to accommodate the increased flow.

3.1.6 Stability calculations and stability manual shall take the exhaust cleaning system installation into account in accordance with the Society rules and IMO requirements.

Guidance note:

Although the exhaust gas cleaning units are subject to assessment of risk of failure (e.g. clogging, water filling etc.) they should not be considered an active component provided arranged in accordance with [3.3.1].

3.1.7 A safety study should be performed and documented in a safety concept. The safety concept shall contain a system description with schematic diagrams of the plant layout and describe the hazards associated with the design and operation of the exhaust gas cleaning system along with suitable measures to control the identified hazards.

Guidance note:

The hazard analysis shall at minimum address: Fresh water and sea water systems (e.g. high/low temperatures, system clogging and flooding), process chemicals (e.g. storage, ventilation, high/low temperatures), exhaust gas piping system (e.g. back-pressure fluctuations or increase), safe mode for bypass valves, fire hazards, material selection, ship motions, and any other relevant hazard.

3.2 Component and system design

3.2.1 The materials used in exhaust gas cleaning components and systems as part of the exhaust system shall be made of materials with a melting point above 925°C, unless systems preventing overheating are provided and arranged with redundancy. Such designs are subject to a separate case by case approval and may be subject to additional requirements to ensure material temperature tolerances are not exceeded at any time in operation and during/after shut down, and corrective measures are implemented. Plastic scrubber unit(s) and piping for water supply/discharge may be used subject to the requirements of Sec.2 as a non-essential seawater system.

3.2.2 Exhaust gas cleaning components shall be certified as required by Sec.1 Table 4.

3.2.3 Interfaces to other ship systems shall be arranged to prevent the backflow of fluids or exhaust gas into such systems. Steam or compressed air supply valves for soot cleaning arrangements are considered normally closed and not covered by this requirement. Treatment fluid tank heating or washing arrangements are subject to special considerations.

3.2.4 Where a common wash water supply or other common systems is serving multiple exhaust gas cleaning units, the isolation arrangements for idle units shall be so designed so that leaking isolation valves do not result in ingress of wash water fluid into idle units.

3.2.5 Where the design of the exhaust gas cleaning system is considered to require additional means for cleaning (e.g. due to soot build up), such arrangements are subject to approval. The system shall be automatically operated and arranged with redundancy.

3.2.6 Systems for cleaning due to soot build up shall be provided where engines shall be operated on heavy fuel oil.
3.2.7 By-pass valves and other valves or dampers arranged for remote or automatic operation shall be provided with position indication (both local and remote).

3.2.8 Scrubber units designed with bottom exhaust inlets, e.g inline scrubbers, or otherwise designed such that failure of the inlet pipe weld or other welded connections in the scrubber unit may cause water ingress into the exhaust line below, are subject to the following additional requirements:

1) Works certificate (W) for scrubber unit material.
2) Manufacture shall be according to the requirements for class III piping.
3) NDT of relevant welded joints shall be according to requirements for class II piping.
4) Scrubber unit shall be regularly inspected for damage to the relevant welds and the condition of structures adjacent to the welds and inlets shall be assessed. This includes internal spray screening arrangements.

Guidance note:
Potential failures that may cause water ingress into the exhaust line below includes, but is not limited to:
— structural failure in water spray screening arrangements for the exhaust inlet
— cracking or corrosion in welded connection between scrubber bottom and exhaust inlet (NA for double-walled inlet pipe)
— failure in load bearing welded connections.

---end---of---guidance---note---

3.2.9 The exhaust gas cleaning unit and exhaust piping exposed to the cleaning water or treated exhaust shall be suitable for the corrosive properties of the two medias.

3.3 Exhaust gas systems

3.3.1 Exhaust pipes from multiple engine installations (i.e. main engines for propulsion, aux. engines for power generation, boilers etc.) shall not be connected, but shall have separate outlets, unless arranged with bypass according to these rules or other precautions are taken to prevent the loss of main function in the event of failure and to prevent the return of exhaust gases to a stopped engine installation.

3.3.2 Bypass shall be arranged for exhaust gas cleaning systems installed on vessels with single main propulsion unit and where failure may lead to loss of any main function. This may be dispensed with if unrestricted flow of exhaust gas is ensured and no risk of failure leading to shut down of engine is demonstrated. Acceptable means for ensuring no risk of failure leading to shutdown shall in such case include:
— soot cleaning arrangements per [3.2.5] for mist catchers (independent of scrubber control system)
— no packing beds or similar internal structures are allowed (except mist catchers)
— all scrubber unit components made of materials with melting point above 925°C.

3.3.3 The bypass valves shall be remotely operated from the control station for the exhaust gas cleaning system. The valves shall fail to safe mode upon loss of power supply or a failure in the pneumatic supply to the actuator(s).

3.3.4 The bypass arrangement shall be provided with interlock logic ensuring that the bypass valve is confirmed open before closing / blocking exhaust gas to the scrubber.

3.3.5 The bypass arrangement shall automatically open to by-pass mode in case of a cleaning unit shutdown or an increase of back-pressure in the scrubber system that may affect the engine served.

3.3.6 It shall be documented that the pressure drop in the exhaust gas cleaning system does not exceed the maximum allowable according to the engine maker and machinery component manufacturers. The pressure drop assessment shall be performed from the exhaust outlet of the engine installations to the exhaust outlet to open air. It shall include pressure drop from pipes and fittings as well as other components that contribute
to pressure drop (e.g. silencers, exhaust gas boilers, NO\textsubscript{x} reduction units, etc.). For cleaning systems where multiple exhaust sources are coupled to same cleaning unit the total pressure drop for all connected units shall be calculated.

The pressure drop shall take into account the exhaust gas flow corresponding to maximum specified operating load of the engine installations.

3.3.7 The exhaust outlets from engine installations used for emergency operations (emergency fire pump engines, emergency generator engines) shall have separate outlets.

3.3.8 Exhaust gas piping and cleaning unit shall be arranged for prevention of water ingress into the engine installations served. The cleaning unit shall be arranged with a water collecting arrangement capable of draining the maximum water supply to the scrubber, including fire extinguishing if applicable. The cleaning unit shall be provided with independent water level detectors for both alarm and cleaning unit system shutdown.

3.3.9 Exhaust collecting pipes (drain pots) shall be provided, with drainage, to prevent any unintended backflow of scrubbing water from reaching the engine installations served.

3.3.10 Exhaust inlet valves to multi inlet scrubbers and other valves installed for the prevention of exhaust backflow into systems/idle machinery shall be provided with arrangements to prevent exhaust gas leakage. This requirement is not applicable for leakages past scrubber unit.

Guidance note:
Acceptable means for prevention of exhaust leakage includes, but is not limited to:
— single valve with sealing air supply at machinery side of valve
— single valve with exhaust fans maintaining underpressure at EGCS side of valve with alarm for loss of underpressure
— double non-sealing dampers with redundant sealing air supply and alarm for loss of sealing air pressure.

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3.3.11 Exhaust valves required to be functional at any time to maintain passage of exhaust (including in case of scrubber system failure and shutdown) and valves installed per [3.3.10] shall be fitted with a permanent soot cleaning arrangement for contact surfaces, or equivalent arrangements maintaining the valve operability. Soot cleaning may be arranged by compressed air, steam or water. Equivalent arrangements, e.g. self-cleaning valves are subject to case by case approval.

3.3.12 Bypass arrangements shall be designed for the maximum exhaust flow of the system.

3.3.13 If exhaust gas fans for the prevention of excessive back-pressure are required the system shall be arranged with a bypass. The fans shall be arranged with redundancy if deemed necessary for safety of the system (control of pressure).

3.4 Sea water systems

3.4.1 Centrifugal sea-water pumps shall be installed as low as possible in the ship.

3.4.2 Strums shall be fitted to all sea chest openings in the shell plating. The total area of the strum holes shall be at least twice the total flow area in the sea water inlet valves.

3.4.3 Regarding sea inlets, see Sec.3 [1.3].

3.4.4 Materials and coatings in tanks and piping systems shall be suitable for the corrosive properties of the cleaning water. Structural tanks shall not be used for untreated cleaning water.
3.4.5 Air and sounding pipes to tanks shall be led to open air and shall terminate in such a location that possible spray or fumes does not represent a hazard to personnel.

3.4.6 The seawater supply system shall be separate of other seawater piping systems onboard. Connections to other seawater supply systems are acceptable provided means for prevention of backflow are arranged.

3.4.7 The exhaust gas cleaning system seawater pumps and sea chest arrangements shall have sufficient capacity for supplying the system at maximum load and without interfering with any essential service on the ship.

3.4.8 Water discharge piping from the exhaust gas cleaning system shall be separate from other seawater piping systems and shall be led overboard through a separate discharge outlet. Seawater from other systems used for diluting are acceptable provided means for prevention of backflow are arranged.

3.4.9 The discharge water piping, including valve(s), shall be protected against corrosion. Distance piece between overboard valve and shell plating shall be of substantial thickness, at least shell plate thickness, but not less than 15 mm.

3.4.10 The discharge water overboard outlet shall be arranged in such a way as to prevent the discharge water from being drawn into sea suctions for other pipe systems, e.g. systems for cooling water for machinery or freshwater generation. If the scrubber system is arranged with any openings or equipment below the freeboard deck which is regarded as an open end according to Pt.3 Ch.12 Sec.9, the discharge(s) shall be fitted with a non return valve in addition to the remote operated overboard valve.

**Guidance note:**
The discharge outlet should located minimum 4 meters aft of any sea water inlet and well below the waterline for any loading condition.

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3.4.11 Drainage arrangements and a high-high bilge level detector shall be fitted in the spaces containing the exhaust gas cleaning system to detect any major cleaning water leak, including, but not limited to, engine room, the engine room casing and any other space normally not fitted with bilge wells, through which the sea water supply is routed. The level detector shall shut down all water supply pumps and trigger automatic cleaning system shutdown. The drain lines may be led to a bilge well in the main bilge system.

3.4.12 For systems with scrubber units designed with bottom exhaust inlets, e.g inline scrubbers, for which bypass is not required according to the rules, the following additional requirements apply:

a) The level build up alarm sensors required in [3.9] for cleaning unit and associated tanks shall, in addition to triggering alarm, also shut down water supply to the relevant scrubber unit.

b) The level build up sensors in the scrubber unit shall be placed with a sufficient safety margin for the system reaction time, both for controlled- and safety shutdown.

c) All valves in drain line from scrubber unit water outlet to overboard, or to holding tank in closed loop systems, shall be confirmed open at all times while the scrubber system is running.

d) Where blocking of filters or other equipment in the discharge line from scrubber units may lead to water build up in scrubber unit, they shall be fitted with differential pressure monitoring.

e) Exhaust collecting pipes (drain pots) as required by [3.3.9] shall be fitted with leakage detection and alarm.

3.5 Freshwater systems

3.5.1 The exhaust gas cleaning freshwater piping system shall be separated from other freshwater piping systems onboard. Connections to other onboard freshwater supply systems are acceptable provided means for prevention of backflow are arranged.
Guidance note:
A screw-down non-return valve is acceptable provided it is not possible to pump exhaust gas cleaning freshwater back into the onboard freshwater piping system.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.5.2 The exhaust gas cleaning system freshwater pumps shall have sufficient capacity for supplying the system at maximum load and without interfering with any essential service on the ship.

3.5.3 Any discharge water piping, including valve(s), shall be protected against corrosion. Distance piece between overboard valve and shell plating shall be of substantial thickness, at least shell plate thickness, but not less than 15 mm.

3.6 NaOH solution systems

3.6.1 NaOH treatment fluid storage, handling and supply systems pertain to class I piping systems regardless of design pressure (ref. IACS UR P2).

3.6.2 Materials in tanks and piping systems shall be of a non-combustible material suitable for storage and transportation of the treatment fluid or mixtures thereof. Integral tanks shall have an efficient corrosion prevention system.

Guidance note:
NaOH solutions are incompatible with zinc (including galvanized components), aluminum, magnesium, bronze, brass, copper, tin, chromium, and tantalum and alloys thereof.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.6.3 The plate thickness in free standing NaOH solution tanks shall not be less than 5 mm. For very small tanks, however, the plate thickness may be reduced to 3 mm. Sides and bottom of the tanks shall be well stiffened. Large tanks shall be fitted with wash bulkheads.

3.6.4 Air and sounding pipes to tanks shall be led to open air and shall terminate in such a location that possible spray does not represent a hazard to personnel.

3.6.5 Spaces containing tanks and piping systems shall be mechanically ventilated by not less than 6 air changes per hour and piping shall not be led through accommodation or control stations. If located in a separate space, leakage detection systems may be specially considered.

3.6.6 Piping systems shall have all welded connections, except in way of valves or connections to equipment. This requirement is not applicable for drip tray drain lines.

3.6.7 Leakage sources shall be screened so that possible spray does not endanger personnel or may come in contact with heated surfaces, and be provided with spill trays leading to a closed tank. Storage tanks shall not be located above heated surfaces. For the treatment fluid bunker station, alternative arrangements may be accepted if the same or higher level of safety can be ensured. Such an arrangement shall be submitted for approval.

3.6.8 The drip trays shall be drained to a closed tank. The leakage drain tank and/or drain piping shall be fitted with leakage detection and the drain tank shall at minimum be dimensioned for 125% of the volume of NaOH remaining in the system after shutdown and closing of storage tank valves. Leakage detection shall trigger alarm and shutdown of treatment fluid system and closing of tank valves. The complete leak containment system shall be of materials suitable for NaOH solutions.

3.6.9 Precautions shall be taken against overflow of NaOH solution from the lowest situated drip trays. Drainpipes led to double bottom tanks shall be provided with means for prevention of backflow.
3.6.10 If the drain tank is part of an overflow system, the overflow line and the tank shall be fitted with alarms and drain lines shall be provided with means for prevention of backflow.

3.6.11 Valves fitted below the top of tanks shall for all tank sizes be arranged for quick acting shut-off from a central position outside the space where the tanks are located and at a safe distance from openings to the same space. The controls shall be located separately from the fuel quick acting shut-off valve system controls in order to avoid erroneous operation. Paint, corrosion, etc. shall not impair the efficiency of the remote operation of the valves.

3.6.12 Portable storage tanks up to 1.25 m³ may be used for handling and storage of NaOH, according to the following additional requirements:
   a) The tank shall be suitable for storage and handling of NaOH.
   b) The tank shall not be arranged for filling, but shall be replaced when empty.
   c) The tank shall be fitted in a dedicated space or enclosure protecting it from mechanical damage and able to contain any leakage. The enclosure or openings to the dedicated space shall be located on open deck.
   d) Any leakage from the tank and associated fittings shall be led to a closed tank dimensioned for the full capacity of the tank and otherwise arranged according to the requirements for the general leakage containment system. Audible and visual leakage alarm shall be provided outside the compartment adjacent to the entrance and clearly marked with a signboard.
   e) The tank drain line shall be arranged for quick acting shut-off at the first point of fixed piping, from a central position outside the space where the tanks are located and at a safe distance from openings to the same space.

3.6.13 Where a common supply system is serving multiple engine or boiler installations, the isolation arrangements for idle units shall be so designed that leaking isolation valves cannot result in ingress of treatment fluid into idle engines.

3.6.14 The following protective measures shall be provided:
   — Eye wash and showers shall be provided in the vicinity of the treatment fluid bunker manifold as well as in the vicinity of, but in a safe distance from treatment fluid pumps.
   — 3 sets of protective equipment, covering all skin so that no part of the body is unprotected (large aprons, special gloves with long sleeves, suitable footwear, coveralls of chemical resistant material, tight-fitting goggles or face shields or both). The equipment shall be resistant to the treatment fluid in question. The equipment shall be used by personnel during bunkering and in operations which may entail danger to personnel.
   — The protective equipment shall be provided in easily accessible lockers outside the accommodation.
   — Permanent warning signs shall be fitted.

3.7 Treatment fluid systems other than NaOH

3.7.1 Treatment fluids considered to represent a hazard to personnel, pertain to class I piping systems regardless of design pressure (ref. IACS UR P2). Treatment fluids with flashpoint below 60°C shall not be accepted.

3.7.2 Tanks (including buffer tanks for water and treatment fluid mixes) and piping systems for treatment fluids that have corrosive properties or are considered to represent a hazard to personnel shall be designed in accordance with the requirements to fuel oil systems in Sec.5 [4] with the following additional requirements:
   a) Materials in tanks and piping systems shall be suitable for storage and transportation of the treatment fluid or mixtures thereof.
   b) Air and sounding pipes to tanks shall be led to open air and shall terminate in such a location that possible spray does not represent a hazard to personnel.
c) Spaces containing tanks and piping systems shall be mechanically ventilated by not less than six (6) air changes per hour and piping shall not be led through accommodation, service spaces or control stations. If located in a separate space, leakage detection systems may be specially considered.

d) Tanks shall be provided with high level alarms.

e) Piping systems shall have all welded connections, except in way of valves or connections to equipment.

f) Leakage sources shall be provided with spill trays leading to a closed tank with leakage detection and alarm. For the treatment fluid bunker station, alternative arrangements may be accepted if the same or higher level of safety can be ensured. Such an arrangement shall be submitted for approval. Leakage sources shall be screened so that possible spray does not endanger personnel.

g) Valves fitted below the top of tanks shall for all tank sizes be arranged for quick acting shut-off from a central position outside the space where the tanks are located and at a safe distance from openings to the same space.

**Guidance note:**

Treatment fluids should be subject to assessment of hazards and location of tanks and piping may be subject to special considerations.

---end---of---guidance---note---

3.7.3 Where a common supply system is serving multiple engine or boiler installations, the isolation arrangements for idle units shall be so designed that leaking isolation valves cannot result in ingress of treatment fluid into idle engines.

3.7.4 If treatment fluids are considered to represent a hazard to personnel, the following protective measures shall be provided:

— Eye wash and showers shall be provided in the vicinity of the treatment fluid bunker manifold as well as in the vicinity of, but in a safe distance from treatment fluid pumps.

— 3 sets of protective equipment, covering all skin so that no part of the body is unprotected (large aprons, special gloves with long sleeves, suitable footwear, coveralls of chemical resistant material, tight-fitting goggles or face shields or both). The equipment shall be resistant to the treatment fluid in question. The equipment shall be used by personnel during bunkering and in operations which may entail danger to personnel.

— The protective equipment shall be provided in easily accessible lockers outside the accommodation.

3.7.5 Treatment systems involving processes that may lead to generation of vapours that are flammable or hazardous to crew are subject to special considerations. See Pt.6 Ch.7 Sec.1.

3.8 Waste and discharge systems

3.8.1 The wash water treatment and monitoring system for the discharge water shall comply with the requirements of IMO Res. MEPC 259(68).

3.8.2 Piping systems and tanks for residues/sludge generated by the exhaust gas cleaning system shall be separate from bilge systems and the normal engine room sludge system, except for a common discharge piping to deck manifold.

3.9 Control and monitoring systems

3.9.1 The exhaust gas cleaning control and monitoring system shall comply with, and be documented according to the requirements of Ch.9.

**Guidance note:**

The exhaust gas cleaning control and monitoring system is considered as an important control system in the context of Ch.9.

---end---of---guidance---note---
3.9.2 The emission control and monitoring system as specified in IMO Res. MEPC.259(68), shall comply with the requirements of Ch.9 when the Society is authorised to issue the IAPP certificate. (the Society is recognised organisation for MARPOL Annex VI).

3.9.3 The required safety shutdown functions for the exhaust gas cleaning installation shall be implemented in a safety system that is independent of the cleaning system control and monitoring system, in line with the principles of Ch.9. This includes all required signals related to shutdown (automatic and manual) of the cleaning system and operation of bypass valves, if installed.

3.9.4 The emission control and monitoring systems as specified in IMO Res. MEPC.259(68) related to environmental performance are subject to verification when the Society is authorised to issue the IAPP certificate under MARPOL Annex VI.

3.9.5 For ships with class notation E0 (periodically unattended machinery space), any alarm and or shutdown condition in the exhaust gas cleaning system shall be relayed to the vessels extension alarm system. Any condition in the exhaust gas cleaning installation causing automatic shut-down of the system shall be identified and analysed in the safety concept, including the eventual influence on the engine(s) served. All such conditions shall be alarmed.

3.9.6 Exhaust gas cleaning units shall be monitored as listed in Table 3. Indicators and alarms shall be provided at the control station for the exhaust gas cleaning unit.

Guidance note:
Additional parameters to monitor and record are described in IMO Res. MEPC.259(68).

---end---of---guidance---note---

Table 3 Monitoring and recording

<table>
<thead>
<tr>
<th>System</th>
<th>Item</th>
<th>Gr 1 Indication and alarm</th>
<th>Gr 2 Shut down with alarm</th>
<th>Data to be recorded according to MEPC.259(68)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Build-up of liquid in exhaust gas cleaning system</td>
<td>Level high in exhaust cleaning unit(s) and/or intermediate tanks 2)</td>
<td>HA, SH\textsuperscript{13})</td>
<td>SH\textsuperscript{8})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level in exhaust collecting pipes (drain pots)\textsuperscript{12})</td>
<td>HA, SH\textsuperscript{13})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust gas cleaning wash water systems</td>
<td>Supply pressure</td>
<td>IR, LA</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>Temperature \textsuperscript{10})</td>
<td>HA, LA</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flow rate</td>
<td>IR</td>
<td></td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>pH, washwater</td>
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<td>R</td>
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<tr>
<td></td>
<td>PAH, washwater</td>
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<td>R</td>
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<td></td>
<td>Turbidity, washwater</td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Treatment fluid supply system</td>
<td>Leakage detection</td>
<td></td>
<td>SH</td>
<td></td>
</tr>
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<td></td>
<td>Supply temperature \textsuperscript{3})</td>
<td>HA, LA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment fluid tanks</td>
<td>Level \textsuperscript{6})</td>
<td>IR, HA, LA</td>
<td>SH\textsuperscript{14})</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature \textsuperscript{3})</td>
<td>IR, HA, LA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust gas system</td>
<td>Pressure drop across unit</td>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td>Control / alarm/ monitoring / safety</td>
<td>Power failure</td>
<td>A</td>
<td></td>
<td></td>
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<tr>
<td>---------------------------------------------</td>
<td>----------------</td>
<td>----</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Valve position</td>
<td>SH</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control air pressure</td>
<td>LA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilge system</td>
<td>Level 9)</td>
<td>SH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel oil combustion units</td>
<td>Load</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exhaust gas emission</td>
<td>SO2 (ppm)</td>
<td>R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO2 (%)</td>
<td>R</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pressure before unit 7) | HA | SH<sup>8,11</sup> | R |
Temperature before unit | IR, HA | R |
Temperature after unit 4) | IR, HA<sup>1</sup> | SH<sup>1,8,11</sup> | R |
Exhaust gas fans run 5) | IR | |
Loss of underpressure/sealing air (as applicable) | LA | |

<table>
<thead>
<tr>
<th>Bilge system</th>
<th>Level 9)</th>
<th>SH</th>
</tr>
</thead>
</table>

Feed water system

Piping systems

SO2 (ppm) R
CO2 (%) R
Part 4 Chapter 6 Section 8

Piping systems

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**Gr 1** = Sensor(s) for indication, alarm (common sensor permitted).
**Gr 2** = Sensor for shut down.
**IR** = Remote indication (presentation of values), in engine control room or another centralized control station.
**A** = Alarm activated for logical value.
**LA** = Alarm for low value.
**HA** = Alarm for high value.
**SH** = Shut down and opening of bypass with corresponding alarm.
**R** = Parameter to be recorded according to MEPC.259(68) when required, see [3.9.2].

1) If required by [3.2.1], the system shall give alarm before the tolerance temperature of internal components is reached and trigger automatic bypass if the temperature is exceeded. Alternatively a separate cooling system for the components may be fitted if arranged with low supply pressure alarm and redundancy.

2) If such build up is possible within the system.

3) In the event the temperature may impact personnel safety, alarms shall be provided for high temperature and also low temperature as found relevant. High temperature alarm is required where fitted with tank heating arrangements, low temperature is required dependent on tank location and arrangement. Treatment fluid supply temperature monitoring may be replaced by tank temperature monitoring if heat tracing is not fitted.

4) Alarm to indicate soot fire.

5) If fans are installed. Indication of operational status.

6) Includes intermediate tanks if installed.

7) Alarm shall be activated before the backpressure exceeds the maximum allowable for the engine installations served. May be served by the same sensor as for pressure drop recording.

8) Shut-down sensor shall be separate from the other sensors, and be connected to the safety system.

9) A bilge level switch shall be fitted in the space containing scrubber and associated piping system. The trigger level shall be at a suitable height above main class bilge alarm level, if applicable, and trigger immediate shutdown of pumps.

10) Sensor(s) shall be arranged in any location necessary to protect temperature sensitive discharge piping, supply piping and/or scrubbing unit internal components from temperatures exceeding the component rating. In case low water temperature may affect scrubber function, low temperature alarm is required.

11) Not applicable for systems with scrubber units designed with bottom exhaust inlets, e.g inline scrubbers, and for which bypass is not required.

12) Only applicable for systems with scrubber units designed with bottom exhaust inlets, e.g inline scrubbers, and for which bypass is not required. See [3.4.12].

13) For systems with scrubber units designed with bottom exhaust inlets, e.g inline scrubbers, or otherwise designed such that manual shutdown due to level alarm is not feasible, the Gr1 level sensor shall also shut down the water supply to the scrubber(s).

14) Only applicable for NaOH transfer/feed pumps and tank valves, in case of leak detection and tank overflow.

---

**3.9.7** All alarms related to the cleaning system installation shall be routed to a permanently manned location, and be presented as individual alarms or alarm groups.

**3.9.8** Exhaust gas cleaning systems arranged for automatic control shall also be arranged with means for manual operation.

**3.9.9** The exhaust gas cleaning unit system shall be arranged for emergency stop from the control station of the exhaust gas cleaning unit and in ECR when provided. Activation of emergency stop shall cause immediate stop of all active components in the exhaust gas cleaning system and shall not lead to stop of the engine installations served. The emergency stop signals may be implemented in the scrubber safety system, and shall comply with the requirements in Ch.8.
3.10 Surveys and testing

3.10.1 Testing of piping systems shall be performed in accordance with Sec.10.

3.10.2 The exhaust gas cleaning system is subject to a function and safety test after installation onboard. The test shall include control and monitoring systems as well as electrical power supply. The test shall be performed with all engine installations served in operation and in all relevant load conditions, including manoeuvring.

**Guidance note:**
The test procedure should give detailed procedures for testing of the following items in addition to the testing of piping according to Sec.10:

- Where a by-pass arrangement is installed this should be verified to fail to safe mode (bypass open) upon loss of power.
- Where the exhaust pipes of multiple engine installations are combined into one cleaning system, the isolation valves should be verified tight in closed position.
- Back pressure of the exhaust gas system shall be verified to be within engine manufacturers’ recommendations.
- Where an oil burner is installed the flame failure switch should be tested.

Additionally for systems utilizing hazardous treatment fluids, e.g. NaOH:

- All drip trays and drainage tanks should be verified installed prior to filling the system with the treatment fluid.
- Quick acting shut off valve system should be tested when applicable.
- Drip tray arrangements including material selection, alarm and/or drainage to closed tank should be verified according to the rules.
- Condition of screening of possible leakage sources should be verified.
- Where installed the functionality of the ventilation system and leakage detection in the storage space should be verified.
- Where treatment fluids are considered to represent a hazard to personnel, protective measures, as required, should be verified in place.

Additionally for control and monitoring systems:

- Test of E-stop.
- Test of independent safety system verifying EGCS shutdown/pump stop with alarm for the required values in column Gr 2 in Table 3.
- Test of automatic stop (with alarm) of water supply pumps in case of high level in the scrubber.
- Test of alarm sensors.
- Test of normal operation: Start/stop; standby start/stop (as applicable); manual operation (as applicable); automatic restart (without manual intervention) of EGCS C&M, wash water system and exhaust gas analyzer when recover from total loss of power; and start interlock.
- Alarm handling: Interface to vessels IAS (as applicable); EGCS alarm transfer to the vessels main alarm system, and to the vessels extension alarm system in case of operation during unattended machinery space; alarm in case of no water flow through the wash water monitoring system during scrubber operation.
- Failures to initiate alarm: Loss of communication; loss of power; broken wire; I/O module failure; redundancy test (as applicable); HMI failure; failure in CEMS (SO₂/CO₂ analyzer); failure in water monitoring system; failure in GPS.
- Data-logger (MEPC): Report generation and download of data.
- Verify software no’s/version.
- Workmanship: Wiring/cabling; labelling / marking of components; earth connection.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

3.10.3 The exhaust gas cleaning system shall also be surveyed and tested in accordance with the requirements of IMO Res. MEPC.259(68).
Guidance note:

Where the Society is authorised to issue the IAPP certificate under MARPOL Annex VI, testing of the environmental performance of the system in accordance with IMO Res. MEPC.259(68) is also considered to fall within the scope of the Society.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---
SECTION 9 PIPES, PUMPS, VALVES, FLEXIBLE HOSES AND DETACHABLE PIPE CONNECTIONS

1 Pipes

1.1 General

1.1.1 The wall thicknesses of pipes shall comply with the requirements in this section.

1.1.2 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.

1.2 Minimum wall thickness

1.2.1 The minimum wall thickness shall not be less than given in Table 1, Table 2 and Table 3 for pipes of copper or copper alloy, steel and stainless steel, respectively.

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

1.2.3 Bilge and ballast pipes and fittings of nodular cast iron shall have minimum wall thickness not less than:

\[
t = K(0.5 + 0.001D_N) \text{ [mm]}
\]

where:

\[
D_N = \text{nominal diameter in mm}
\]

\[
K = \begin{cases} 
9 & \text{for pipes} \\
12 & \text{for fittings other than tees} \\
14 & \text{for tees.}
\end{cases}
\]

1.3 Calculation of wall thickness of pipes being subject to internal pressure

1.3.1 The wall thickness of pipes subjected to internal pressure shall be calculated as specified in this subsection. The nominal wall thickness is, however, not to be less than specified in [1.2].

1.3.2 Symbols used in calculation of wall thickness of pipes:

\[
t_1 = \text{nominal wall thickness [mm]}
\]

\[
t_0 = \text{strength thickness [mm]}
\]

\[
t = \text{minimum required wall thickness [mm]}
\]

\[
c = \text{corrosion allowance [mm]}
\]

\[
b = \text{bending allowance [mm]}
\]

\[
\sigma_t = \text{permissible stress [N/mm}^2\text{]}
\]

\[
\sigma_b = \text{specified minimum tensile strength of the material at } 20^\circ \text{C [N/mm}^2\text{]}
\]
σ_{\text{ft}} = \text{specified minimum yield stress or 0.2% proof stress of the material at design material temperature [N/mm}^2]\text{]} \\
p = \text{design pressure [bar]} \\
D = \text{outer diameter of pipe [mm]} \\
σ_{b 100 000} = \frac{\text{average value for stress to rupture after 100 000 hours at design material temperature [N/mm}^2]\text{]}}{100 000} \\
a = \text{percentage negative manufacturing tolerance} \\
e = \text{strength ratio.}

1.3.3 The design pressure \( p \) to be used in the formula in [1.3.6], is defined as the maximum working pressure, and shall not be less than the highest set pressure of the safety valve or relief device. For special cases, the design pressure shall be specially considered. For pipes which are connected to pumps, \( p \) shall be taken equal to the maximum pump pressure, i.e. the safety valve set pressure for displacement pumps, and for centrifugal pumps the maximum pressure on the head-capacity characteristic.

When determining the maximum working pressure \( p \), consideration shall be given to possible pressure surges in the piping.

For steam pipes between boiler and superheater, and for steam pipes leading from the superheater, where the superheater safety valve is controlled by a pilot valve operated by the steam pressure in the saturated steam drum, the design pressure shall be taken equal to the set pressure of this safety valve.

For pipes without safety valves and pressure gauges on the low-pressure side of pressure-reducing valves, \( p \) shall be taken equal to the pressure on the high-pressure side of the pressure-reducing valve.

For feed pipes, \( p \) shall be taken equal to 1.25 times the boiler design pressure.

**Table 1 Minimum wall thickness for pipes of copper and copper alloys**

<table>
<thead>
<tr>
<th>External pipe diameter ( D ) [mm]</th>
<th>Minimum wall thickness [mm]</th>
<th>Copper</th>
<th>Copper alloy</th>
</tr>
</thead>
<tbody>
<tr>
<td>( D \leq 10 )</td>
<td></td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>( 10 &lt; D \leq 20 )</td>
<td></td>
<td>1.2</td>
<td>1</td>
</tr>
<tr>
<td>( 20 &lt; D \leq 44.5 )</td>
<td></td>
<td>1.5</td>
<td>1.2</td>
</tr>
<tr>
<td>( 44.5 &lt; D \leq 76.1 )</td>
<td></td>
<td>2</td>
<td>1.5</td>
</tr>
<tr>
<td>( 76.1 &lt; D \leq 108 )</td>
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<td>2.5</td>
<td>2</td>
</tr>
<tr>
<td>( 108 &lt; D \leq 159 )</td>
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<td>3</td>
<td>2.5</td>
</tr>
<tr>
<td>( 159 &lt; D \leq 267 )</td>
<td></td>
<td>3.5</td>
<td>3</td>
</tr>
<tr>
<td>( 267 &lt; D \leq 470 )</td>
<td></td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>( 470 &lt; D \leq 508 )</td>
<td></td>
<td>4.5</td>
<td>4</td>
</tr>
</tbody>
</table>
### Table 2 Minimum wall thickness for steel pipes

<table>
<thead>
<tr>
<th>External diameter D [mm]</th>
<th>Pipes in general 3) 4) 5) 6) 7) 8)</th>
<th>Air, overflow and sounding pipes for structural tanks 1) 2) 3) 5) 8) 9)</th>
<th>Bilge, ballast and general seawater pipes 1) 3) 4) 5) 7) 8)</th>
<th>Bilge, air, overflow and sounding pipes through ballast or fuel oil tanks, ballast lines through fuel oil tanks and fuel oil lines through ballast tanks 1) 2) 3) 4) 5) 7) 8) 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2 to 12</td>
<td>1.6</td>
<td>3.2</td>
<td>3.6</td>
<td>6.3</td>
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<td>13.5 to 17.2</td>
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<tr>
<td>20</td>
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<td>4.5</td>
<td>3.6</td>
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<td>3.6</td>
<td>6.3</td>
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<td>51 to 63.5</td>
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<td>70</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>76.1 to 82.5</td>
<td>2.6</td>
<td>4.5</td>
<td>4.5</td>
<td>6.3</td>
</tr>
<tr>
<td>88.9 to 108</td>
<td>2.9</td>
<td>4.5</td>
<td>4.5</td>
<td>6.3</td>
</tr>
<tr>
<td>114.3 to 127</td>
<td>3.2</td>
<td>4.5</td>
<td>4.5</td>
<td>6.3</td>
</tr>
<tr>
<td>133 to 139.7</td>
<td>3.6</td>
<td>4.5</td>
<td>4.5</td>
<td>8</td>
</tr>
<tr>
<td>152.4 to 168.3</td>
<td>4</td>
<td>4.5</td>
<td>4.5</td>
<td>8.8</td>
</tr>
<tr>
<td>177.8</td>
<td>4.5</td>
<td>5</td>
<td>5</td>
<td>8.8</td>
</tr>
<tr>
<td>193.7</td>
<td>4.5</td>
<td>5.4</td>
<td>5.4</td>
<td>8.8</td>
</tr>
<tr>
<td>219.1</td>
<td>4.5</td>
<td>5.9</td>
<td>5.9</td>
<td>8.8</td>
</tr>
<tr>
<td>244.5 to 273</td>
<td>5</td>
<td>6.3</td>
<td>6.3</td>
<td>8.8</td>
</tr>
<tr>
<td>298.5 to 368</td>
<td>5.6</td>
<td>6.3</td>
<td>6.3</td>
<td>8.8</td>
</tr>
<tr>
<td>406 to 457</td>
<td>6.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) For pipes efficiently protected against corrosion, the thickness may be reduced by 20% of the required wall thickness but not more than 1 mm.

2) For sounding pipes, except those for cargo tanks with cargo having a flash point less than 60°C, the minimum wall thickness is intended to apply to the part outside the tank.

3) For threaded pipes, where allowed, the minimum wall thickness shall be measured at the bottom of the thread.

4) The minimum wall thickness for bilge lines and ballast lines through deep tanks and for cargo lines is subject to special consideration.

5) For larger diameters the minimum wall thickness is subject to special consideration.

6) The wall thickness of pipes within cargo oil and ballast tanks in systems for remote control of valves shall be no less than 4 mm.

7) For inlets and sanitary discharges, see Pt.3 Ch.12 Sec.9.

8) For stainless steel pipes, the minimum wall thickness shall be specially considered, but it shall not be less than given in Table 3.

9) For air pipes on exposed decks, see Pt.3 Ch.12 Sec.7 [3].
Table 3 Minimum wall thickness for stainless steel pipes

<table>
<thead>
<tr>
<th>External diameter D [mm]</th>
<th>Minimum wall thickness [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.2 to 17.2</td>
<td>1.0</td>
</tr>
<tr>
<td>21.3 to 48.3</td>
<td>1.6</td>
</tr>
<tr>
<td>60.3 to 88.9</td>
<td>2.0</td>
</tr>
<tr>
<td>114.3 to 168.3</td>
<td>2.3</td>
</tr>
<tr>
<td>219.1</td>
<td>2.6</td>
</tr>
<tr>
<td>273.0</td>
<td>2.9</td>
</tr>
<tr>
<td>323.9 to 406.4</td>
<td>3.6</td>
</tr>
<tr>
<td>over 406.4</td>
<td>4.0</td>
</tr>
</tbody>
</table>

Note:
The external diameters and thickness have been selected from ISO-Standard 1127. For pipes covered by other standards, thickness slightly less may be accepted.

1.3.4 The design temperature to be considered for determining the permissible stresses, may be the maximum temperature of the medium inside the pipe. For special cases, the design temperature shall be specially considered.

For steel pipes and pipes of copper and copper alloys, whose working temperature is lower than 50°C, the design temperature shall be taken equal to 50°C.

For saturated steam, the design temperature shall be equal to the saturation temperature.

For superheated steam with manual steam temperature regulation, the design temperature shall be taken at least equal to the steam temperature +15°C. For installations with automatic temperature control of the superheated steam, the design temperature may be equal to the steam temperature +5°C. It is assumed that any temperature fluctuations greater than 15°C or 5°C, respectively, above the normal working temperature shall be of short duration.

1.3.5 The minimum wall thickness of a straight or bent pipe shall not be less than:

\[ t = t_0 + c \]

If to be bent, the minimum wall thickness before bending shall not be less than: \( t + b \).

1.3.6 The strength thickness, \( t_0 \), shall not be less than calculated by the following formula:

\[ t_0 = \frac{pD}{20a_t^b + p} \]

The formula is valid for pipes having a ratio of wall thickness to outside diameter of 0.17 or less. For higher ratios the calculation of wall thickness shall be given special consideration.

1.3.7 For steel pipes the permissible stress, \( \sigma_t \), shall be based on the lower value of the following criteria:

\[
\frac{\sigma_b}{2.7} \quad \text{and} \quad \frac{\sigma_{ft}}{1.6} \quad \text{for austenitic} \quad \text{or} \\
\frac{\sigma_{ft}}{1.8} \quad \text{and} \quad \frac{\sigma_{b100,000}}{1.8} \quad \text{for other materials}
\]

Values for specified minimum yield or proof stress shall be in accordance with recognised standards given in Pt.2 Ch.2 Sec.4.
### Table 4 Tensile strength and permissible stress in pipes of copper and copper alloys

<table>
<thead>
<tr>
<th>Pipe material</th>
<th>Copper</th>
<th>Aluminium brass</th>
<th>Copper nickel Cu Ni 5 Fe 1 Mn</th>
<th>Copper nickel Cu Ni 10 Fe 1 Mn</th>
<th>Copper nickel Cu Ni 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material condition</td>
<td>Annealed</td>
<td>Annealed</td>
<td>Annealed</td>
<td>Annealed</td>
<td>Annealed</td>
</tr>
<tr>
<td>Minimum tensile strength [N/mm$^2$]</td>
<td>215</td>
<td>325</td>
<td>275</td>
<td>365</td>
<td></td>
</tr>
<tr>
<td>50°C</td>
<td>41</td>
<td>78</td>
<td>68</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>75°C</td>
<td>41</td>
<td>78</td>
<td>68</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>100°C</td>
<td>40</td>
<td>78</td>
<td>67</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>125°C</td>
<td>40</td>
<td>78</td>
<td>65.5</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>150°C</td>
<td>34</td>
<td>78</td>
<td>64</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>175°C</td>
<td>27.5</td>
<td>51</td>
<td>62</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>200°C</td>
<td>18.5</td>
<td>24.5</td>
<td>59</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>225°C</td>
<td>-</td>
<td>-</td>
<td>56</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>250°C</td>
<td>-</td>
<td>-</td>
<td>52</td>
<td>65.5</td>
<td></td>
</tr>
<tr>
<td>275°C</td>
<td>-</td>
<td>-</td>
<td>48</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>300°C</td>
<td>-</td>
<td>-</td>
<td>44</td>
<td>62</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1) Intermediate values may be determined by linear interpolation.
2) For materials not included in the table, the permissible stress shall be specially considered by the Society.

### Table 5 Corrosion allowance c for steel pipes

<table>
<thead>
<tr>
<th>Piping service</th>
<th>c [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superheated steam</td>
<td>0.3</td>
</tr>
<tr>
<td>Saturated steam</td>
<td>0.8</td>
</tr>
<tr>
<td>Steam coils in cargo tanks</td>
<td>2</td>
</tr>
<tr>
<td>Feed water for boilers in open circuit systems</td>
<td>1.5</td>
</tr>
<tr>
<td>Feed water for boilers in closed circuit systems</td>
<td>0.5</td>
</tr>
<tr>
<td>Blowdown pipes (for boilers)</td>
<td>1.5</td>
</tr>
<tr>
<td>Compressed air</td>
<td>1</td>
</tr>
<tr>
<td>Hydraulic oil</td>
<td>0.3</td>
</tr>
<tr>
<td>Lubricating oil</td>
<td>0.3</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>1</td>
</tr>
<tr>
<td>Cargo oil</td>
<td>2</td>
</tr>
<tr>
<td>LPG</td>
<td>0.3</td>
</tr>
<tr>
<td>Refrigerants</td>
<td>0.3</td>
</tr>
<tr>
<td>Fresh water</td>
<td>0.8</td>
</tr>
<tr>
<td>Sea water in general</td>
<td>3</td>
</tr>
</tbody>
</table>
1.3.8 For pipes made of copper and copper alloys the permissible stresses are given in Table 4 which refers to copper and copper alloys specified in Pt.2 Ch.2 Sec.11.

1.3.9 For pipes made of materials other than steel, copper and copper alloys the permissible stresses shall be especially considered.

1.3.10 When the allowance for bending \( b \) is not determined by a more accurate procedure, or when the bending is not carried out by a bending procedure ensuring a control of the wall thickness, the allowance shall not be less than:

\[
b = \frac{1}{2.5} \frac{D}{R} t_0
\]

where:

\[
R = \text{mean radius of the bend [mm]}
\]

In case the bending ratio:

\[
\frac{D}{R}
\]

is not given, this ratio shall be taken equal to 1:3.

1.3.11 For steel pipes the corrosion allowance \( c \) shall be as specified in Table 5.

For pipes of copper, brasses, copper-tin alloys and Cu—Ni alloys with Ni-content < 10% the corrosion allowance is 0.8 mm. For pipes of Cu—Ni alloys with Ni-content ≥ 10% the corrosion allowance is 0.5 mm. For media with small corrosive action in respect of the material employed, the corrosion allowance may upon approval be reduced to zero.

For pipes where there is a risk of heavy corrosion and/or erosion, a greater corrosion allowance may be required.

1.3.12 For seamless pipes and for welded pipes delivered by manufacturer approved for making welded pipes which are considered equivalent to seamless pipes, the strength ratio \( e = 1 \).

For welded pipes from other approved pipe manufacturers, \( e = 0.9 \).

1.3.13 The value of \( t \) does not account for any negative manufacturing tolerance, therefore the nominal wall thickness, \( t_1 \), shall not be less than:

\[
t_1 = \frac{t}{1 - \frac{a}{100}}
\]

1.3.14 The minimum wall thickness of branch pipe and main pipe in way of branch connections shall be determined according to a recognised standard and using permissible stresses in accordance with [1.3.7]. Alternatively, the thicknesses may be calculated according to [1.3.15]. However, the validity of [1.3.15] is limited by a maximum ratio for main line wall thickness/branch lines wall thickness of 2.

1.3.15 The minimum pipe wall thickness of main pipes at a branch connection shall not be less than:

\[
t = t_0 + c \ [\text{mm}]
\]
\[ e_0 = \frac{pD}{20\sigma_e} \] [mm]

e, the strength ratio, is expressed by the formula:

\[ e = e_1 \sin\gamma \frac{1.25}{1.25 + \frac{d_{\text{max}} - d_{\text{min}}}{2d_{\text{min}}}} \]

\( e_1 \) = basic strength ratio. Its variation with the parameter

\[ \frac{D_b}{\sqrt{D't_b}} \]

is shown in Figure 1.

\( \gamma \) = angle between centre lines of main pipe and branch. \( \gamma \) shall not be less than 45°

\( d_{\text{max}}, d_{\text{min}} \) = maximum and minimum diameter, respectively, of extruded opening in the main pipe, see Figure 1.

![Figure 1 Basic strength ratio](image)
Figure 2 Details of main pipe and branch pipe

The wall thickness $t_0$ of the main pipe shall have an extension not less than:

$$\sqrt{(D - t_0)t_0}$$

from the branch, see Figure 1.

The branch thickness $t_b$ shall have an extension not less than:

$$1.25\sqrt{(D_b - t_b)t_b}$$

from the main pipe, see Figure 1.

Examples of acceptable branch connections for use in piping systems for steam temperature above 400°C and for liquefied gases with temperature below -110°C are shown in Figure 2.
1.4 Thermal expansion stresses

1.4.1 For piping systems for steam at temperatures above 400°C, an analysis of thermal stresses shall be performed. In the following special cases, the analysis is not considered to be necessary:

— when the proposed piping system is considered equivalent to a successfully operating and approved installation
— when the proposed piping system, on being closely examined, may be regarded as being in no way inferior to a previously approved installation.

1.5 Documentation of thermal stress calculation

1.5.1 When an analysis of the piping system is necessary, full details of the thermal stress calculations shall be submitted for approval. All assumptions and approximations which are made, shall be stated clearly.

1.5.2 Plans or diagrams of the proposed piping system, including specifications of coordinate axes, pipe lengths, bend radius in pipe bends, together with information on suspension details shall be submitted. When the piping system has been subject to initial pre-stressing, the degree and location of the same shall be stated.
1.6 Stress calculation

1.6.1 When a thermal stress analysis of a piping system between two or more anchor points is carried out, the system shall be treated as a whole. The significance of all parts of the line, of restraints such as solid hangers, sway braces and guides and of intermediate restraints built in for the purpose of reducing loads on equipment or small branch lines, shall be duly considered. The stress analysis shall be carried out on the assumption that the piping system expands from 20°C to the highest operating temperature. The modulus of elasticity to be used for the pipe material, is the value of same at 20°C.

1.6.2 In carrying out a thermal stress analysis, stress concentration factors found to exist in components other than straight pipes, shall be taken into account. In cases where it is known that such components possess extra flexibility, this may be incorporated in the stress calculations. Stress concentration factors and flexibility factors given in Table 6 may be accepted for use in the calculations when other substantiated factors may be lacking.

1.6.3 The thermal expansion resultant stress \( \sigma_r \) is defined as:

\[
\sigma_r = \sqrt{\sigma_b^2 + 4 \tau^2} \quad [\text{N/mm}^2]
\]

where:

\[
\sigma_b = \frac{\sqrt{(i_1 M_1)^2 + (i_0 M_0)^2}}{Z},
\]

= total bending stress \([\text{N/mm}^2]\)

\[
\tau = \frac{M_T}{2Z},
\]

= torsional stress \([\text{N/mm}^2]\)

\[
M_T = \text{torsional moment} \quad [\text{Nm}]
\]

\[
M_I = \text{bending moment in plane of member} \quad [\text{Nm}]
\]

\[
M_0 = \text{bending moment transverse to plane of member} \quad [\text{Nm}]
\]

\[
i_1 = \text{stress concentration factor for in-plane bending moments}
\]

\[
i_0 = \text{stress concentration factor for out-of-plane bending moments}
\]

\[
Z = \text{section modulus in bending of member} \quad [\text{mm}^3].
\]

When the member cross-section is non-uniform, the section modulus of the matching pipe shall be used.

For branched systems, where the branch diameter is less than the header diameter, the branch section modulus may be taken as the smaller value of:

\[
\pi r_b^2 t_h \quad \text{and} \quad \pi r_b^2 i_{ib} t_b
\]

where:

\[
r_b = \text{mean cross-sectional radius of branch} \quad [\text{mm}]
\]

\[
t_h = \text{thickness of pipe which matches header} \quad [\text{mm}]
\]

\[
t_b = \text{thickness of pipe which matches branch} \quad [\text{mm}]
\]

\[
r_b = \text{mean cross-sectional radius of branch} \quad [\text{mm}]
\]

\[
i_{ib} = \text{in-plane stress concentration factor for branch.}
\]
1.6.4 The resultant stress $\sigma_r$ is at no point of the piping system to exceed the corresponding stress range $\sigma_{int}$:

$$
\sigma_{int} = 0.75\sigma_{tk} + 0.25\sigma_{tv}
$$

where:

$\sigma_{tk}$ = permissible pipe wall stress at 100°C or lower [N/mm$^2$]

$\sigma_{tv}$ = permissible pipe wall stress at maximum working temperature of system [N/mm$^2$].

For low temperature piping $\sigma_{int}$ shall be determined upon special consideration.

1.6.5 The sum of axial bending stress in the pipe wall due to static loading (pipe weight) and axial tensile stress due to internal pressure, is at no point in the system to exceed the permissible stress $\sigma_{tv}$.

**Table 6 Stress concentration factors and flexibility factors for metallic pipe-line elements**

<table>
<thead>
<tr>
<th>Type of element</th>
<th>Sketch</th>
<th>Flexibility parameter $\gamma$</th>
<th>Flexibility factor $k$</th>
<th>In-plane stress concentration factor $i_0^{(1)}$</th>
<th>Out-of-plane stress concentration factor $i_0^{(1)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight buttwelded pipe</td>
<td><img src="image1" alt="Sketch" /></td>
<td>$tR^2/r_m$</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Curved pipe</td>
<td><img src="image2" alt="Sketch" /></td>
<td>$\frac{1.65}{\gamma} \left[ \frac{1}{1 + 0.6E_k \frac{r_m}{t} \frac{r_m^2}{R^3}} \right]$</td>
<td>$\frac{0.9}{\gamma^3}$</td>
<td>$\frac{0.75}{\gamma^3}$</td>
<td></td>
</tr>
<tr>
<td>Welding tee</td>
<td><img src="image3" alt="Sketch" /></td>
<td>$4.4\frac{t}{r_m}$</td>
<td>1.0</td>
<td>$\frac{3}{4}i_0 + 0.25$</td>
<td>$\frac{0.9}{\gamma^3}$</td>
</tr>
<tr>
<td>Fabricated tee $\frac{d_b}{d_h} &gt; 0.3$</td>
<td><img src="image4" alt="Sketch" /></td>
<td>$\frac{r_h}{r_m}$</td>
<td>1.0</td>
<td>$\frac{3}{4}i_0 + 0.25$</td>
<td>$\frac{0.9}{\gamma^3}$</td>
</tr>
<tr>
<td>Type of element</td>
<td>Sketch</td>
<td>Flexibility parameter $\gamma$</td>
<td>Flexibility factor $k$</td>
<td>In-plane stress concentration factor $i_0^{(1)}$</td>
<td>Out-of-plane stress concentration factor $i_0^{(1)}$</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------</td>
<td>-------------------------------</td>
<td>------------------------</td>
<td>-----------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Branch-connection with</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\frac{d_b}{d_h} \leq 0.3$</td>
<td></td>
<td>$\frac{t_h}{r_m}$</td>
<td>$R_{bi} = 0.9 \left(\frac{d_h}{t_h}\right)^{3/2} \frac{t_b}{r_m} \frac{d_b}{d_h}$ for $M_{bi}$</td>
<td>$\frac{3}{4} i_0 + 0.25$</td>
<td>$0.9 \frac{1}{\gamma^3}$</td>
</tr>
<tr>
<td>If $\frac{d_b}{d_h} &gt; 0.3$ as for fabricated tee</td>
<td></td>
<td>$0.27 \left(\frac{d_h}{t_h}\right)^{3/2} \frac{t_b}{r_m} \frac{d_b}{d_h}$ for $M_{bo}$</td>
<td>$\frac{3}{4} i_0 + 0.25$</td>
<td>$0.9 \frac{1}{\gamma^3}$</td>
<td></td>
</tr>
</tbody>
</table>

1) $i_0$ and $i_1$ shall be taken less than 1.0.

**Guidance note:**
If the piping system is fitted with pre-stress (cold spring), allowance for this is given in evaluating the pipe reaction forces on connected machinery. The following formulae for estimating pipe reaction forces may be applied whenever an effective method of obtaining the designed pre-stress is specified and used, and may be used for calculating the hot and cold reaction forces, respectively:

$$R_V = \left(1 - \frac{2}{3} C\right) \frac{E_V}{E_K} R$$

$$R_K = C R \quad \text{or} \quad R_K = \left(1 - \frac{\sigma_{tw} E_K}{\sigma_r E_V}\right) R$$

whichever is the greater.

- $R$ = reaction force at 20°C with no pre-stress [N]
- $C$ = amount of pre-stress; with no pre-stress $C = 0.0$; with 100% pre-stress $C = 1.0$
- $E_V$ = modulus of elasticity for pipe material in hot condition [N/mm$^2$]
- $E_K$ = modulus of elasticity for pipe material at 20°C [N/mm$^2$].

The quantity:

$$\frac{\sigma_{tw} E_K}{\sigma_r E_V}$$

shall in all cases be less than 1.0.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

### 1.7 Plastic pipes

1.7.1 The nominal internal pressure for a pipe shall be determined by dividing the short-term hydrostatic test failure pressure by a safety factor of 4 or the long-term hydrostatic (> 100 000 h) test failure pressure...
by a safety factor 2.5 whichever is the lesser. The hydrostatic test failure pressure shall be verified experimentally or by a combination of testing and calculation methods according to a recognised standard.

1.7.2 The nominal external pressure for a pipe shall not be less than 1 bar and shall be determined by dividing the collapse test pressure by a safety factor of 3. The collapse test pressure shall be verified experimentally or by a combination of testing and calculation methods according to a recognised standard.

1.7.3 High temperature limits and pressure reductions relative to nominal pressures shall be according to the recognised standard, but in each case the maximum working temperature shall be at least 20°C lower than the minimum heat distortion temperature (determined according to ISO 75-1 method A, or equivalent) of the resin or plastic material. The minimum heat distortion temperature shall not be less than 80°C.

1.7.4 Temperature limits and pressure reductions are indicated in Table 7 and Table 8 for some material types. 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.

1.7.5 Glass fibre reinforced epoxy and polyester pipes are considerably more exposed to damage from impact and local overloading than steel. Wall thickness of piping and fittings shall be equivalent to nominal pressure 10 bar and piping $D > 100$ mm shall be rigid enough to carry a load of 100 kg at midspan, where midspan is taken from manufacturer’s recommendation. The susceptibility to impact damage shall be duly taken into consideration when handling, installing, and inspecting.

1.7.6 The tables Table 7 and Table 8 are related to water service only. Services involving other media shall be considered case by case.

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

1.7.8 Plastic pipes are normally made of electrically insulating materials and are as such not acceptable for service in gas hazardous areas. Special conductive qualities can be permitted if in accordance with the following principles:

— piping systems in or through gas hazardous areas carrying conductive fluids shall be electrically conductive on the outside

— piping systems in or through gas hazardous areas carrying non-conductive fluids, e.g. refined oil products and distillates, shall be electrically conductive on the inside and outside.

Where conductive piping is required, the resistance per unit length of pipe, fitting, etc. shall not exceed $10^5$ ohm/m, and the resistance to earth from any point in the piping system shall not exceed $10^6$ ohm.

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

1.7.10 In cases where design loads incorporate a significant cyclic or fluctuating component, fatigue shall be considered in material selection and installation design.

1.7.11 Piping materials’ compatibility with the fluid to be carried or in which it will be immersed, shall be ensured (e.g. for other liquids/gases than the normal such as water and common hydrocarbons).
Table 7 Thermoplastic pipes. Permissible pressures and temperature limits

<table>
<thead>
<tr>
<th>Material</th>
<th>Nominal pressure 1) PN [bar]</th>
<th>Permissible working pressure [bar]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-20 to 0°C</td>
<td>30°C</td>
</tr>
<tr>
<td>PVC</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>ABS</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>HDPE</td>
<td>10</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>12</td>
</tr>
</tbody>
</table>

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

Table 8 Glassfibre reinforced epoxy 1) and polyester pipes (GRP). Permissible pressures and temperature limits

<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></td>
<td>-50 to 30°C</td>
<td>40°C</td>
</tr>
<tr>
<td>80</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>16</td>
</tr>
<tr>
<td>135</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>16</td>
</tr>
</tbody>
</table>

1) Minimum heat distortion temperature 135°C.
2) According to recognised standards for marine use.

2 Pumps and fans or blowers

2.1 General

2.1.1 Pumps listed in Sec.1 Table 4 shall be delivered with the Society's product certificate. Drawings of pumps may not be required submitted for approval.

2.1.2 Fans listed in Sec.1 Table 4 shall be delivered with the Society's product certificate.

2.2 Relief valves

2.2.1 Displacement pumps shall be fitted with relief valves. For pumps transporting flammable liquids, the discharge from the relief valve may be led back to suction side of the pump.
2.3 Hydrostatic tests

2.3.1 Pump housings, except those for cargo oil pumps, shall be hydrostatically tested at a pressure of 1.5 times the design pressure. However, the test pressure need not exceed the design pressure by more than 70 bar.

Cargo oil pumps shall be tested to 1.3 times the design pressure, with a minimum of 14 bar. For centrifugal pumps the design pressure shall be the design pressure head on the head-capacity curve. For displacement pumps the design pressure shall not be taken less than the relief valve opening pressure.

The steamside of steam-driven pumps shall be hydraulically tested to 1.5 times the steam pressure. Hydrostatic testing of pump housings on submerged pumps may not be required.

2.4 Capacity tests

2.4.1 Pump capacities shall 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 m$^3$/h, the pump characteristic (head-capacity curve) shall be determined for each type of pump. For centrifugal pumps having capacities equal to or greater than 1,000 m$^3$/h, the pump characteristic shall be determined over a suitable range on each side of the design point, for each pump.

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

2.5 Fans or blowers

2.5.1 Fans serving gas dangerous spaces shall comply with the requirements Pt.5 Ch.5 Sec.6 [1.2].

2.5.2 For inert gas fans, see Pt.6 Ch.5 Sec.8.

3 Valves

3.1 Valve design

3.1.1 Drawings and specifications shall 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.

3.1.2 Pressure-temperature ratings for valves shall be in accordance with a recognised standard.

   Guidance note:
   Pressure-temperature ratings according to DIN, EN, JIS, ASME and ANSI may be accepted.

3.1.3 Screwed-on valve bonnets shall not be used for valves with nominal diameter exceeding 40 mm in class I piping systems, for valves on ship's side and bottom and for valves in systems for flammable fluids. Bolted bonnets having bonnet secured to body by less than four bolts and/or having secured bonnet by U-bolts shall only be accepted for class III service.

3.1.4 Screwed-on valve bonnets shall be secured against loosening when the valve is operated.
3.1.5 Valves shall be closed by turning the handwheel clockwise.

3.1.6 Indicators shall be provided to show the open and closed position of the valve, unless this can be observed in some other way.

3.1.7 Handles on cocks shall be removable only when the cocks are in closed position.

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

3.1.9 When the valves are designed for one way flow, the direction of flow shall be clearly and legible marked on the valve. The direction may be cast into the valve housing.

3.1.10 Suitable mechanical stops shall be provided on valves where the spindle is turned a part of a 360° turn between open and closed position. Manually operated butterfly valves, which are designed for throttling service, shall be equipped with a locking arrangement that holds the disc in any relevant position.

3.1.11 Non-integral seats or seat linings shall be locked in such a manner that they cannot become loose in service.

3.1.12 Valves with threaded end flanges or piping connections are subject for the restrictions given in [5].

3.2 Hydrostatic tests

3.2.1 All valve bodies shall 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 ship’s side and bottom the test pressure shall not be less than 5 bar.

3.2.2 Butterfly valves fitted on ship’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.

3.3 Certification of valves

3.3.1 The Society’s product certificates are required for valves with $D_N > 100\,\text{mm}$ having a design pressure, $p > 16\,\text{bar}$ and for ship side valves with $D_N > 100\,\text{mm}$ regardless of pressure rating. For other valves, works certificate will be accepted.

3.3.2 Valves shall be delivered with material certificates in accordance with Sec.2 Table 3.

4 Flexible hoses

4.1 General

4.1.1 A flexible hose assembly is a short length of metallic or non-metallic hose normally with prefabricated end fittings ready for installation.

4.1.2 Flexible hose assemblies may be accepted for use in fuel systems, lubricating, hydraulic and thermal oil systems, fresh water and sea water cooling systems, compressed air systems, bilge and ballast systems, refrigeration systems and class III steam systems. Flexible hoses in high pressure fuel oil injection systems are not accepted. For double walled hoses used in gas fuel systems where the secondary enclosure is required, the double barrier shall be maintained in the hose coupling, e.g. by the use of two O-rings.
4.1.3 Flexible hoses may only be used when necessary to admit relative movements between machinery and fixed piping systems. The hoses with couplings shall be type approved. Flexible hoses intended for installation in piping systems for flammable media and sea water system where failure may result in flooding are to be of fire-resistant type. This is not applicable in cases where such hoses are installed on open decks, as defined in SOLAS II-2/Reg. 9.2.3.2.2(10) and not used for fuel oil lines.

4.1.4 In fresh cooling water lines for diesel engines and compressors, flexible hoses without type approved couplings may be used provided each engine or compressor is arranged with an independent cooling system. Rubber hoses with internal textile reinforcement fitted by means of hose clamps may be accepted provided the hose is a short and reasonably straight length fitted between two metallic pipes with double hose clamps on each side.

4.1.5 For hoses of non-metallic materials documentation, showing the suitability of the hose for its intended use, shall be submitted for approval.

4.1.6 Flexible hoses constructed of rubber materials and intended for use in bilge, ballast, compressed air, oil fuel, lubricating, hydraulic and thermal oil systems shall incorporate a single, double or more, closely woven integral wire braid or other suitable material reinforcement. Flexible hoses of plastics materials for the same purposes, such as teflon or nylon, which are unable to be reinforced by incorporating closely woven integral wire braid, shall have suitable material reinforcement as far as practicable. Where rubber or plastics materials hoses shall be used in oil supply lines to burners, the hoses shall have external wire braid protection in addition to the reinforcement mentioned above. Flexible hoses for use in steam systems shall be of metallic construction.

4.1.7 Every hose shall be hydrostatically tested at a hydrostatic pressure of 1.5 times the maximum working pressure.

4.2 Installation

4.2.1 Flexible hoses shall be accessible for inspection.

4.2.2 Flexible hoses shall be limited to a length necessary to provide for relative movement between fixed and flexibly mounted items of machinery/equipment or systems.

4.2.3 Means shall be provided to isolate flexible hoses used in systems for fuel oil, lubricating oil, sea-water cooling and compressed air.

4.2.4 When used in systems conveying flammable fluids flexible hoses shall be shielded from hot surfaces and other sources of ignition.

5 Detachable pipe connections

5.1 Flange connections

5.1.1 Flanges with their pressure-temperature ratings in accordance with a recognised national standard may be accepted.

5.1.2 Examples of accepted flange connections for steel piping are shown in Figure 3. Typical applications of these types of connections are given in Table 9 depending upon the class of piping, media, size, pressure and temperature. Other types of flange connections may be considered in each particular case.
For type D the pipe and flange shall be screwed with a tapered thread and the diameter of the screw portion of the pipe over the thread shall not be appreciably less than the outside diameter of the unthreaded pipe. For certain types of thread after the flange has been screwed hard home, the pipe shall be expanded into the flange.

![Figure 4 Types of pipe flanges](image)

**Table 9 Type of flange connections**

<table>
<thead>
<tr>
<th>Class of piping</th>
<th>Steam</th>
<th>Lubricating and fuel oil</th>
<th>Other media</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t [°C]</td>
<td>Typical flange application</td>
<td>t [°C]</td>
</tr>
<tr>
<td>I</td>
<td>&gt; 400</td>
<td>A (^1)</td>
<td>A - B</td>
</tr>
<tr>
<td></td>
<td>≤ 400</td>
<td>A - B (^1)</td>
<td>A - B</td>
</tr>
<tr>
<td>II</td>
<td>&gt; 250</td>
<td>A - B - C</td>
<td>A - B - C</td>
</tr>
<tr>
<td></td>
<td>≤ 250</td>
<td>A - B - C - D - E</td>
<td>A - B - C - D - E</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td>A - B - C - D - E</td>
<td>A - B - C - E</td>
</tr>
</tbody>
</table>

1) Type B for outer diameter < 150 mm only.

**5.2 Pipe couplings other than flanges**

**5.2.1** Mechanical joints including pipe unions, compression couplings, slip-on joints and similar joints shall be type approved for the service conditions and the intended application. Examples of mechanical joints are shown in **Table 10**.

**5.2.2** Slip-on joints shall not be used in pipelines in cargo holds, tanks, and other spaces which are not easily accessible. Application of these joints inside tanks may be permitted only for the same media that is in the tanks.
Mechanical joints, which in the event of damage could cause fire or flooding, shall not be used in piping sections directly connected to the ship's side below the bulkhead deck of passenger ships and freeboard deck of cargo ships or tanks containing flammable fluids.

The number of mechanical joints in flammable fluid systems shall be kept to a minimum. Flanged joints conforming to recognised standards shall be used.

5.2.3 Piping, in which a mechanical joint is fitted, shall be adequately adjusted, aligned and supported. Supports or hangers shall not be used to force alignment of piping at the point of connection.

5.2.4 The use of slip type slip-on joints as a means of pipe connection is not permitted except for cases where compensation of axial pipe deformation is necessary.

5.2.5 Application of mechanical joints and their acceptable use for each service is indicated in Table 11. Dependence upon the class of piping and pipe dimensions is indicated in Table 12.

5.2.6 Slip-on threaded joints having pipe threads where pressure-tight joints are made on the threads with parallel or tapered threads, shall comply with requirements of a recognized national or international standard.

Slip-on threaded joints may be used for outside diameters as stated below except for piping systems conveying toxic or flammable media or services where fatigue, severe erosion or crevice corrosion is expected to occur.

Threaded joints in CO₂ systems shall be allowed only inside protected spaces and in CO₂ cylinder rooms. Threaded joints for direct connectors of pipe lengths with tapered thread shall be allowed for:
- class I, outside diameter not more than 33.7 mm
- class II and class III, outside diameter not more than 60.3 mm.

Threaded joints with parallel thread shall be allowed for class III, outside diameter not more than 60.3 mm.

**Table 10 Examples of mechanical joints**

<table>
<thead>
<tr>
<th>Pipe unions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welded and brazed types</td>
</tr>
<tr>
<td>Compression coupling</td>
</tr>
<tr>
<td>Swage type</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Press type</td>
</tr>
<tr>
<td>Bite type</td>
</tr>
<tr>
<td>Flared type</td>
</tr>
<tr>
<td>Slip-on joints</td>
</tr>
<tr>
<td>Grip type</td>
</tr>
<tr>
<td>Machined grooved type</td>
</tr>
</tbody>
</table>
The following table indicates systems where the various kinds of joints may be accepted. However, in all cases, acceptance of the joint type shall be subject to approval for the intended application, and subject to conditions of the approval and applicable rules.

Table 11 Application of mechanical joints

<table>
<thead>
<tr>
<th>Systems</th>
<th>Kind of connections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pipe Unions</td>
</tr>
<tr>
<td>Flammable fluids (flash point ≤ 60°C)</td>
<td></td>
</tr>
<tr>
<td>1 Cargo oil lines&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>2 Crude oil washing lines&lt;sup&gt;4)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>3 Vent lines&lt;sup&gt;3)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>Inert gas</td>
<td></td>
</tr>
<tr>
<td>4 Water seal effluent lines</td>
<td>+</td>
</tr>
<tr>
<td>5 Scrubber effluent lines</td>
<td>+</td>
</tr>
<tr>
<td>6 Main lines&lt;sup&gt;2),4)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>7 Distributions lines&lt;sup&gt;4)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>Flammable fluids (flash point &gt; 60°C)</td>
<td></td>
</tr>
<tr>
<td>8 Cargo oil lines&lt;sup&gt;1)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>9 Fuel oil lines&lt;sup&gt;2),3)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>10 Lubricating oil lines&lt;sup&gt;2),3)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>11 Hydraulic oil&lt;sup&gt;2),3)&lt;/sup&gt;</td>
<td>+</td>
</tr>
<tr>
<td>Systems</td>
<td>Kind of connections</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>12 Thermal oil$^{2),3)}$</td>
<td></td>
</tr>
<tr>
<td>Sea water</td>
<td></td>
</tr>
<tr>
<td>13 Bilge lines$^1)$</td>
<td></td>
</tr>
<tr>
<td>14 Water filled fire</td>
<td></td>
</tr>
<tr>
<td>extinguishing systems, e.g.</td>
<td></td>
</tr>
<tr>
<td>sprinkler systems$^3)$</td>
<td></td>
</tr>
<tr>
<td>15 Non water filled fire</td>
<td></td>
</tr>
<tr>
<td>extinguishing systems, e.g.</td>
<td></td>
</tr>
<tr>
<td>foam, drencher systems$^3)$</td>
<td></td>
</tr>
<tr>
<td>16 Fire main (not</td>
<td></td>
</tr>
<tr>
<td>permanently filled)$^3)$</td>
<td></td>
</tr>
<tr>
<td>17 Ballast system$^1)$</td>
<td></td>
</tr>
<tr>
<td>18 Cooling water system$^1)$</td>
<td></td>
</tr>
<tr>
<td>19 Tank cleaning services</td>
<td></td>
</tr>
<tr>
<td>20 Non-essential systems</td>
<td></td>
</tr>
<tr>
<td>Fresh water</td>
<td></td>
</tr>
<tr>
<td>21 Cooling water system$^1)$</td>
<td></td>
</tr>
<tr>
<td>22 Condensate return$^1)$</td>
<td></td>
</tr>
<tr>
<td>23 Non-essential system</td>
<td></td>
</tr>
<tr>
<td>Sanitary/drains/scuppers</td>
<td></td>
</tr>
<tr>
<td>24 Deck drains (internal)$^5$</td>
<td></td>
</tr>
<tr>
<td>25 Sanitary drains</td>
<td></td>
</tr>
<tr>
<td>26 Scuppers and discharge</td>
<td></td>
</tr>
<tr>
<td>(overboard)</td>
<td></td>
</tr>
<tr>
<td>Sounding/vent</td>
<td></td>
</tr>
<tr>
<td>27 Water tanks/dry spaces</td>
<td></td>
</tr>
<tr>
<td>28 Oil tanks (f.p. &gt; 60°C)$^{2),3)}$</td>
<td>+</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td></td>
</tr>
<tr>
<td>29 Starting/control air$^1)$</td>
<td></td>
</tr>
<tr>
<td>30 Service air (non-essential)</td>
<td></td>
</tr>
<tr>
<td>31 Brine</td>
<td></td>
</tr>
<tr>
<td>32 CO$_2$ system$^1)$</td>
<td></td>
</tr>
<tr>
<td>33 Steam</td>
<td></td>
</tr>
</tbody>
</table>
### Abbreviations:

| + | application is allowed |
| - | application is not allowed |

### Footnotes - Fire resistance capability

If mechanical joints include any components which may readily deteriorate in case of fire, they are to be of an approved fire resistant type under consideration of the following footnotes:

1. Inside machinery spaces of category A - only approved fire resistant types.
2. Valid for slip-on joints only: Not inside machinery spaces of category A or accommodation spaces. May be accepted in other machinery spaces provided the joints are located in easily visible and accessible positions.
3. Approved fire resistant types except in cases where such mechanical joints are installed on exposed open decks, as defined in SOLAS II-2/Reg. 9.2.3.3.2.2(10) and not used for fuel oil lines.
4. Only in pump rooms and open decks - only approved fire resistant types.
5. Slip type slip-on joints as shown in Table 10 - Examples of mechanical joints. May be used for pipes on deck with a design pressure of 10 bar or less.
6. Only above bulkhead deck of passenger ships and freeboard deck of cargo ships.

### Table 12 Application of mechanical joints depending upon the class of piping

<table>
<thead>
<tr>
<th>Types of joints</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe unions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Welded and brazed type</td>
<td>+ (OD ≤ 60.3 mm)</td>
<td>+ (OD ≤ 60.3 mm)</td>
<td>+</td>
</tr>
<tr>
<td>Compression couplings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swage type</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Bite type</td>
<td>+ (OD ≤ 60.3 mm)</td>
<td>+ (OD ≤ 60.3 mm)</td>
<td>+</td>
</tr>
<tr>
<td>Flared type</td>
<td>+ (OD ≤ 60.3 mm)</td>
<td>+ (OD ≤ 60.3 mm)</td>
<td>+</td>
</tr>
<tr>
<td>Press type</td>
<td>-</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Slip-on joints</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Machine grooved type</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Grip type</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Slip type</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

### Abbreviations:

| + | application is allowed |
| - | application is not allowed |
5.3 Expansion bellows

5.3.1 The use of expansion bellows shall be restricted as far as practicable.

5.3.2 Expansion bellows are subject to approval for their intended use and shall be delivered with the Society's type approval certificate. The bellows shall be so designed and installed that pulling or blowing out is prevented.

The pipeline in which an expansion bellow shall be fitted, shall be adequately adjusted, aligned and clamped. When found necessary, protection against mechanical damage of the expansion bellows may be required.

Guidance note:
Design review of metallic expansion bellows may be carried out in accordance with the EJMA standard.

---e-n-d---o-f---g-u-i-d-a-n-c-e---n-o-t-e---

5.3.3 The positions of expansion bellows shall be clearly shown in the drawing of the piping systems.

6 Socket welded joints and slip-on sleeve welded joints

6.1 General

6.1.1 Socket welded joints and slip-on sleeve welded joints may be used for class I and II pipes with an outer diameter of 88.9 mm and less.

6.1.2 Socket welded joints and slip-on sleeve welded joints may be used for class III pipes.

6.1.3 Socket welded joints and slip-on sleeve welded joints shall not be used in overboard pipes where substantial thickness is required, see Pt.3 Ch.12 Sec.9.

6.1.4 Joint designs and socket dimensions in accordance with a recognised national standard may be accepted.

6.1.5 Socket welded joints and slip-on sleeve welded joints in stainless steel pipes shall be subject to the Society's consideration in each case.
1 Welding

1.1 General

1.1.1 The welding of joints shall be carried out by qualified welders using approved welding procedure specifications and type approved welding consumables, see Pt.2 Ch.4. Welding of joints belonging to class I and class II piping systems, requires approval based on a welding procedure qualification test (WPQT).

1.1.2 Oxy-acetylene welding shall not be used for steel pipes in class I and II with outer diameter greater than 101.6 mm or wall thickness exceeding 10 mm.

1.1.3 Welding of pipes of copper and copper-nickel may be carried out by gas tungsten arc welding (GTAW) and for greater wall thicknesses by gas metal arc welding (GMAW) or by other approved welding processes.

1.1.4 Welding of pipes of aluminium-brass is subject to special consideration and requires approval based on a WPQT. Testing shall be performed in accordance with Pt.2 Ch.4 and a recognised standard.

1.1.5 Welding of a material grade where the welding shops have limited experience, requires the welding procedures to be based on a WPQT.

1.2 Welded connections

1.2.1 Welded butt joints shall be of the full penetration type. For class I pipes special provisions shall be taken to ensure a high quality of the root side.

1.2.2 Branches shall be welded to the main pipe by means of full penetration welds. For reinforcement in way of branches, see Sec.9 [1].

1.2.3 Joint preparation and alignment shall be in accordance with a recognised standard.

1.2.4 If the parts to be joined differ in wall thickness, the thicker wall shall be gradually tapered to that of the thinner of the butt joint with a slope not steeper than 1 : 4.

1.2.5 Assembling for welding shall be appropriate and within prescribed tolerances. Tack welds shall be made with welding consumables suitable for the base material. Tack welds that form part of the finished weld shall be made using approved welding procedure specifications. When welding materials require preheating, the same preheating shall be applied during tack welding.

1.2.6 For pipe-flange connections, see Sec.9 [5].

1.3 Preheating of steel pipes

1.3.1 Preheating of the different types of steel shall be dependent upon their thickness and chemical composition as indicated in Table 1. In any case, dryness shall be ensured using, if necessary, suitable preheating.

1.3.2 The values in Table 1 are based on use of low hydrogen processes; consideration should be given to using higher preheating temperatures when low hydrogen processes are not used.
Table 1 Preheating prior to welding of steel pipes

<table>
<thead>
<tr>
<th>Type of steel</th>
<th>Thickness of thicker part (mm)</th>
<th>Minimum preheating temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C and C/Mn Steel, $C + \frac{Mn}{6} \leq 0.40$</td>
<td>$\geq 20$ ²)</td>
<td>50</td>
</tr>
<tr>
<td>C and C/Mn Steel, $C + \frac{Mn}{6} &gt; 0.40$</td>
<td>$\geq 20$ ²)</td>
<td>100</td>
</tr>
<tr>
<td>0.3Mo</td>
<td>$&gt; 13$ ²)</td>
<td>100</td>
</tr>
<tr>
<td>1Cr 0.5Mo</td>
<td>$&lt; 13$ $\geq 13$</td>
<td>100 150</td>
</tr>
<tr>
<td>2.25Cr 1Mo and 0.5Cr 0.5Mo 0.25V ¹)</td>
<td>$&lt; 13$ $\geq 13$</td>
<td>150 200</td>
</tr>
</tbody>
</table>

1) For these materials, preheating may be omitted for thicknesses up to 6 mm if the results of hardness tests carried out during the welding procedure qualification test are considered acceptable.
2) For welding in ambient temperature below 0°C, the minimum preheating temperature is required independent of the thickness unless specially approved by the Society.

1.3.3 Austenitic stainless steel shall not be preheated.

1.3.4 Preheating shall be applied in accordance with agreed procedures. Special attention shall be paid to temperature control during the welding process such that the preheat temperature is kept uniformly in affected part of the welded object.

1.4 Heat treatment after welding of steel pipes

1.4.1 The heat treatments shall not impair the specified properties of the material. The heat treatments are preferably to be carried out in suitable furnaces provided with temperature recording equipment. However, also localised heat treatments on a sufficient portion of the length in way of the welded joint, carried out with approved procedures, can be accepted. The width of the heated circumferential band shall be at least 75 mm on both sides of the weld.

1.4.2 For austenitic stainless steel heat treatment after welding may not be required.

1.4.3 For other alloy steel grades the necessary heat treatment after welding shall be considered in each case.

1.4.4 Stress relieving heat treatment after welding is required as indicated in Table 2 depending on the type of steel and thickness. For oxy-acetylene welding the heat treatment given in Table 3 is required unless otherwise specified.

The stress relieving heat treatment shall consist of heating the piping slowly and uniformly to a temperature within the given range, soaking at this temperature for a suitable period, one hour per 25 mm of thickness with minimum half an hour, cooling slowly and uniformly in the furnace to a temperature not exceeding 400°C and subsequently cooling in still air.

For quenched and tempered steel, the heat treatment temperature shall not be higher than $t_T -20°C$ where $t_T$ is the temperature of the final tempering treatment of the material.
Table 2 Stress relieving heat treatment after forming and welding

<table>
<thead>
<tr>
<th>Type of steel</th>
<th>Thickness of thicker part (mm)</th>
<th>Stress relief heat treatment temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C and C/Mn Steel</td>
<td>≥ 15</td>
<td>550 to 620</td>
</tr>
<tr>
<td>0.3Mo</td>
<td>≥ 15</td>
<td>580 to 640</td>
</tr>
<tr>
<td>1Cr 0.5Mo</td>
<td>&gt; 8</td>
<td>620 to 680</td>
</tr>
<tr>
<td>2.25Cr 1Mo and 0.5Cr 0.5Mo 0.25V</td>
<td>any</td>
<td>650 to 720</td>
</tr>
</tbody>
</table>

1) When steel with specified Charpy V-notch impact properties at low temperature is used, the thickness above which post-weld heat treatment shall be applied may be increased by special agreement.
2) Heat treatment may be omitted for pipes having thickness ≤ 8 mm, diameter ≤ 100 mm and minimum service temperature above 450°C.
3) For C and C-Mn steel, stress relieving heat treatment may be omitted up to 30 mm thickness by special agreement.

Table 3 Full heat treatment after forming and welding

<table>
<thead>
<tr>
<th>Type of steel</th>
<th>Heat treatment and temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C and C/Mn Steel</td>
<td>Normalising 880 to 940</td>
</tr>
<tr>
<td>0.3Mo</td>
<td>Normalising 900 to 940</td>
</tr>
<tr>
<td>1Cr 0.5Mo</td>
<td>Normalising 900 to 960</td>
</tr>
<tr>
<td></td>
<td>Tempering 640 to 720</td>
</tr>
<tr>
<td>2.25Cr 1Mo</td>
<td>Normalising 900 to 960</td>
</tr>
<tr>
<td></td>
<td>Tempering 650 to 780</td>
</tr>
<tr>
<td>0.5Cr 0.5Mo 0.25V</td>
<td>Normalising 930 to 980</td>
</tr>
<tr>
<td></td>
<td>Tempering 670 to 720</td>
</tr>
</tbody>
</table>

1.5 Non-destructive testing

1.5.1 The welded joints including the inside wherever possible shall be visually examined. Non-destructive tests may be required depending on the class of pipes and type of joints as hereunder indicated:

**Butt welded joints:**
- for class I pipes with an outer diameter greater than 75 mm, 100% radiographic testing (RT) is required
- for class II pipes with an outer diameter greater than 100 mm and for class I pipes with an outer diameter ≤ 75 mm, at least 10% random radiographic testing is required. More stringent requirements may be applied at the surveyors discretion depending on the kind of materials, welding procedure and controls during the fabrication.

**Fillet welds:**
- for fillet welds of flange type connections in class I pipes with an outer diameter greater than 75 mm, 100% magnetic particle testing (MT) is required
- for class II pipes with an outer diameter greater than 100 mm and for class I pipes with an outer diameter ≤ 75 mm, 10% random magnetic particle testing at the discretion of the surveyor is required.

In addition welded joints in pipes for thermal oil shall be subject to at least 10% random radiographic testing.
1.5.2 Heating coils in cargo tanks shall be subject to NDT in accordance with Table 4.

Table 4 Non-destructive testing of heating coils

<table>
<thead>
<tr>
<th>Material in coils</th>
<th>Joint types</th>
<th>Erection welds</th>
<th>Shop welds</th>
<th>Erection joints</th>
<th>Shop welded or brazed joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt welds 1)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleeve or lap type welded or brazed joints</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild steel</td>
<td>10%</td>
<td>5%</td>
<td>10%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Stainless steel</td>
<td>10%</td>
<td>5%</td>
<td>5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cu-Ni or Al-brass</td>
<td>10%</td>
<td>5%</td>
<td>Spot-check NDT. Steam testing onboard 2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1) If automatic welding is used, the percentage may be reduced at the surveyors discretion.
2) Experience shows that pressure tests do not always reveal leaks in joints because a capillary gap can be temporarily sealed by flux residues. A recommended part of the procedure for testing a heating coil system should therefore be to apply a steam test, which shall dissolve flux residues and reveal leaks.

1.5.3 An approved ultrasonic testing (UT) procedure may be accepted, at the discretion of the Society, in lieu of radiographic testing when the conditions are such that a comparable level of weld quality is assured. For non-magnetic materials dye-penetrant testing (PT) shall be used in lieu of magnetic particle examination.

1.5.4 Non-destructive testing shall be performed by operators certified in accordance with a recognised scheme, using suitable equipment and procedures. The radiographs shall be marked in such a way that their position on the pipe line may easily be located.

1.5.5 The radiographs shall be judged according to ISO 5817 *Arc-welded joints in steel - Guidance on quality levels for imperfections*, and are at least to meet the requirements for quality level B for welds in class I piping and for quality level C otherwise.

The results from surface examination (e.g. MT, PT) shall satisfy the requirements of level B of ISO 5817.

1.5.6 If a non-conforming discontinuity is detected, the lengths welded immediately before and after the section containing the discontinuity shall be examined by the same method. If systematically repeated discontinuities are revealed, the extent of testing shall be increased for welds manufactured under same conditions and where similar defects may be expected.

1.5.7 If non-conforming discontinuities are found to occur regularly, the welding procedures shall be reassessed before continuation of the welding, and necessary actions shall be taken to bring the production to the required quality level.

Detected non-conforming discontinuities shall be repaired unless they are found acceptable by the Society. Removal of weld discontinuities and repair shall be performed in accordance with a procedure approved by the Society.

1.5.8 After repair welding has been performed, the complete weld shall be subjected to at least to the same NDT method(s) as specified for the original weld.
2 Brazing of copper and copper alloys

2.1 General

2.1.1 The clearance between surfaces to be brazed shall be as recommended for the selected type of filler material, to ensure complete capillary distribution of the filler material. For lap joints, the lap length shall be 3 to 5 times the wall thickness of the pipes to be joined.

2.1.2 Filler materials to be used in contact with sulphur-containing oil at an operating temperature above 100°C and maximum 200°C (such as heating coil systems) shall be of type BAg in accordance with AWS 5.8, or equivalent. Only filler materials where sufficient corrosion resistance can be documented from either relevant service experience or testing, shall be used.

2.1.3 The brazing shall be carried out by qualified brazers using approved brazing procedures (e.g. ASME IX). The filler material shall have a melting point above 450°C. Brazing of copper alloys containing aluminium (Al-bronze and Al-brass) require use of a flux type FB4-A according to AWS 5.31 or equivalent.

3 Pipe bending

3.1 General

3.1.1 The bending procedure shall be such that the flattening of the pipe cross-section is as small as possible.

Guidance note:
For class I and II pipes the out-of-roundness, should preferably not exceed 7% where is defined by:

\[
\eta = \frac{D_{\text{max}} - D_{\text{min}}}{D_{\text{max}} + D_{\text{min}}} \times 100 \%
\]

where:
- \( D \) = outer pipe diameter.

3.1.2 Pipe bends in class I and II pipes shall be free from wrinkles on the inner side of the bend.

3.1.3 Copper alloy pipes in seawater systems are as far as possible to be free from wrinkles.

3.1.4 For tolerances in wall thickness and allowance for bending, see Sec.9 [1.3.5] and Sec.9 [1.3.10].

3.2 Heat treatment after bending

3.2.1 Hot forming shall be carried out in the temperature range 850°C to 1000°C for all grades. However, the temperature may decrease to 750°C during the forming process. When the hot forming is carried out within this temperature range, the following requirements apply:

- for C, C-Mn and C-Mo steel, no subsequent stress relieving heat treatment is required
- for Cr-Mo and Cr-Mo-V steel, a subsequent stress relieving heat treatment in accordance with Table 2 is required
- for other alloy steel heat treatment after bending shall be considered in each case.
When the hot forming is carried out outside the above temperature range, a subsequent new heat treatment in accordance with Table 3 may be required for all grades.

Hot forming of austenitic stainless steel shall be carried out in the temperature range 850 to 1150°C.

3.2.2 All grades of pipes may be cold formed when \( r > 4D \) (where \( r \) is the mean bending radius and \( D \) is the outside diameter of pipe). For \( r \leq 4D \) a stress relieving heat treatment in accordance with Table 2 is required for all grades other than C and C/Mn with specified minimum tensile strength \( \leq 410 \text{ N/mm}^2 \) and not used for low temperature service or sour service. In order to accept cold forming of pipes when \( r \leq 4D \), documentation of the properties after bending is required. Cold forming of austenitic and ferritic/austenitic (duplex) stainless steels may be performed when \( r \geq 2.5D \) provided that the properties are documented after bending.

3.2.3 Aluminium-brass pipes shall be stress-relieved or soft annealed at a temperature of 350 to 400°C or 600 to 650°C respectively, after cold working.

3.2.4 Normalising shall be performed in a furnace. Stress-relieving may be performed locally covering the deformed zone. Method of heat-treatment and temperature control shall be according to [1.4.1].

4 Joining of plastic pipes

4.1 General

4.1.1 Joining or bonding of plastic pipes by welding, gluing, lamination or similar method:
— shall be carried out in accordance with the pipe manufacturer's installation guidelines
— shall be carried out by qualified personnel certified by the manufacturer.

4.1.2 Each joining or bonding procedure shall be qualified before the installation commences.

4.1.3 Joining or bonding operator's (installer's) certificate shall contain:
— the name of the holder
— the type of joining the holder is qualified for
— reference to joining or installation procedure (procedure date of issue to be stated)
— date of issue and validity period for certificate
— pipe manufacturer's stamp and signature.

In addition to being certified, each joining or bonding operator shall make a test assembly consisting of one pipe-to-pipe joint and one pipe-to-fitting joint in accordance with joining or bonding procedure qualified according to [4.1.4] to [4.1.5]. The test procedure and acceptance criterion shall be as described in [4.1.4] to [4.1.5].

4.1.4 Procedure qualification testing

Each joining or bonding operator shall make a test assembly fabricated in accordance with the joining or bonding procedure to be qualified, consisting of at least:
— one pipe-to-pipe joint
— one pipe-to-fitting joint.

After curing, the assembly shall be subjected to a hydrostatic test pressure at a safety factor of min. 2.5 times the nominal pressure rating (pressure class) of the piping system. The test duration shall be no less than 1 hour. Acceptance criterion: No leakage or separation of joints.
4.1.5 Pipe size for procedure qualification test assembly shall be:

   a) When the largest size to be joined is \( \leq 200 \) mm nominal outside diameter, the test assembly shall be the largest piping size to be joined.

   b) When the largest size to be joined is \( > 200 \) mm, the size of the test assembly shall be either 200 mm or 25\% of the largest piping size to be joined, whichever is greater.

4.1.6 The joining or bonding procedure shall include:

   - materials and suppliers
   - tools and equipment
   - environmental requirements
   - joint preparation including surface treatment and cleanliness
   - dimensional requirements and tolerances
   - curing time and temperature
   - tests and examinations with acceptance criteria.

4.1.7 Any change in the joining or bonding procedure which may affect the physical or mechanical properties of the joint or bond shall imply re-qualification of the procedure.

4.1.8 The pipe manufacturer shall maintain a record of earlier certifications of procedures and operators.

4.1.9 Electrical conductivity

   Piping systems in or through gas hazardous areas shall be electrically conductive according to Sec.9 \[1.7.8\]. After installation, the conductivity of the piping system shall be measured, and the resistance to earth from any point in the piping system shall not exceed \( 10^6 \) ohm.

5 Hydrostatic tests of piping

5.1 Hydrostatic testing before installation on board

5.1.1 All class I and II pipes and integral fittings, after completion of manufacture but before insulation and coating, if any, shall be subjected to a hydrostatic test in the presence of the surveyor at the following pressure:

\[
P_H = 1.5p
\]

where:

\( P_H \) = test pressure in bar
\( p \) = design pressure in bar as defined in Sec.9 \[1.3.3\].

For steel pipes and integral fittings for design temperatures above 300\(^\circ\)C the test pressure shall be determined by the following formula but need not exceed \( 2p \):

\[
P_H = 1.5 \frac{\sigma_{t100}}{\sigma_t} p
\]

where:

\( \sigma_{t100} \) = permissible stress at 100\(^\circ\)C
\( \sigma_t \) = permissible stress at the design temperature.
The value of the test pressure may be reduced with the approval of the surveyor, to 1.5 $p$ in order to avoid excessive stress in way of bends, branches, etc.

In any case the membrane stress shall not exceed 0.9 the yield stress at the testing temperature.

5.1.2 Pressure testing of small bore pipes (less than about 15 mm) may be waived at the discretion of the surveyor, depending on the application.

5.1.3 Non-integral fittings and pressure containing components other than valves, pump housing and pressure vessels shall be tested as specified in [5.1.1]. The requirements for hydrostatic testing of valves and pumps are given in Sec.9 [2] and Sec.9 [3].

5.2 Hydrostatic testing after assembly on board

5.2.1 The piping shall be hydrostatically tested in the presence of the surveyor after installation on board, according to Table 5.

Table 5 Hydrostatic testing after installation on board

<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></td>
</tr>
<tr>
<td>Bilge and fire pipes</td>
<td></td>
</tr>
<tr>
<td>Class III pipelines for steam,</td>
<td>1.5 $\times$ design pressure, minimum 4 bar</td>
</tr>
<tr>
<td>compressed air and feed water</td>
<td></td>
</tr>
<tr>
<td>Treatment fluid pipes for exhaust gas</td>
<td></td>
</tr>
<tr>
<td>cleaning systems</td>
<td></td>
</tr>
<tr>
<td>Hydraulic piping</td>
<td>1.5 $\times$ design pressure.</td>
</tr>
<tr>
<td></td>
<td>The test pressure need not exceed the design pressure by more than 70 bar</td>
</tr>
<tr>
<td>Piping systems made from non-metallic</td>
<td>1.5 $\times$ design pressure. Minimum 4 bar. Minimum duration 1 hour</td>
</tr>
<tr>
<td>material (plastic)</td>
<td></td>
</tr>
<tr>
<td>Refrigeration piping 1)</td>
<td>1.5 $\times$ design pressure</td>
</tr>
</tbody>
</table>

1) Hydraulic pressure tests may be carried out with any liquid, including water, unless it has an unfavourable effect on the refrigerant. Pneumatic pressure tests may be carried out with nitrogen, CO$_2$ or air.

5.2.2 Pressure testing of small bore pipes (less than about 15 mm) may be waived at the discretion of the surveyor, depending on the application.

5.2.3 If pipes specified in [5.1.1], are being welded together during assembly on board, they shall be hydraulically tested as specified in [5.1.1] after welding. If a 100% radiographic examination and heat treatment after welding is carried out, the surveyor may refrain from the hydraulic test.

5.2.4 Separate pipe lengths, which have been hydraulically tested in the workshop, may be insulated before the hydrostatic test is carried out, except for connections between the pipe lengths.
6 Functional testing

6.1 General

6.1.1 All piping systems shall be properly flushed, checked for leakage and functionally tested under working conditions to the satisfaction of the surveyor.

6.1.2 For refrigeration systems the safety instrumentation, including automatic stop functions, refrigerant leakage detection systems, emergency stops, alarm call buttons etc. shall be tested.
# CHANGES – HISTORIC

## January 2018 edition

### Changes January 2018, entering into force 1 July 2018

<table>
<thead>
<tr>
<th>Topic</th>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Update of Documentation requirements</td>
<td>Sec.1 Table 2</td>
<td>Documentation requirement for control and monitoring of ventilation systems for spaces containing ozon piping has been removed.</td>
</tr>
<tr>
<td>Plastic pipes</td>
<td>Sec.2 [1.7.1]</td>
<td>The requirements for the piping are in conformance with IMO Resolution A.753(18), except for the requirements for smoke generation and toxicity.</td>
</tr>
<tr>
<td>Drainage of drip trays to closed tank</td>
<td>Sec.5 [1.2.3]</td>
<td>The following text is added to the paragraph: For drip trays intended for small leakages and located far away from the nearest drain tank, other solutions may be considered.</td>
</tr>
<tr>
<td>Requirements for fuel and lubrication oil filters</td>
<td>Sec.5 [1.3.1]</td>
<td>It is specified in the paragraph that the lubrication oil supply shall be ensured to main and auxiliary engines, and any other machinery used for main functions.</td>
</tr>
<tr>
<td>Alignment with IACS UR M10</td>
<td>Sec.5 [3.1.3]</td>
<td>Added requirement covering that drain pipes from the engine sump to the drain tank shall be submerged at their outlet ends.</td>
</tr>
<tr>
<td>Pre-heaters in the fuel oil service system</td>
<td>Sec.5 [4.8.1]</td>
<td>The term &quot;end preheater&quot; has been removed and replaced by &quot;pre-heaters in the fuel oil service system&quot;. It has been made clear that the requirement is applicable only when pre-heating of the fuel is required.</td>
</tr>
<tr>
<td>Use of bellows and flanges in thermal oil systems</td>
<td>Sec.5 [5.1.4]</td>
<td>Bellows or similar expansion elements in thermal-oil piping within machinery spaces shall be installed with proper protection in case of bellow rupture or leakages, and is only permitted on the suction side of pumps.</td>
</tr>
<tr>
<td>Require additional valve in heating coils for tanks containing oil residues or fuel</td>
<td>Sec.5 [7.3.3]</td>
<td>It is specified in the existing rule text that shut-off valves shall be provided at the inlet and outlet of the tank. Testing device is only required at the outlet, as was required before the update.</td>
</tr>
<tr>
<td>Opening for use of R744 refrigeration systems where decks and bulkheads surrounding the refrigeration machinery space is not steel</td>
<td>Sec.6 [4.1.3]</td>
<td>Guidance note has been added: In case of R744, refrigerating machinery rooms surrounded by decks and bulkheads constructed of other materials than steel may be accepted upon special considerations.</td>
</tr>
<tr>
<td>Hazardous zones around ventilation for refrigeration machinery rooms for ammonia systems</td>
<td>Sec.6 [4.1.4]</td>
<td>Areas on open deck within a distance of 1 m from inlet ventilation openings and within a distance of 3 m from outlet ventilation openings of refrigeration machinery rooms with R717 (ammonia) shall be classified as hazardous zone 2.</td>
</tr>
<tr>
<td>Allow CO₂ systems with more than 25 kg filling</td>
<td>Sec.6 [4.1.5]</td>
<td>R744 systems may be accepted with more than 25 kg filling if it can be proven that leakage of the complete refrigerant charge from the system will not result in oxygen concentration below 19% by volume.</td>
</tr>
<tr>
<td>Use of flexible hoses in gas fuelled systems</td>
<td>Sec.9 [4.1.2]</td>
<td>For double walled hoses in gas fuel systems where secondary enclosure is required, the double barrier shall be maintained in the hose coupling, e.g. by the use of two o-rings.</td>
</tr>
</tbody>
</table>
### Changes July 2017, entering into force 1 January 2018

<table>
<thead>
<tr>
<th>Topic</th>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implementation of IACS UR M77 - Storage and use of SCR reductants.</td>
<td>Sec.8 [2.2.1]</td>
<td>Moved requirement to Sec.8 [2.4.3]</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.1]</td>
<td>Editorial change</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.2]</td>
<td>Per UR M77, current drafted amendment.</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.3]</td>
<td>Pipe material requirement moved from Sec.8 [2.2.1] and modified per current drafted amendment to M77</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.4]</td>
<td>Clarification of what “safe location” means (required by M77)</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.5]</td>
<td>Per UR M77</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.6]</td>
<td>Added ref. to UR M77</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.7]</td>
<td>Added ref. to UR M77</td>
</tr>
<tr>
<td></td>
<td>Sec.8 [2.4.8]</td>
<td>Per UR M77, lubricating oil is not required by UR</td>
</tr>
<tr>
<td></td>
<td>Sec.8 Table 2</td>
<td>Per UR M77, tank temperature monitoring always required</td>
</tr>
<tr>
<td>Backflow detection in drain pots - Inline scrubbers</td>
<td>Sec.8 [3.4.12]</td>
<td>Added requirement for backflow detection in exhaust drain pots for inline scrubber systems. This will detect backflow to fuel oil combustion units in case of structural failure or design failure in scrubber unit allowing backflow of water without water build up in the scrubber unit. This has occurred in one instance and is identified as a potential future issue.</td>
</tr>
<tr>
<td>Alternative to using dampers in FO systems introduced</td>
<td>Sec.5 [4.10.5]</td>
<td>Add guidance note: <em>Dampers may be dispensed with if adequate damping is confirmed by the engine manufacturer or engine licensor.</em></td>
</tr>
<tr>
<td>Test procedures for non-metallic pipes aligned with revised IMO Resolution A.753(18)</td>
<td>Sec.2 [1.7.1]</td>
<td>New test procedures for non-metallic piping in IMO Resolution A.753(18) reflected in the rules. More lenient acceptance criteria for certain systems have been introduced. The references to IMO resolutions and applicability of which pipes to be exempted from fire test have also been updated. Update the rule text as follows: Plastic pipes used in systems and location according to Table 1 shall meet the fire endurance requirements specified therein. The permitted use and the requirements for the piping are in conformance with IMO Resolution A.753(18) <em>Guidelines for the Application of Plastic Pipes on Ships</em> except for the requirements for smoke generation and toxicity. All pipes, except those fitted on open decks and within tanks, cofferdams, void spaces, pipe tunnels and ducts, if separated from accommodation, permanent manned areas and escape ways by means of an A class bulkhead, shall have low flame spread characteristics not exceeding average values listed in IMO Resolution A.653(16)A753(18) Appendix 3. Surface flame spread characteristics may also be determined using the test procedures given in ASTM D635, or in other national equivalent standards.</td>
</tr>
</tbody>
</table>
### January 2017 edition

**Main changes January 2017, entering into force 1 July 2017**

- **General**
  - All remaining redundancy requirements removed (e.g. filters to be redundant or fitted with bypass, minimum two sea chests required for scrubber systems) as exhaust gas cleaning is not considered an essential function
  - Redundancy requirements for EGC systems have been removed (filters no longer to be redundant or fitted with bypass, single sea chest now allowed for scrubber systems).
  - Aqueous and anhydrous ammonia generally not allowed as reductant in NOx SCR systems.

- **Sec.1 General**
  - Docreq item for NOx systems requiring measurement report has been removed as the requirement is obsolete. Sec.1 [3.1.1] Table 4 has been deleted.

- **Sec.8 Pollution prevention**
— Sec.8 [2.4] and Table 2: Added specific section for urea based NOx reduction systems, incorporating relevant requirements from fuel oil system requirements, in line with IACS UR for ammonia storage and handling, coming into force in January 2018. Other treatment fluids are still covered by the old rules. This replaces the previous method of cross-referencing the fuel requirements, regarding pipe class, arrangements, testing, material selection, etc.
— Sec.8 [3.2]: Added new requirements for inline exhaust gas cleaning systems, should have been added when these were first introduced in 2014
— Sec.8 [3.6] and Table 3: Added specific section for NaOH based treatment fluid systems for SOx cleaning systems, incorporating the relevant requirements from fuel oil system requirements and thus replacing the old general reference to these rules. Other treatment fluids are still covered by the old rules.
— Sec.8 [3.6]: Added specific section for NaOH based systems incorporating relevant requirements from fuel oil system requirements
— Sec.8 [3.6.12]: New requirement for portable storage tanks for NaOH handling and storage.
— Sec.8 [3.2.8], Sec.8 [3.4.12] and Sec.8 [3.9.6]: New requirements for inline exhaust gas cleaning systems, taking into account increased risk of backflow and consequences of structural failures in scrubber unit. The requirements cover the design of the scrubber unit, the drainage arrangements and additional control and monitoring scope.
— Minor clarifications and changes to exhaust gas cleaning system rules in Sec.8 [2.2.1, 2.2.3, 2.3.1, 2.4.10, 2.4.12, Table 2, 3.2.3, 3.3.1, 3.3.8, 3.3.9, 3.4.10, 3.4.11 and Table 3] and Sec.10 [5.2.1].
— Sec.8 [3.10.2]: Clarified required content in test procedure for quay and sea trial for SOx cleaning systems.

• Sec.10 Manufacture, workmanship, inspection and testing
  — Minor clarifications and changes to exhaust gas cleaning system rules in Sec.10 [5.2.1].

**July 2016 edition**

**Main changes July 2016, entering into force 1 January 2017**

• Sec.1 General requirements
  — Sec.1 Table 5: A requirement for product certification of the safety and monitoring system for refrigeration systems has been included.

• Sec.4 Ship piping systems
  — Sec.4 [11.3.1]: The rule text has been revised to clarify that the subsequent rules are applicable only if an overflow system is fitted.

• Sec.5 Machinery piping systems
  — Sec.5 [1.1.3]: Paragraph regarding general redundancy type requirement has been removed, as the general redundancy requirements are covered in Pt.4 Ch.1 Sec.3.

• Sec.6 Refrigeration systems
  — Sec.6 [3.1]: A sentence has been included requiring that group 2 refrigerants shall not be used in air conditioning systems with direct expansion.
  — Sec.6 [7.1.6]: A guidance note has been included.
• Sec.9 Pipes, pumps, valves, flexible hoses and detachable pipe connections etc.
  — Sec.9 Figure 5 and Sec.9 Table 10 have been moved to [5.1] Flange connections.
  — Sec.9 Table 11, Sec.9 Table 12 and Sec.9 Table 13 have been moved to [5.2] Pipe couplings other than flanges.
  — Sec.9 [4.1.2]: Refrigeration systems have been added to the list of systems in which flexible hoses may be accepted
  — Sec.9 [4.1.3]: Rule text revised to align with IACS UR P2.12 Rev.2.
  — Sec.9 [5.2]: Sub-section revised to align with IACS UR P2.7.4 Rev.8.

**October 2015 edition**

This is a new document.
The rules enter into force 1 January 2016.

**Amendments January 2016**

• Sec.1 General requirements
  — Table 2: Documentation requirements for control and monitoring of valves and pumps have been included.
About DNV GL

DNV GL is a global quality assurance and risk management company. Driven by our purpose of safeguarding life, property and the environment, we enable our customers to advance the safety and sustainability of their business. We provide classification, technical assurance, software and independent expert advisory services to the maritime, oil & gas, power and renewables industries. We also provide certification, supply chain and data management services to customers across a wide range of industries. Operating in more than 100 countries, our experts are dedicated to helping customers make the world safer, smarter and greener.